2012

Oysters and catfish: resource exploitation at Rollins Shell Ring, Ft. George Island, Florida

Julie Ann Doucet
Louisiana State University and Agricultural and Mechanical College, jdouce6@lsu.edu

OYSTERS AND CATFISH: RESOURCE EXPLOITATION AT ROLLINS SHELL RING, FT. GEORGE ISLAND, FLORIDA

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Arts

in

The Department of Geography and Anthropology

by:
Julie Ann Doucet
B.A., Louisiana State University, 1994
May 2012

ACKNOWLEDGEMENTS

I am very grateful to the National Science Foundation Graduate Fellowship program; the support they provided allowed me to focus on my graduate research full time. I would like to acknowledge my thesis committee members, Drs. Rebecca Saunders, David Chicoine and Kristine DeLong from the Department of Geography and Anthropology, and Dr. John Lynn from the Department of Biological Sciences. Dr. Rebecca Saunders has shown infinite patience with my schedule over the many years of our acquaintance, and was always willing to accommodate my passion for archaeology. She served not only as the chair of my thesis committee, but as a friend. Dr. John Lynn was very supportive of my desire to continue with graduate school full time, even as it meant replacing me as his research associate. I have certainly benefited from his input as a member of my committee and value the experience I gained working with him on 'live' oysters. His expertise and guidance with microscopy and Adobe Photoshop™ were invaluable in producing the otolith images in this thesis. Dr. David Chicoine has provided me with many lively conversations about cultural theory and my first international field school experience; I will always remember my time in Peru with great fondness. Dr. Kristine DeLong offered the resources of her Paleoclimate and Archaeology laboratory, as well as her expertise during the otolith sectioning. She was invaluable in deciphering the hieroglyphs, also known as experimental statistics.

I owe many thanks to Dr. William Kelso and Ms. Melissa Fries for their support and guidance in analyzing the marine catfish otoliths. They saved me valuable time and effort in assessing age and season of harvest, and demonstrated a user-friendly technique for my analysis. Dr. James Geaghan, Professor and Chair of the Department of Experimental Statistics, is largely responsible for guiding the statistical analyses in this project. His patience and knowledge of not only statistics but ecology and biology were the perfect combination to understand what was happening with oysters and marine catfish at this site. Suping Zhang, graduate assistant in Experimental Statistics, offered invaluable support in writing the programming language for SAS.

My success in completing of this degree would not have been possible without the love and support of my family, immediate as well as extended. While I do not have the space to thank them all, I would like to acknowledge that their love and faith helped me carry on. Michele has been my best friend and faithful advocate for many years, and a mother could not ask for a better daughter. And to Gregg, I don't know how I could have finally accomplished this long-held dream were it not for his love and support. He sacrificed what no other would so I could attain this very personal goal. There are few words to convey my love and appreciation for his place in my life.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Detailed faunal analyses were conducted on two major subsistence resources, oysters and marine catfish, at Rollins Shell Ring, a Late Archaic (5000 – 3000 B.P.) site on the northeast coast of Florida. The focus of this investigation was on resource exploitation, and, specifically, whether there was evidence that oysters from this site were over-exploited. Three units from previous excavations at the site were selected for analysis, and represent the span of occupation recorded for this site. Measurements were obtained from oysters to determine habitat, and, along with shell height, were compared across time for any changes in the pattern of exploitation that would indicate over-exploitation. Marine catfish otoliths were used to provide seasonal data for oyster harvesting, as well as information on fish ages and harvesting of this resource.

My analysis revealed that the majority of oysters used in the construction of the main shell ring, ringlets, and other structures at this site were harvested from the same habitat. While there were differences in oyster habitat exploitation and shell height between samples, the difference was attributed to the variability of oyster habitats exploited and shell height in the earliest sample of the analysis, Test Unit 10, and in the latest sample, Test Unit 2; there was less variability noted in oyster habitat and shell height for the middle activity period recorded at the site, Test Unit 12c. Further results indicated a seasonal preference for exploitation of both oyster and marine catfish in warm water temperatures, and that oyster resources did not appear to be under stress during the period of activity recorded for the site. These data suggest that it is unlikely that over-exploitation of oysters played a role in permanent site abandonment.

CHAPTER 1 INTRODUCTION

Research into Late Archaic (5000 – 3000 B.P.) shell rings of the Southeastern U.S. coast has experienced an upsurge in the last decade; of particular interest are questions about their construction and use, and why these sites were all abandoned by about 3500 B.P. The issues of Late Archaic shell ring construction and abandonment are tied to discussions of cultural complexity; specifically, what type of society built such architecture, and how did it organize labor to carry out the task. Related topics focus on how social complexity arises, and why, in some cases (e.g., Southeastern shell rings), it was not maintained. Following the abandonment of these coastal sites, there is little evidence of the large social nucleation and monumental architecture exemplified by shell rings for over 1000 years (Thomas and Sanger 2010).

As with any seemingly dramatic change in prehistoric human population or migration, there is speculation that over-exploitation of the natural resources may have had an influence (e.g., Mannino and Thomas 2002; Dame 2009). This is especially true in the case of Southeastern shell rings, when confronted with their numbers, massive size, relatively brief period of occupation (recorded for some sites), and the permanent abandonment of these sites.

In this thesis, I address natural resource exploitation at Rollins Shell Ring, a Late Archaic site on the northeast coast of Florida (Figure 1). My research will focus particularly on the issue of oyster exploitation at Rollins Shell Ring, and whether there is evidence of over-exploitation of this resource.

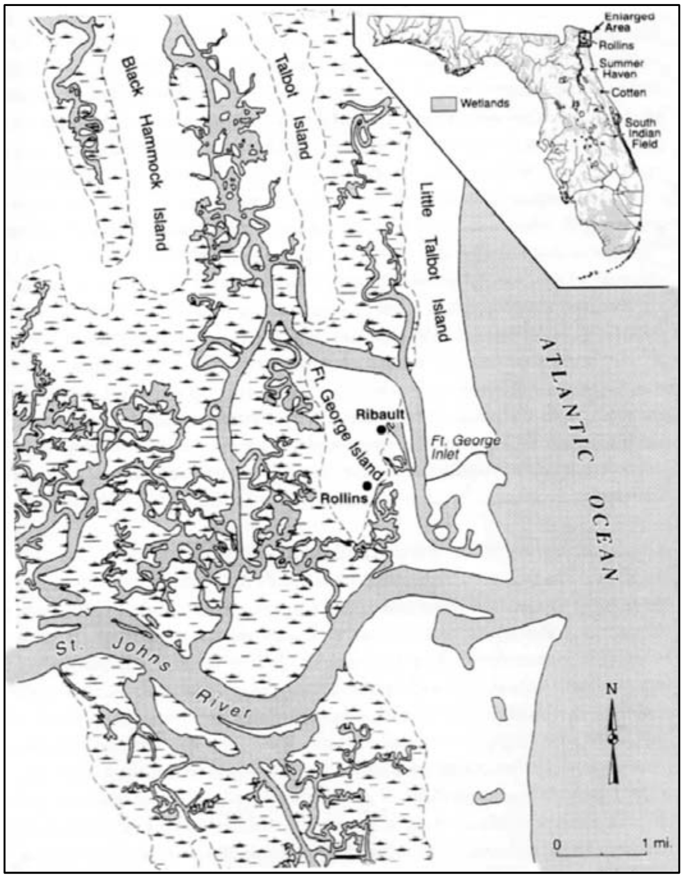


Figure 1. Location of Rollins Shell Ring, 8DU7510, and an associated habitation site, Ribault, 8DU76 (taken from Saunders 2004b).

I would like to offer clarification regarding radiocarbon dates discussed in this thesis, and use Thomas and Sanger (2010:18) as my guide. Following the standards established by the journal *Radiocarbon* (August 2005, and updated August 2006), “B.P.” is understood to mean “conventional radiocarbon years before A.D. 1950.” Uncalibrated radiocarbon dates are presented as *3470 ± 80 B.P.*, where 3470 is the age in radiocarbon years before 1950, and 80 is the laboratory’s estimate of error at 1σ (one standard deviation level). The term “cal” is used to express calibrated radiocarbon ages, not calendar ages. Furthermore, I will use 1σ date ranges to draw particular distinction between the samples in this analysis and accept the lower confidence level; 2σ date ranges would allow for significant overlap in the samples and would render any changes through time less significant.

Rollins is one of the largest recorded shell rings along the Southeastern coast, measuring 250 m in diameter and over 4 m in height. It has a basic horseshoe shape that is common to many Florida ring sites (Figure 2). Rollins differs from other shell ring sites along the Southeastern coast in the addition of “ringlets,” which are found in only one other site, that of Fig Island (38CH42) in South Carolina (Saunders 2002). Radiocarbon dates from basal midden deposits in units excavated on the east and west sides of the main ring at Rollins are contemporaneous and put the initial construction of the site at about 3600 cal B.P. (Lab #Beta-119816 and Beta-119817, Table 1). Additional dates from Rollins indicate a relatively short construction period for the main ring (top to bottom dates of the ring differ less than 100 years; Lab #Beta-119816 and WK-7438 in Table 1); however, occupation at this site may have spanned two to three hundred years (Saunders 2010).

Radiocarbon dates from oyster shell indicated that the earliest shell deposit currently known is one of the ringlets, Ringlet F. A sample from Ringlet F (Lab #GX-30737) returned a conventional date of 3930 ± 80 B.P., which calibrates to about 4050-3820 1 cal B.P. This date was approximately 200 years earlier than dates from the east and west arms of the main ring (see Table 1; Saunders 2010:16). Stratigraphy of this ringlet wall indicates that it was built up rapidly as well. Thus, each shell feature at the site was constructed relatively quickly, and the overall horseshoe-shape design was part of the original plan for the main ring, which was then maintained throughout site use (Saunders 2004b:252). Figure 3 depicts excavations at Rollins from 1992, 1998 (Russo and Saunders 1999), and 2004 (Saunders 2010); Test Units 2 (trench), 10, 11 and 12 (in red) are of particular interest in this study.

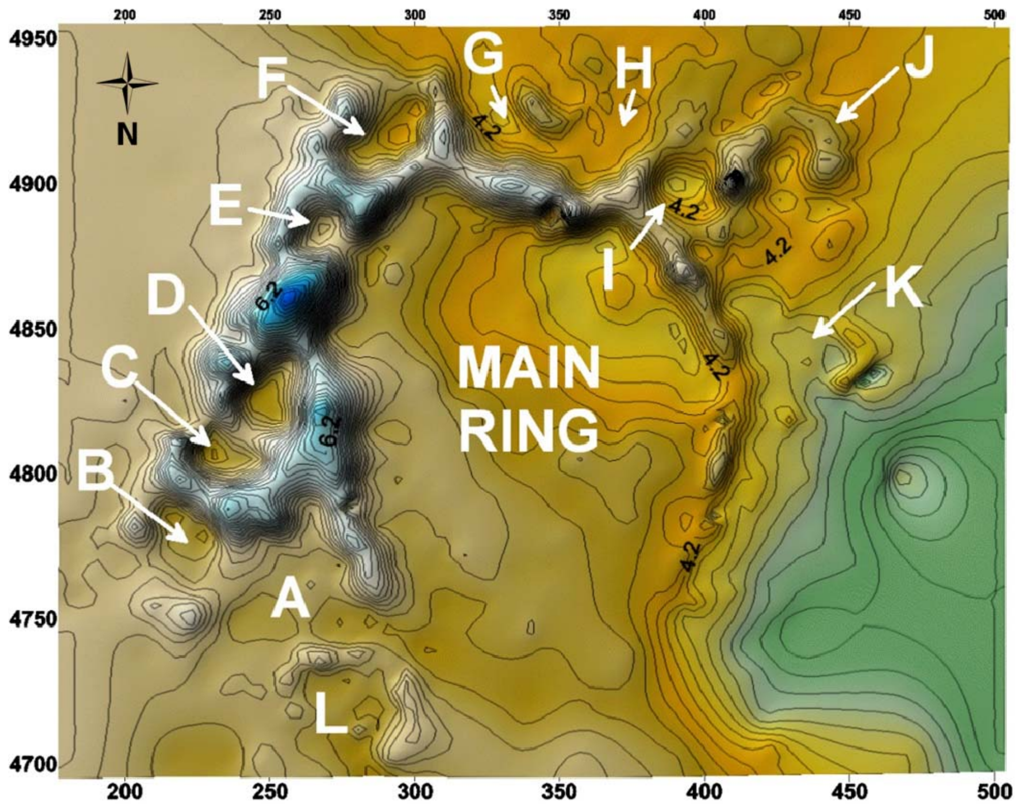


Figure 2. Updated contour map of Rollins Shell Ring with additional topographic information and letters denoting ringlets (from Saunders 2010:Figure 3).

Table 1. Radiocarbon dates from Rollins Shell Ring[1] (from Saunders 2010:Table 1).

Lab#	Provenience	Material	Corr B.P.	$\delta^{13}C$	2/1 cal (intercept) 1/2cal delta R-5±20
WK-7438	Trench 1, TU 1, Feature 1, top deposit, 33 cm bs	Oyster	3600 ±60	-2.4‰	3660/3580 – 3420/3360
Beta-119816	Trench 1, TU 2, Feature 1, bottom deposit, 90-100 cm bs	Oyster	3670 ±70	-2.5‰	3795/3680 – 3480/3400
Beta-119817	TU 3197, base of shell	Oyster	3710 ±70	-0.3‰	3830/3740 – 3540/3450
Beta-50155	4850N/250E, 60-65 cm bs (Russo 1993)	Oyster	3760 ±60	Est	3880/3800 – 3620/3530
GX-25750	Trench 1, Feature 11, base (below ring base) 200 cm bs	Bulk Carbon	3730 ±80	-25.6‰	4300/4162 – 3973/3850[3]
GX-30737	TU 10, base of shell	Oyster	3930 ±80	-2.1	4150/4050 – 3820/3690
GX-30739	TU 11, base of shell	Oyster	3630 ±70	-3.6	3720/3630 – 3440/3360
GX-30740	TU 11, Feature 28 (below ringlet base)	Oyster	3820 ±70	-2.0	3970/3870 – 3680/3580
GX30738	TU 12, Feature 26, base of shell	Oyster	3840 ±70	-2.0	4000/3890 – 3690/3600
GX29516	TU 1097, Ringlet J, pit feature (in profile)	Oyster	2460 ±70	-3.0‰	2300/2210 – 2010/1940[2]
WK-7433	TU 3197, top of shell	Oyster	2690 ±60	-3.7‰	2660/2480 – 2310/2260

1. All calibrated ranges were calibrated with Calib 5.0 (Stuiver and Reimer 1986)
2. 1 sig = 96%, 2 sig = 100%
3. 1 sig = 85%, 2 sig = 96%

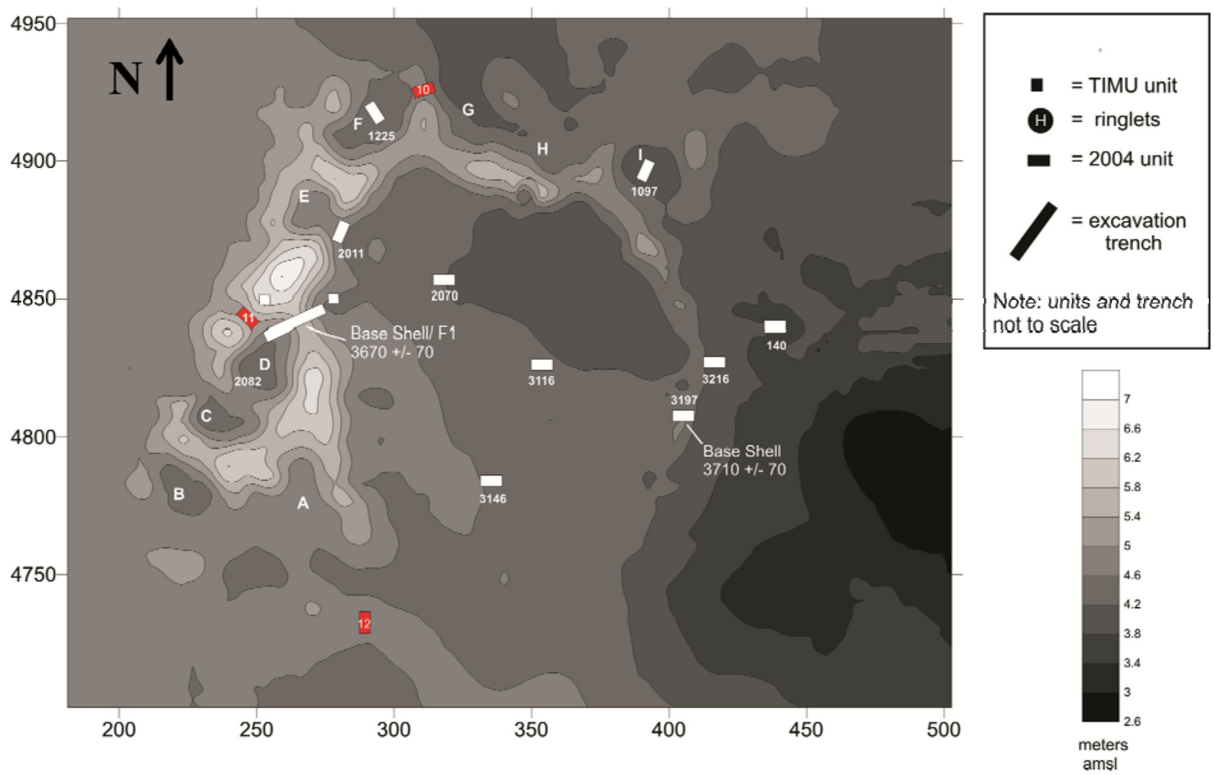


Figure 3. Contour map of Rollins Shell Ring with 1998 1 x 2 meter units plotted in white, 2004 units in red (units analyzed in this study). Square units above the trench were excavated in 1992 (units not to scale; from Saunders 2010:Figure 2).

Saunders referred to Rollins Shell Ring as a “unique site for the Orange cultural phase in the area between the Nassau and St. Johns Rivers,” and notes that the sheer magnitude and complexity of the site makes it unlikely to have been the result of a simple egalitarian village settlement (Saunders 2004b:261). Given its topographically complex nature and undisturbed condition, Rollins presents an ideal research opportunity that has the potential to yield important information on the shell ring culture of the Late Archaic Southeastern coast.

My research focuses on the two most abundant resources found at the site, oysters (*Crassostrea virginica*) and otoliths from marine catfish (*Bagre marinus* and *Arius felis*).

Samples for my analysis are taken from units representing the span of activity at the site. Measurements are taken from oysters to determine the particular environmental niche from which they were harvested, and the marine catfish otoliths are sectioned and analyzed for age and seasonality data. Results are then compared across the temporal range of the site for: 1) changes in the pattern of oyster harvest (habitat) through time; 2) changes in shell size (and by extension age) for oysters through time; 3) and, changes in seasonal activity that may indicate a change in site use through time. All of these changes may be interpreted as evidence of over-exploitation.

Following this introduction is a literature review (Chapter 2) which provides a background on Southeastern shell rings as well as a discussion on the prevailing theories concerning their form, function, and abandonment. In Chapter 3, I provide a description of the Late Archaic natural and cultural landscape along the Southeastern coast, and introduce studies that address the antiquity of human exploitation of coastal and estuarine environments. I present the previous research at Rollins Shell Ring in Chapter 4, and discuss in detail the test units analyzed in this study. Materials, methods and results of analyses on the oysters and marine catfish otoliths are combined into a single chapter for continuity, Chapter 5. However, the discussion related to each resource is somewhat extensive; therefore the chapter is split into two sections devoted to each resource. I begin an introduction and background on the resource, followed by the methods and materials. The results for oysters and catfish otoliths will be discussed within each individual section, and a discussion of the significance of the combined results will conclude the chapter. In Chapter 6, I summarize this project and offer conclusions on the results and options for future research.

CHAPTER 2 LITERATURE REVIEW

Southeastern Shell Rings: Description and History

In this section, I introduce Southeastern shell rings (shapes, composition, and material remains), discuss the similarities, and highlight the differences of rings from shell mounds or sheet middens. Then I present prevailing theories surrounding shell ring form, function, and meaning, highlighting the Rollins Shell Ring.

Southeastern shell rings are intentionally mounded shellfish remains that are a by-product of coastal and estuarine exploitation by fisher-hunter-gatherers. Along the Southeastern coast, rings are composed of mollusc shells, most commonly oyster. They also include a variety of other molluscs and fishes (brackish water and marine), though generally only a few species are targeted. Additionally, shell rings contain the remains of terrestrial flora and fauna as well as cultural remains such as pottery and tools. They are considered by some to be the first monumental architecture along the Southeastern coast (Russo 2002; Saunders 2002, 2003, 2004b, 2010), where monumental is defined as a special purpose structure whose "scale and elaboration exceed the requirements of any practical functions that a building *or structure* is intended to perform" (Trigger 1990:119; italics added by this author).

Southeastern shell rings range in diameter from 30 to 250 m and can reach over 6 m in height; they are located adjacent to estuaries on the lower Atlantic and Gulf coasts (Figure 4). Shell rings differ from shell middens in that rings are intentionally formed into a particular shape, and contain loose, whole shell. In contrast, sheet middens form a distinct stratum of broken and crushed shell in dark organic sediment that extends over large areas of a site.

Amorphous shell middens are discrete shell piles with no discernible shape, and shell and soil characteristics are similar to sheet middens (Russo and Saunders 1999; Saunders 2004a). Shell rings come in a variety of clearly defined shapes that include closed circles, horseshoe-shapes, and open circles with ringlets (Figure 5). Shell rings also possess relatively sterile areas within the arms of the ring, which are commonly considered to be plazas.

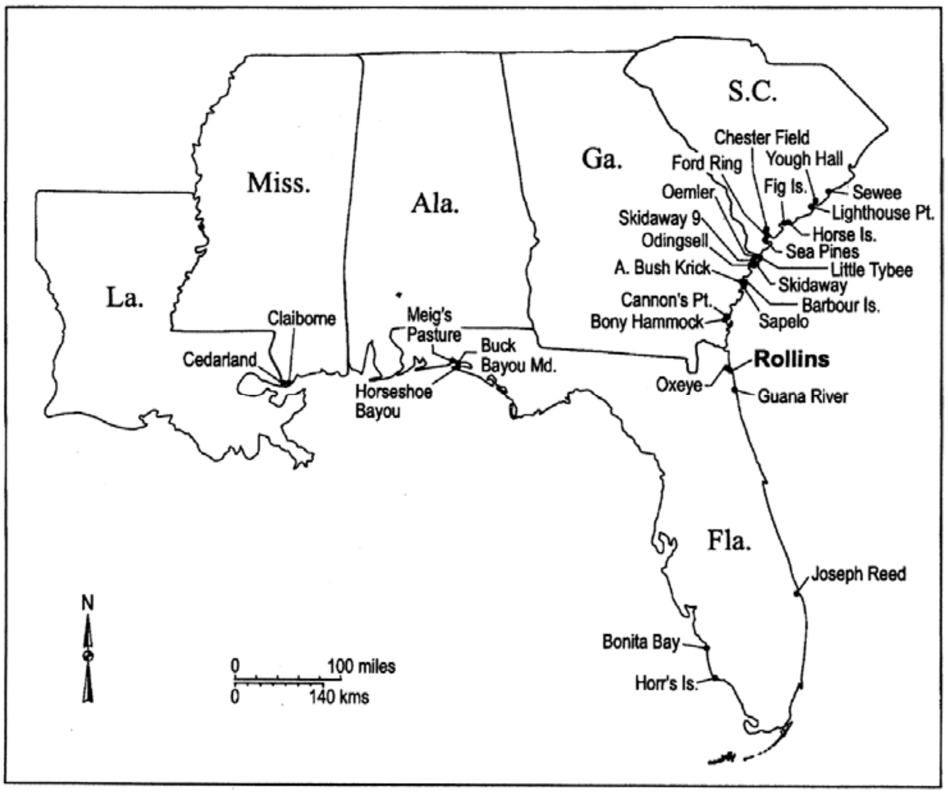


Figure 4. Shell ring locations (from Saunders 2003:Figure 1).

Southeastern shell rings share certain characteristics: they contain plazas; they were constructed from about 4500 – 3500 B.P. (Saunders 2010) and most were used for approximately 100 – 400 years, and then abandoned. Additionally, archaeologists have noted an absence, or paucity, of exotic objects (e.g., lithics and stone), easily definable prestige items, and burials have are recorded contemporaneous with the rings (Russo and Heide 2002). Some of the earliest evidence of pottery has been found at shell ring sites, and some shell rings along the Southeast coast pre-date the production of pottery, such as Oxeye (8DU7478), Horr's Island (8CR209), and Bonita Bay (8LL717) (Russo 2006). Other material remains that are found at these sites are tools made from bone and shell, and include adzes, punches, awls, pins, and chisels.

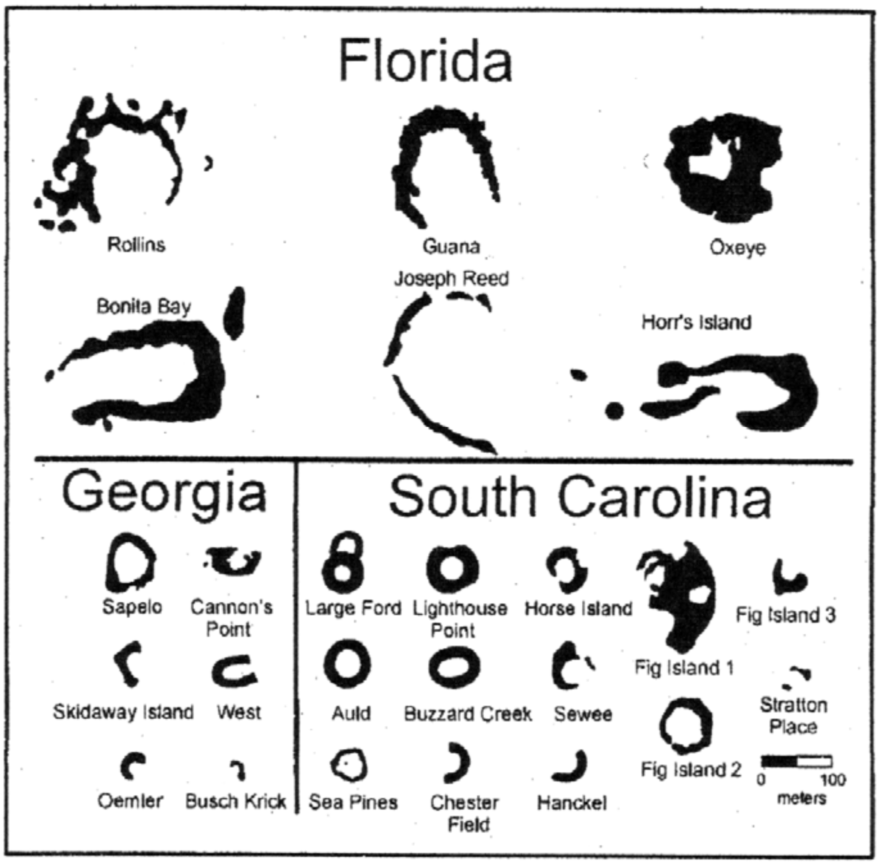


Figure 5. Shapes of Southeastern shell rings (from Russo and Heide 2002:Figure 2); note ringlets associated with Fig Island and Rollins.

Prevailing Theories Regarding Southeastern Shell Rings

One of the earliest written accounts of this architectural type was provided by William McKinley, when in 1873 he came upon the Sapelo Island Ring complex (Georgia) while performing a survey for the Smithsonian Institution. Since then, numerous professional and avocational archaeologists have investigated these somewhat mysterious sites (Cable 1997; DePratter and Howard 1980; Edwards 1965; Ford 1969; Marrinan 1975; Michie 1980; Moore 1897, 1898; Russo 2002; Russo and Heide 2002; Russo and Saunders 1999; Sassaman 1993; Saunders 2002, 2004a, 2004b; Thomas 2008; Thompson 2007; Trigger 1990; Trinkley 1985; Waring 1968; Waring and Larson 1968).

Functional explanations are split into three basic camps: utilitarian, ceremonial, or a combination thereof. Shell rings have been described as fish weirs or traps (Edwards 1965; Waring and Larson 1968), water containment structures (Marquardt 2010), habitation sites and seasonal hunting camps (Ford 1969; Moore 1897; Trinkley 1985), ceremonial and feasting centers (Cable 1997; Heide and Russo 2003; McKinley 1873; Moore 1897; Russo 2002; Russo and Heide 2002; Russo and Saunders 1999; Saunders 2002, 2004a, 2004b; Thomas 2008; Trigger 1990; Waring 1968), and a combination of functions such as habitation sites and ceremonial or feasting centers (DePratter and Howard 1980; McKinley 1873; Russo 1991; Thompson 2007).

In his survey of sites along the Georgia coast for the Smithsonian, McKinley (1873) described three shell rings on Sapelo Island. He remarked on the massive size of the largest of the three rings, measuring at that time over six meters high (three meters of shell placed upon three meters of bluff). He also noted the relative symmetry of the architecture and that the interiors of each of the rings were devoid of artifacts or observable features. In his letter to the Smithsonian, McKinley speculated that the largest of the Sapelo Island rings was likely a ‘pow-wow’ or state house, while the two smaller rings may have been where dances and sports or games were held (McKinley 1873:422-423).

Moore (1897) wrote in his report on the Sapelo Island shell rings that he discovered "an almost circular aboriginal fortification or ceremonial enclosure", and he was convinced that the Sapelo Island shell rings in Georgia were the result of ceremonial activity. In a later report, Moore noted that his survey of the coast revealed that the use of shell as an "article of diet" by Native Americans appeared to increase as one traveled south "since the shell deposits of South Carolina are greatly exceeded by those of Georgia, which, in their turn, yield the palm to the mighty masses of shell along the Florida coast" (Moore 1898:165).

Edwards (1965) hypothesized that the Sewee shell ring in South Carolina functioned as a fish trap. His conclusion was based on the shape of the structure, and the belief that the structure must have been located nearer the water during occupation, which would have subjected the ring to periods of inundation and wave action. Edwards based this conclusion on evidence of barnacle colonization that was visible on shell in the lower strata of the ring, as well as on pieces of highly eroded pottery fragments found in lower levels of the structure. The barnacle-encrusted and eroded pottery fragments were in close proximity to more pristinely preserved fragments that would have been above his theorized water level. According to Edwards (1965:36), a serviceable fish trap would be circular with a narrow gap that could quickly be closed as the tide receded to prevent escape of captured prey. Edwards' fish trap model has been criticized by Russo and Heide (2003) who concluded that Sewee was originally designed and built as a completely enclosed ring with no gap, making it unlikely that the site would have been used as a fish trap. In addition, local sea level was at least one meter lower, which would place the ring farther from, not nearer to the ocean.

As a result of excavations undertaken at the Sapelo Island Shell Ring in Georgia, Waring and Larson concluded that regardless of the ultimate intention or use, the site was composed of "occupational midden in primary position which was deposited as the result of habitation sites located on the ring" (Waring and Larson 1968:273). Investigating the issue of function and use further, the authors found it difficult to explain the shape of the ring, and decided, somewhat contradictory, that the sheer size and mass of the structure would indicate that it "very likely represents a ceremonial or social arrangement," which these authors thought somewhat unusual for the geographical location or time period (Waring and Larson 1968:273).

Ford (1969) offered a diffusionist explanation for the form of shell rings—he believed that the concept of the ring shape was brought to the Southeast by peoples migrating from Colombia. He noted the similarity of Southeastern shell rings to those in Colombia, and proposed that the rings, as well as the fiber-tempered pottery, could be attributed to direct colonization of the Georgia coast by migrating South American peoples. However, recent studies (e.g., Saunders and Russo 2011) propose a long history of coastal exploitation in the Southeast United States that would refute this diffusionist theory, and Saunders (in press, 2012) proposed that the postulated similarities in shape and contents of Columbian and Atlantic coastal rings are illusory.

Trinkley's (1985) work at Lighthouse Point and Stratton Place Shell Rings (South Carolina, 38CH12 and 38CH24, respectively) employed large block excavations in an effort to uncover clues regarding the function and use of shell rings. Initial investigations at Lighthouse Point produced data from middens, as well as areas on the interior and exterior of the ring edge, and two areas on the ring interior (Trinkley 1985:107). The focus of his excavations at Stratton Place was on the shell ring interior and a few areas outside the ring. He stated that shell rings, while not identical, bore strong similarities in intrasite patterning and he listed four common activity areas: exterior edge of the midden; shell midden ring; interior edge of the ring; and, the interior of the ring (Trinkley 1985:108).

As to the function of the rings, Trinkley concluded that both Lighthouse Point and Stratton Place shell rings were “gradually formed habitation sites, with occupation taking place on the rings,” and that “the rings were formed from kitchen refuse” (Trinkley 1985:117). His excavations also revealed steam pits in midden areas likely used to open large quantities of shellfish and to cook snails (e.g., periwinkle – *Littorina littorea*). As to the ring shape, Trinkley attributed the design to the egalitarian nature of Early Woodland societies where the placement of housing structures in a circular pattern would “promote communication and social interaction” (Trinkley 1985:118)

Cable’s (1997) work at Sea Pines and Skull Creek Shell Rings (South Carolina) led him to speculate on how often ceremonial activities and subsequent shell construction activity may have taken place. Based on the layering of crush shell and sand lenses at these two sites, the amount of time necessary to build the rings in their completed form, and the number of sites in close proximity along the Southeastern coast, Cable proposed that the shell rings may have been the result of feasting activities that took place on a rotational basis, perhaps every 10-20 years. He further hypothesized that groups responsible for large rings in the area took turns hosting such events, and that these sites were used as gatherings for mate exchange and networking.

Russo investigated mounds in South Carolina, Georgia, and Florida (Russo et al. 1993; Russo and Saunders 1999; Russo and Heide 2003). He (Russo et al. 1993) was the first to record Rollins Shell Ring, which he located during a survey of the newly established Timucuan Ecological and Historic Preserve. As to the function of shell rings, Russo has offered conclusions ranging from villages or long-term habitation sites (Russo 2004), to ceremonial or feasting centers (e.g., Joseph Shell Ring, Russo and Heide 2002), and that they were used either seasonally or year round (e.g., Rollins Shell Ring, Russo and Saunders 1999).

Saunders has investigated several shell rings along the Southeastern coast of the United States (Russo and Saunders 1999; Saunders 2002, 2004b), and to date has carried out the most extensive research at Rollins Shell Ring (Saunders 2003, 2004b, 2010). Saunders and Russo differed somewhat in their conclusions of site function and season of activity for Rollins (Russo and Saunders 1999). Russo proposed year round activity and that Rollins was a village site that hosted feasting activities. Saunders maintained that seasonal data from the most abundant natural resources from the site (oyster and marine catfish) indicated a preference for activity in warm water temperatures and the site was used mainly for feasting activities, with habitation away from the ring. Both authors agree, however, that the site was constructed through feasting activities.

On her work at the Fig Island ring complex, Saunders concluded that the "site can be used to dismiss the argument that all rings are simple village sites" (Saunders 2002:158); its size, ramps, conical mound, and other smaller enclosures indicated more structural elements than would be present in a simple egalitarian village. This architectural information, along with abundant pottery remains with an emphasis on serving vessels, are consistent with an hypothesis of feasting activities at Fig Island.

Important evidence for Saunders' conclusion of a ceremonial or feasting purpose for other shell rings included ceramic styles found at shell ring sites that were highly decorated and believed to be more in line with ceremony and feasting than everyday use (Saunders 2004a, 2004b). Further support in favor of a ceremonial (including feasting) nature was the fact that there was little evidence of household structures at many shell ring sites; although Russo (1991) suggests that there may be evidence of household structures at Horr's Island. The massive size of the rings, some indicating rapid accumulation, their formal shapes along with components such as ramps and ringlets, all appear to suggest something other than egalitarian habitation sites.

Saunders provided detailed analyses from the 1998 (Saunders 2003, 2004b) and 2003 – 2004 (Saunders 2010) excavations at Rollins Shell Ring. One of the goals of the excavations was to determine if the main ring was the product of "daily refuse discard," or the result of deposits from feasting (i.e., large deposits with minimal post-depositional disturbance), or some combination of the two (Saunders 2004). Trench excavations provided stratigraphy indicating purposeful mounding in large, discrete depositional episodes, which indicated feasting activities. Another goal of the 1998 investigations at Rollins was to conduct soil chemistry analyses within the plazas of the ringlets to determine if these areas were devoid of shell as a result of plantation period or modern shell mining; however, test results indicated that shell had not overlain the sand in the ringlet plazas (Saunders 2003).

In her 2004 report on features from the 1998 excavations at Rollins, and radiocarbon dates from bulk carbon and oyster shell, Saunders made a case for evidence in support of a special purpose site: site context (only Orange cultural phase ring in lower St. Johns drainage); intrasite organization indicating intentional mounding and maintenance of the ring structure throughout activity recorded for the site; and, little evidence of post-depositional crushing as would be expected of a site used for habitation (Saunders 2004:261). Saunders presented data that indicated a seasonal nature to the deposits at Rollins, as well as a high frequency of decorated pottery (Saunders 2003); taken together, her conclusions would strongly suggest a special purpose site that very likely was constructed through feasting activity.

Thompson (2007) proposed a ‘developmental model’ for ring function; his model took into account some of the aspects proposed by other shell ring researchers, but placed the use and formation of shell rings within a diachronic perspective. His model was based upon ideas on the archaeology of place (Binford 1982), in which the nature of occupation and function of a site on the landscape changed through time. Thompson proposed three phases of development of shell rings. In Phase I, shell rings developed from the gradual accumulation of discontinuous shell-filled pits beside residences; in Phase II, at some point in the history of the shell ring, the ring becomes continuous, and residence is either on top of or immediately inside the ring; and, in Phase III, the mound is intentionally enlarged, and takes on a more ceremonial function (Thompson 2007:92).

According to Thompson (2007), these phases of development should be reflected in the interior of the rings: Phase I and II should contain evidence of household and/or ceremonial activities, while rings that have transformed into ceremonial structures (Phase III) should have minimal or no evidence of household activities in the interior. He argues for this pattern of development for the smallest ring (Ring III) at Sapelo Island, Georgia. However, there is debate as to whether Ring III at Sapelo Island has been disturbed since its initial recording by McKinley in 1873 (Russo 2006); therefore, any interpretation based on its current condition would have to consider the possibility that the site has been altered since its discovery. Thompson (2007) cautions that ring function may alternate between residential and ceremonial, and that his proposed model should not be used as a unilinear development of ring function. He suggests that each site be tested independently to determine the history of activities (Thompson 2007:94).

While Thompson’s developmental model offers a viable research tool when considering the function of prehistoric shell rings, it does not fit what we already know of Rollins Shell Ring.

Saunders (2004b, 2010) presented evidence that the main ring was constructed in a relatively short period of time, and that the large scale design was part of the original plan.

The theory that shell rings are habitation sites is not supported by the data from several sites that report minimal evidence of material remains along the outer edges of the rings; researchers suggest that if habitation occurred on a daily basis one could expect to find more artifacts in these areas (Cable 1997; Michie 1979, 1980; Moore 1897, 1898; Russo 2002; Russo and Heide 2002; Russo and Saunders 1999; Sassaman 1993; Saunders 2002, 2004a, 2004b). Additionally, for many recorded shell rings there is scant evidence of structures and crushed shells on the ring ridge, which are also indicators of habitation. Thus, it is my position that many shell rings, Rollins in particular, represent ceremonial sites where rituals, including feasting, took place, and that the shell rings are the remains of these activities.

Debate among Southeastern archaeologists still continues as to the formation and function of shell rings, but many agree that these rings were the product of seasonal gatherings, and that shell rings played a major role in the natural and social landscape of the area (Russo and Saunders 1999; Saunders 2002, 2004a, 2004b). Discussions into shell rings also focus on the decline of these sites, and what may have contributed to their permanent abandonment; however, studies focusing specifically on the abandonment of these sites are relatively few (Sanger 2010 is an exception), and no consensus has been reached as to an overriding cause.

This study adds to our knowledge of the ecological, environmental, and cultural factors that were so important to the creation of Rollins Shell Ring, and investigates whether these same factors, specifically over-exploitation, may have played a part in the abandonment of this site.

CHAPTER 3 LATE ARCHAIC OF THE SOUTHEAST ATLANTIC COAST

Late Archaic cultures (ca. 5000 – 3000 B.P.) introduced a number of innovations, including the first fired clay containers, and adaptation and expansion of new subsistence strategies, particularly new solutions to subsistence problems that arose from an expanding population (Bense 2009). One of these solutions was mound building on the lower Atlantic coast; however, specific environmental and cultural conditions related to these structures are still being investigated.

The previously hot, dry weather conditions of the Early Archaic (ca. 10000 – 8000 B.P.) gave way to cooler temperatures and moist environments in the Middle Archaic (ca. 8000 – 5000 B.P.); cooler, moister conditions continued into the Late Archaic (Bense 2009:85). The rapidly rising local sea level of the Early and Middle Archaic slowed, and approached near present day levels by ca. 4500 B.P. (DePratter and Howard 1981). Modern-day barrier islands and coastal ecosystems developed, and embayed river mouths filled with sediments forming mud flats and marshes, which provided a favorable environment for dense and diverse populations of coastal marine life.

The ability of prehistoric coastal and estuarine habitats to sustain large populations of early peoples has enjoyed lively discussion since the late 18th century (Cushing 1896), and continues to be the focus of current discussion and consideration (e.g., Bailey 1975; Crook 1992; Erlandson et al. 2008, 2009; Frazier 2007; Jones 1992; Mannino and Thomas 2002; McKechnie 2007; Rick and Erlandson 2008; Russo and Saunders 1999; Saunders and Russo 2011; Thomas 2008; Thompson and Worth 2011; Waselkov 1987; Whitaker 2008; Yesner 1980).

There were several studies along the west coast of North America regarding the antiquity of coastal and estuarine exploitation by humans (e.g., Erlandson et al. 2008, 2009; Whitaker 2008). Erlandson et al. (2008) reported on an area along the Pacific coast that included approximately 6000 sq km and 40 degrees of latitude, and comprised a large amount of environmental variation (Erlandson et al. 2008:2233). Within that area, there was archaeological evidence for maritime settlement by at least 11,500 years ago, and the authors argued that the productivity of coastal and estuarine habitats was sufficient to provide the early inhabitants "with a majority of ... calories or protein derived from marine resources" (Erlandson et al. 2008:2242). In the Channel Islands off the California coast, Erlandson et al. (2009) discovered a nearly continuous record of Native American coastal and marine exploitation spanning over 12,000 years; here, advances in maritime hunting technologies along with productive environments contributed to "population growth..., cultural specialization, and elite control" among the Chumash during the Late Holocene (Erlandson et al. 2009:718).

Saunders and Russo (2011) proposed a long history of human exploitation of productive coastal and estuarine environments along the Southeastern and Gulf coasts. According to these authors, there is evidence dating to about 7000 B.P. in the Florida panhandle of coastal and estuarine exploitation by early peoples, but that the total reliance on these niches for subsistence wasn't realized until about 5000 – 4000 B.P. "when intensive exploitation of marine shellfish and fish is recognized along the shore" (Saunders and Russo 2011:38). These authors take us through the conceptual continuum regarding the importance of shellfishing to the diet of early coastal peoples, and described the progression of coastal and estuarine exploitation along with the effect on settlement patterns, social systems, and trade. Saunders and Russo (2011:48) concluded that the productive coastal and estuarine environments allowed for population nucleation, large-scale ceremonialism, and feasting. Furthermore, these authors credit humans and estuarine species with great adaptive abilities, and as resilient species they would not likely be adversely affected by minor fluctuations in local sea levels, such as those proposed for the Gulf and Southeastern coasts during the Middle and Late Archaic periods of North America (ca. 8000 – 3000 B.P.).

Changes in demography in the Southeastern region during the Late Archaic also set it apart from earlier periods by the number, location, and density of recorded sites (Milanich 1994). Coastal sites are numerous compared to interior sites of this period, which suggests that preference was given to the estuaries and shores. By ca. 5000 – 4000 B.P., the success of these early coastal peoples could be seen in the large shell rings and middens located along the Southeastern coast.

In northeast Florida, archaeologists have identified a pre-ceramic Middle – Late Archaic cultural phase (Mount Taylor, ca. 8000 – 3000 B.P.), and a Late Archaic cultural phase (Orange, ca. 5000 – 3000 B.P.). The Orange cultural phase is associated with the Rollins site (Russo 1992; Russo and Saunders 1999) and will be the main focus of this section (for a detailed cultural chronology of the area the reader is referred to Russo 1992:109, Figure 2). Here, I limit my discussion to the St. Marys region (Russo 1992) for the geographical and cultural area that includes the Rollins site.

Orange material culture has been described in previous studies (e.g., Bullen 1972; Milanich 1994; Saunders 2004a, 2004b). The construction of large shell rings, along with the first fiber tempered pottery recorded, are among the most well known features of this cultural phase. Orange pottery is characterized as low-fired earthenware tempered with Spanish moss (Saunders 2004a:40); the production of Orange wares has been dated to ca. 4500 and 2500 B.P.

Saunders (2004a, 2010) described the extensive distribution of the Orange cultural phase along the Atlantic and Gulf coast of Florida during the Late Archaic (5000 – 3000 B.P.). Spatial distribution of the characteristic pottery extends from southern coastal Georgia, overlapping with another Late Archaic coastal cultural phase, St. Simons (also known for fiber-tempered pottery), and south along the Atlantic coast (including the St. John and Indian River drainages), down to the Florida Everglades, and west along the Gulf coast (Tampa Bay region) to the panhandle (Mitchell River sites, Saunders and Russo 2011). However, the major area of the distribution of the Orange cultural phase is the St. Johns River valley along the Atlantic coast (Saunders 2004a:40).

Other artifacts associated with the Orange cultural phase include tools such as shell hammers and adzes, gouges, and bone pins (Saunders 2004a). Stone artifacts are rare as lithic resources are not locally available in the range of the Orange cultural phase. Along the Atlantic coast, Orange cultures were completely adapted to estuarine environments, as evidenced by the abundant remains of small, net-able fishes (Saunders 2004a, 2010), and molluscs (primarily the American oyster); these resources made up over 95% of their diet (Saunders 2004a:40).

Models of human settlement for this cultural phase range from seasonal migration to semi-sedentary and even sedentary habitation along the coast (Russo 1992; Milanich 1994). Site types include shell rings, sheet middens, and non-shell sites (Saunders 2004a). Some investigators explain the function of sheet middens as refuse from kitchen activities (e.g., Trinkley 1985). Traditionally, non-shell sites are considered short-term hunting camps, and sheet and mounded shell middens were seasonal habitation or special extraction sites. Non-shell sites lack soil color changes but contain lithics and pottery; how these three different site types fit together remains unclear, but they all occur in the Southeastern coastal environment (Saunders 2010:14).

The tradition of building shell rings along the Southeastern coast dates from ca. 5000 – 3500 cal B.P.; after about 3500 B.P. there is minimal evidence of activity related to shell ring construction in the area. One of the more detailed studies of abandonment of these sites focused on St. Catherines Shell Ring in Georgia (Thomas and Sanger 2010). Radiocarbon dates indicate that the site, and in fact the entire island, was abandoned ca. 3800 cal. B.P. (or ca. 1800 cal. B.C.; Sanger 2010:214)   There was evidence of repopulation in the area about 300 – 500 yrs later, but these sites were small, and there is no evidence of additional shell rings being constructed at this time, nor that the existing shell rings were utilized (Sanger 2010). According to Sanger, shell ring abandonment along the Atlantic coast occurred in waves over a period of about 800 – 1000 years, and may correlate with current models of local sea level change (Sanger 2010:210).

The first wave of abandonments took place ca. 4230 B.P. (or 2280 cal. B.C.), and occurred among sites lowest in elevation (e.g., Oxeye). The second wave of abandonments occurred ca. 3980 B.P. (or 2030 cal. B.C.), but these sites may have been affected by a drop in sea level and subsequently left high and dry (e.g., Fig Island I, St. Catherines, McQueen, and Sapelo rings I and III). However, the third wave of abandonments at ca. 3670 B.P. (or 1720 cal. B.C.) occurred at a time of local sea level rise and among sites that were higher in elevation (e.g., Sewee, Patent, Coosaw 2, Sea Pines, Large Skull Creek, Meig's Pasture, Rollins, and Guana); Sanger finds it difficult to connect this final wave of abandonments with prevailing theories of local sea level change (Sanger 2010:210-213).

Many contributing factors have been offered for the abandonment of shell rings along the Southeastern coast. As with any seemingly dramatic change in prehistoric human population or migration, there is the hypothesis that over-exploitation of the natural resources drove the Late Archaic coastal dwellers inland (Mannino and Thomas 2002). Thomas and Sanger (2010) suggest that the Late Archaic (5000 – 3000 B.P.) throughout the southeastern U.S. was brought to a close by climatic events that included catastrophic storms, massive flooding, and abrupt local sea level fluctuations. While these large, areal hypotheses are not within the scope of this current investigation, I can test whether over-exploitation of oysters is discernible at Rollins Shell Ring.

CHAPTER 4 PREVIOUS RESEARCH AT ROLLINS SHELL RING

Rollins Shell Ring was first recorded as part of an archaeological survey of the Timucuan Ecological and Historic Preserve, which is located in the St. Johns River valley, Florida (Russo et al. 1993). Russo's survey located "a large curved shell ridge" with a series of smaller shell rings attached to the exterior of the ridge (Russo et al. 1993:98). A total of 219 shovel test, measuring 0.5 by 0.5 meters, were placed at 50 meter intervals along north/south transects, and 25 meter intervals along east/west transects during this survey. Two hundred and seventeen of these tests yielded fiber tempered pottery from within the 'midden' (the term Russo used at the time, but later changed to ring); the area within and immediately outside of the ridge contained significantly less material. Analysis of the pottery indicated that this site was primarily deposited during the Orange cultural phase of Florida, which, according to Milanich (1994:94), was from ca. 3950 – 2450 B.P. (or 2000 – 500 B.C.) in northeast Florida.

Russo et al. (1993) also noted that the fauna at Rollins was dominated by oyster, coquina, herring, and catfish. Based on the amount of material recovered, as well as the size and species of fish and shellfish, Russo concluded this was the site of an intensive, year round occupation. While seasonal data of pinfish atlas vertebra (minimum number of individuals, or MNI = 16) indicate a summer season of harvest, analysis of menhaden atlases (MNI = 50) indicate a winter season of harvest (Russo et al. 1993:100). Russo et al. further observe that the shell ridge was in pristine condition with no obvious indication of disturbance, assuring the validity of the depositional stratigraphy.

Following Russo's initial work at Rollins, the site was further investigated by Russo and Saunders (1999). Their study, "America's First Coast", funded by the National Geographic Society, was undertaken with two specific goals: the first goal was to determine whether three Florida shell sites (Spencer's Midden, Oxeye, and Rollins) were 'shell rings'; the second was to determine the function of the sites, i.e., whether they were secular or ceremonial (Russo and Saunders 1999:1). The authors employed close interval, laser transit contour mapping, shovel tests, excavation units, and soils analysis to investigate these questions. They concluded that Spencer's Midden was not a shell ring, while Oxeye and Rollins were comprised of purposefully mounded shell.

Radiocarbon dates from the main ring indicated that deposition occurred between 3600 – 3800 B.P. (Russo and Saunders 1999:3). Additional radiocarbon dates from samples of shell from the east and west arms of the ring indicated that construction started at about the same time in both areas, demonstrating that "the size of the [main] ring was planned from the beginning" (Russo and Saunders 1999:3, and their Figures 3 and 4). Based on the size of Rollins and its associated 'ringlets,' as well as an increase in overall population size in the area (as evidenced by sites contemporaneous with, and geographically proximate to, Rollins), Russo and Saunders suggested that the "rings and events held there had a potential participant audience theretofore unknown in the Southeast" (Russo and Saunders 1999:4). As to the function of Rollins, they conclude that it was likely the site of public gatherings, particularly those involving feasting, and that the ring itself was evidence of these activities. The faunal remains suggest that the participants at Rollins were fed with locally abundant resources, such as oysters and fish. On the basis of the uniformity of the remains from sampled areas across the site, they postulate an egalitarian organization for the inhabitants of the site-- there was no indication of any one group having access to higher trophic level species than others (Russo and Saunders 1999:5).

In a 2003 report to the Florida Department of Historical Resources, Saunders provided a detailed analysis of the material excavated in 1998 at Rollins. Analyzed were ten 1 x 2 m units that were judgmentally placed throughout the site: in the east arm of the main ring, the main ring plaza and ringlet plazas, and one 1 x 16 m trench (Test Unit 2, Trench 1) on the western side of the main ring. Based on the analysis of the material remains from these test units and associated radiocarbon dates (see Table 1), and according to Saunders, the site possessed multiple artifacts from Orange and St. Marys cultural phases, approximately 3800 – 2500 B.P. (Saunders 2003:10). She further suggested that no features associated with structures had been found in the ring interiors dating to the period of main ring construction (Saunders 2003:11). Some artifacts, predominantly pottery, were found in the ringlet centers, but the overall perception was that the main ring and ringlet centers were kept relatively free of debris throughout the principal occupation of the site, indicating site maintenance throughout recorded use.

Data from Test Unit 2, Trench 1 (Figure 6) yielded important information regarding site formation processes. Saunders (2003:11) noted the trench was intended to “bisect the ring feature as a whole and to provide stratigraphic evidence of the depositional events that made up the ring” (Saunders 2003:11). According to Saunders, initial activity in the location of the main ring involved the deposition of an earth midden, which contained pottery and bone, but only traces of shell. Initial shell ring deposits were placed upon this earth midden (for a detailed description of her findings see Saunders 2003:16).

Test Unit 2, Trench 1 comprised three discrete episodes of “rapid deposition” separated by “thin lenses of sand or clayey sand” (Saunders 2003, Feature 1). All three deposits contained large, whole, clean shell with no soil, making the shell very loose (Saunders 2003:12). The orientation of the shell had a jumbled appearance, and small fish bones were abundant in up-turned shells. There was no evidence of breakage, such as would be expected if regular activity (habitation) would have taken place on the main ring. Shell from the top of Feature 1 (from Test Unit 2) returned a radiocarbon date of 3570 – 3420 1 cal B.P., and shell from the base of Feature 1 returned a radiocarbon date of 3675 – 3470 1 cal B.P., suggesting that the main shell ring at Rollins was constructed quickly (see Table 1 for dates).

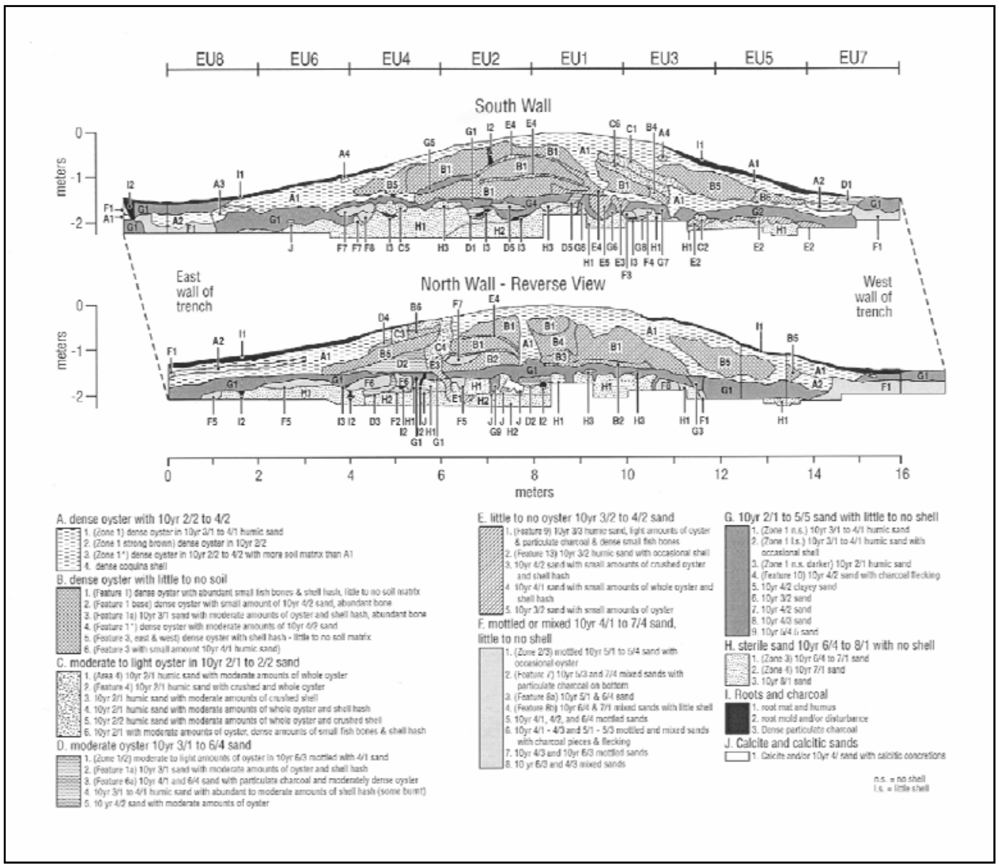


Figure 6. Test Unit 2, Trench 1, north and south profiles, Rollins Shell Ring (taken from Saunders 2003:Figure 5).

Saunders made another visit to Rollins in December 2003 – January 2004 to further investigate ring construction. Her goals were to gather more information regarding the temporal position of the ringlets in relation to the main ring construction (i.e., were the ringlets part of the original site plan), and to determine the relationship of Orange cultural phase material remains found south of the main ring with the ring proper (Saunders 2010). Excavations included 1 x 2 m units on two of the ringlets, Ringlet F (Test Unit 10) and Ringlet D (Test Unit 11), to determine how the ringlets were constructed as well as the relation of the ringlets to each other and to the main ring. Another unit, Test Unit 12, was placed south and outside of the main ring in an area where Russo et al. (1993) had recovered Orange pottery, with the intent of establishing the relationship of this area to the main ring.

Test Unit 10 was placed on the northern arm of Ringlet F, and perpendicular to the direction of the shell deposit, in a broad, flat area that was unaffected by slope edges. The unit, at ground surface, had a layer of broken and whole shell mixed with organic sandy soil, which overlay a deep deposit of whole, clean, jumbled shell containing less soil. While an attempt was made to map discrete deposits (Figure 7), the overall impression was of rapid deposition. A sample of oyster shell from the base of Test Unit 10 provided a conventional radiocarbon date of 3930 ± 80 B.P. (4050 – 3820 1 cal B.P., see Table 1), which is about 200 years earlier than the base of the east and west arms of the main ring (Figure 8).

According to Saunders, the size of Ringlet F (Test Unit 10) is well within the range of stand-alone rings found in South Carolina and Georgia and, based on the radiocarbon dates, could represent one of the first ring structures built at Rollins. This unit contained Archaic (Orange Period, ca. 4100 B.P.) and Post-Archaic pottery (many [n=20] of the Orange sherds were decorated), lithics (scant), worked bone, and worked shell. Faunal remains indicated a predominance of bony fishes, with marine catfish being the most abundant. One surprise in the faunal remains was the discovery of dolphin, adding a distinctive marine mammal element to the faunal assemblage at Rollins (Saunders 2010:16-19).

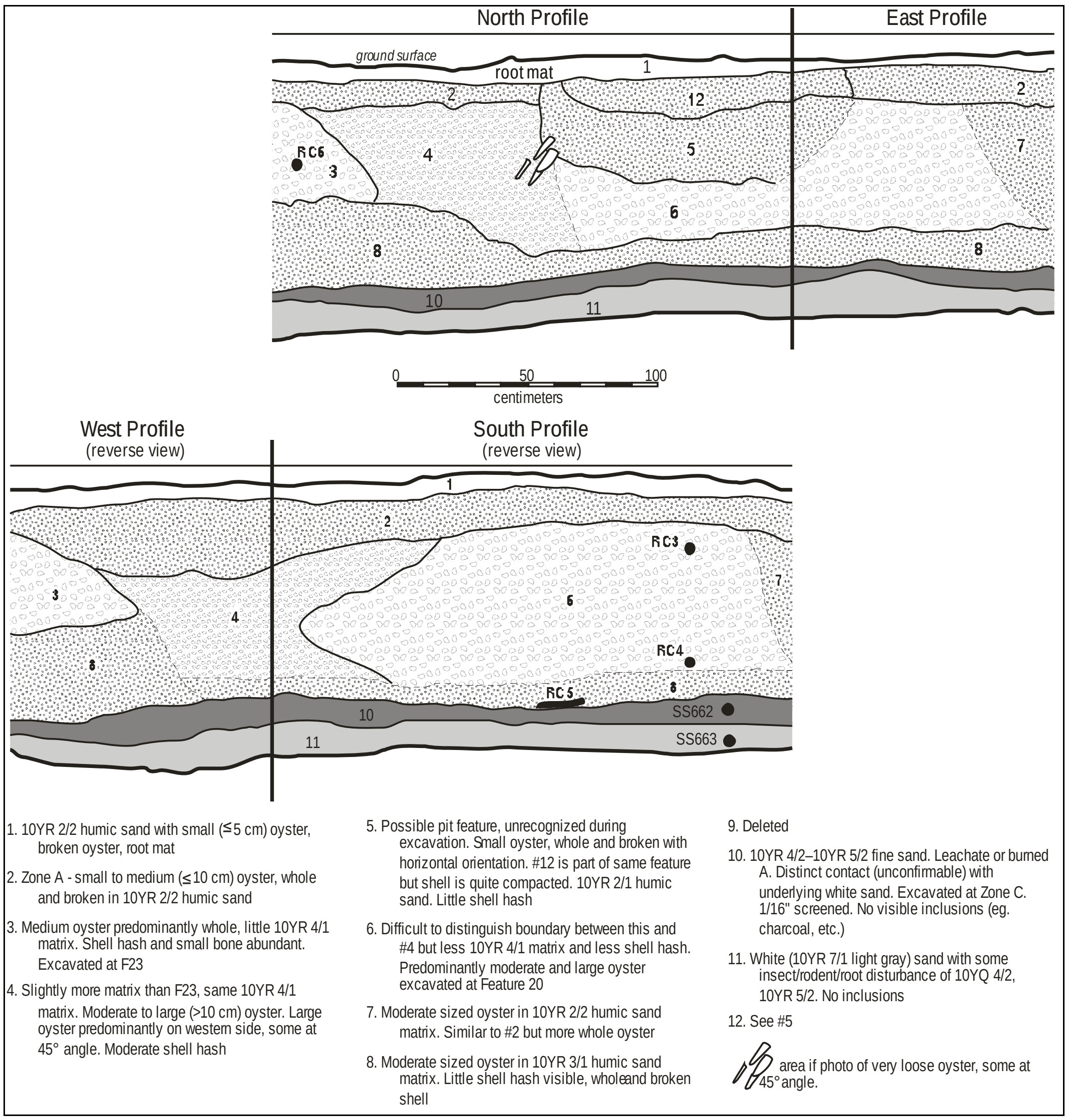


Figure 7. Test Unit 10 profiles, Rollins Shell Ring (from Saunders 2010:Figure 10).

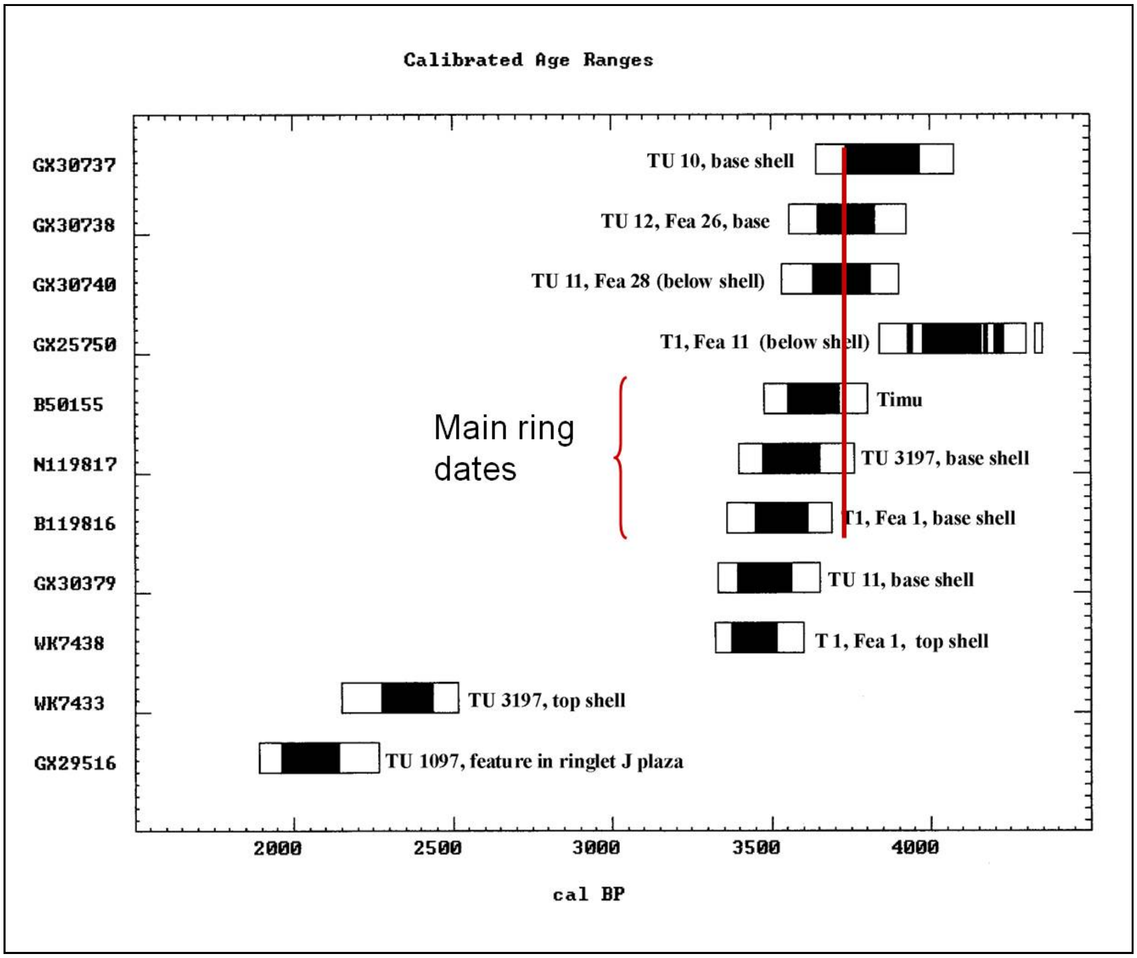


Figure 8. Block plot of radiocarbon dates for Rollins (from Saunders 2010:Figure 19).

Test Unit 11 (Figure 9) was placed in the northern arm of Ringlet D between two shell peaks. Many disturbances were noted in this unit, resulting in more area and feature designations, but in the end it appeared that Ringlet D was constructed like Ringlet F and the main ring, that is, by rapid accumulation of whole, large, clean oyster shell. Two radiocarbon samples (both oyster) from the base of shell and Feature 28 (below the ringlet shell) in Test Unit 11 provided conventional dates of 3630 ± 70 B.P. (3700 – 3560 1 cal B.P.) and 3820 ± 70 B.P. (3890 – 3750 1 cal B.P.), with the former date contemporary with dates from the main ring (see Table 1 for all radiocarbon dates). Decorated and plain Orange sherds were recovered, along with a small amount of lithic artifacts, as well as worked bone. Bony fish were again the most abundant faunal remains, with marine catfish leading the way. There were also cartilaginous fish (shark) and crabs present, as well as mammal, bird, and reptile (Saunders 2010:19-20).

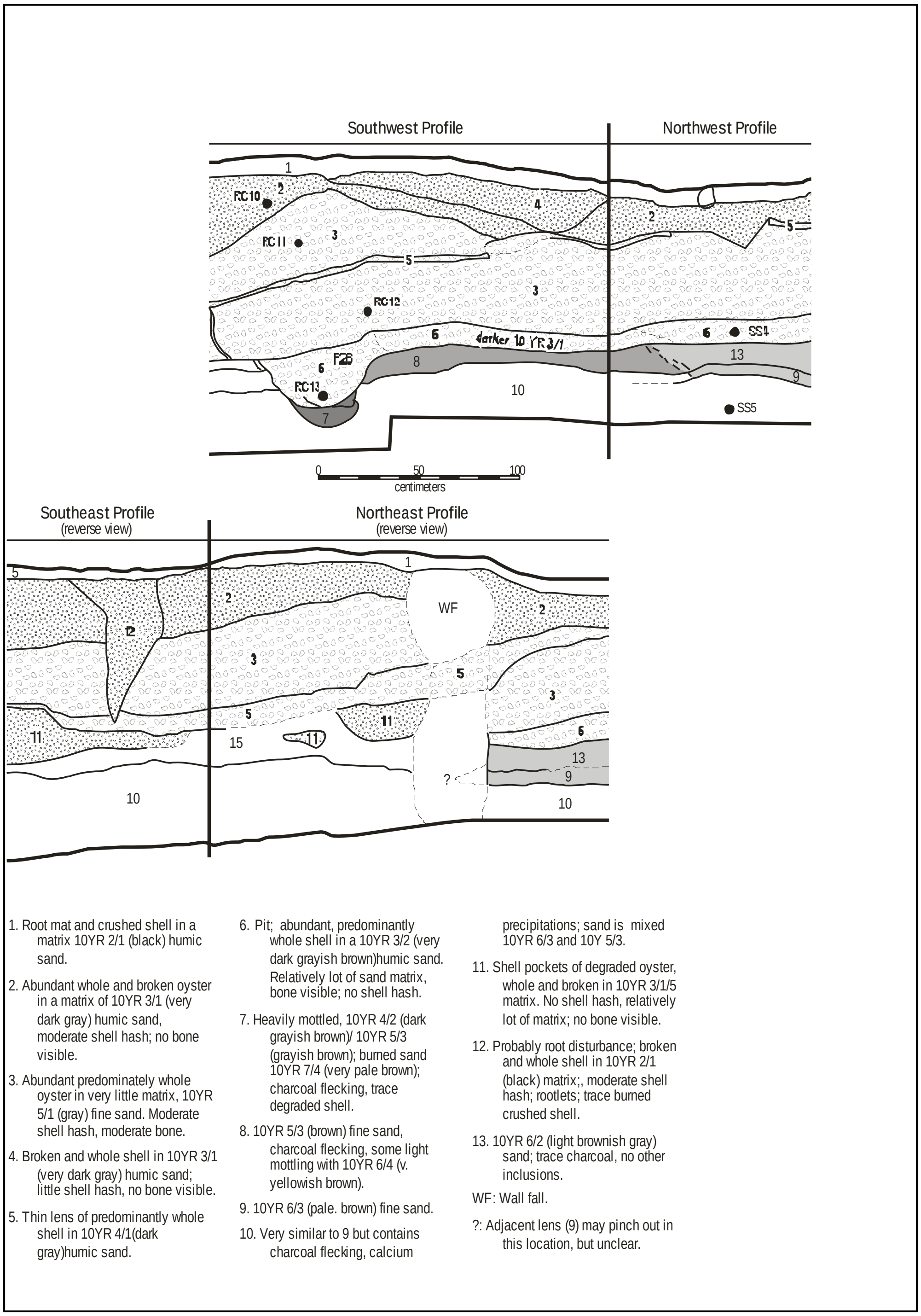


Figure 9. Test Unit 11, Rollins Shell Ring (from Saunders 2010:Figure 14).

The location of Test Unit 12 (Figure 10), south of the main ring, was chosen based on a shovel test by Russo in 1998 that yielded a high frequency of Orange pottery. Results from Russo and Saunders' 2006 mapping of this portion of the site (see Figure 2) indicated that this unit was placed in a previously unrecognized ringlet, or 'proto-ringlet,' now referred to as Ringlet L (Saunders 2010:21). Test Unit 12 initially began as a 1 x 1 m unit, but the discovery of a large shell feature at the southern end of the unit prompted a 1 m extension to the south. Ultimately, a deep (1.8 m) shell-filled pit was uncovered (see Figure 9 in this study; Saunders 2010:22, Figure 17). Shell from the base of this large feature returned a date of 3840 ± 70 B.P., or 3890 – 3690 1 cal B.P. (Saunders 2010:22). Test Unit 12 contained the least amount of artifacts of the three units described here, but Orange pottery (decorated and plain) was recovered, along with bony fishes (marine catfish, flounder, sea trout, ladyfish, gar, mullet and sea bass/grouper) from brackish and marine environments (Saunders 2010:21-23).

Saunders and Russo revisited Rollins Shell Ring in May 2006 for three days of intensive mapping of the northeast and southern portions of the site. A revised topographic map was created (see Figure 2) and suggested that previously unresolved ringlets may have been under construction at the time the site was abandoned (Saunders 2010:21).

The 2004 excavations and 2006 mapping added more information to what was already known about Rollins, but it also offered more possible points of investigation. The earlier date of Ringlet F (Test Unit 10) compared to the main ring, and the discovery of previously unrecognized ringlets prompted Saunders to consider the small-scale beginnings of the site, and that more ringlets may await mapping.

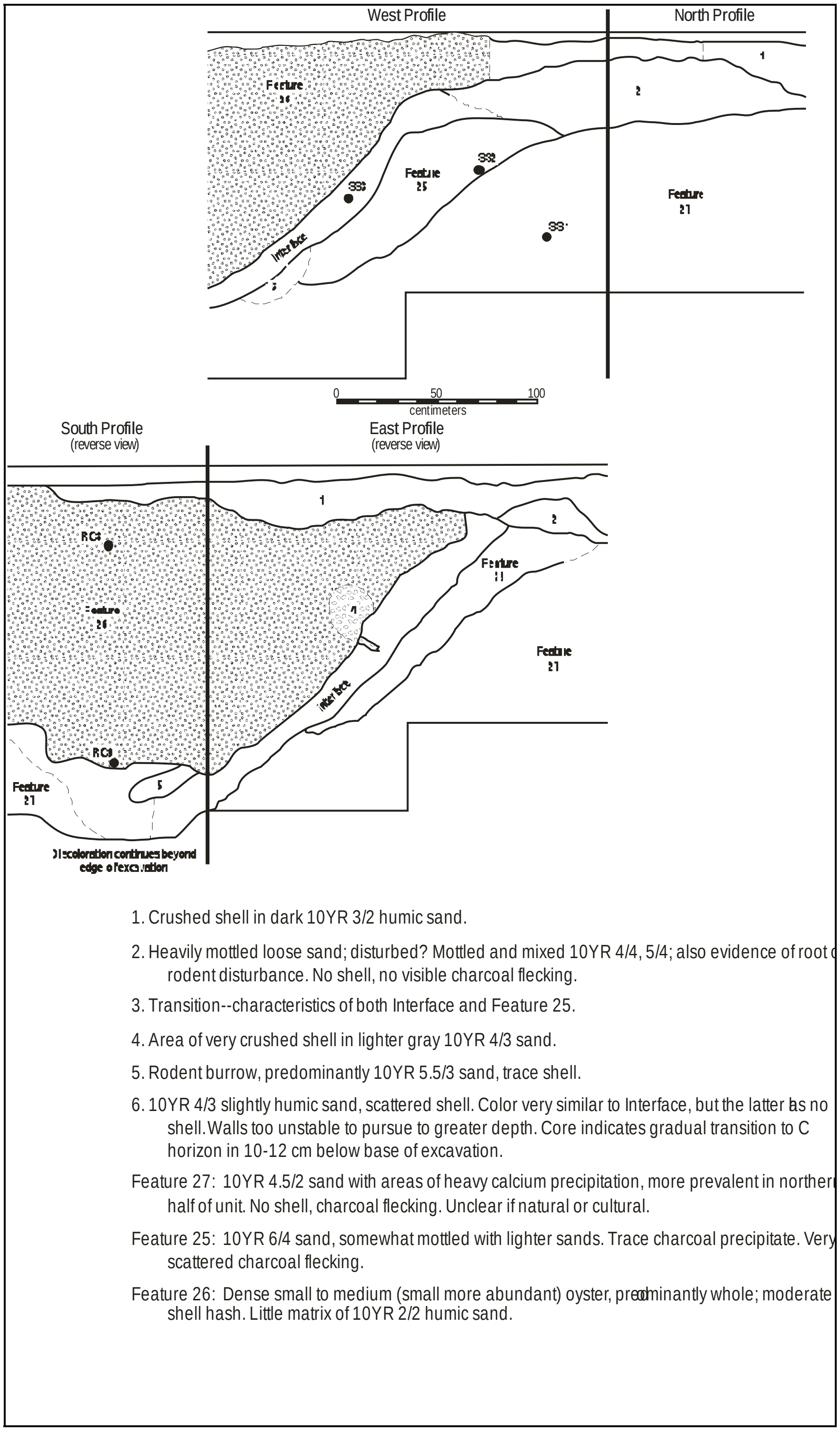


Figure 10. Test Unit 12, Ringlet L, Rollins Shell Ring (from Saunders 2010:Figure 17).

Saunders undertook an extensive analysis of the 1998 and 2003-2004 excavated materials (results presented earlier in this study), and her overall interpretation of Rollins Shell Ring is that it was “a special purpose site where Orange... populations of the area aggregated seasonally for feasting and other activities,” and that the ring itself was likely composed of the remains of these feasts. She further stated that such an interpretation was “consistent with cross-cultural comparative studies that demonstrate an association between feasting and spatial differentiation” (Saunders 2003:32), in that feasting was often carried out in specific areas that were separate, and separated from, domestic or village life (Adler and Wilshusen 1990; Dietler and Hayden 2001; Hayden 2001).

The stage is now set for Rollins as a special purpose site, capable of hosting large numbers of early coastal peoples for ceremonial and feasting activities, with easy access to a productive resource base. My investigation was undertaken to provide a detailed analysis of the two major natural resources at the site, oysters and marine catfish (otoliths), to add to what we currently know of site activities as they pertain to resource exploitation.

CHAPTER 5 MATERIALS AND METHODS

Two of the most abundant subsistence resources at the site, oysters and marine catfish, were chosen for this analysis to gain a better understanding of resource procurement at Rollins Shell Ring. Seasonality data from growth bands in marine catfish otoliths were used to determine season of harvest for fish, and as an indicator for the season of harvest of oysters associated with the otoliths; oxygen isotope analysis may be more reliable to assess seasonality but the high cost greatly reduces sample size. Fish age was assessed along with season of harvest, and detailed measurements were taken on oysters to provide information on the particular ecological niche where they may have been harvested. These analyses were supplemented by seasonal data already known for the site from Russo and Saunders (1999) and Saunders (2003, 2004b, 2010). The results of this analysis addressed the question of over-exploitation at Rollins by determining if there were changes through time in the location(s) of oyster exploitation, the height of oyster shells, and fish age distribution. Over-exploitation is often discussed as a contributing factor in the permanent abandonment of Southeastern shell rings, as well as the demise of the shell ring culture of the Late Archaic (e.g., Dame 2009; Mannino and Thomas 2002).

This section is divided into two parts due to the different methods of analysis regarding the oysters and marine catfish otoliths. Each section contains an introduction that includes a background on the resource, followed by the materials and methods, and concludes with the results and a brief discussion. A summary discussion on both analyses concludes the Materials and Methods section.

Oyster Analysis

Introduction

The eastern oyster, *Crassostrea virginica*, is the most conspicuous component in the majority of Late Archaic (5000 – 3000 B.P.) shell rings along the Atlantic and Gulf coasts of North America, and is the main structural component of the Rollins Shell Ring. This resource is particularly important in understanding what specific estuarine environments were exploited for subsistence at the Rollins site, and, by extension, how a large part of the subsistence quest was structured.

Previous studies on the nutritional contribution of shellfish to the diet of early Native Americans considered the resource marginal (e.g., Yesner et al. 1980); the presence of shellfish at archaeological sites was thought to represent population pressure on more favored resources like game (Bailey 1975; Byrd 1977; Wing and Brown 1979). More recent studies (e.g., Bicho and Haws 2008; Bicho et al. 2011; Finlayson 2008; Saunders and Russo 2011) argue that shellfish are more significant nutritionally than previously considered, and, rather than a marginal resource, shellfish were desirable. In the Southeast, the abundance of shell rings and middens located along the Atlantic and Gulf coasts certainly indicate that shellfish, and oysters in particular, were an important and plentiful resource. The social impact of oyster exploitation may be implied by the massive structures built from their remains. Rollins has previously been described as a ceremonial site, possibly used on a seasonal basis, which would signify that oysters played an important part in the activities that took place there – activities through which the site was created (Saunders 2003:20-25).

The objectives for the analysis of oysters from Rollins were to: 1) determine the nature of environments from which oysters were harvested by using a technique developed by Kent (1992); 2) observe the colonization and predation of oysters (e.g., barnacles, sponges, polychaete worms), which also may help identify the particular environment from which the oysters were harvested; 3) note any cultural modifications on the shells (e.g., opening methods) that may provide clues to how oysters were harvested prior to being used as construction material for the ring; and, 4) compare data across units for any changes in oyster habitat, size (specifically oyster shell height), or exploitation patterns that may indicate stress on the population, which may be interpreted as evidence of over-exploitation.

Background and Habitats

Oysters can be found along many coasts, and their abundance and availability make them a major resource for past and current coastal occupants (Kent 1992:11). In the Southeast, they are most abundant in shallow, brackish water, and, with optimal temperatures, adequate food, and water currents strong enough to prevent silting, can form extensive beds (Shumway 1996). Oysters act as filters for their aquatic environment, removing many harmful pollutants from the water while feeding, which in turn helps support other aquatic life.

The combined effects of temperature and salinity of an oyster habitat will have the greatest biological consequences regarding feeding, respiration, reproduction, parasite-disease interactions, predation rates, growth, and distribution. Temperature is the most important factor for growth and development, and salinity is influential in determining distribution (Heilmayer et al. 2008; Shumway 1996). Adult oysters are commonly found in waters with annual temperature ranges from -2 ^{o} to 36 ^{o}C, with extremes on either end noted in a few areas

(Shumway 1996:468-469). There is a correlation between water temperature and reproduction, with low reproduction occurring in extremes of low and high temperatures, while moderate temperatures (~15 ^{o}C) are more favorable for spawning (Shumway 1996:474-475).

The optimum salinity for oysters is 14-28 ppt, but there have been reports of oysters growing in water with salinity ranges from 2-3 ppt up to 40 ppt; in many cases, these extremes can only be tolerated for short periods. Consistently low salinity ranges tend to produce small, roundish oysters with whitish shells, and these environments will only support small populations. Steady, average salinity ranges produce more elongated shells, and are capable of supporting dense populations with a low concentration of predators. While consistently high salinity ranges promote high reproductive rates, the competition in this regime is also high, as is predation; this regime is characterized by high mortality, slow growth, and sparse populations (Shumway 1996:475).

Heilmayer et al. (2008) looked at stress on oyster populations from the combined effects of temperature and salinity in the St. Lucie River estuary, one of the largest estuaries along the Florida coast and located approximately 400 km (250 mi) south of Rollins Shell Ring. Their data show that while oysters have a great ability to survive extreme salinity conditions, their chances of survival are much better when accompanied by lower temperatures; likewise, their ability to handle extremes in temperature is much better at or near optimum salinities (Heilmayer et al. 2008:6).

Materials and Methods

A total of 1,092 left oyster valves were analyzed from three test units at Rollins Shell Ring: Test Unit 2 (Trench 1, from the main shell ring); Test Unit 10 (Ringlet F); and Test Unit

12c (Table 2; detailed unit descriptions can be found in Saunders 2004b). The contour map in Figure 11 shows the location of units analyzed in this study, and Table 2 provides the associated radiocarbon dates. Test Units 2 and 10 are in the main ring and ringlet walls, respectively; Test Unit 12c is a deep shell-filled pit associated with what came to be known as Ringlet L (Saunders 2010:26).

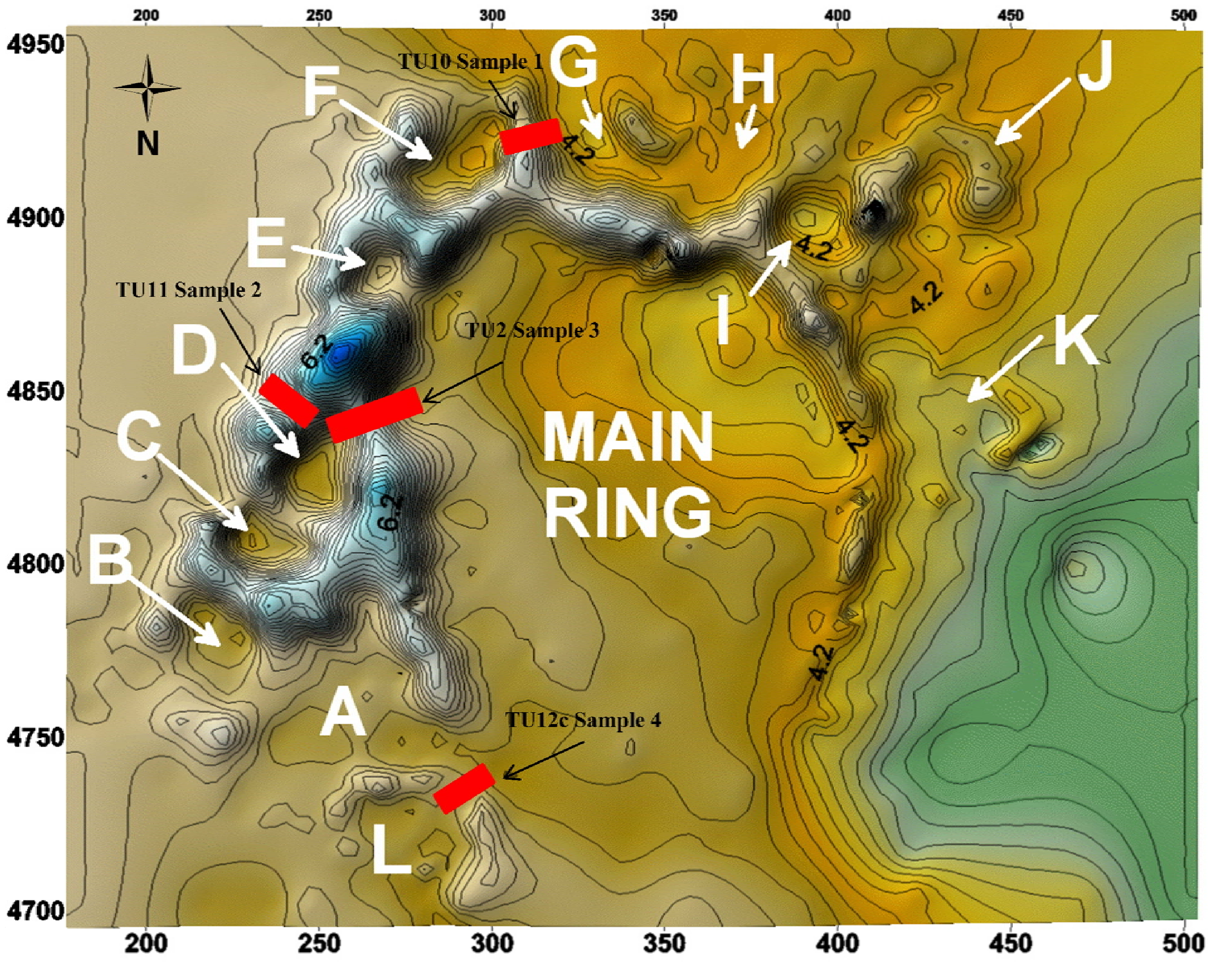


Figure 11. Sample locations analyzed in this study. Oysters were analyzed from Test Unit 10 (Ringlet F, Sample 1), Test Unit 12c (Ringlet L, Sample 4), and Test Unit 2 (Trench, Sample 3); otolith samples were analyzed from Test Unit 10 (Sample 1), Test Unit 11 (Ringlet D, Sample 2), and Test Unit 12c (Sample 4) (base map from Saunders 2010:Figure 3).

Table 2. Radiocarbon dates for samples analyzed in this study (from Saunders 2010, Table 1). See Table 1 (this paper) for all dates discussed in the current study.

Lab#	Provenience	Material	Corrected B.P.	$\delta^{13}C$	2/1 cal (intercept) 1/2cal delta R-5±20
GX-30737	TU 10, base of shell	Oyster	3930 ±80	-2.1	4150/4050 – 3820/3690
GX30738	TU 12, Feature 26, base of shell	Oyster	3840 ±70	-2.0	4000/3890 – 3690/3600
Beta-119816	Trench 1, TU 2, Feature 1, bottom deposit, 90-100 cm bs	Oyster	3670 ±70	-2.5‰	3795/3680 – 3480/3400

Oysters from Test Units 10 and 12c were from 5-gallon fine-screened sediment samples from ring contexts; the sample from Test Unit 2 comprised the entire ring feature in that level. Prior to analysis, the bulk samples were rinsed to remove any residual soil, and then the faunal remains were sorted by species. Complete results of faunal analysis are listed in Appendix A. Further sorting of the oysters for detailed analysis were by left and right valves, followed by a determination of whether the valve was whole or fragmentary. A valve was considered whole if measurements of maximum length and height could be taken. Left valves only were chosen for analysis, as well as to count minimum number of individuals (MNI), and were measured for height and length using digital calipers. The shells were weighed, and observations of epibiont activity (predation and colonization), as well as cultural modifications were noted. Bulk samples from Test Units 10 and 12c were analyzed in their entirety; however, a subsample was taken for analysis from Test Unit 2 due to the quantity of material present.

The oysters were classified using analytical techniques described by Kent (1992). Kent's work on oysters has aided archaeology by providing tools which yield information on the habitats from which oysters were collected, the intensity and season of exploitation, and the methods that were likely used for harvesting and opening oysters. In habitat determination, Kent's technique employs a ratio of the maximum height (dorsal-ventral dimension) and maximum length (anterior-posterior dimension) of the lower (left) valve (Figure 12). A ratio of the height divided by the length (HLR, originally based on Gunter 1938) provides a convenient method for quantifying and statistically analyzing oysters from archaeological sites.

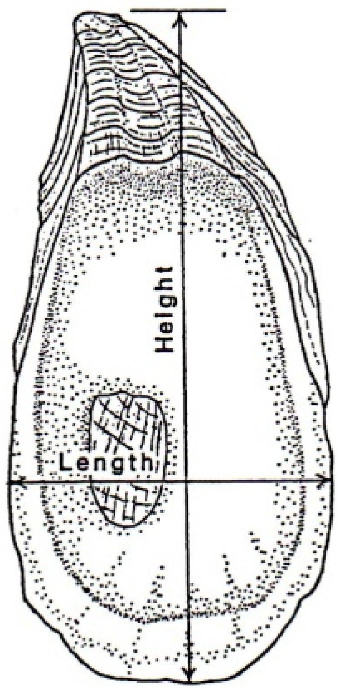


Figure 12. Diagram indicating measurements taken on oysters for HLR (Kent 1992).

Based on the HLR, oyster valves were classified into the following categories after Kent (1992):

Sand Oysters – short, broad oysters (HLR less than 1.3) from beaches and bars of coarse, firmly packed sand;
Bed Oysters – intermediate oysters (HLR between 1.3 and 2.0) from mixed muddy sand, which occur either singly or in loose clusters;
Channel Oysters – large, elongated oysters (HLR greater than 2.0) from soft mud, generally found in deeper channels; and,
Reef Oysters – small, elongate oysters (HLR greater than 2.0) from densely clustered oyster reefs.

The classification of oyster habitats offered by Kent can be further described as intertidal, which include sand, bed, and reef oysters, and subtidal, which include channel oysters. Intertidal and subtidal habitats will host specific epibionts (colonizers and predators) that will also help identify the habitat from which the oysters were harvested.

Kent states that due to overlap in the discrete measurements of individual oysters from different habitats, the mean HLR can be used to accurately determine habitats where the oysters grew (Kent 1992:27). However, Kent cautions that mean HLR alone cannot accurately distinguish between some classifications, such as channel and reef oysters. To distinguish between these two classifications, Kent suggests noting the attachment scars; channel oysters are found in loose clusters with few attachments, whereas reef oysters are found in dense clusters and will have more attachment scars. Attachment scars were not part of the analysis in this study. However, to distinguish between channel (HLR > 2.0, large and elongate) and reef (HLR > 2.0, small, elongate) oysters, a measurement of 6 cm in height was used to divide the two groups: 0 – 6 cm in height was classified as a reef oyster, and > 6 cm in height was classified as a channel oyster.

Multiple habitat exploitation can be determined by a frequency plot of HLR; bi-modal or multi-modal data distributions indicate more than one habitat being harvested (Kent 1992:65-67). My interpretation of oyster exploitation at Rollins was based upon frequency data for HLR (habitat) and oyster shell height (size); values from the units were then compared to determine if there were changes in exploitation patterns or shell size through time.

Additional information on habitat was established by noting signs of epibiont activity; epibionts are organisms that colonize and prey upon oysters. These organisms typically require a certain habitat, and their identification can provide supplemental ecological data on oyster habitat. Not all of the organisms that colonize or prey upon oysters leave evidence on the shell that can be used in analysis, but five groups are typically useful in this endeavor:

- sponges, *Cliona sp.* (shallow water intertidal; species range from brackish to higher salinity areas);
- polychaete worms (subtidal and low salinity);
- encrusting ectoprocts, bryozoans (lower to higher salinities depending on species);
- boring bivalves, i.e., *Boonea impressa* (0-30 m depth; full salinity range of oyster habitats);
- barnacles (subtidal and high salinity, to intertidal and low salinity, depending on species).

Further observations were made regarding cultural modifications, particularly opening methods such as shucking, hacking/cracking, and burning (Kent 1992:44-46). This analysis can be the most subjective classification in any study, and would not account for roasting or steaming of oysters; two processing techniques that leave no visible evidence on the shells, but are popular methods for opening large quantities of bivalves in contemporary as well as prehistoric times (Waselkov 1987).

One indicator of over-exploitation would be a change in the average size of the oyster shell through time. If oyster valve height changed through time at Rollins Shell Ring, specifically if oyster height was reduced from the beginning of site activity (Test Unit 10) through abandonment of the site (Test Unit 2), one could make the argument that oysters were an over-exploited resource at the site. Over-exploitation could further be implied if there were changes in habitats exploited through time.

However, there are other factors that may cause oyster shells to change over time; environmental changes, variations in sea surface temperatures, hurricanes, and floods (providing fresh water influx into estuaries, thereby reducing salinity levels subsequently affecting growth and development). It is beyond the scope of this current study to investigate all potential causes of changes in shell size; however, a reduction in the relative size of oyster shell through time at sites associated with human occupation and exploitation is used as an indicator of over-exploitation (e.g., Claassen 1998).

Results and Discussion

Data for individual units are discussed below, and are organized according to the age of the samples, beginning with the oldest sample (Test Unit 10), through the middle period of activity recorded for the site (Test Unit 12c), and ending with the youngest sample (Test Unit 2). Following the discussion of the individual units is a general discussion on the results and interpretation. Please refer to Table 1 for all radiocarbon dates discussed in this section.

Test Unit 10, Feature 20 (ca. 4050 – 3820 1 cal. B.P.)

A total of 371 left oyster valves were analyzed from Feature 20 in Test Unit 10. All oyster habitat classifications were represented in this sample, but the majority of oysters, 61.7% (n=229), fall into the bed classification (Figure 13, denoted in red). Following the bed oysters, channel oysters represented 17% (n=63) of the sample, sand oysters represented 14% (n=52) of the sample, and reef oysters represented 7.3% (n=27) of the sample.

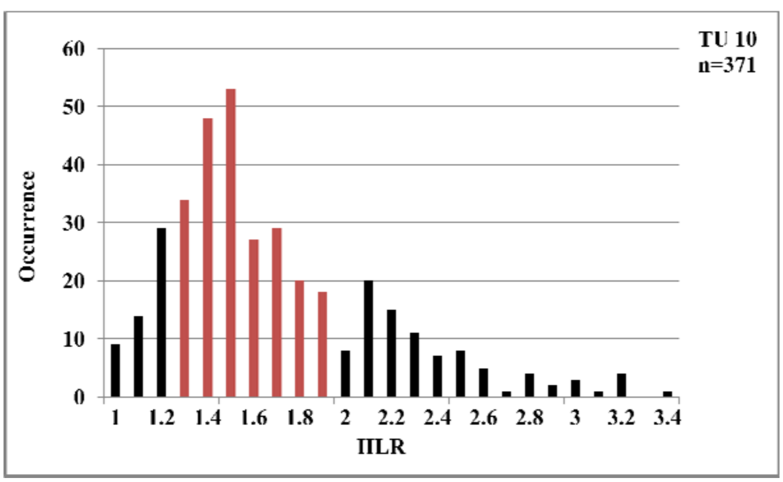
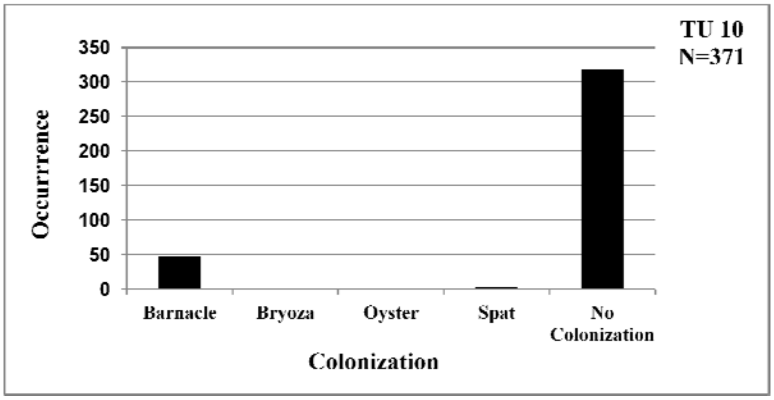


Figure 13. HLR of oysters from Test Unit 10, Rollins Shell Ring: sand oysters HLR less than 1.3; bed oysters HLR 1.3 to 2.0 (in red); channel oysters HLR > 2.0 (large, elongate); reef oysters HLR >2.0 (small, elongate).

Analysis of colonization and predation (Figure 14) indicate a small amount of barnacle activity, identified as acorn barnacles. Acorn barnacles inhabit intertidal zones and have salinity tolerances that span the full range of oyster habitats. A small amount of oyster spat colonization was observed (0.8%; n=3), and their presence may lend seasonal data. Contemporary studies (e.g., Manley et al. 2008; O'Beirn et al. 1995) report a long reproductive period for *C. virginica* along the lower Southeastern coast (Georgia) occurring from early April – late October. Recruitment of oyster spat onto cultch (the substrate to which young oysters attach, and in this specific case other oysters) has been observed from July through October.

Minimal evidence of predation from the polychaete worm (2.7%; n=10) and boring sponge (0.3%; n=1) was observed on oysters from Test Unit 10 (see Figure 14). Polychaete worms prefer soft, muddy substrates. The boring sponge observed in this unit yielded borehole measurements between .8 mm and 1.4 mm, which are considered small and attributed to *Cliona trutti*. Along the Southeastern coast near the study area, *C. trutti* are found in lower salinity regimes of about 10-15 ppt (Hopkins 1962:122). While some epibiont activity was observed in Test Unit 10, a majority of the oysters showed no signs of colonization (86%; n=319) or predation (97%; n=360).

Observations of modification indicated that 30.2% (n=112) of the oysters from this unit displayed evidence of hacking/cracking, 14.2% (n=52) had evidence of shucking, and 1.9% (n=7) evidenced both hacking/cracking and shucking (Figure 15). Over half of the oysters analyzed, 53.9% (n=200), displayed no obvious signs of modification; there was no evidence of burned shell in this unit.



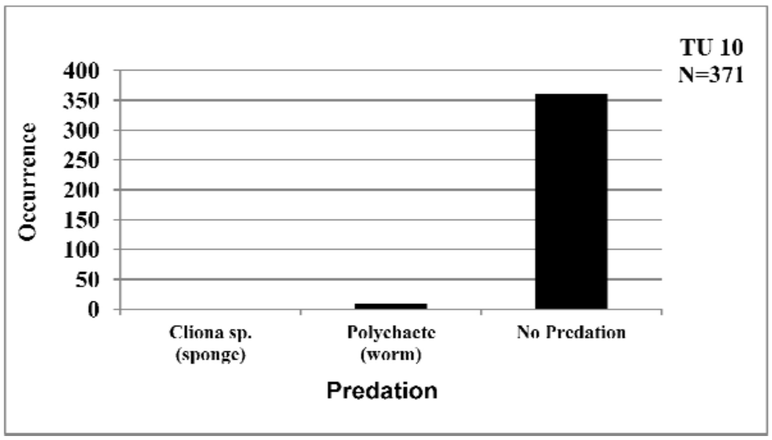


Figure 14. Colonization and predation for oysters from Test Unit 10, Rollins Shell Ring.

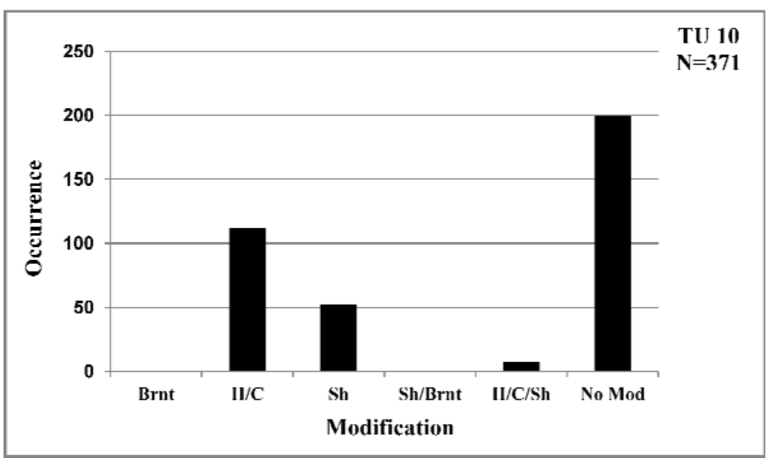


Figure 15. Modification of oysters from Test Unit 10, Rollins Shell Ring.

Mean height of oyster shell was 5.5 cm, with a mode of 6.4 cm; the data were highly skewed (Figure 16) with one outlier of >15 cm. Test Unit 10, the oldest sample analyzed from Rollins, exhibited a higher range of oyster shell heights as well as habitats (see HLR distribution in Figure 12). This data suggested a wide exploitation pattern for oysters during the early period of shell construction activity recorded for this site.

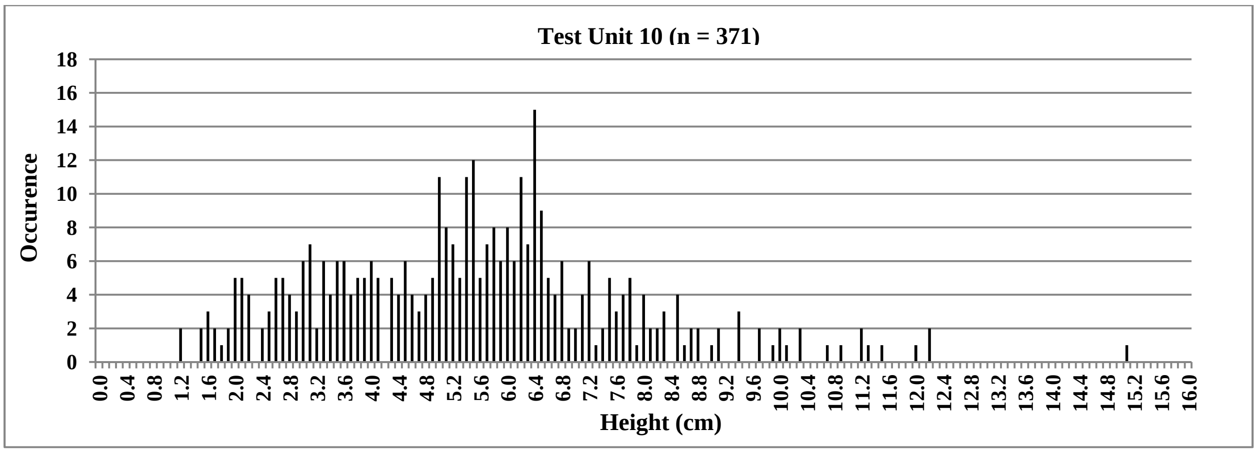


Figure 16. Oyster shell height from Test Unit 10, Rollins Shell Ring. Mean shell height was 5.5 cm, with a mode of 6.4 cm.

Test Unit 12c, Feature 26 (ca. 3890 – 3690 1 cal. B.P.)

A total of 359 left oyster valves were analyzed from Test Unit 12c. As with Test Unit 10, oysters from all four habitat classifications were noted, but the majority of oysters, 73.5% (n=288), were from the bed classification (Figure 17, noted in red). Bed oysters were followed by channel oysters at 10% (n=36), sand oysters at 8.4% (n=30), and reef oysters at 8.1% (n=29). When compared to Test Unit 10, there appeared to have been an increase in the presence of bed oysters, but an overall decrease in exploitation from other oyster habitats.

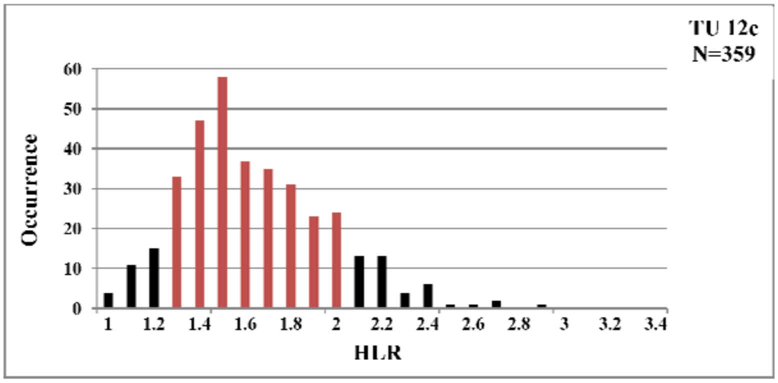
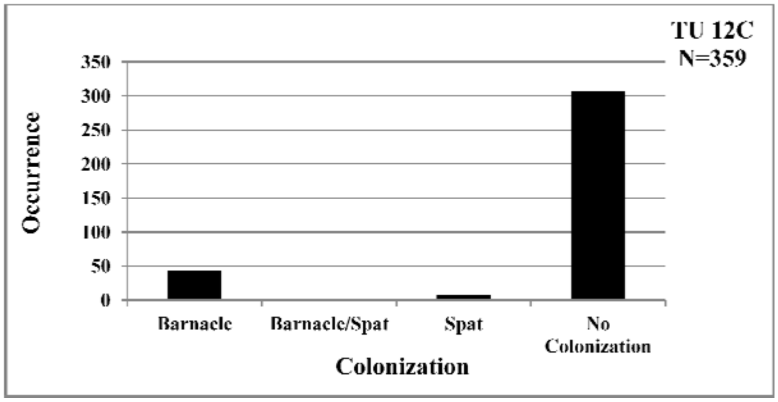


Figure 17. HLR of oysters from Test Unit 12c, Rollins Shell Ring: sand oysters HLR less than 1.3; bed oysters HLR 1.3 to 2.0 (in red); channel oysters HLR > 2.0 (large, elongate); reef oysters HLR >2.0 (small, elongate).

Analysis of colonization (Figure 18) indicated acorn barnacle activity (12%; n=43), acorn barnacle and spat activity (0.6%; n=2), and spat activity (1.9%; n=7); however, the majority (85.5%; n=307) of oysters from Test Unit 12c showed no signs of colonization activity. The presence of acorn barnacles signified an intertidal zone and salinity range suitable for oysters. The presence of oyster spat lends a seasonal component, July through October. There was minimal predation observed from the polychaete worm (0.6%; n=2) and boring sponge (1.4%; n=5), but the majority of oysters (98.1%; n=352) had no evidence of predation. The presence of the boring sponge, *C. trutti*, while minimal, offers a salinity regime of 10-15 ppt and a preference for intertidal zones.

Observations of modification (Figure 19) indicated that 11.7% (n=42) of the oysters from this unit were hacked/cracked, 13.1% (n=47) evidenced shucking, and 2.5% (n=9) evidenced both hacking/cracking and shucking. There was a small amount of burned shell, 0.3% (n=1). The majority of the oysters analyzed, 72.4% (n=260), display no obvious signs of modification.



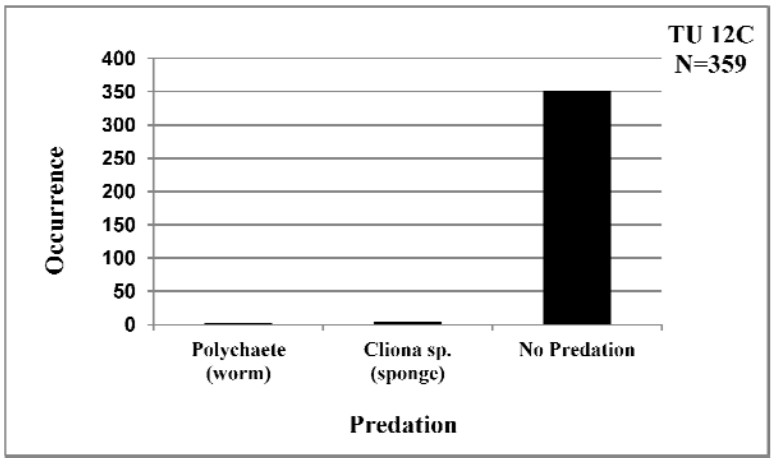


Figure 18. Colonization and predation for oysters from Test Unit 12c, Rollins Shell Ring.

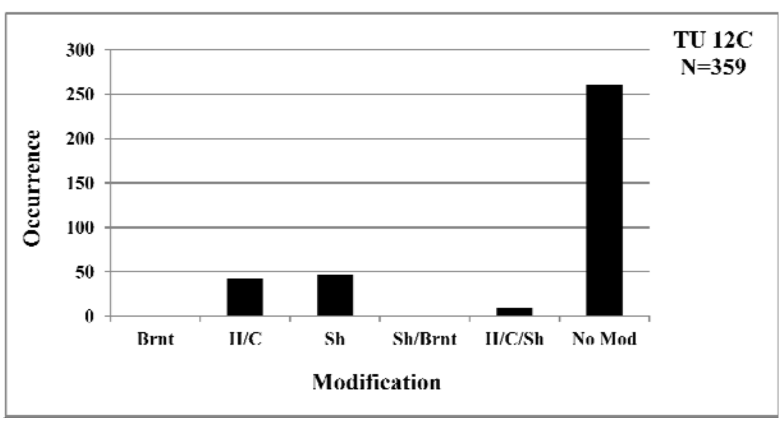


Figure 19. Modification of oysters from Test Unit 12c, Rollins Shell Ring.

The mean height of oyster shell from this unit was 5.1 cm, with a mode of 5.5 cm. Data were slightly skewed with a number of data points (heights) to the right of the mean (Figure 20), including a few outliers (oyster heights > 9.0 cm) that contributed to the skewness. A more narrow range of oyster height was seen in Test Unit 12c when compared to Test Unit 10, and, when taken together with the HLR data (see Figure 18), indicated an overall decrease in the range of oyster sizes. A slight change seems to have occurred in this sample in that oyster exploitation patterns were less inclusive than in earlier shell construction activity, as represented by Test Unit 10. At this time, the types of oyster habitats exploited may have become smaller, and/or a more specific size range was targeted.

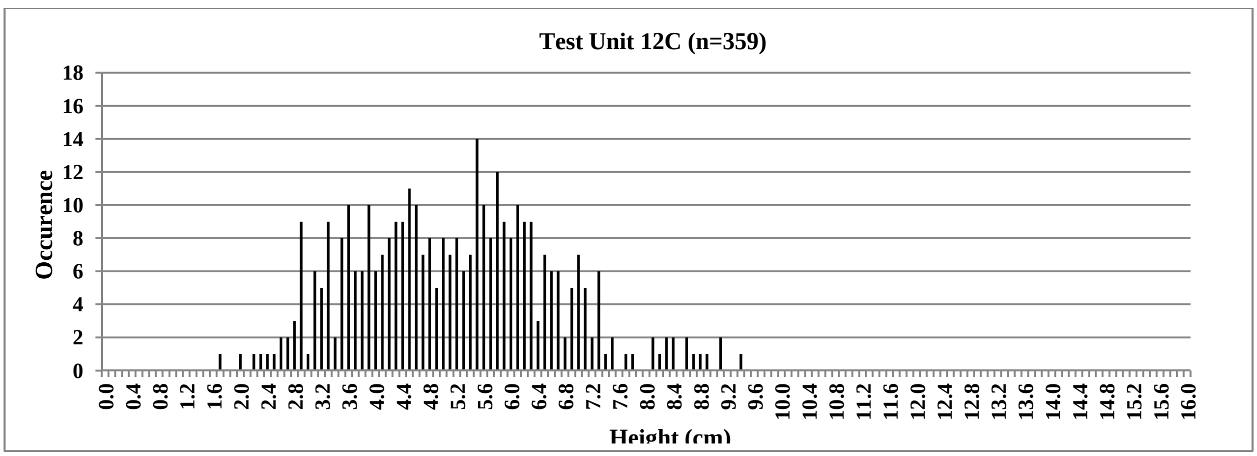


Figure 20. Oyster shell height from Test Unit 12c, Rollins Shell Ring. Mean shell height is 5.1 cm and mode is 5.5 cm.

Test Unit 2, Feature 1 (ca. 3680 – 3480 1 cal. B.P.)

A total of 362 left oyster valves were analyzed from Test Unit 2. Oyster valves from all habitat classifications were noted, but over half of the valves analyzed, 67.7% (n=245), were classified as bed oysters (Figure 21, noted in red). Channel oysters represented 15.2% (n=55), followed by sand and reef oysters which were equally represented at 8.6% (n=31). If compared to Test Unit 12c, there appears to be a slight decrease in the presence of bed oysters, and a slight increase in the presence of channel oysters; there was little change in the representation of sand and reef oysters when compared to Test Unit 12c. Habitat variability appeared to have increased when compared to Test Unit 12c, but did not reach the numbers noted in Test Unit 10.

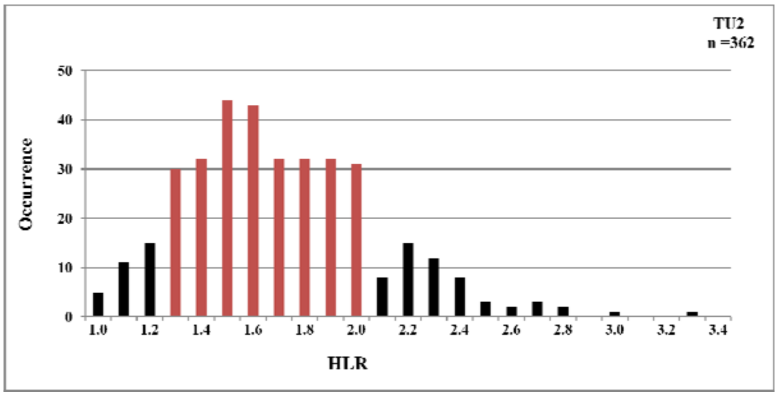


Figure 21. HLR of oysters from Test Unit 2, Rollins Shell Ring: sand oysters HLR less than 1.3; bed oysters HLR 1.3 to 2.0 (in red); channel oysters HLR > 2.0 (large, elongate); reef oysters HLR >2.0 (small, elongate).

Analysis of colonization indicated that nearly 32% (n=115) of the oysters from this unit showed evidence of acorn barnacle (Figure 22), which was the most colonizing activity seen in the samples analyzed. Observations of other colonizing activity, such as acorn barnacle together with spat (0.8%; n=3), attachments by other oysters (4.1%; n=15) and spat (3.9%; n=14) were also noted. Over half of the oysters (59.4%; n=215) showed no colonizing activity, now was there was evidence of predation in this unit. Colonization by acorn barnacles does not compromise the shell of the oyster, but the two organisms may compete for food resources. In addition to competing for resources, barnacles can, in large numbers, foul the water, which could potentially mean added stress for the oyster population.

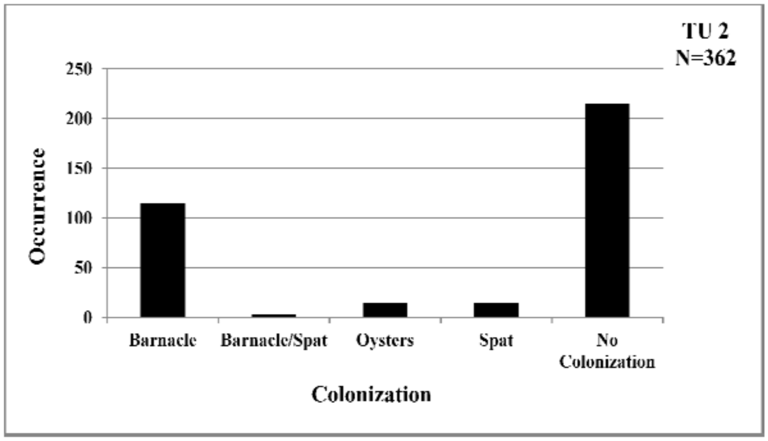


Figure 22. Colonization of oysters from Test Unit 2, Rollins Shell Ring.

Observations of modification of the oysters indicated that 19.1% (n=69) of the oysters from Test Unit 2 displayed evidence of hacking/cracking, 13.5% (n=49) had evidence of shucking, and 5.2% (n=19) evidenced both hacking/cracking and shucking (Figure 23). There was more evidence of burning, 6.4% (n=23), and a small number, 0.8% (n=3), that exhibited signs of shucking and burning. However, over half of the oysters analyzed, 55% (n=199), displayed no obvious signs of modification.

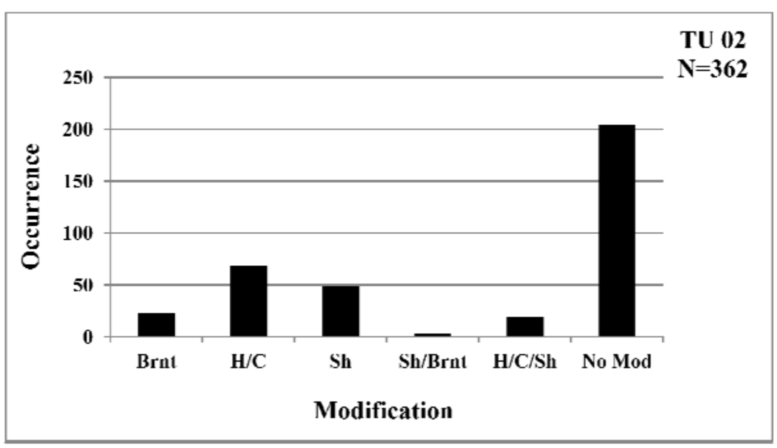


Figure 23. Modification of oysters from Test Unit 2, Rollins Shell Ring.

The mean height of oyster shells from Test Unit 2 was 5.4 cm, with a mode of 5.2 cm. The data were slightly skewed to the right (Figure 24), and included outliers of > 10 cm. Test Unit 2, the youngest sample analyzed from this site, exhibits a range of variability in oyster shell height as well as habitats exploited (see Figure 21), similar to the variability in Test Unit 10.

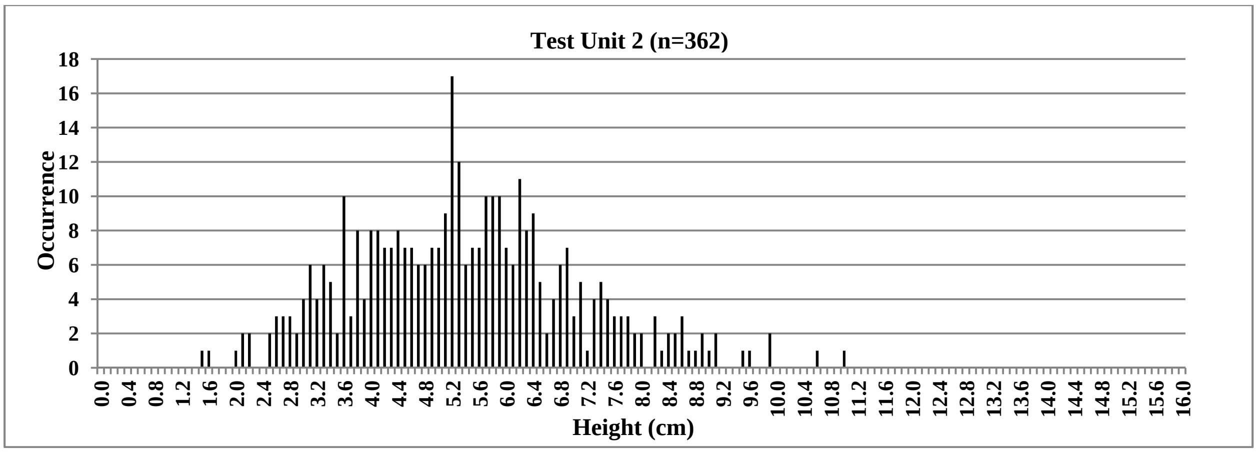
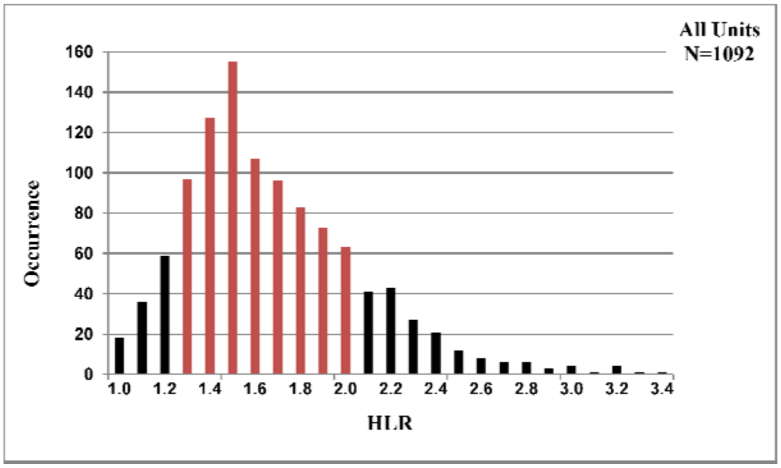


Figure 24. Oyster shell height from Test Unit 2, Rollins Shell Ring. Mean shell height was 5.4 cm with a mode of 5.2 cm.

While oyster specimens from all four of Kent's habitat classifications were noted, the most abundant classification from all units analyzed was bed oysters (HLR between 1.3 and 2.0), representing 67.7% of all oyster valves analyzed, or 739 out of 1,092 (Figure 25, in red). Test Unit 10 exhibited more variability in habitat classifications, and, while Test Unit 12c and Test Unit 2 also contained oysters from other habitats, these units show an overall decrease in variability of oyster habitats exploited when compared to Test Unit 10. This data suggested that through time at Rollins Shell Ring there was remained a preference for bed oysters, but in the beginning of ring construction (as represented by Test Unit 10), a wider range of oyster habitats were exploited than in subsequent occupations at the site.



Provenience	Oyster Habitat				Totals
	Sand HLR < 1.3	**Bed HLR 1.3 – 2.0**	**Reef HLR > 2.0 (small, elongate)**	**Channel HLR > 2.0 (large, elongate)**	
Test Unit 10	51 (13.8%)	230 (62.0%)	27 (7.3%)	63 (17.0%)	371 (34.0%)
Test Unit 12c	30 (8.4%)	264 (73.5%)	29 (8.1%)	36 (10.0%)	359 (32.9%)
Test Unit 2	31 (8.6%)	245 (67.7%)	31 (8.6%)	55 (15.2%)	362 (33.2%)
Totals	**112 (10.3%)**	**739 (67.7%)**	**87 (8.0%)**	**154 (14.1%)**	**1,092**

Figure 25. Oyster HLR for all units, Rollins Shell Ring (bed oysters noted in red).

Taken together, mean of all HLR yielded a distribution skewed somewhat to the right (see graph in Figure 25). If graphed based on the mean HLR (Figure 26), as is common in some faunal analyses (e.g., Quitmyer 2002), only bed oysters would be represented. Thus, it's probably inappropriate to use only mean HLR for the combined units due to the variety of oyster habitats presented by the data, and discussed in more detail below.

When the units are compared, the predominance of bed oysters noted across the samples might suggest that little had changed in oyster exploitation patterns through time at Rollins. However, there were some statistically significant differences in the presence of sand, and reef and channel oysters within and between units. Figure 27 displays the results of Pearson's chi-square test. The difference in oyster habitat classifications recorded from Test Units 10 and 12c are statistically significant (*p*=<.0001) and have an inverse relationship, while the differences recorded in Test Unit 2 reveal no striking departures from the expected.

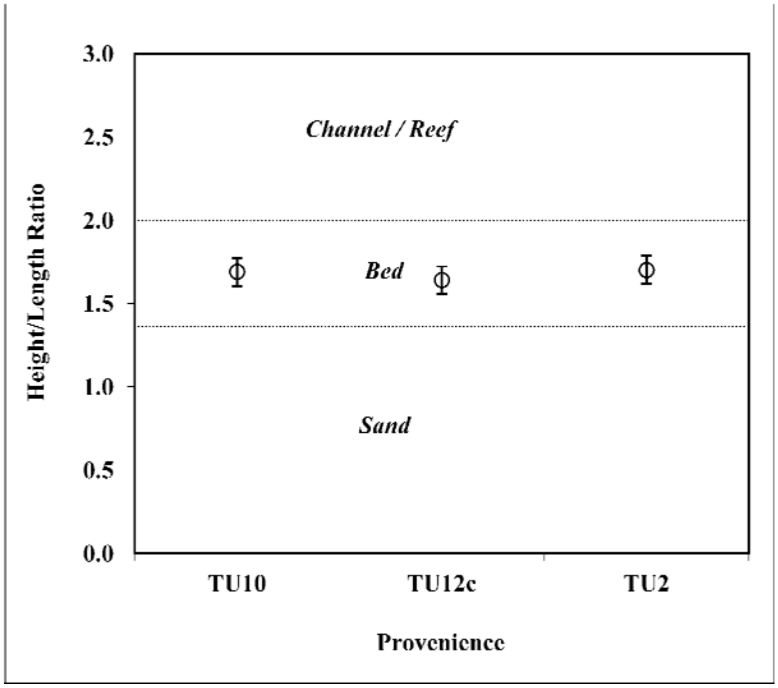


Figure 26. Box plot of the mean HLR for all units with 95% confidence interval. The mean HLR for Test Unit 10 is 1.69, with a standard deviation of 0.47; mean HLR for Test Unit 12c is 1.64, with a standard deviation of 0.33; and mean HLR for Test Unit 2 is 1.70, with a standard deviation 0.37. Graph patterned after Quitmyer 2002.

In order to assess the significance of the HLR data on oyster exploitation at Rollins Shell Ring, a more detailed description of the habitats for the oyster classifications used in this study is needed. The four classifications of oysters (bed, sand, channel and reef) can be further defined as intertidal oysters (bed, sand, and reef) and subtidal oysters (channel). Intertidal oysters typically live in shallow water that is periodically exposed to air at certain times and tides (Pugliese and Brouwer 2009). Exposure to air benefits oysters as it reduces predation by some species of sponges (e.g., *Cliona trutti*), in addition to regulating bio-fouling organisms (e.g., barnacles). The downside of air exposure is that it can cause stress on the population, which in turn can have an effect on growth and development of the oyster. In comparison, subtidal oysters are always submerged and never exposed to air. Continual submersion can reduce stress from exposure to air, but deeper water also means an increase in predators, particularly some species of the boring sponge *Cliona*.

Classification	**Provenience**			
Frequency Expected Cell Chi-Square	**Test Unit 10**	**Test Unit 12c**	**Test Unit 2**	**Total**
Bed Oyster	**231 259.56 3.1434**	**288 251.17 5.401**	245 253.27 0.2699	764
Channel Oyster	**62 46.885 4.8731**	**21 45.368 13.089**	55 45.747 1.8714	138
Reef Oyster	27 26.5 0.0094	20 25.643 1.2417	31 25.857 1.0229	78
Sand Oyster	**51 38.051 4.4064**	30 36.821 1.2634	31 37.128 1.0115	112
Total	371	359	362	1092

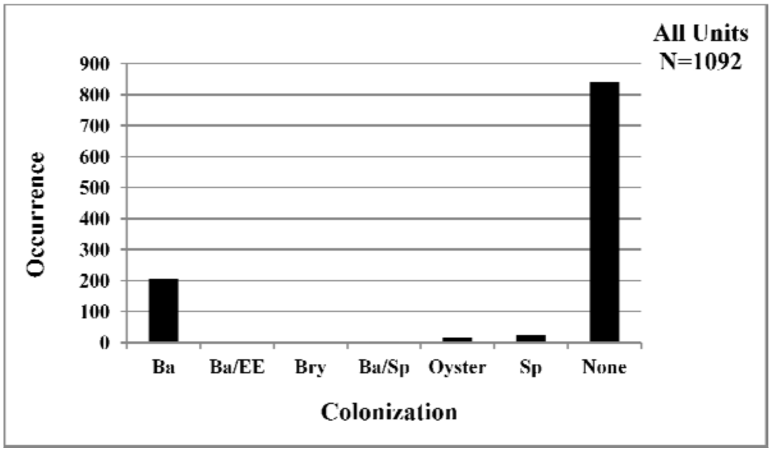
Statistic	**DF**	**Value**	**Probability**
Chi-Square	6	37.6028	<.0001

Figure 27. Pearson's chi-square test and significance for HLR.

Test Unit 10, the earliest of the three samples analyzed (4050 – 3820 1 cal B.P.), displayed several departures from the expected outcome. During this early period of shell ring activity at Rollins, bed oysters were predominant, but other oyster habitats were also being exploited to a noticeable degree (bolded data in table). The frequency of channel oysters was more than expected (62:47, respectively), as was sand oysters (51:38, respectively), while the frequency of bed oysters was less than expected (231:260, respectively). Channel oysters are found in deep water (subtidal) relative to bed, sand, and reef oysters, which are found in shallow water (intertidal).

Test Unit 12c (3890 – 3690 1 cal B.P.) showed the inverse of Test Unit 10 regarding bed and channel oysters. In this unit, reef and sand oysters displayed little departure from the expected; however, there were nearly half the frequency of channel oysters as expected (21:45, respectively), and more bed oysters were observed than expected (288:251, respectively). This is the opposite in relation to water depth as found in Test Unit 10, with the majority of oysters still being harvested from shallow water (i.e., intertidal bed oysters), and only minimal exploitation of oysters from deep water (i.e., subtidal channel oysters).

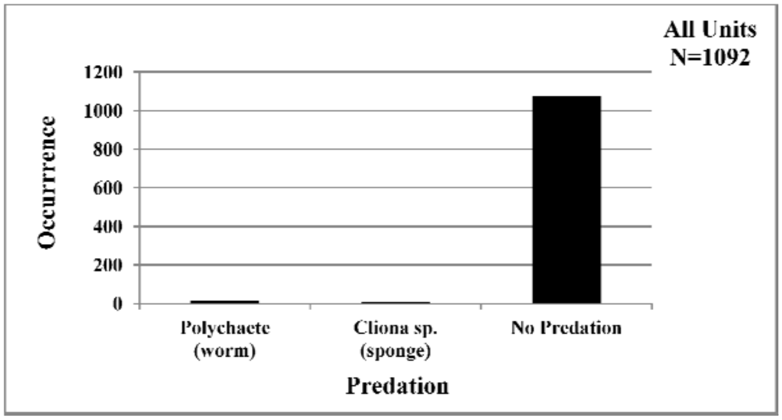
The colonization data for all units is presented in Figure 28. While a majority of oysters from the test units analyzed exhibited no signs of colonizing activity (77%), there were some observations that provided more information on the harvesting environment. The presence of acorn barnacles was noted in all units analyzed; however, of the total number of observations for barnacle activity (n=204), some were noted as occurring on the inside of the shell, which indicated that the shell was dead at harvest (about 11%, n=22). Spat, as previously discussed, may provide seasonal data (July through October), and of the total observations noted in this study (n=24) the majority of spat activity was from Test Unit 2 (58%, n=14). Spat from Test Unit 2 were present on oysters from sand, bed, and reef habitats, and all observations were noted on the inside of the shell indicating the oysters were dead at harvest (see Appendix B for oyster data). Only one incidence of encrusting ectoprocts and bryozoans were noted from the entire analysis, but their presence does not enlighten us further about the harvesting environment.



Provenience	Colonization							Totals
	Ba	Ba/EE	Bry	Ba/Sp	Oyster	Sp	None	
Test Unit 10	46 (12.4%)	1 (0.3%)	1 (0.3%)	0	1 (0.3%)	3 (0.8%)	319 (86.0%)	371
Test Unit 12c	43 (12.0%)	0	0	2 (0.6%)	0	7 (2.0%)	307 (85.5%)	359
Test Unit 2	115 (31.8%)	0	0	3 (0.8%)	15 (4.1%)	14 (3.9%)	215 (59.4%)	362
Totals	**204 (18.7%)**	**1 (0.1%)**	**1 (0.1%)**	**5 (0.5%)**	**16 (1.5%)**	**24 (2.2%)**	**841 (77.0%)**	**1,092**

Figure 28. Oyster colonization for all units, Rollins Shell Ring: Ba-barnacle; Ba/EE-barnacle and encrusting ectoprocts; Bry-byrozoan; Ba/Sp-barnacle and spat; Sp-spat.

The predation data for all units (Figure 29) indicated that the majority of observations of polychaete worms came from Test Unit 10 (83%, n=10), and observations were split between oysters from bed and channel habitats (n=5 each). Boring sponge activity was noted at a higher incident in Test Unit 12c (83%, n=5) and all observations were from bed oysters. As noted earlier, polychaete worms prefer a soft, muddy substrate which explains their association with bed oysters, and boring sponges (*C. trutti*) in the site area prefer low salinity (10-15 ppt) and intertidal zones. The presence of these predatory species is quite small given the total number of valves analyzed (1.6%, n=18), but the information they provide on habitat supports an intertidal (shallow), low salinity regime. The vast majority of oysters analyzed exhibit no signs of predation activity (98.4%).



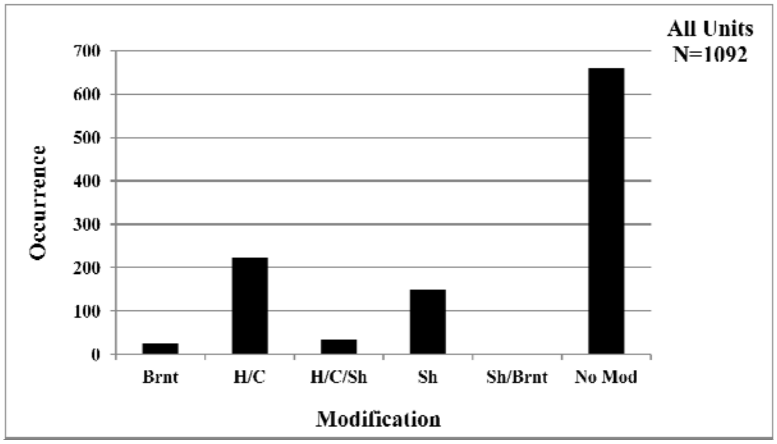
Provenience	Predation			Totals
	Polychaete **(worm)**	***Cliona sp.*** **(sponge)**	**No Predation**	
Test Unit 10	10 (2.7%)	1 (0.3%)	360 (97.4%)	371
Test Unit 12c	2 (0.6%)	5 (1.4%)	352 (98.1%)	359
Test Unit 2	0	0	362 (100%)	362
Totals	**12 (1.1%)**	**6 (0.5%)**	**1,074 (98.4%)**	**1,092**

Figure 29. Oyster predation for all units from Rollins Shell Ring.

Observations of cultural modification from all units indicated that only about 2% (n=24) were burned, while a little over 20% (n=223) showed signs of hacking/cracking, and 13.6% (n=148) were shucked (Figure 30). A majority, 60% (n=659), showed no signs of modification. While roasting and steaming have been offered as efficient and oft used methods for opening large quantities of oysters (Waselkov 1987), these techniques leave no visual evidence on shell and therefore cannot be confirmed in this study. However, even if oysters were roasted or steamed, shucking would still need to be employed in order to fully remove the meat. The lack of other evidence suggests that roasting and steaming may have been the preferred method for opening the large numbers of oysters present at this site.

A comparison of height data across the samples was used to determine if oyster shell size changed through time at Rollins. Oyster shell height can be associated with age (Lynn, personal communication 2011), and the goal was to determine if there were changes in shell height, and by extension age. Statistics for shell height are presented in Table 3. The most notable difference is in modes, with Test Unit 10 exhibiting a mode of 6.40 cm, compared to the mode from Test Unit 12c of 5.5 cm, and Test Unit 2 of 5.2 cm. An overall decrease in the mode of oyster shell height did occur through time at Rollins, and this difference was due to a decrease in the variety of oyster habitats exploited through time and across samples.

Pearson's chi-square test of oyster height indicated a statistical significance in the differences between units (p=0.0084), and further investigation of the data revealed that the higher incident of oysters from other habitats in Test Unit 10 was responsible for this difference. The increased shell height and variation of Test Unit 10 can be explained by a large number of channel oysters present in this sample, which are by Kent's definition, larger. A box plot of oyster heights (Figure 31) confirmed the high incident of oysters from other habitats in Test Unit 10. Test Unit 12c displayed a decrease in shell size, and variability of oysters harvested when compared to Test Unit 10. While Test Unit 2 included higher incidents of oysters from other habitats than Test Unit 12c, it contained somewhat fewer quantities than Test Unit 10, particularly regarding the larger channel oysters.   These data support the conclusion that in early shell ring construction at Rollins (represented by Test Unit 10) more oysters from a variety of habitats were being exploited. In the middle period of shell ring construction at the site (represented by Test Unit 12c) a more selective process occurred, which resulted in less variability in oyster shell heights due to fewer individuals from other oyster habitats. In the later period of shell ring construction at the site (represented by Test Unit 2), some variability returned to oyster exploitation at Rollins, but does not quite match the numbers seen in Test Unit 10.



Provenience	Modification						Totals
	Brnt	H/C	H/C/Sh	Sh	Sh/Brnt	No Mod	
Test Unit 10	0	112 (30.2%)	7 (1.9%)	52 (14.0%)	0	200 (53.9%)	371
Test Unit 12c	1 (0.3%)	42 (11.7%)	9 (2.5%)	47 (13.1%)	0	260 (72.4%)	359
Test Unit 2	23 (6.4%)	69 (19.1%)	19 (5.3%)	49 (13.5%)	3 (0.8%)	199 (55.0%)	362
Totals	**24 (2.2%)**	**223 (20.4%)**	**35 (3.2%)**	**148 (13.6%)**	**3 (0.3%)**	**659 (60.4%)**	**1,092**

Figure 30. Oyster modification for all units, Rollins Shell Ring: Brnt-burnt; H/C-hacked/cracked; H/C/Sh-hacked/cracked and shucked; Sh-shucked; Sh/Brnt-shucked and burnt; No Mod-no modification.

Table 3. Mean, median, and mode of oyster shell height, Rollins Shell Ring.

Provenience	Radiocarbon date B.P.	Mean Ht (cm)	Median Ht (cm)	Mode (cm)
Test Unit 10	**ca. 4050-3820 (1 cal)**	**5.49**	**5.50**	**6.40**
Test Unit 12c	**ca. 3890-3690 (1 cal)**	**5.15**	**5.10**	**5.50**
Test Unit 2	**ca. 3680-3480 (1 cal)**	**5.40**	**5.30**	**5.20**

The predominance of bed oysters throughout the samples is not in question, and while there is evidence of more than one oyster habit being exploited, bed oysters comprised the majority spatially and temporally at Rollins. Oyster shell height did vary throughout the period of activity recorded at this site, due mainly to the higher incident of channel oysters in Test Unit 10. Minimal epibiont activity (colonization and predation) was present in the Rollins oysters (see Figure 27). The few instances of boring sponge activity noted in this study were attributed to *C. trutti*, and indicated a shallow (intertidal) zone with low salinity. The most significant colonizer was the acorn barnacle which supported an intertidal zone with a salinity range suitable for most oysters.

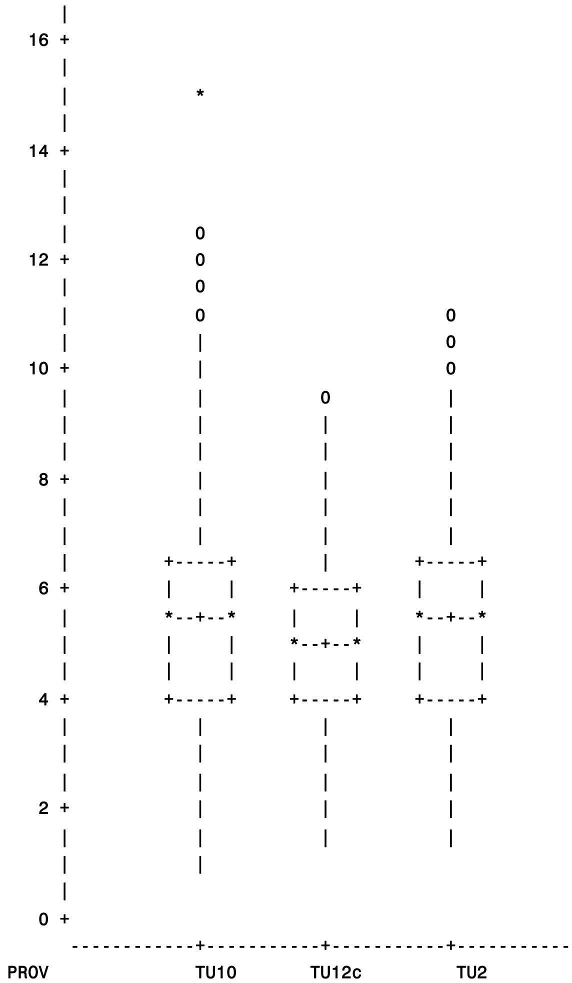


Figure 31. Box plot of oyster shell heights, Rollins Shell Ring. At first glance Test Unit 2 appears similar to Test Unit 10, but there is a wider range of variation present in Test Unit 10 with higher incidents of smaller and larger individuals present, as seen in the tails of the boxes.

These results strongly suggest that oysters used in the early shell construction at Rollins were largely exploited from one ecological niche. The population of oysters, as represented by these archaeological samples, appeared to have been relatively healthy, as evidenced by the low predation rates and stable shell sizes through time. It is my opinion that oysters used in the construction of the Rollins Shell Ring and associated features were likely not an over-exploited resource.

Marine Catfish Otolith Analysis

Introduction

Otoliths, or fish ear stones (Figure 32), are important analytical tools in the fields of biology and archaeology (Van Neer et al. 1999). Both disciplines use them as indicators of species, age, and general health (Van Neer et al. 1999; VanderKooy 2009). Additionally, archaeologists use otoliths as indicators of seasonality and resource procurement strategies at prehistoric sites (Andrus 2011; Van Neer et al. 1993). Otolith seasonal records are based on changes in water temperature and salinity recorded in the daily growth patterns of the otoliths (Pannella 1971; Wurster and Patterson 2001:82). Information gleaned from these biological paleoenvironmental markers can also document changes in habitat and exploitation patterns through time (Claassen 1998).

Figure 32. Marine catfish otolith, *Arius felis* (VanderKooy 2009).

Otolith specimens were analyzed from three units of the 2003 – 2004 excavations at the Rollins Shell Ring: Test Unit 10 (Ringlet F), Test Unit 11 (Ringlet D), and Test Unit 12c (shell-filled pit associated with Ringlet L). The units were chosen to represent the span of occupation recorded for the site (Table 4), and because they contained large numbers of otoliths. In addition, otoliths from Test Unit 2 (1998 excavations) analyzed by Andrew Fisher, previously from Coastal Fisheries at Louisiana State University (LSU), are included in this analysis. Primary data were gathered from 81 otoliths belonging to two species of marine catfish found at Rollins, *B. marinus* and *A. felis* (Figure 33); left-sided otoliths were selected for analysis, and also served as MNI. Of particular interest in this study were their use: 1) as seasonal proxies for oyster harvesting; 2) as phenological (the study of plant and animal life cycle events as influenced by seasonal and interannual variations in climate) proxies regarding the behavior patterns of the marine catfish species in this study; and, 3) in determining procurement patterns for marine catfish at the site.

Table 4. Radiocarbon dates for otolith samples analyzed in this study (from Saunders 2004b).

Provenience	**Description**	**Radiocarbon date B.P (corrected)**
Test Unit 10	Oyster sample, base of shell	3930 ± 80, ca. 4050 – 3690 B.P. (1 cal)
Test Unit 12c	Oyster sample, base of shell	3840 ± 70, ca. 3890 – 3600 B.P. (1 cal)
Test Unit 11	Oyster sample, base of shell	3630 ± 70, ca. 3700 – 3650 B.P. (1 cal)

Previous analysis at Rollins indicated that fishes, especially marine catfish, made up more than 90% (in numbers of individuals present) of the vertebrate faunal remains from Test Units 10 and 11, and, while Test Unit 12c produced comparatively little faunal remains overall, marine catfish were predominant in that unit as well (Saunders 2010:25). This suggested that marine catfish were an important subsistence resource at this site, and their inclusion in this study may provide additional information on resource exploitation.

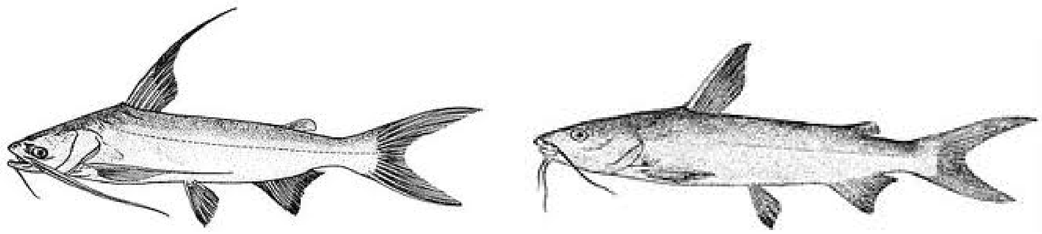


Figure 33. Marine catfish species found at Rollins Shell Ring: *B. marinus*, common name gafftopsail catfish (left), and *A. felis*, common name hardhead catfish (taken from the Smithsonian Field Guide to Boney Fishes, http://www.sms.si.edu/irlfieldguide/bonyfishes.htm).

Background and Habitats

B. marinus and *A. felis* are very similar in characteristics and habits, and are often discussed collectively by fisheries experts. This study will follow suit, but for a more complete description of the morphology and identification on each species the reader is referred to Muncy and Wingo (1983). Both species are found in Atlantic coastal waters from Massachusetts to the Yucatan and prefer turbid, shallow, coastal waters with sand or mud substrates during certain seasons. It has been reported that *A. felis* can also be found in freshwater (Muncy and Wingo 1983:11).

Spawning occurs from May to August in back bays of shallow (approximately 9-12 m), warm water mudflats, with salinity ranges from about 13 to 30 ppt. Oral gestation, with the male of the species carrying fertilized eggs, larvae, and small juveniles in their mouths has been described in both species (Muncy and Wingo 1983:4); therefore, adverse environmental factors are highly regulated for the young due to the mobility that the male can provide, which greatly increases the survival chances of the juveniles. In most Southeastern waters areas where these species are found, juveniles remain in low salinity estuaries while adults move around according to spawning schedules and water temperatures, migrating offshore in winter and returning inshore during spring. In both species, sexual maturity is reached in as little as 2 years.

The diet of these marine catfish are also similar, and includes items such as algae, sea grasses, coelenterates, holothurians, gastropods, polychaetes, crustaceans, and blue crabs (specifically associated with *B. marinus*). Interestingly, in modern times these species are not considered a favored food or sport fish, and when caught are discarded by most anglers (especially *A. felis*); however, they are found in great abundance at Rollins Shell Ring.

Materials and Methods

In teleost (bony) fishes there are three pairs of otoliths: lapillus, sagitta, and asteriscus (Figure 34), with the sagitta being the largest and the pair most commonly used in archaeological research (Pannella 1971; Simons 1986).

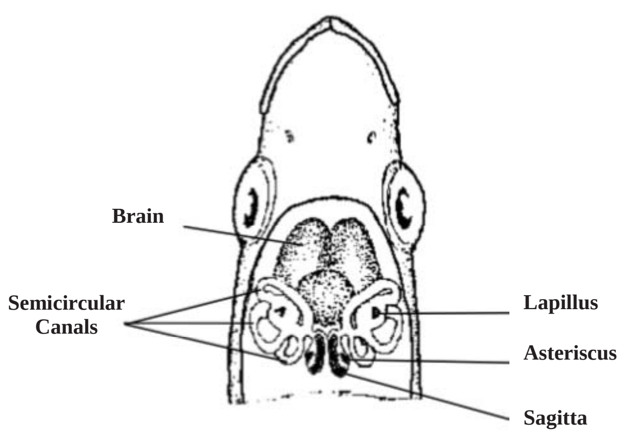


Figure 34. Generalized diagram of fish skeleton with location of otolith pairs (from VanderKooy 2009 Figure 2.1A).

Otoliths are formed by dense layers of aragonite and calcite, along with a small amount of organic matrix (Van Neer et al. 1993). The layers are deposited in opaque and translucent bands (Figure 35) that, in southern waters, coincide with cool and warm water temperatures, respectively; the translucent band indicates the more stressful environment for the organism. Bands are laid down yearly throughout the life of the fish, with the seasonal groupings discernible under low magnification (Pannella 1971). One pair of opaque and translucent banding denotes an annual cycle in the life of the fish, with the terminal band indicating season of harvest. The ability to assess season of harvest for this subsistence resource at coastal prehistoric sites can add to our knowledge of seasonal procurement patterns.

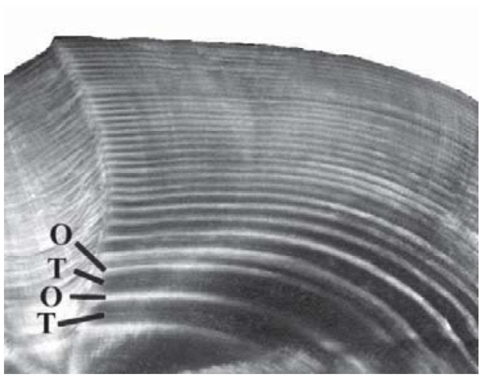


Figure 35. Example of opaque (O) and translucent (T) bands in sectioned otolith (from VanderKooy 2009 Figure 2.4).

In paleoenvironmental reconstructions, seasonal proxies are chosen based on the appropriate scale for the study, but researchers must also consider the accuracy and resolution of these proxies (Bradley 1999:4-8). The dates for the units analyzed in this study are well established; otolith specimens were taken from controlled levels of no more than 10 cm in depth and the samples were well segregated from each other in space (refer to Figure 11). Taken together, the units chosen for the otolith analysis represent occupation from about 4010-3770 1 cal B.P. (Saunders 2004b). The resolution of otolith banding is annual (for age assessment) and seasonal (terminal band representing season of harvest).

Prior to sectioning, otoliths were assigned to species using a modern comparative collection housed in the LSU Museum of Natural Science Archaeology Laboratory. Marine catfish otoliths are quite distinct from other species of fish that inhabit coastal and estuarine waters and are easily recognizable. However, there are slight differences between the otoliths of *B. marinus* and *A. felis*; therefore, I followed the technique used by Simons (1986:139, Figure 1) based on angle. Digital calipers were used to take measurements such as height, length, width, breadth, and thickness (Figure 36). These measurements, along with weight, were recorded following Colaninno (2010). The additional measurements may be useful for future analysis regarding correlations between otolith size and specimen size (e.g., skeletal mass allometry modeling), but will not be addressed in this study.

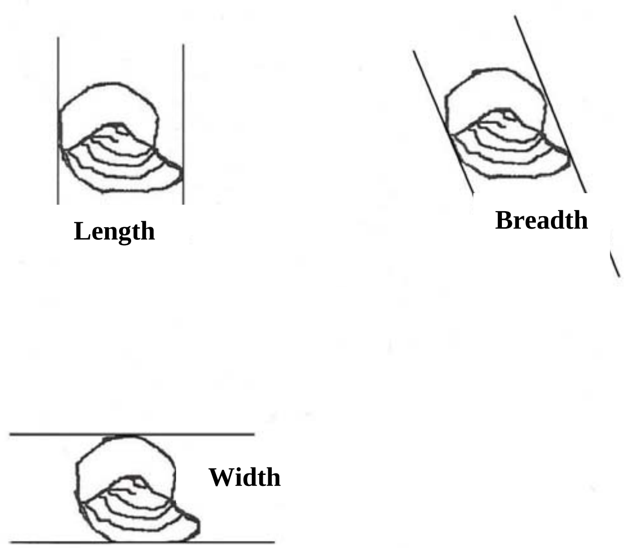
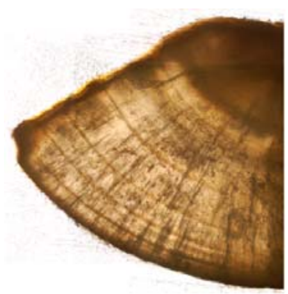


Figure 36. Diagram of additional measurements taken on otoliths of marine catfish; the three measurements shown here were not put to use in this study (after Colaninno 2010).

Thin sections of otoliths were used to assess age and season of harvest. Two thin sections of the otoliths were taken from each specimen; these were then mounted on a glass slide (see VanderKooy 2009 for details on this technique). After sectioning and mounting, the otoliths were sanded and polished using a series of increasingly finer grit polishing sheets and a Dremel™ tool with a sanding stone attachment. Sanding and polishing removes abrasions left by cutting, and renders the section thin enough for light to penetrate and reveal the banding. The thin-sections were then wiped clean, treated with a small amount of emersion oil, and viewed under a compound binocular microscope using transmitted light at low magnification (4X). When necessary, the thin sections were further sanded in precise locations using the Dremel™ tool to better reveal the bands, particularly the terminal band. In Figure 37, four otolith specimens are depicted from this study; the numerous small bands in the oldest individual (Figure 37C) appears almost like a record or vinyl recording.

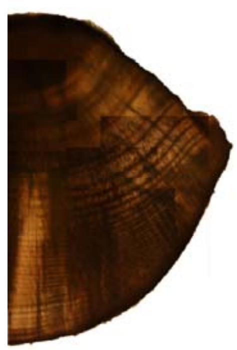
The reliability of otoliths, or any faunal remains from an archaeological site to accurately suggest past exploitation depends heavily on site formation and taphonomic processes (i.e., how the site was constructed and used, and the preservation qualities at the site), and the affect these processes have on biological and cultural remains. Rollins Shell Ring has been previously described as a seasonal ceremonial site; the loose and minimally broken oyster shell suggests that there was no habitation directly on the surface of the ring; additionally, no historic disturbance has been observed at the site (Saunders 2003). The fact that Rollins is not considered to be a habitation site, nor that it has been impacted by historic activity is significant in that compaction or other disturbance has not taken place at the site; therefore, one could be reasonably assured that there was little re-working of the faunal remains from the site. While otoliths could have slipped through the interstices of shell, there were large numbers of otoliths per level; this would not have been the case if significant movement had taken place.

The issue of preservation is particularly important regarding otoliths from prehistoric sites as it determines whether the terminal edge of the specimen does in fact represent the final season, or moment in the life, of the fish. Given the site formation processes at Rollins, and the preservation qualities inherent in shell rings, this author is confident that the terminal edges of otoliths from the samples analyzed accurately reflect the season of harvest for marine catfish at this site.



A – 5 years of age

B – 5 years of age



C – 32 years of age

D – 7 years of age

Figure 37. Otolith thin sections from study: A-Specimen #10; B-Specimen #22; C-Specimen #25; D-Specimen #80 (detailed information on otolith data is located in Appendix C). Photos were taken with a Nikon D50 SLR digital camera, and viewed on a Nikon inverted light microscope using transmitted light, at 2X. Each image is the compilation of several frames which were put together in a montage using Adobe Photoshop™.

Processing and analysis for this part of the study took place in several laboratories at LSU. Initial artifact sorting and species identification took place in the archaeology laboratory of the Museum of Natural Science under the direction of Dr. Rebecca Saunders. The otoliths were sectioned and mounted in the Paleoclimate and Archaeology Laboratory in the Department of Geography and Anthropology with assistance from Dr. Kristine DeLong. Assessment of age and terminal banding was carried out in collaboration with Dr. William Kelso and Melissa Fries in the Department of Renewable Natural Resources (RNR). Images of otolith thin sections were taken in the histology laboratory in the Department of Biological Sciences under the direction of Dr. John Lynn, who also guided the creation of the montage images used in this study (see Figure 36).

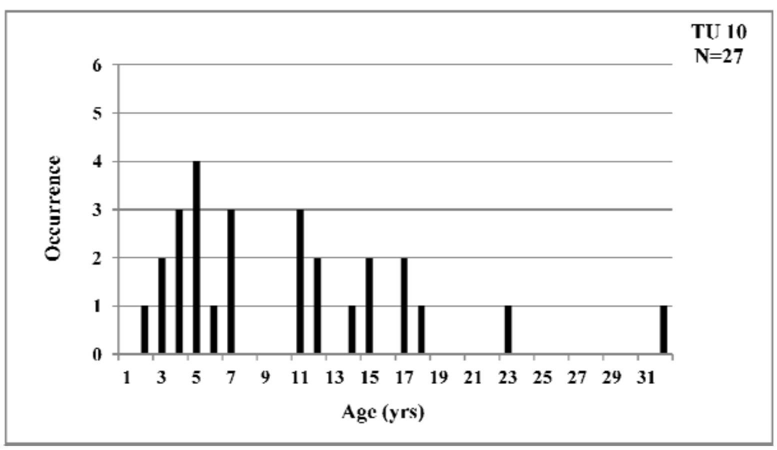
Results and Discussion

Of the 81 otoliths analyzed, five were assigned to the species *B. marinus*, and 75 otoliths were assigned to the species *A. felis*; one specimen could not be assigned to either species due to eroded diagnostic features. Analysis of the terminal band yielded 100% assessment with a translucent band, indicating that the fish were harvested in warm water temperatures, but could include a range of April through October in southeastern waters of the United States.

Assignment of species was difficult as the otoliths of *B. marinus* and *A. felis* are similar and difficult to distinguish even for a practiced analyst when dealing with samples from an archaeological collection of the age of Rollins (approximately 4000 years old). As these fish have similar lifestyles and are often grouped together by fisheries experts, they will be referred to collectively from this point forward. Data for individual units are discussed below, followed by a general discussion of the results and interpretation. Subsequent to this discussion of the marine catfish otolith analysis, there is a discussion on the results and interpretation of both resources analyzed.

Test Unit 10 (ca. 4050 – 3820 B.P. – 1 cal.)

A total of 27 left sagittal otoliths were analyzed from Test Unit 10, and was comprised of specimens from Level 4 (Zone A1, 30-40 cmbs), Level 5 (Zone A1, 40-50 cmbs), Level 6 (Zone A1, 50-60 cmbs), Level 7 (Zone A1, 60-70 cmbs), and Level 9 (Feature 20). A histogram reflects bi-modal distributions in age of the fishes, with two noticeable outliers at 23 and 32 years (Figure 38). The mean age was 10.2 years, with a mode of 5 years (n=4) representing about 15% of the unit sample.



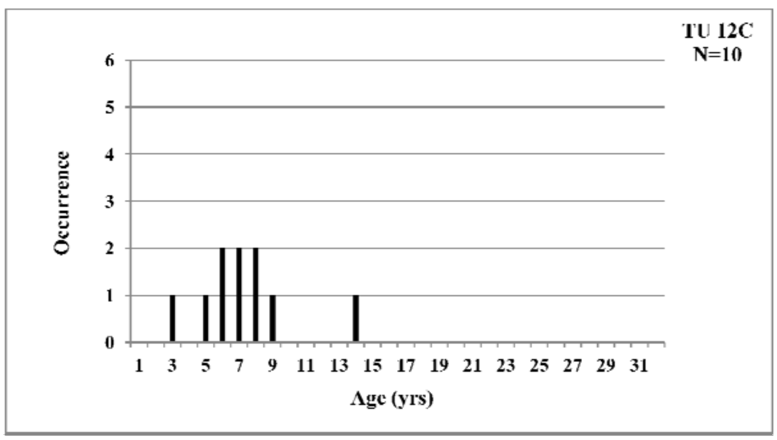
Age in Years

2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**11**	**12**	**13**	**14**	**15**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**32**	**Total**
1	2	3	4	1	3	0	0	3	2	0	1	2	2	1	0	0	0	0	1	1	**27**

Figure 38. Histogram and data table of fish age distribution for Test Unit 10. Of the 27 specimens analyzed, 11 (or 40.7% of the unit total) represented ages 6 years and younger, and 16 each (or 59.3% of the unit total) represented ages 7 years and older.

Test Unit 12c (ca. 3890 – 3690 B.P. – 1 cal.)

Test Unit 12c contained the fewest otoliths, comprised of only 10 specimens. Otoliths came from Level 5-6 (Interface, 45-60 cmbs; and Cleanup), Level 7-8 (Feature 26, 60-70 cmbs), Level 9 (Feature 26, 78-90 cmbs), Level 10-11 (Feature 26, 90-110 cmbs). A histogram of the data might suggest a bi- or uni-modal distribution in fish ages (Figure 39). The mean age was 11.6 years, and there were several modes occurring at 6, 7, and 8 years (n=2 each); each mode represented 20% of the unit sample. However, interpretations of the statistical analysis of this unit should take the small sample size into consideration.



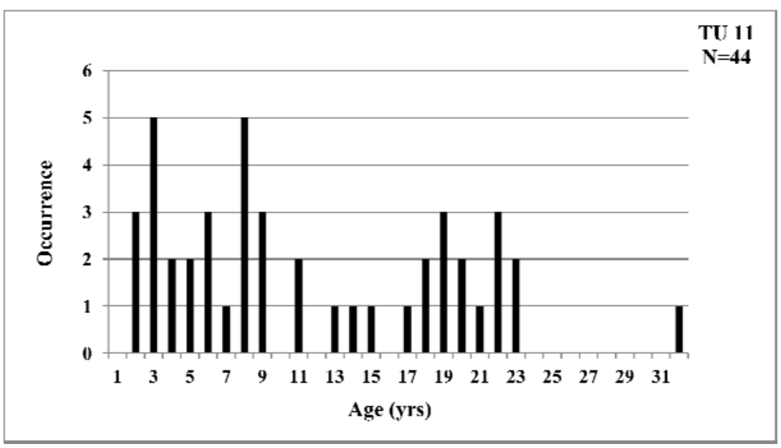
Age in Years

2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**11**	**12**	**13**	**14**	**15**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**32**	**Total**
0	1	0	1	2	2	2	1	0	0	0	1	0	0	0	0	0	0	0	0	0	**10**

Figure 39. Histogram and data table of fish age distribution for Test Unit 12c. Of the 10 samples analyzed, 4 each (or 40% of the unit total) represented ages 6 years and younger, and 6 each (or 60% of the unit total) represented ages 7 years and older.

Test Unit 11 (ca. 3630 – 3440 B.P., 1 cal.)

Test Unit 11 yielded the largest sample of otoliths, n=44, and included specimens from Level 4 (Zone A, 30-40 cmbs), Level 5 (Area 2, 40-50 cmbs), Level 6 (Area 2, 50-60 cmbs), Level 7 (Area 2), Level 8 (Area 4), Level 9 (Area 2; Area 4, 80-90 cmbs), and Level 12 (Area 2). A histogram of the data (Figure 40) revealed a multi-modal distribution of fish ages with a noticeable outlier at 32 years. The mean was 11.6 years, and there were two modes at 3 and 8 years (n=5 each); each mode represented 11% of the unit sample. There was a noticeable grouping of 2-9 year old individuals, and another grouping of individuals between 17 and 23 years old. Curiously, the outlier of a single, large individual of 32 years seen here is also present in Test Unit 10 (see Figure 38). This test unit includes a wide variety of ages (and sizes) of marine catfish, but suggested perhaps a slight preference for relatively younger (and smaller) fishes as indicated by higher numbers of individuals < 10 years.

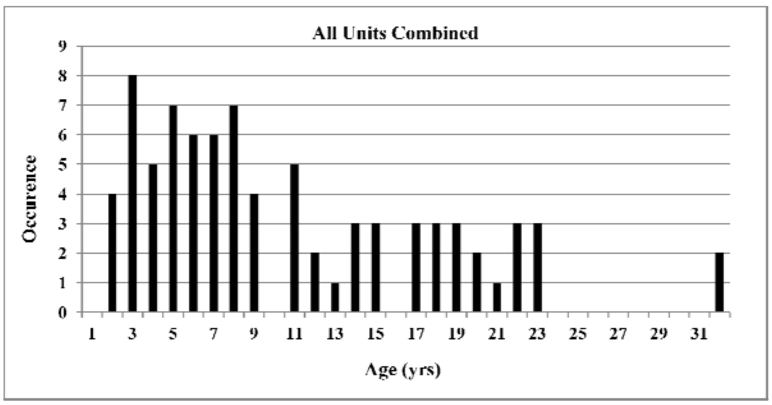


Age in Years

2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**11**	**12**	**13**	**14**	**15**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**32**	**Total**
3	5	2	2	3	1	5	3	2	0	1	1	1	1	2	3	2	1	3	2	1	**44**

Figure 40. Histogram and data table of fish age distribution for Test Unit 11. Of the 44 specimens analyzed, 15 each (or 34.1% of the unit total) represented ages 6 years and younger, and 29 each (or 65.9% of the unit total) represented ages 7 years and older.

Analysis of fish ages for all units yielded a range from 2 to 32 years, and a histogram of the data revealed a multi-modal distribution (Figure 41). Fish age distribution can provide clues to the fishing grounds exploited, if one takes into account the modern distribution of age groups (Van Neer et al. 1999:117), and a comparison of the age distribution by unit may indicate if there were any changes in resource exploitation.



Age in Years

	Young (n=23)				Middle Age (n=23)				Old (n=35)													
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**11**	**12**	**13**	**14**	**15**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**32**	**Unit Totals**
TU10	1	2	3	4	1	3	0	0	3	2	0	1	2	2	1	0	0	0	0	1	1	**27**
TU11	3	5	2	2	3	1	5	3	2	0	1	1	1	1	2	3	2	1	3	2	1	**44**
TU12c	0	1	0	1	2	2	2	1	0	0	0	1	0	0	0	0	0	0	0	0	0	**10**
Totals	**4**	**8**	**5**	**7**	**6**	**6**	**7**	**4**	**5**	**2**	**1**	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**3**	**3**	**2**	**81**

Figure 41. Histogram and data table of fish age distribution for all units.

To determine whether there were significant differences between units, Pearson's chi-square tests were performed; however, chi square tests do not work well with small cell sizes, and many of the age categories from Rollins were represented by 5 or fewer individuals.

Therefore, to obtain a valid chi-square result, fish ages were grouped into three categories: *young* for ages 0-5 years, *middle aged* for ages 6-10 years, and *old* for ages greater than 10 years (Figure 42). A description of the statistical analyses by test unit follows.

Statistically speaking, there is a significant difference between young, middle age and older fishes within and between samples (p=0.0240). Test Unit 12c had many more middle-aged fish than expected (see Figure 41), while Test Unit 10 had fewer. The fish age data revealed interesting distributions within some of the units. The largest sample, Test Unit 11 (n=44), showed multi-modal distributions for fish ages, as does Test Unit 10 (n=27). Sample size in Test Unit 12c is too small to accurately assess the distribution of fish ages.

Age Group	**Provenience**			
Frequency **Expected** **Cell Chi-Square**	**Unit 10**	**Unit 11**	**Unit12c**	**Totals**
Middle Age	**4** **7.6667** **1.7536**	12 12.494 0.0195	**7** **2.8395** **6.096**	23
Old	13 11.667 0.1524	20 19.012 0.0513	2 4.321 1.2467	35
Young	10 7.6667 0.7101	12 12.494 0.0195	1 2.8395 1.1917	23
Totals	27	44	10	81

Statistic	**DF**	**Value**	**Probability**
Chi-Square	4	11.2409	0.0240

Figure 42. Pearson's chi-square test of fish ages for all units.

An explanation for the multi-modal age distribution patterns seen in the samples analyzed may be explained by the type of fishing technology employed for marine catfish. In other words, the hunting technique and equipment used by the Late Archaic (5000 – 3000 B.P.) peoples at Rollins Shell Ring were very efficient at capturing fish between 3 and 8 years of age.

After age was established, the terminal band was assessed for season of harvest (see Appendix C). In southern waters, an opaque terminal band is formed in cool water temperatures and infers collection in winter, while a translucent terminal band is formed in warm water temperatures and infers collection in spring, summer, or fall (VanderKooy 2009, Section 2-2). A more precise season of harvest, such as discerning between spring or summer, could be determined by noting the width of the preceding band compared to the width of the terminal band, but this was only possible in a few of the otoliths analyzed in this study; time and lack of experience of this author did not allow for such a precise determination, therefore the seasonal assessment for this study is based on procurement in either cool water temperature (opaque terminal band, indicating a winter harvest), or warm water temperature (translucent terminal band, indicating harvest in spring, summer or fall).

A translucent terminal band was noted on all specimens analyzed in this study, which indicated a season of harvest in warm water temperatures. In her 2003 report on the analysis of faunal material at Rollins, Saunders provided the season of harvest for fishes from Test Unit 2, which was an analysis unit used in this study for oysters, that indicated a spring harvest (warm water temperatures) for marine fishes (Table 5).

Documented studies on behavioral characteristics of both species of marine catfish note that they spawn from May to August (Wingo and Muncy 1983:4), and the eggs incubate in the mouth of the male for about 8-11 weeks. These reproductive activities take place in shallow, near shore environments, when sea surface temperatures (SST) are warm. The assessment of a warm water temperature for the harvest of marine catfish in this study, and a similar assessment for marine fishes from Saunders' 2003 report, along with the documented behavior of *B. marinus* and *A. felis*, would support the hypothesis put forth by Saunders (2003, 2004b and 2010) that prehistoric peoples at Rollins Shell Ring harvested this resource seasonally, in warm water temperatures, from shallow, near-shore waters.

Table 5. Season of harvest for fishes from Test Unit 2 (Saunders 2003, Table 4). These samples were from the 1998 excavations at Rollins.

Sample #	Genus/species	Age	season
1	Bagre marinus (Gaftop sail catfish)	7-4	Spring
2	Cynoscion nebulosus (spotted seatrout)	2-4	Spring
3	Micropogonias undulates (Atlantic croaker)	2-4	Spring
4	Bagre marinus (Gaftop sail catfish)	6-4	Spring
5	Micropogonias undulates (Atlantic croaker)	3-4	Spring
6	Broken	---	n/a
7	Micropogonias undulates (Atlantic croaker)	yoy	n/a
8	Micropogonias undulates (Atlantic croaker)	6-4	Spring

Discussion of Oysters and Marine Catfish Otoliths

The results of the analysis of oysters from Rollins Shell Ring determined they were harvested from similar environments throughout shell ring construction and subsequent occupation of the site. The overwhelming preference came from the bed classification (67.7%); however, data indicated that sand, channel and reef oysters were also collected, with Test Unit 10 showing the most variability in oyster exploitation, with higher incidents of individuals from a variety of oyster habitats. Oyster height did change through time, with the most significant change occurring in the middle activity period recorded at the site (Test Unit 12c), compared to the initial shell ring construction period (Test Unit 10), and construction activity noted in the main ring (Test Unit 2) near the time of site abandonment. Test Unit 10 showed the most variability in oyster heights and habitats exploited, while Test Unit 12c showed a decrease in variability through time. Test Unit 2 showed more variability than Test Unit 12c, but did not have the higher incident of individuals as Test Unit 10.

What these results suggest is that in the middle period of shell construction activity recorded, the people of Rollins Shell Ring may have consolidated their exploitation activity to target mainly bed oysters, and did not utilize oysters from other habitats as frequently as in the early and later shell construction activity recorded for the site. There was no obvious indication of over-exploitation of oysters, as evidenced by the variety of oyster habitats that were exploited as well as the numbers exploited, particularly from bed oysters. In addition, the low predation rates noted for the samples indicated that the oyster populations, as represented by the archaeological samples, were not under stress from predation of organisms other than humans.

The results of seasonality and age assessment of marine catfish otoliths provided a solid assessment of harvest in warm water temperatures for oysters and marine catfish. The otolith age data were noticeably skewed due to large numbers of younger (and by extension smaller) individuals and the presence of very old individuals (> 20 years). Test Units 10 and 11 displayed clear bi-modal distributions in fish ages, with a high frequency of individuals younger than 6 years, and another noticeable grouping of middle aged fishes from 7 – 10 years. Explanations for the multi-modal distributions of otolith age data may be explained by natural and cultural behavior. These two marine catfish species are mouth brooders, with the males protecting eggs and young in shallow, warm waters, insulating the offspring from external environmental pressures; this behavior may have contributed to the large number of younger fish present in this study.

As for cultural behavior, differential fishing strategies likely played a part in the age (and size) groupings. In previous studies at Rollins Shell Ring, netting has been inferred as the technique used to capture the vast numbers of small fishes recovered. This technique could conceivably snare the younger (i.e., smaller) marine catfish. However, a different fishing technique would have been necessary for the older (and by extension larger) fishes. Larger mesh nets, hook and line, trot lines, weirs, and fish baskets could all have been used to trap the older (larger) fishes.

The fish age percentages by category (young, middle aged, old) varied slightly through time. But overall, the marine catfish population appeared stable, with young, middle aged and older individuals represented, and some individuals living well into old age. It was not within the scope of this study to determine whether marine catfish were over-exploited.

CHAPTER 6 SUMMARY AND CONCLUSIONS

Fine screened samples from the 2003 – 2004 excavations at Rollins Shell Ring, a Late Archaic (5000 – 3000 B.P.) site on the northeast Atlantic coast of Florida, were chosen for detailed analysis. The focus was on two of the most abundant natural resources at the site, oyster (*C. virginica*) and marine catfish (otoliths from *B. marinus* and *A. felis*). The main goal for the oyster analysis was to identify the specific ecological niche harvested; marine catfish otoliths were used to provide seasonality data for oysters as well as marine catfish, and also provided fish age at capture. The units selected for analysis were chosen to represent the span of activity recorded for the site, and a comparison of the units was undertaken to see if there were any observable changes through time that would indicate over-exploitation of oysters. Statistical analyses, particularly Pearson's chi-square tests, were employed to determine the significance of observations.

Analysis of oysters from the bulk shell samples indicated that the majority of oysters used in shell construction activities at this site were harvested from the same ecological niche and that the oyster population, as represented by the archaeological sample, was a healthy one. The evidence for both conclusions was supported by the consistency in HLR across time at the site, and low epibiont (colonization and predation) activity. An additional testament of a healthy oyster population at Rollins came from Saunders who noted the absence of *Boonea impressa*, a predatory snail and oyster parasite (Saunders personal communication, 2011). The presence of this snail is viewed as an indicator of a stressed oyster population (White 1988:360; Wilson 1988:553). Oyster shell height, particularly if shell size changed through time, was used to assess over-exploitation. Results indicated that shell height did change through time; however, this change was due to the variety of oyster habitats present in the samples analyzed.

This project also explored characteristics of otoliths as indicators for seasonal procurement patterns of oysters as well as marine catfish, and as phenological tools for the documented behavioral patterns of marine catfish. All marine catfish otoliths analyzed in this study indicated a season of harvest in warm water temperatures, which supported an earlier assessment on molluscs and fishes at Rollins (Russo and Saunders 1999; Saunders 2003). Additionally, the season of capture determined in this study supports the documented behavior of these two species, which are known to inhabit shallow, near shore areas during warm water temperatures for spawning. The multi-modal distributions of fish age required closer scrutiny and prompted a consideration of natural and cultural explanations for this phenomenon. Harvesting technology is a plausible explanation for the multi-modal distribution of fish ages seen in this analysis, and it is likely that different harvesting techniques were employed on younger (smaller) marine catfish than on older (larger) individuals.

Another goal of this research was to address the issue of over-exploitation of oysters as a contributing factor to permanent site abandonment, as has been previously suggested (e.g., Dame 2009). The results presented in this thesis indicated that the oyster population used to construct the shell ring, ringlets, and other structures at Rollins appeared to have come from healthy, productive populations with no visible signs of stress due to over-exploitation by humans or other organisms.

A determination of how often Rollins was host to ritual or ceremonial gatherings cannot be made from this study; however, given a healthy estuarine ecosystem it would take only 1-2 years for an oyster population to rebound, even from heavy exploitation as may have occurred at

Rollins (Lynn 2011, personal communication). Studies have indicated (e.g., Swalding 1976; Thomas 2008) that regular exploitation may in fact help natural oyster populations, as regular culling increases the growth and health of the remaining population. Given the many shell rings along the southeastern Atlantic coast, it is plausible that ceremonial or ritual gatherings at some rings (those indicating seasonal activity) could have taken place on a rotational basis, that would have allowed time for oyster colonies to rebound between visits (Cable 1997). This brief intermission in the intense exploitation of oyster would ensure its continuation as renewable natural resource for subsequent generations.

The fact that the majority of oysters were exploited from a bed habitat may have implications for the organization of harvesting and who may have participated. Bed oysters occur in mixed, muddy substrates, and are exposed to the air at certain times (tides), making this resource easily accessible. Bed oysters occur singly or in loose clusters which means they could be harvested with minimal equipment. Claassen (1991) indicated that much of the collection of shellfish in prehistoric and historic hunter-gatherer societies is attributed to women and children; the environment of bed oysters at Rollins Shell Ring would certainly make oysters easily accessible by these groups. Greater range would be afforded by the use of baskets contained in canoes or skiffs; a canoe or skiff could be pulled along the exposed oyster ground, greatly extending the carrying capacity of a single person.

What should be obvious from the summary of shell ring research presented in this thesis, and the conclusions put forth by this author, is that there are many stories to be told regarding shell rings. In his study of the Timucuan Preserve, Russo (1992:120) offered an alternative perspective on the variety of scenarios regarding Late Archaic coastal cultures: these were unique cultures along the Southeastern coast – cultures unique unto themselves, and from surrounding contemporary cultures. This author is of the opinion that shell ring sites are quite unique, and each one with their own story to tell of construction, use, and meaning to their original builders. Models can be helpful in classifying and discussing shell rings, such as those put forth by Thompson (2007); however, there is sufficient evidence from Rollins to indicate that the main ring did not undergo a transition from village to ceremonial site.

The antiquity of human exploitation of coastal and estuarine resources, and the ability of these areas to support large populations, has forced the North American archaeological community to re-assess its concept of shellfish and estuarine resources. From studies highlighted in this thesis it is clear Late Holocene coastal and estuarine environments on the lower Atlantic coast of North America were very productive, were resistant to over-exploitation, were capable of supporting large populations of early Native Americans, and, in some cases, were *the* desired resource base. Our concept of the importance of coastal and estuarine resources to Archaic and Late Archaic people will continue to change as more evidence of coastal sites is uncovered.

If over-exploitation is ruled out as an influence in the permanent abandonment of Rollins Shell Ring, we are left to consider other factors that may have played a part in the abandonment of this site in particular, and of Southeastern shell rings in general. Erratic and intense climate conditions is a theory gaining more ground as the major influence in the abandonment of shell ring sites, as well as having contributed to the decline of the Late Archaic shell ring culture along the Southeastern coast. It is not within the scope of my study to focus on the issue of climate change and its effect on the abandonment of shell rings; the reader is referred to Thomas and Sanger (2010) for the most current debate on this issue.

Future Directions

I plan to continue work at Rollins Shell Ring for my dissertation, and will concentrate on a more detailed paleoenvironmental picture of the site. Future directions for oyster analysis at Rollins will include oxygen isotope analysis to determine season of harvest on oysters. Several less expensive methods are currently employed to determine seasonality on this natural resource, such as the analysis of growth bands on the umbo, but they are somewhat subjective. Oxygen isotope analysis is costly, but it would provide conclusive seasonal data based on sea surface temperature (SST).

Future directions for otolith analysis at the site could be expanded to include a method to correlate fish size from otolith dimensions (i.e., skeletal mass allometry), which would be useful to estimate the amount of meat supplied by marine catfish, and by extension the number of people that could be sustained from this resource. Oxygen isotope analysis could also be employed on otoliths, as this technique would more precisely determine SST. Both of these subsistence resources still have much they can tell us of the paleoenvironment at Rollins.

References

Adler, Michael A., and Richard H. Wilshusen
1990 Large-Scale Integrative Facilities in Tribal Societies: Cross-Cultural and Southwestern US Examples. *World Archaeology* 22(2):133-146.

Andrus, C. Fred T.
2011 Shell midden sclerochronology. *Quaternary Science Reviews* Vol. 30, Issues 21-22, October 2011, pp. 2892-2905.

Bailey, Geoff N.
1975 The role of molluscs in coastal economies: The results of midden analysis in Australia. *Journal of Archaeological Science* 2(1):45-62.

Bense, Judith A.
2009 *Archaeology of the Southeastern United States, Paleoindian to World War I*. Walnut Creek: Left Coast Press, Inc.

Bicho, Nuno and Jonathan Haws
2008 At the land’s end: Marine resources and the importance of fluctuations in the coastline in the prehistoric hunter-gatherer economy of Portugal. *Quaternary Science Reviews* 27(23-24):2166-2175.

Bicho, Nuno, Jonathan Haws, and Loren David
2011 *Trekking the shore: Changing coastlines and the antiquity of coastal settlement*. Springer, New York.

Binford, Lewis R.
1982 The Archaeology of Place. *Anthropological Archaeology* 1:5-31.

Bradley, Raymond S.
1999 *Paleoclimatology: Reconstructing Climates of the Quaternary*. Volume 68: Elsevier Academic Press.

Bullen, R. P.
1972 The Orange Period of Peninsular Florida. In Fiber-Tempered Pottery in Southeastern United States and Northern Colombia: Its Origins, Context, and Significance. Florida Anthropological Society Publications Vol. 6, pp. 9-33, Gainesville.

Byrd, Kathleen M.
1977 The Brackish Water Clam (*Rangia cuneata*): A Prehistoric 'Staff of Life' or a Minor Food Resource. *Louisiana Archaeology* 3:23-31.

Cable, Jay S.
1997 The Ceremonial Mound Theory: New Evidence for the Possible Ceremonial Function of Shell Rings. In *Shell Rings of the Late Archaic*, South Carolina Archaeology Week Poster. South Carolina Institute of Archaeology and Anthropology, University of South Carolina, Columbia.

Claassen, Cheryl P.
1991 Gender, Shellfishing, and the Shell Mound Archaic. In *Engendering Archaeology, Women in Prehistory*, Basil Blackwell Ltd, Oxford. Chapter 10, pp. 276-300.

—
1998 *Shells*. Cambridge University Press, Cambridge.

Colaninno, Carol E.
2010 *Zooarchaeological Analysis of Vertebrate Remains from Five Late Archaic Shell Rings on the Georgia Coast*. Unpublished Ph.D. dissertation, University of Georgia, Department of Anthropology.

Crook, Morgan R.
1992 Oyster Sources and their Prehistoric use on the Georgia Coast. *Journal of Archaeological Science* 19(5):483-496.

Cushing, Frank H.
1896 Exploration of Ancient Key Dwellers' Remains on the Gulf Coast of Florida. *Proceedings of the American Philosophical Society*, Vol. 35 Issue 153 pp. 329-448.

Dame, Richard F.
2009 Shifting Through Time: Oysters and Shell Rings in Past and Present Southeastern Estuaries. Journal of Shellfish Research, Vol. 28, No. 3, pp. 425-430.

DePratter, Chester B., and J.D. Howard
1980 Indian Occupation and Geologic History of the Georgia Coast: a 5,000 Year Summary. In *Excursions in Southeastern Geology: The Archaeology-Geology of the Georgia Coast*. J. D. Howard, C.B. DePratter and R.W. Frey, eds. pp. 1-65. Guidebook 20. Geological Society of America, Atlanta.

—
1981 Evidence for a Sea Level Lowstand between 4500 and 2400 Years B.P. on the Southeast Coast of the United States. *Sedimentary Petrology* 51(4):1287-1295.

Dietler, Michael, and Brian Hayden
2001 Digesting the Feast - Good to Eat, Good to Drink, Good to Think: An Introduction. In *Feasts: Archaeological and Ethnographic Perspectives on Food, Politics, and Power*. M. Dietler and B. Hayden, eds. pp. 1-22. Smithsonian Institution Press, Washington, D.C.

Edwards, W.E.
1965 *A Preliminary Report on the Sewee Mound Shell Ring, Charleston County, South Carolina*. South Carolina Institute of Archaeology and Anthropology.

Erlandson, Jon M., Madonna L. Moss, and Matthew Des Lauriers
2008 Life on the Edge: Early maritime Cultures of the Pacific Coast of North America. *Quaternary Science Reviews* 27:2232-2245.

Erlandson, Jon M., Torben C. Rick, and Todd F. Braje
2009 Fishing Up the Food Web?: 12,000 Years of maritime Subsistence and Adaptive Adjustments on California’s Channel Islands. *Pacific Science* 63(4):711-724.

Finlayson, Clive
2008 On the importance of coastal areas in the survival of Neanderthal populations during the Late Pleistocene. *Quaternary Science Reviews* 27(23-24):2246-2252.

Ford, James B.
1969 A Comparison of Formative Cultures in the Americas. In *Smithsonian Contributions to Anthropology*, Vol. 11: Smithsonian Institute, Washington, D.C.

Frazier, J.
2007 Sustainable Use of Wildlife: The View from Archaeozoology. *Journal for Nature Conservation* 15:163-173.

Gunter, G.
1938 Comments on the Shape, Growth and Quality of the American Oyster. *Science* 88(2293):546-547.

Hayden, Brian
2001 Fabulous Feasts: A Prolegomenon to the Importance of Feasting. *In Feasts: Archaeological and Ethnographic Perspectives on Food, Politics, and Power*. M. Dietler and B. Hayden, eds., pp. 23-64. Smithsonian Institution Press, Washington, D.C.

Heide, Greg, and Michael A. Russo
2003 *Investigation of the Coosaw Island Shell Ring Complex (38BU1866)*. Southeast Archaeological Center, National Park Service.

Heilmayer, Olaf, Julian Digialleonardo, Lianfen Qian, and Guritno Roesijadi
2008 Stress Tolerance of a Subtropical *Crassostrea virginica* Population to the Combined Effects of Temperature and Salinity. *Estuarine, Coastal and Shelf Science* 2008:1-7.

Hopkins, Sewell H.
1962 Distribution of Species of Cliona (Boring Sponge) on the Eastern Shore of Virginia in Relation to Salinity. *Chesapeake Science* 3(2):121-124.

Jones, Terry L.
1991 Marine-Resource Value and the Priority of Coastal Settlement: A California Perspective. *American Antiquity* 56(3):419-443.

Kent, Bretton W.
1992 Making Dead Oysters Talk. In *Popular Laboratory Study Manuals*, Maryland Historical Trust, Crownsville.

Manley, Justin, Alan Power and Randal Walker
2008 Wild Eastern Oyster, Crassostrea virginica, Spat Collection for Commercial Grow-out in Georgia. Occasional Papers of the University of Georgia Marine Extension Service, Vol. 2, 2008, 21 pages. Marine Extension Service, University of Georgia, Shellfish Research Laboratory, Savannah, Georgia.

Mannino, Marcello A., and Kenneth D. Thomas

2002 Depletion of a Resource? The Impact of Prehistoric Human Foraging on Intertidal Mollusc Communities and Its Significance for Human Settlement, Mobility and Dispersal. *World Archaeology* 33(3):452-474.

Marquardt, William H.

2010 Mounds, Middens, and Rapid Climate Change During the Archaic-Woodland Transition in the Southeastern United States. In *Trend, Tradition, and Turmoil: What Happened to the Southeastern Archaic?* D.H. Thomas and M.C. Sanger, eds. pp. 341. Anthropological Papers of the American Museum of Natural History, Vol. 93. New York.

Marrinan, Rochelle A.

1975 *Ceramics, Molluscs, and Sedentism: The Late Archaic Period on the Georgia Coast*. Unpublished Ph.D. dissertation, Department of Anthropology, University of Florida, Gainesville.

McKechnie, Iain

2007 Investigating the Complexities of Sustainable Fishing at a Prehistoric Village on Western Vancouver Island, British Columbia, Canada. *Journal for Nature Conservation* 15:208-222.

McKinley, W.

1873 Mounds in Georgia. Annual Report to the Board of Regents, Vol. 22. Smithsonian Institution, Washington, D.C., pp. 422-428.

Michie, James L.

1979 The Bass Pond Site: Intensive Archaeological Testing at a Formative Period Base Camp on Kiawah Island, South Carolina. In *Research Manuscript Series, No. 154*. Institute of Archaeology and Anthropology, University of South Carolina.

—

1980 An Intensive Shoreline Survey of Archaeological Sites in Port Royal Sound and the Broad River Estuary, Beaufort County, South Carolina. In *Research Manuscript Series, No. 167*. Institute of Archaeology and Anthropology, University of South Carolina.

Milanich, J.T.

1994 *Archaeology of Precolumbian Florida*. University Press of Florida.

Moore, Charles B.
1897 Certain Aboriginal Mounds of the Georgia Coast. *Academy of Natural Sciences of Philadelphia* 2:71-73.

—
1898 Certain Aboriginal Mounds of the Coast of South Carolina. *Academy of Natural Sciences of Philadelphia* 11:147-166.

Muncy, Robert J., and William M. Wingo
1983 Sea Catfish and Gafftopsail Catfish. In *Species Profiles: Life Histories and Environment Requirements of Coastal Fishes and Invertebrates (Gulf of Mexico)*. U.S. Fish and Wildlife Service, Division of Biological Services, Vicksburg, MS. Document Number FWS/OBS-82/11.5, RE EL-82-4.

O'Beirn, Francis, Peter Heffernan, Randal Walker
1995 Preliminary recruitment studies of the eastern oysters, Crassostrea virginica, and their potential applications in coastal Georgia. *Aquaculture* 136 (1995), pp. 231-242.

Pannella, Giorgio
1971 Fish Otoliths: Daily Growth Layers and Periodical Patterns. *American Association for the Advancement of Science* 173(4002):1124-1127.

Pugliese, R., and M. Brouwer
2009 *Fishery Ecosystem Plan of the South Atlantic Region*. South Atlantic Fishery Management Council, Charleston, South Carolina.

Quitmyer, Irvy R.
2002 *The Zooarchaeology of a Middle-Holocene archaeological site along the Mitchell River (8WL1278): Subsistence, seasonality, and paleoenvironment in the Late Archaic (ca. 5000 B.P.)*. Report to the Florida Museum of Natural History, Gainesville.

Rick, Torben C., and Jon M. Erlandson
2008 *Human Impacts on Ancient Marine Ecosystems: A Global Perspective*. University of California Press, Berkley.

Russo, Michael A.
1991 *Archaic Sedentism on the Florida Coast: a Case Study from Horr's Island*. Unpublished Ph.D. dissertation, Department of Anthropology, University of Florida, Gainesville.

—
1992 Chronologies and Cultures of the St. Marys Region of Northeast Florida and Southern Georgia. *The Florida Anthropologist* 45:107-126.

—
1993 *The Timucuan Ecological and Historic Preserve Phase III Final Report*. SEAC Accession Number 899, Florida Museum of Natural History. Submitted to the Southeast Archaeological Center, National Park Service, Tallahassee, Florida, Contract CA-5000-9-8011.

—
2002 *Faunal Analysis at Fig Island*. Report submitted to the South Carolina Dept of Archives and History.

—
2004 Measuring Shell Rings for Social Inequality. In *Signs of Power: The Rise of Cultural Complexity in the Southeast*, J.L. Gibson and P.J. Carr, eds. University of Alabama Press, Tuscaloosa, pp. 26-70.

—
2006 *Archaic Shell Rings of the Southeast U.S.* Southeast Archaeological Center, National Park Service.

Russo, Michael A., and Greg Heide
2002 The Joseph Reed Shell Ring. *The Florida Anthropologist* 55(2):67-88.

—
2003 *Mapping the Sewee Shell Ring*. Report submitted to the Francis Marion and Sumter National Forests.

Russo, Michael A., and Rebecca Saunders
1999 *Identifying the Early Use of Coastal Fisheries and the Rise of Social Complexity in Shell Rings and Arcuate Middens on Florida's Northeast Coast*. Report submitted to the National Geographic Society, Washington, D.C.

Russo, Michael, Ann Cordell, and Donna Ruhl
1993 The Timucuan Ecological and Historic Preserve Phase III Final Report. Report submitted to the Southeast Archeological Research Center, National Park Service, Tallahassee. Contract CA-50000-9-8011.

Sanger, Matthew C.
2010 Leaving the Rings: Shell Ring Abandonment and the End of the Late Archaic. In *Trend, Tradition, and Turmoil: What Happened to the Southeastern Archaic?* D.H. Thomas and M.C. Sanger, eds. Anthropological Papers of the American Museum of Natural History, Vol. 93. American Museum of Natural History - Scientific Publications, New York.

Sassaman, Kenneth E.
1993 *Early Pottery in the Southeast: Tradition and Innovation in Cooking Technology*. University of Alabama Press, Tuscaloosa.

Saunders, Rebecca
2002 *The Fig Island Ring Complex (38CH42): Coastal Adaptation and the Question of Ring Function in the Late Archaic*. Grant #4501-16441. Report prepared for the South Carolina Department of Archives and History under Grant #45-01-16441.

—
2003 *Feast or Quotidian Fare: Rollins Shell Ring and the Question of Ring Function*. Report submitted to the Florida Department of Archives and History, permit #1A-32 9697.04.

—
2004a Spatial Variation in Orange Culture Pottery: Interaction and Function. In *Early Pottery: Technology, Function, Style, and Interaction in the Lower Southeast*. R. Saunders and C.T. Hays, eds. pp. 40-62. University of Alabama Press, Tuscaloosa.

—
2004b The Stratigraphic Sequence at the Rollins Shell Ring: Implications for Ring Function. *The Florida Anthropologist* 57(4):249-268.

Saunders, Rebecca
2010 Rollins Redux: Rings, Ringlets and Really Big Pits. Report to the Florida Department of Archives and History, Permit No. 0304.38.

—
(In press 2012) Shell Rings of the Lower Atlantic Coast of the United States: Defining Function by Contrasting Details, with Reference to Ecuador and Japan. In *The Cultural Dynamics of Shell Middens and Shell Mounds: A Worldwide Perspective*. Mirjana Roksandic, Sheila Mendonça de Souza, Sabine Eggers, Meaghan Burchell, Daniela Klokler, eds. University of New Mexico Press.

Saunders, Rebecca, and Michael A. Russo
2011 Coastal Shell Middens in Florida: A View from the Archaic Period. *Quaternary International*, Vol. 239:38-50.

Shumway, S.E.
1996 Natural Environmental Factors. In *The Eastern Oyster, Crassostrea virginica*. V.S. Kennedy, R.I.E. Newell and A.F. Eble, eds. pp. 467-503. Maryland Sea Grant College, College Park.

Simons, Erika H.
1986 A guide for Identifying Otoliths from Archaeological Sites. *Southeastern Archaeology* 5(2):138-145.

Swalding, P.
1976 Changes Induced by Human Exploitation in Prehistoric Shellfish Populations. *Mankind* 10(3):156-162.

Thomas, David H.
2008 *Native American Landscapes of St. Catherines Island*. American Museum of Natural History, Anthropological Papers, Number 88, Parts I, II and III.

Thomas, David H., and Matthew C. Sanger
2010 *Trend, Tradition, and Turmoil: What Happened to the Southeastern Archaic?* D.H. Thomas and M.C. Sanger, eds. Anthropological Papers of the American Museum of Natural History, New York.

Thompson, Victor D.
2007 Articulating Activity Areas and Formation Processes at the Sapelo Island Shell Ring Complex. *Southeastern Archaeology* 26:91-107.

Thompson, Victor D., and John E. Worth
2011 Dwellers by the Sea: Native American Adaptations along the Southern Coasts of Eastern North America. *Journal of Archaeological Research* 19:51-101.

Trigger, Bruce G.
1990 Monumental Architecture: A Thermodynamic Explanation of Symbolic Behavior. *World Archaeology* 22(2):121-132.

Trinkley, Michael B.
1985 The Form and Function of South Carolina's Early Woodland Shell Rings. In *Structure and Process in Southeastern Archaeology,* pp. 102-118. R.S. Dickens and .H.T. Ward, eds. University of Alabama Press, Tuscaloosa.

Van Neer, W., S. Augustynen, and T. Linkowski
1993 Daily Growth Increments on Fish Otoliths as Seasonality Indicators on Archaeological Sites: the Tilapia from Late Palaeolithic Makhadma in Egypt. *International Journal of Osteoarchaeology* 3:241-248.

Van Neer, W., L. Lougas, and A.D. Rijnsdorp
1999 Reconstructing Age Distribution, Season of Capture and Growth Rate of Fish from Archaeological Sites Based on Otoliths and Vertebrae. *International Journal of Osteoarchaeology* 9:116-130.

VanderKooy, Steve
2009 *A Practical Handbook for Determining the Ages of Gulf of Mexico Fishes, Second Edition*. National Oceanographic and Atmospheric Administration (NOAA), ed, Vol. 167. Ocean Springs: Gulf States Marine Fisheries Commission, Mississippi.

Waring, Antonio J., Jr.
1968 The Archaic Hunting and Gathering Cultures: The Archaic and Some Shell Rings. In *The Waring Papers: The Collected Works of Antonio J. Waring, Jr.* S. Williams, ed. Papers of the Peabody Museum of Archaeology and Ethnology, pp. 243-246.

Waring, Antonio J., Jr., and L.H. Larson
1968 The Shell Ring on Sapelo Island. In *The Waring Papers: The Collected Works of Antonio J. Waring, Jr.* S. Williams, ed., pp. 263-278: Papers of the Peabody Museum of Archaeology and Ethnology.

Waselkov, Gregory A.
1987 Shellfish Gathering and Shell Midden Archaeology. In *Advances in Archaeological Method and Theory*. M.B. Schiffer, ed. Pp. 93-210: Academic Press.

Wing, Elizabeth S., and A.B. Brown
1979 *Paleonutrition: Method and Theory in Prehistoric Foodways*. Gainesville: University of Florida Press.

Whitaker, Adrian R.
2008 Incipient Aquaculture in Prehistoric California?: Long-term Productivity and Sustainability vs. Immediate Returns for the Harvest of marine Invertebrates. *Journal of Archaeological Science* 35:1114-1123.

White, M.E., E.N. Powell, and S. M. Ray
1988 Effect of Parasitism by the Pyramidellid Gastropod *Boonea impressa* on the Net Productivity of Oysters (*Crassostrea virginica). Estuarine, Coastal and Shelf Science* 26:359-377.

Wilson, Elizabeth A., Eric N. Powell, and Sammy M. Ray
1988 The Effect of the Ectoparasitic Pyramidellid Snail, *Boonea impressa*, on the Growth and Health of Oysters, *Crassostrea virginica*, under field conditions. Fisheries Bulletin 86(8):553-566.

Wurster, Christopher M., and William P. Patterson
2001 Late Holocene climate change for the eastern interior United States: evidence from high-resolution d18O values of sagittal otoliths. *Paleogeography, Paleoclimatology, Palaeoecology* 170:81-100.

Yesner, D.R., W.S. Ayres, D.L. Carlson, R.S. Davis, R. Dewar, M.R. Gonzales Morales, F.A. Hassan, B. Hayden, J.J. Lischka, P.D. Sheets, A. Osborn, D.L. Pokotylo, T. Rogers, E. Sapnier, B.L. Turner II, E.E. Wreshner
1980 Maritime Hunter-Gatherers: Ecology and Prehistory [and Comments and Reply]. *Current Anthropology* 21(6):727-750.

APPENDIX A – FAUNAL ANALYSIS

Fauna identified from Test Unit 2, Rollins Shell Ring, Ft. George Island, FL.

Scientific Name	Common Name	Count	MNI	Wt (g)
Gastropoda	gastropods			
Polygyera sp.	land snail	3	-	0.10
Buccinidae sp.	whelk	1	1	2.60
Littorina sp.	periwinkle	1	1	0.50
Crustacea	crustaceans			
Cirripedia sp.	barnacle	11	-	2.70
Callinectes sp.	crab	162	-	67.90
Bivalvia	bivalve			
*Crassostrea virginica**	eastern oyster	4385	2221	24838.00
*Donax variabilis***	surf clam	102	62	24.80
Amblema sp.	freshwater mussel	1	1	4.90
Dinocardium robustus	giant cockle	1	1	1.90
Tellinidae sp.	tellin	1	1	0.20
Tagelus plebius	razor clam	1	1	0.40
Arcidae sp.	ark clam	1	1	0.40
Mytilidae sp.	ribbed mussel	4	-	3.70
Unidentified Shell		3	-	0.50
Osteichthyes	bony fish	34	-	0.15
Siluriformes	catfishes	5	-	0.50
Mammalia	mammal	20	-	3.90
Amphibia	amphibian	1	1	0.04
Aves	birds	1	1	0.03
Unidentified Bone		7	-	0.03
Unknown bone		3	-	0.02
Total Taxa		4748	2292	24953.27

*** - MNI left vales only**
**** - MNI one-sided valve only**

Fauna identified from Test Unit 10, Rollins Shell Ring, Ft. George Island, FL.

Scientific Name	Common Name	Count	MNI	Wt (g)
Gastropoda	gastropods			
Polygyera sp.	land snail	20	-	0.70
Crustacea	crustaceans			
Cirripedia sp.	barnacle	211	-	13.00
Callinectes sp.	crab	1	1	0.10
Bivalvia	bivalve			
*Crassostrea virginica**	eastern oyster	1156	529	9010.00
*Donax variabilis***	surf clam	11	5	1.30
Tagelus plebius	razor clam	1	1	0.80
Mytilidae sp.	ribbed mussel	-	-	3.00
Unidentified Shell		-	-	1.00
Osteichthyes	bony fish	2	2	0.21
Unidentified Bone		-	-	4.80
Total Taxa		1402	538	9034.91

*** - MNI left vales only**
**** - MNI one-sided valve only**

Fauna identified from Test Unit 12c, Rollins Shell Ring, Ft. George Island, FL.

Scientific Name	Common Name	Count	MNI	Wt (g)
Gastropoda	gastropods			
Polygyera sp.	land snail	7	-	0.30
Crustacea	crustaceans			
Cirripedia sp.	barnacle	7	-	0.50
Bivalvia	bivalve			
*Crassostrea virginica**	eastern oyster	1250	528	7482.00
*Donax variabilis***	surf clam	1	1	0.50
Osteichthyes	bony fish			
Siluriformes	catfishes	15	-	4.20
Bagre marinus	gaftopsail catfish	3	3	3.00
Unidentified Fish		7	-	0.20
Unknown Fish		27	-	2.11
Mammalia	mammal			
Procyon lotor	racoon	1	1	0.06
Total Taxa		1318	533	7492.87

*** - MNI left vales only**
**** - MNI one-sided valve only**

APPENDIX B – OYSTER ANALYSIS

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU2	5	1	20	*C. virginica*	4.1	4.3	1.0	Sand	8.0		barnacle	
TU2	5	1	20	*C. virginica*	3.9	4.0	1.0	Sand	6.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	1.6	1.6	1.0	Sand	0.5		barnacle	
TU2	5	1	20	*C. virginica*	4.0	4.0	1.0	Sand	10.0			
TU2	5	1	20	*C. virginica*	3.0	2.9	1.0	Sand	2.0		spat	spat on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	4.4	4.1	1.1	Sand	7.0			
TU2	5	1	20	*C. virginica*	4.0	3.7	1.1	Sand	6.0			oyster on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	2.6	2.4	1.1	Sand	1.0		barnacle	barnacle on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	3.6	3.3	1.1	Sand	3.0		barnacle	burned
TU2	5	1	20	*C. virginica*	3.3	3.0	1.1	Sand	6.0			burned
TU2	5	1	20	*C. virginica*	3.1	2.8	1.1	Sand	4.0			
TU2	5	1	20	*C. virginica*	5.8	5.2	1.1	Sand	13.0		spat	spat on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	3.6	3.2	1.1	Sand	5.0		barnacle	
TU2	5	1	20	*C. virginica*	3.4	3.0	1.1	Sand	4.0	shucked		
TU2	5	1	20	*C. virginica*	3.3	2.9	1.1	Sand	3.0			
TU2	5	1	20	*C. virginica*	5.7	5.0	1.1	Sand	22.0			
TU2	5	1	20	*C. virginica*	5.1	4.4	1.2	Sand	11.0	shucked		
TU2	5	1	20	*C. virginica*	6.2	5.3	1.2	Sand	21.0	hacked/cracked	barnacle	
TU2	5	1	20	*C. virginica*	4.6	3.9	1.2	Sand	6.0		barnacle	burned
TU2	5	1	20	*C. virginica*	4.4	3.7	1.2	Sand	3.0	shucked		
TU2	5	1	20	*C. virginica*	4.4	3.7	1.2	Sand	12.0		barnacle	
TU2	5	1	20	*C. virginica*	3.1	2.6	1.2	Sand	3.0			
TU2	5	1	20	*C. virginica*	3.1	2.6	1.2	Sand	1.0		barnacle	predation on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	5.2	4.3	1.2	Sand	13.0	hacked/cracked; shucked		
TU2	5	1	20	*C. virginica*	4.0	3.3	1.2	Sand	4.0			burned
TU2	5	1	20	*C. virginica*	3.8	3.1	1.2	Sand	3.0		barnacle	burned; predation on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	2.1	1.7	1.2	Sand	0.5			
TU2	5	1	20	*C. virginica*	2.1	1.7	1.2	Sand	1.0			oyster on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	5.2	4.2	1.2	Sand	8.0	shucked		
TU2	5	1	20	*C. virginica*	3.1	2.5	1.2	Sand	2.0		barnacle	
TU2	5	1	20	*C. virginica*	3.6	2.9	1.2	Sand	3.0		barnacle	
TU2	5	1	20	*C. virginica*	5.9	4.7	1.3	Bed	17.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	3.4	2.7	1.3	Bed	2.0	shucked		
TU2	5	1	20	*C. virginica*	4.3	3.4	1.3	Bed	8.0			
TU2	5	1	20	*C. virginica*	3.3	2.6	1.3	Bed	2.0			
TU2	5	1	20	*C. virginica*	5.5	4.3	1.3	Bed	14.0	shucked	barnacle	
TU2	5	1	20	*C. virginica*	3.6	2.8	1.3	Bed	1.0			
TU2	5	1	20	*C. virginica*	4.9	3.8	1.3	Bed	4.0		barnacle	
TU2	5	1	20	*C. virginica*	4.9	3.8	1.3	Bed	7.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	7.1	5.5	1.3	Bed	31.0	hacked/cracked; shucked	barnacle	
TU2	5	1	20	*C. virginica*	5.3	4.1	1.3	Bed	7.0	shucked		

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU2	5	1	20	*C. virginica*	5.7	4.4	1.3	Bed	11.0			
TU2	5	1	20	*C. virginica*	4.8	3.7	1.3	Bed	9.0	hacked/cracked	barnacle	
TU2	5	1	20	*C. virginica*	5.2	4.0	1.3	Bed	12.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	5.6	4.3	1.3	Bed	18.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	4.3	3.3	1.3	Bed	5.0			
TU2	5	1	20	*C. virginica*	4.2	3.2	1.3	Bed	6.0	shucked		
TU2	5	1	20	*C. virginica*	4.6	3.5	1.3	Bed	8.0	shucked		
TU2	5	1	20	*C. virginica*	4.6	3.5	1.3	Bed	8.0			
TU2	5	1	20	*C. virginica*	2.9	2.2	1.3	Bed	2.0			
TU2	5	1	20	*C. virginica*	4.5	3.4	1.3	Bed	8.0		barnacle	
TU2	5	1	20	*C. virginica*	4.5	3.4	1.3	Bed	3.0		barnacle	
TU2	5	1	20	*C. virginica*	2.0	1.5	1.3	Bed	1.0			
TU2	5	1	20	*C. virginica*	2.8	2.1	1.3	Bed	1.0			
TU2	5	1	20	*C. virginica*	4.0	3.0	1.3	Bed	3.0			
TU2	5	1	20	*C. virginica*	3.2	2.4	1.3	Bed	1.0			
TU2	5	1	20	*C. virginica*	4.4	3.3	1.3	Bed	4.0			
TU2	5	1	20	*C. virginica*	5.1	3.8	1.3	Bed	14.0			
TU2	5	1	20	*C. virginica*	4.7	3.5	1.3	Bed	6.0			
TU2	5	1	20	*C. virginica*	3.9	2.9	1.3	Bed	3.0		barnacle	
TU2	5	1	20	*C. virginica*	6.1	4.5	1.4	Bed	18.0	shucked		
TU2	5	1	20	*C. virginica*	4.1	3.0	1.4	Bed	3.0		barnacle; spat	predation on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	2.6	1.9	1.4	Bed	0.8		barnacle	
TU2	5	1	20	*C. virginica*	5.2	3.8	1.4	Bed	14.0			
TU2	5	1	20	*C. virginica*	4.4	3.2	1.4	Bed	11.0		barnacle	burned
TU2	5	1	20	*C. virginica*	5.5	4.0	1.4	Bed	16.0	shucked		
TU2	5	1	20	*C. virginica*	6.2	4.5	1.4	Bed	15.0			
TU2	5	1	20	*C. virginica*	7.6	5.5	1.4	Bed	38.0	hacked/cracked	barnacle	
TU2	5	1	20	*C. virginica*	5.4	3.9	1.4	Bed	14.0	hacked/cracked	barnacle	
TU2	5	1	20	*C. virginica*	2.5	1.8	1.4	Bed	0.5		barnacle	
TU2	5	1	20	*C. virginica*	4.6	3.3	1.4	Bed	7.0		barnacle	burned
TU2	5	1	20	*C. virginica*	5.3	3.8	1.4	Bed	12.0		barnacle	
TU2	5	1	20	*C. virginica*	5.3	3.8	1.4	Bed	7.0			
TU2	5	1	20	*C. virginica*	5.3	3.8	1.4	Bed	9.0			
TU2	5	1	20	*C. virginica*	4.9	3.5	1.4	Bed	10.0		barnacle	
TU2	5	1	20	*C. virginica*	5.9	4.2	1.4	Bed	13.0			burned
TU2	5	1	20	*C. virginica*	5.2	3.7	1.4	Bed	11.0		barnacle	
TU2	5	1	20	*C. virginica*	3.1	2.2	1.4	Bed	1.0			
TU2	5	1	20	*C. virginica*	6.2	4.4	1.4	Bed	10.0		barnacle	
TU2	5	1	20	*C. virginica*	4.8	3.4	1.4	Bed	4.0		barnacle	
TU2	5	1	20	*C. virginica*	5.1	3.6	1.4	Bed	9.0			
TU2	5	1	20	*C. virginica*	6.1	4.3	1.4	Bed	17.0	shucked		
TU2	5	1	20	*C. virginica*	2.7	1.9	1.4	Bed	1.0			
TU2	5	1	20	*C. virginica*	6.4	4.5	1.4	Bed	24.0		barnacle	three shells together, data on largest; predation on inner shell - deat at harvest
TU2	5	1	20	*C. virginica*	6.4	4.5	1.4	Bed	17.0	shucked		
TU2	5	1	20	*C. virginica*	5.7	4.0	1.4	Bed	6.0			
TU2	5	1	20	*C. virginica*	3.0	2.1	1.4	Bed	2.0			
TU2	5	1	20	*C. virginica*	5.0	3.5	1.4	Bed	8.0			
TU2	5	1	20	*C. virginica*	5.3	3.7	1.4	Bed	10.0			
TU2	5	1	20	*C. virginica*	5.3	3.7	1.4	Bed	19.0			two shells together

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU2	5	1	20	*C. virginica*	7.6	5.3	1.4	Bed	33.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	4.2	2.9	1.4	Bed	5.0			
TU2	5	1	20	*C. virginica*	3.2	2.2	1.5	Bed	1.0			
TU2	5	1	20	*C. virginica*	3.5	2.4	1.5	Bed	2.0		barnacle	
TU2	5	1	20	*C. virginica*	7.0	4.8	1.5	Bed	27.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	5.4	3.7	1.5	Bed	10.0		spat	spat/predation on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	3.8	2.6	1.5	Bed	4.0		barnacle	
TU2	5	1	20	*C. virginica*	5.7	3.9	1.5	Bed	9.0			
TU2	5	1	20	*C. virginica*	5.7	3.9	1.5	Bed	13.0			burned
TU2	5	1	20	*C. virginica*	6.0	4.1	1.5	Bed	28.0	hacked/cracked		attached to another oyster
TU2	5	1	20	*C. virginica*	6.0	4.1	1.5	Bed	18.0			
TU2	5	1	20	*C. virginica*	6.0	4.1	1.5	Bed	11.0			
TU2	5	1	20	*C. virginica*	4.1	2.8	1.5	Bed	4.0			
TU2	5	1	20	*C. virginica*	2.2	1.5	1.5	Bed	0.5		barnacle	
TU2	5	1	20	*C. virginica*	4.4	3.0	1.5	Bed	5.0			predation on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	4.7	3.2	1.5	Bed	7.0			
TU2	5	1	20	*C. virginica*	3.1	2.1	1.5	Bed	1.0			
TU2	5	1	20	*C. virginica*	3.7	2.5	1.5	Bed	1.0		barnacle	
TU2	5	1	20	*C. virginica*	4.3	2.9	1.5	Bed	4.0		barnacle	
TU2	5	1	20	*C. virginica*	5.2	3.5	1.5	Bed	9.0		barnacle; spat	spat/predation on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	4.8	3.2	1.5	Bed	9.0	hacked/cracked	barnacle	NOTEWORTHY: predation on inner shell - dead at harvest, but may have been modified????
TU2	5	1	20	*C. virginica*	2.7	1.8	1.5	Bed	1.0			
TU2	5	1	20	*C. virginica*	3.0	2.0	1.5	Bed	1.0		barnacle	predation on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	3.9	2.6	1.5	Bed	3.0			
TU2	5	1	20	*C. virginica*	4.5	3.0	1.5	Bed	5.0		barnacle	
TU2	5	1	20	*C. virginica*	5.7	3.8	1.5	Bed	9.0		barnacle	burned
TU2	5	1	20	*C. virginica*	6.5	4.3	1.5	Bed	17.0			
TU2	5	1	20	*C. virginica*	5.3	3.5	1.5	Bed	8.0	shucked		
TU2	5	1	20	*C. virginica*	5.3	3.5	1.5	Bed	11.0		barnacle; spat	barnacle/spat on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	4.1	2.7	1.5	Bed	6.0		barnacle	
TU2	5	1	20	*C. virginica*	4.1	2.7	1.5	Bed	2.0		barnacle	
TU2	5	1	20	*C. virginica*	3.8	2.5	1.5	Bed	4.0		barnacle	
TU2	5	1	20	*C. virginica*	3.8	2.5	1.5	Bed	4.0	shucked		
TU2	5	1	20	*C. virginica*	3.8	2.5	1.5	Bed	3.0	shucked		
TU2	5	1	20	*C. virginica*	7.3	4.8	1.5	Bed	32.0		barnacle	
TU2	5	1	20	*C. virginica*	6.4	4.2	1.5	Bed	15.0	hacked/cracked; shucked		
TU2	5	1	20	*C. virginica*	5.8	3.8	1.5	Bed	33.0	hacked/cracked		attached to right valve of another oyster
TU2	5	1	20	*C. virginica*	5.5	3.6	1.5	Bed	6.0	shucked	barnacle	
TU2	5	1	20	*C. virginica*	5.2	3.4	1.5	Bed	6.0			
TU2	5	1	20	*C. virginica*	7.8	5.1	1.5	Bed	17.0		barnacle	
TU2	5	1	20	*C. virginica*	4.3	2.8	1.5	Bed	6.0			burned

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU2	5	1	20	*C. virginica*	3.7	2.4	1.5	Bed	2.0		barnacle	
TU2	5	1	20	*C. virginica*	3.7	2.4	1.5	Bed	2.0			
TU2	5	1	20	*C. virginica*	3.4	2.2	1.5	Bed	1.0			
TU2	5	1	20	*C. virginica*	3.4	2.2	1.5	Bed	4.0		spat	spat on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	6.5	4.2	1.5	Bed	13.0	shucked	barnacle	
TU2	5	1	20	*C. virginica*	6.2	4.0	1.6	Bed	13.0		barnacle	
TU2	5	1	20	*C. virginica*	4.5	2.9	1.6	Bed	4.0			
TU2	5	1	20	*C. virginica*	5.9	3.8	1.6	Bed	8.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	5.6	3.6	1.6	Bed	12.0			
TU2	5	1	20	*C. virginica*	5.3	3.4	1.6	Bed	20.0			
TU2	5	1	20	*C. virginica*	6.4	4.1	1.6	Bed	10.0	hacked/cracked; shucked		
TU2	5	1	20	*C. virginica*	2.5	1.6	1.6	Bed	0.5		barnacle	barnacle on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	5.0	3.2	1.6	Bed	11.0			
TU2	5	1	20	*C. virginica*	3.6	2.3	1.6	Bed	4.0	shucked		
TU2	5	1	20	*C. virginica*	3.6	2.3	1.6	Bed	3.0			
TU2	5	1	20	*C. virginica*	3.6	2.3	1.6	Bed	2.0			
TU2	5	1	20	*C. virginica*	3.6	2.3	1.6	Bed	2.0		barnacle	
TU2	5	1	20	*C. virginica*	4.7	3.0	1.6	Bed	3.0		barnacle	burned
TU2	5	1	20	*C. virginica*	4.7	3.0	1.6	Bed	6.0			
TU2	5	1	20	*C. virginica*	3.3	2.1	1.6	Bed	1.0			
TU2	5	1	20	*C. virginica*	6.3	4.0	1.6	Bed	13.0			two shells together - data taken on larger
TU2	5	1	20	*C. virginica*	5.2	3.3	1.6	Bed	9.0	shucked		
TU2	5	1	20	*C. virginica*	5.2	3.3	1.6	Bed	8.0			
TU2	5	1	20	*C. virginica*	3.8	2.4	1.6	Bed	2.0		barnacle	predation on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	6.5	4.1	1.6	Bed	14.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	6.2	3.9	1.6	Bed	15.0			
TU2	5	1	20	*C. virginica*	6.2	3.9	1.6	Bed	7.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	4.3	2.7	1.6	Bed	11.0			two shells together, data from lower valve
TU2	5	1	20	*C. virginica*	5.9	3.7	1.6	Bed	13.0	hacked/cracked	barnacle	
TU2	5	1	20	*C. virginica*	4.8	3.0	1.6	Bed	5.0	shucked	barnacle	
TU2	5	1	20	*C. virginica*	3.2	2.0	1.6	Bed	0.5		barnacle	
TU2	5	1	20	*C. virginica*	4.0	2.5	1.6	Bed	2.0			
TU2	5	1	20	*C. virginica*	4.0	2.5	1.6	Bed	3.0			
TU2	5	1	20	*C. virginica*	4.5	2.8	1.6	Bed	4.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	5.8	3.6	1.6	Bed	21.0		spat; sponge	spat/predation on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	5.8	3.6	1.6	Bed	10.0	hacked/cracked	barnacle	
TU2	5	1	20	*C. virginica*	5.8	3.6	1.6	Bed	13.0	shucked		
TU2	5	1	20	*C. virginica*	5.8	3.6	1.6	Bed	12.0	shucked		
TU2	5	1	20	*C. virginica*	7.1	4.4	1.6	Bed	20.0	hacked/cracked; shucked		
TU2	5	1	20	*C. virginica*	6.3	3.9	1.6	Bed	17.0		barnacle	burned; heavy barnacle activity; attached to another oyster
TU2	5	1	20	*C. virginica*	4.7	2.9	1.6	Bed	4.0	shucked		

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU2	5	1	20	*C. virginica*	5.2	3.2	1.6	Bed	5.0	hacked/cracked; shucked		
TU2	5	1	20	*C. virginica*	5.2	3.2	1.6	Bed	8.0	shucked	barnacle	
TU2	5	1	20	*C. virginica*	5.7	3.5	1.6	Bed	6.0		barnacle	
TU2	5	1	20	*C. virginica*	4.4	2.7	1.6	Bed	3.0			oyster on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	6.2	3.8	1.6	Bed	10.0	shucked	barnacle	
TU2	5	1	20	*C. virginica*	4.6	2.8	1.6	Bed	3.0			
TU2	5	1	20	*C. virginica*	6.9	4.2	1.6	Bed	20.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	3.3	2.0	1.7	Bed	2.0			
TU2	5	1	20	*C. virginica*	3.8	2.3	1.7	Bed	2.0			
TU2	5	1	20	*C. virginica*	4.8	2.9	1.7	Bed	5.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	5.8	3.5	1.7	Bed	6.0		barnacle	
TU2	5	1	20	*C. virginica*	6.3	3.8	1.7	Bed	12.0	hacked/cracked	barnacle	
TU2	5	1	20	*C. virginica*	1.5	0.9	1.7	Bed	0.3			
TU2	5	1	20	*C. virginica*	3.0	1.8	1.7	Bed	1.0		barnacle	
TU2	5	1	20	*C. virginica*	7.0	4.2	1.7	Bed	8.0	hacked/cracked; shucked	barnacle	
TU2	5	1	20	*C. virginica*	4.0	2.4	1.7	Bed	3.0		barnacle	burned
TU2	5	1	20	*C. virginica*	7.5	4.5	1.7	Bed	33.0		spat	spat on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	6.2	3.7	1.7	Bed	13.0	shucked		
TU2	5	1	20	*C. virginica*	6.2	3.7	1.7	Bed	13.0			burned
TU2	5	1	20	*C. virginica*	5.2	3.1	1.7	Bed	11.0			
TU2	5	1	20	*C. virginica*	8.4	5.0	1.7	Bed	29.0		barnacle	
TU2	5	1	20	*C. virginica*	7.4	4.4	1.7	Bed	14.0	hacked/cracked; shucked	barnacle	
TU2	5	1	20	*C. virginica*	5.9	3.5	1.7	Bed	5.0		barnacle	
TU2	5	1	20	*C. virginica*	5.9	3.5	1.7	Bed	16.0	shucked	barnacle	
TU2	5	1	20	*C. virginica*	4.9	2.9	1.7	Bed	4.0	shucked		
TU2	5	1	20	*C. virginica*	5.1	3.0	1.7	Bed	6.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	5.1	3.0	1.7	Bed	5.0			
TU2	5	1	20	*C. virginica*	2.9	1.7	1.7	Bed	0.5		barnacle	
TU2	5	1	20	*C. virginica*	5.3	3.1	1.7	Bed	10.0		barnacle	oyster on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	3.6	2.1	1.7	Bed	2.0			
TU2	5	1	20	*C. virginica*	3.6	2.1	1.7	Bed	3.0			
TU2	5	1	20	*C. virginica*	7.2	4.2	1.7	Bed	14.0	hacked/cracked; shucked		
TU2	5	1	20	*C. virginica*	5.5	3.2	1.7	Bed	8.0	hacked/cracked	barnacle	
TU2	5	1	20	*C. virginica*	7.4	4.3	1.7	Bed	13.0	shucked		
TU2	5	1	20	*C. virginica*	6.2	3.6	1.7	Bed	16.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	6.9	4.0	1.7	Bed	16.0	hacked/cracked	barnacle	
TU2	5	1	20	*C. virginica*	5.2	3.0	1.7	Bed	8.0			
TU2	5	1	20	*C. virginica*	6.6	3.8	1.7	Bed	12.0			
TU2	5	1	20	*C. virginica*	6.1	3.5	1.7	Bed	6.0		barnacle	
TU2	5	1	20	*C. virginica*	6.3	3.6	1.8	Bed	9.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	4.2	2.4	1.8	Bed	4.0			
TU2	5	1	20	*C. virginica*	7.9	4.5	1.8	Bed	25.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	5.8	3.3	1.8	Bed	9.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	6.7	3.8	1.8	Bed	14.0	hacked/cracked	barnacle	
TU2	5	1	20	*C. virginica*	6.7	3.8	1.8	Bed	12.0			burned
TU2	5	1	20	*C. virginica*	6.0	3.4	1.8	Bed	9.0		barnacle	

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU2	5	1	20	*C. virginica*	7.1	4.0	1.8	Bed	14.0			
TU2	5	1	20	*C. virginica*	4.8	2.7	1.8	Bed	2.0		barnacle	
TU2	5	1	20	*C. virginica*	3.2	1.8	1.8	Bed	2.0		barnacle	
TU2	5	1	20	*C. virginica*	6.4	3.6	1.8	Bed	16.0	shucked		
TU2	5	1	20	*C. virginica*	8.9	5.0	1.8	Bed	41.0	shucked		burned; several oysters growing on outer shell (excessive wt explanation)
TU2	5	1	20	*C. virginica*	4.1	2.3	1.8	Bed	3.0			
TU2	5	1	20	*C. virginica*	5.9	3.3	1.8	Bed	12.0		barnacle	burned
TU2	5	1	20	*C. virginica*	6.8	3.8	1.8	Bed	12.0	shucked		burned
TU2	5	1	20	*C. virginica*	6.8	3.8	1.8	Bed	13.0	hacked/cracked; shucked	barnacle	
TU2	5	1	20	*C. virginica*	4.3	2.4	1.8	Bed	4.0			
TU2	5	1	20	*C. virginica*	4.3	2.4	1.8	Bed	3.0			
TU2	5	1	20	*C. virginica*	2.7	1.5	1.8	Bed	1.0			
TU2	5	1	20	*C. virginica*	6.3	3.5	1.8	Bed	11.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	7.4	4.1	1.8	Bed	24.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	6.0	3.3	1.8	Bed	21.0			
TU2	5	1	20	*C. virginica*	4.2	2.3	1.8	Bed	16.0			attached to several shells
TU2	5	1	20	*C. virginica*	4.2	2.3	1.8	Bed	2.0			
TU2	5	1	20	*C. virginica*	4.2	2.3	1.8	Bed	4.0		barnacle	predation on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	6.4	3.5	1.8	Bed	12.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	5.5	3.0	1.8	Bed	5.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	7.9	4.3	1.8	Bed	15.0	shucked		
TU2	5	1	20	*C. virginica*	5.7	3.1	1.8	Bed	6.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	4.6	2.5	1.8	Bed	3.0			
TU2	5	1	20	*C. virginica*	5.9	3.2	1.8	Bed	12.0			
TU2	5	1	20	*C. virginica*	6.1	3.3	1.8	Bed	8.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	5.0	2.7	1.9	Bed	4.0		barnacle	
TU2	5	1	20	*C. virginica*	9.1	4.9	1.9	Bed	20.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	6.5	3.5	1.9	Bed	9.0	hacked/cracked	barnacle	
TU2	5	1	20	*C. virginica*	6.5	3.5	1.9	Bed	8.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	8.0	4.3	1.9	Bed	19.0		spat	spat on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	5.4	2.9	1.9	Bed	6.0	hacked/cracked	barnacle	
TU2	5	1	20	*C. virginica*	4.1	2.2	1.9	Bed	4.0		spat	spat on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	4.1	2.2	1.9	Bed	2.0		spat	spat on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	2.8	1.5	1.9	Bed	0.5			
TU2	5	1	20	*C. virginica*	5.6	3.0	1.9	Bed	5.0			
TU2	5	1	20	*C. virginica*	5.6	3.0	1.9	Bed	6.0	shucked		
TU2	5	1	20	*C. virginica*	5.8	3.1	1.9	Bed	9.0	shucked	barnacle	
TU2	5	1	20	*C. virginica*	5.5	2.9	1.9	Bed	10.0		barnacle	predation on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	7.4	3.9	1.9	Bed	15.0			burned
TU2	5	1	20	*C. virginica*	3.8	2.0	1.9	Bed	4.0			
TU2	5	1	20	*C. virginica*	5.7	3.0	1.9	Bed	8.0		barnacle	burned
TU2	5	1	20	*C. virginica*	5.9	3.1	1.9	Bed	7.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	4.0	2.1	1.9	Bed	2.0	shucked		
TU2	5	1	20	*C. virginica*	6.1	3.2	1.9	Bed	11.0			

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU2	5	1	20	*C. virginica*	8.2	4.3	1.9	Bed	14.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	4.2	2.2	1.9	Bed	5.0		spat	spat on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	8.8	4.6	1.9	Bed	24.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	4.6	2.4	1.9	Bed	3.0			
TU2	5	1	20	*C. virginica*	5.0	2.6	1.9	Bed	6.0	hacked/cracked; shucked	barnacle	
TU2	5	1	20	*C. virginica*	5.2	2.7	1.9	Bed	7.0		spat	spat on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	5.4	2.8	1.9	Bed	6.0			
TU2	5	1	20	*C. virginica*	3.3	1.7	1.9	Bed	2.0			
TU2	5	1	20	*C. virginica*	6.6	3.4	1.9	Bed	16.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	6.8	3.5	1.9	Bed	12.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	3.5	1.8	1.9	Bed	2.0			
TU2	5	1	20	*C. virginica*	7.4	3.8	1.9	Bed	12.0	shucked		burned
TU2	5	1	20	*C. virginica*	7.6	3.9	1.9	Bed	21.0	hacked/cracked; shucked		two shells together - data taken on larger
TU2	5	1	20	*C. virginica*	8.2	4.2	2.0	Channel	16.0	shucked		
TU2	5	1	20	*C. virginica*	8.6	4.4	2.0	Channel	22.0		barnacle	barnacle on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	4.5	2.3	2.0	Reef	4.0			
TU2	5	1	20	*C. virginica*	9.0	4.6	2.0	Channel	22.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	4.9	2.5	2.0	Reef	2.0		barnacle	
TU2	5	1	20	*C. virginica*	5.1	2.6	2.0	Reef	9.0	shucked		
TU2	5	1	20	*C. virginica*	5.1	2.6	2.0	Reef	4.0		spat	spat on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	5.3	2.7	2.0	Reef	8.0			
TU2	5	1	20	*C. virginica*	5.3	2.7	2.0	Reef	5.0	hacked/cracked; shucked		
TU2	5	1	20	*C. virginica*	6.3	3.2	2.0	Channel	11.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	2.2	1.1	2.0	Reef	0.3			
TU2	5	1	20	*C. virginica*	2.6	1.3	2.0	Reef	1.0			oyster on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	2.8	1.4	2.0	Reef	2.0		barnacle	predation on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	3.4	1.7	2.0	Reef	2.0			
TU2	5	1	20	*C. virginica*	5.0	2.5	2.0	Reef	6.0		barnacle	
TU2	5	1	20	*C. virginica*	5.2	2.6	2.0	Reef	3.0	shucked	barnacle	
TU2	5	1	20	*C. virginica*	5.2	2.6	2.0	Reef	5.0			
TU2	5	1	20	*C. virginica*	6.0	3.0	2.0	Channel	9.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	6.4	3.2	2.0	Channel	6.0			
TU2	5	1	20	*C. virginica*	6.8	3.4	2.0	Channel	15.0	shucked	barnacle	
TU2	5	1	20	*C. virginica*	7.8	3.9	2.0	Channel	12.0		barnacle	
TU2	5	1	20	*C. virginica*	7.5	3.7	2.0	Channel	11.0	hacked/cracked; shucked		
TU2	5	1	20	*C. virginica*	7.3	3.6	2.0	Channel	19.0	hacked/cracked	barnacle	
TU2	5	1	20	*C. virginica*	6.9	3.4	2.0	Channel	9.0			
TU2	5	1	20	*C. virginica*	6.7	3.3	2.0	Channel	11.0	shucked		
TU2	5	1	20	*C. virginica*	5.9	2.9	2.0	Channel	11.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	5.5	2.7	2.0	Reef	4.0			
TU2	5	1	20	*C. virginica*	4.9	2.4	2.0	Reef	4.0			
TU2	5	1	20	*C. virginica*	4.9	2.4	2.0	Reef	2.0		barnacle	burned; pred on inner shell - dead at harvest

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU2	5	1	20	*C. virginica*	4.7	2.3	2.0	Reef	4.0			
TU2	5	1	20	*C. virginica*	4.5	2.2	2.0	Reef	3.0		barnacle	
TU2	5	1	20	*C. virginica*	3.9	1.9	2.1	Reef	2.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	6.2	3.0	2.1	Channel	4.0	hacked/cracked; shucked		
TU2	5	1	20	*C. virginica*	5.4	2.6	2.1	Reef	4.0		barnacle	
TU2	5	1	20	*C. virginica*	6.3	3.0	2.1	Channel	10.0	hacked/cracked	barnacle	
TU2	5	1	20	*C. virginica*	5.7	2.7	2.1	Reef	6.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	8.5	4.0	2.1	Channel	18.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	7.7	3.6	2.1	Channel	20.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	5.8	2.7	2.1	Reef	7.0	hacked/cracked	barnacle	
TU2	5	1	20	*C. virginica*	8.6	4.0	2.2	Channel	22.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	5.6	2.6	2.2	Reef	6.0	shucked		
TU2	5	1	20	*C. virginica*	5.6	2.6	2.2	Reef	5.0			
TU2	5	1	20	*C. virginica*	6.9	3.2	2.2	Channel	15.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	5.2	2.4	2.2	Reef	10.0			
TU2	5	1	20	*C. virginica*	5.0	2.3	2.2	Reef	7.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	6.1	2.8	2.2	Channel	8.0	shucked		
TU2	5	1	20	*C. virginica*	8.3	3.8	2.2	Channel	15.0		barnacle	
TU2	5	1	20	*C. virginica*	6.8	3.1	2.2	Channel	7.0			
TU2	5	1	20	*C. virginica*	7.7	3.5	2.2	Channel	12.0	hacked/cracked	barnacle	
TU2	5	1	20	*C. virginica*	11.0	5.0	2.2	Channel	30.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	7.5	3.4	2.2	Channel	14.0	hacked/cracked	barnacle	
TU2	5	1	20	*C. virginica*	7.3	3.3	2.2	Channel	19.0			
TU2	5	1	20	*C. virginica*	8.0	3.6	2.2	Channel	11.0	shucked		
TU2	5	1	20	*C. virginica*	6.9	3.1	2.2	Channel	6.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	7.0	3.1	2.3	Channel	6.0	hacked/cracked	barnacle	
TU2	5	1	20	*C. virginica*	8.6	3.8	2.3	Channel	16.0	shucked		
TU2	5	1	20	*C. virginica*	8.9	3.9	2.3	Channel	20.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	7.8	3.4	2.3	Channel	8.0		barnacle	
TU2	5	1	20	*C. virginica*	6.9	3.0	2.3	Channel	13.0		barnacle	
TU2	5	1	20	*C. virginica*	6.9	3.0	2.3	Channel	10.0	hacked/cracked		
TU2	5	1	20	*C. virginica*	9.9	4.3	2.3	Channel	35.0		barnacle	
TU2	5	1	20	*C. virginica*	5.6	2.4	2.3	Reef	5.0		barnacle	
TU2	5	1	20	*C. virginica*	7.7	3.3	2.3	Channel	15.0			oyster attached to inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	8.2	3.5	2.3	Channel	18.0		barnacle	
TU2	5	1	20	*C. virginica*	7.5	3.2	2.3	Channel	10.0			
TU2	5	1	20	*C. virginica*	6.8	2.9	2.3	Channel	13.0			lots of spat on outer shell
TU2	5	1	20	*C. virginica*	7.1	3.0	2.4	Channel	10.0			burned
TU2	5	1	20	*C. virginica*	5.0	2.1	2.4	Reef	5.0			
TU2	5	1	20	*C. virginica*	6.7	2.8	2.4	Channel	12.0		barnacle	
TU2	5	1	20	*C. virginica*	6.0	2.5	2.4	Channel	8.0			
TU2	5	1	20	*C. virginica*	8.4	3.5	2.4	Channel	19.0			
TU2	5	1	20	*C. virginica*	9.6	4.0	2.4	Channel	21.0	hacked/cracked	barnacle	
TU2	5	1	20	*C. virginica*	5.1	2.1	2.4	Reef			spat	burned; spat on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	8.5	3.5	2.4	Channel	14.0	hacked/cracked	barnacle	
TU2	5	1	20	*C. virginica*	6.4	2.6	2.5	Channel	9.0			
TU2	5	1	20	*C. virginica*	9.1	3.6	2.5	Channel	15.0			
TU2	5	1	20	*C. virginica*	7.1	2.8	2.5	Channel	14.0			burned
TU2	5	1	20	*C. virginica*	5.1	2.0	2.6	Reef	7.0			

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU2	5	1	20	*C. virginica*	9.9	3.8	2.6	Channel	20.0	hacked/cracked; shucked		
TU2	5	1	20	*C. virginica*	10.6	4.0	2.7	Channel	27.0			
TU2	5	1	20	*C. virginica*	6.4	2.4	2.7	Channel	12.0			
TU2	5	1	20	*C. virginica*	7.3	2.7	2.7	Channel	10.0	hacked/cracked; shucked		
TU2	5	1	20	*C. virginica*	8.7	3.1	2.8	Channel	10.0	shucked		
TU2	5	1	20	*C. virginica*	5.4	1.9	2.8	Reef	3.0	shucked		
TU2	5	1	20	*C. virginica*	9.5	3.2	3.0	Channel	13.0			
TU2	5	1	20	*C. virginica*	4.4	3.4	1.3	Bed	4.0		barnacle	predation on inner shell - dead at harvest
TU2	5	1	20	*C. virginica*	6.3	1.9	3.3	Channel	4.0			
TU10	40-50	20	626	*C. virginica*	2.2	2.5	0.9	Sand	1.0			
TU10	40-50	20	626	*C. virginica*	1.7	1.9	0.9	Sand	1.0			
TU10	40-50	20	626	*C. virginica*	2.7	2.8	1.0	Sand	2.0			
TU10	40-50	20	626	*C. virginica*	3.1	3.1	1.0	Sand	2.0		barnacle	barnacle colonization
TU10	40-50	20	626	*C. virginica*	1.9	1.9	1.0	Sand	0.4			
TU10	40-50	20	626	*C. virginica*	1.2	1.2	1.0	Sand	0.2			
TU10	40-50	20	626	*C. virginica*	3.1	3.0	1.0	Sand	2.0			
TU10	40-50	20	626	*C. virginica*	2.7	2.6	1.0	Sand	2.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	2.5	2.4	1.0	Sand	2.0			
TU10	40-50	20	626	*C. virginica*	3.5	3.3	1.1	Sand	5.0	shucked?		possibly shucked
TU10	40-50	20	626	*C. virginica*	1.5	1.4	1.1	Sand	0.3			
TU10	40-50	20	626	*C. virginica*	2.4	2.2	1.1	Sand	2.0			
TU10	40-50	20	626	*C. virginica*	3.6	3.3	1.1	Sand	4.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	4.9	4.4	1.1	Sand	9.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	3.7	3.3	1.1	Sand	3.0			
TU10	40-50	20	626	*C. virginica*	3.7	3.3	1.1	Sand	3.0	shucked		shucked
TU10	40-50	20	626	*C. virginica*	3.6	3.2	1.1	Sand	4.0			
TU10	40-50	20	626	*C. virginica*	5.4	4.8	1.1	Sand	18.0			
TU10	40-50	20	626	*C. virginica*	2.6	2.3	1.1	Sand	2.0			
TU10	40-50	20	626	*C. virginica*	5.1	4.5	1.1	Sand	28.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	3.3	2.9	1.1	Sand	3.0			
TU10	40-50	20	626	*C. virginica*	1.6	1.4	1.1	Sand	0.5			
TU10	40-50	20	626	*C. virginica*	3.9	3.4	1.1	Sand	3.0			
TU10	40-50	20	626	*C. virginica*	4.5	3.9	1.2	Sand	7.0	shucked?		possibly shucked
TU10	40-50	20	626	*C. virginica*	5.2	4.5	1.2	Sand	16.0			
TU10	40-50	20	626	*C. virginica*	4.4	3.8	1.2	Sand	9.0			
TU10	40-50	20	626	*C. virginica*	4.9	4.2	1.2	Sand	13.0			
TU10	40-50	20	626	*C. virginica*	4.7	4.0	1.2	Sand	9.0	shucked	barnacle	shucked
TU10	40-50	20	626	*C. virginica*	2.0	1.7	1.2	Sand	0.5			
TU10	40-50	20	626	*C. virginica*	3.3	2.8	1.2	Sand	4.0			
TU10	40-50	20	626	*C. virginica*	5.9	5.0	1.2	Sand	23.0	shucked	barnacle	shucked
TU10	40-50	20	626	*C. virginica*	3.9	3.3	1.2	Sand	6.0			
TU10	40-50	20	626	*C. virginica*	4.3	3.6	1.2	Sand	6.0			
TU10	40-50	20	626	*C. virginica*	1.2	1.0	1.2	Sand	0.3			
TU10	40-50	20	626	*C. virginica*	5.3	4.4	1.2	Sand	17.0	shucked		shucked
TU10	40-50	20	626	*C. virginica*	3.5	2.9	1.2	Sand	3.0			
TU10	40-50	20	626	*C. virginica*	5.2	4.3	1.2	Sand	12.0	hacked/cracked	barnacle?	hacked/cracked with possible barnacle predation

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU10	40-50	20	626	*C. virginica*	6.2	5.1	1.2	Sand	19.0	shucked	barnacle	shucked with barnacle colonization
TU10	40-50	20	626	*C. virginica*	2.8	2.3	1.2	Sand	2.0			
TU10	40-50	20	626	*C. virginica*	2.2	1.8	1.2	Sand	1.0			
TU10	40-50	20	626	*C. virginica*	3.8	3.1	1.2	Sand	3.0			
TU10	40-50	20	626	*C. virginica*	3.8	3.1	1.2	Sand	4.0		barnacle	barnacle colonization
TU10	40-50	20	626	*C. virginica*	2.7	2.2	1.2	Sand	0.5			
TU10	40-50	20	626	*C. virginica*	4.8	3.9	1.2	Sand	14.0	shucked?		possibly shucked
TU10	40-50	20	626	*C. virginica*	3.2	2.6	1.2	Sand	2.0	shucked?		possibly shucked
TU10	40-50	20	626	*C. virginica*	5.8	4.7	1.2	Sand	13.0		barnacle	barnacle colonization
TU10	40-50	20	626	*C. virginica*	2.1	1.7	1.2	Sand	0.5			
TU10	40-50	20	626	*C. virginica*	5.2	4.2	1.2	Sand	10.0			strange marks on interior of shell
TU10	40-50	20	626	*C. virginica*	4.1	3.3	1.2	Sand	7.0	shucked?		possibly shucked
TU10	40-50	20	626	*C. virginica*	4.6	3.7	1.2	Sand	5.0		barnacle	barnacle colonization
TU10	40-50	20	626	*C. virginica*	5.1	4.1	1.2	Bed	21.0			smaller oyster attached
TU10	40-50	20	626	*C. virginica*	5.0	4.0	1.3	Bed	13.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	2.5	2.0	1.3	Bed	0.5		barnacle	barnacle colonization
TU10	40-50	20	626	*C. virginica*	1.5	1.2	1.3	Bed	0.3			
TU10	40-50	20	626	*C. virginica*	4.9	3.9	1.3	Bed	8.0			
TU10	40-50	20	626	*C. virginica*	3.9	3.1	1.3	Bed	5.0			
TU10	40-50	20	626	*C. virginica*	5.8	4.6	1.3	Bed	20.0			
TU10	40-50	20	626	*C. virginica*	5.6	4.4	1.3	Bed	11.0	hacked/cracked	barnacle	hacked/cracked with barnacle colonization
TU10	40-50	20	626	*C. virginica*	5.1	4.0	1.3	Bed	17.0	shucked?		possibly shucked
TU10	40-50	20	626	*C. virginica*	5.5	4.3	1.3	Bed	15.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	4.1	3.2	1.3	Bed	5.0			
TU10	40-50	20	626	*C. virginica*	5.8	4.5	1.3	Bed	17.0			
TU10	40-50	20	626	*C. virginica*	4.9	3.8	1.3	Bed	15.0			
TU10	40-50	20	626	*C. virginica*	6.2	4.8	1.3	Bed	34.0			
TU10	40-50	20	626	*C. virginica*	5.7	4.4	1.3	Bed	22.0			
TU10	40-50	20	626	*C. virginica*	3.5	2.7	1.3	Bed	4.0			
TU10	40-50	20	626	*C. virginica*	5.2	4.0	1.3	Bed	17.0			
TU10	40-50	20	626	*C. virginica*	4.3	3.3	1.3	Bed	6.0			
TU10	40-50	20	626	*C. virginica*	3.0	2.3	1.3	Bed	2.0	shucked?		possibly shucked
TU10	40-50	20	626	*C. virginica*	3.0	2.3	1.3	Bed	3.0			
TU10	40-50	20	626	*C. virginica*	3.0	2.3	1.3	Bed	2.0			
TU10	40-50	20	626	*C. virginica*	5.1	3.9	1.3	Bed	16.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	3.4	2.6	1.3	Bed	3.0			
TU10	40-50	20	626	*C. virginica*	5.5	4.2	1.3	Bed	9.0		barnacle	barnacle colonization
TU10	40-50	20	626	*C. virginica*	7.6	5.8	1.3	Bed	18.0	shucked		shucked
TU10	40-50	20	626	*C. virginica*	6.3	4.8	1.3	Bed	15.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	5.0	3.8	1.3	Bed	9.0			
TU10	40-50	20	626	*C. virginica*	3.7	2.8	1.3	Bed	2.0			
TU10	40-50	20	626	*C. virginica*	4.5	3.4	1.3	Bed	10.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	5.3	4.0	1.3	Bed	14.0			
TU10	40-50	20	626	*C. virginica*	2.0	1.5	1.3	Bed	0.5			
TU10	40-50	20	626	*C. virginica*	4.4	3.3	1.3	Bed	8.0	shucked		shucked
TU10	40-50	20	626	*C. virginica*	3.2	2.4	1.3	Bed	2.0			
TU10	40-50	20	626	*C. virginica*	3.1	2.3	1.3	Bed	2.0			

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU10	40-50	20	626	*C. virginica*	5.8	4.3	1.3	Bed	26.0		polychaete worm	possible polychaete worm evidence
TU10	40-50	20	626	*C. virginica*	5.4	4.0	1.4	Bed	13.0		byrozoa?	sample bagged separately
TU10	40-50	20	626	*C. virginica*	5.4	4.0	1.4	Bed	6.0	shucked?		possibly shucked
TU10	40-50	20	626	*C. virginica*	2.7	2.0	1.4	Bed	1.0		barnacle	barnacle colonization
TU10	40-50	20	626	*C. virginica*	5.0	3.7	1.4	Bed	13.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	6.5	4.8	1.4	Bed	15.0			
TU10	40-50	20	626	*C. virginica*	6.5	4.8	1.4	Bed	18.0	hacked/cracked	barnacle	barnacle colonization
TU10	40-50	20	626	*C. virginica*	3.4	2.5	1.4	Bed	2.0		barnacle	barnacle colonization
TU10	40-50	20	626	*C. virginica*	7.1	5.2	1.4	Bed	20.0			
TU10	40-50	20	626	*C. virginica*	4.1	3.0	1.4	Bed	5.0		barnacle	barnacle colonization
TU10	40-50	20	626	*C. virginica*	5.5	4.0	1.4	Bed	17.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	5.5	4.0	1.4	Bed	11.0			very eroded; possibly dead at harvest
TU10	40-50	20	626	*C. virginica*	2.2	1.6	1.4	Bed	1.0			
TU10	40-50	20	626	*C. virginica*	6.2	4.5	1.4	Bed	15.0			
TU10	40-50	20	626	*C. virginica*	4.0	2.9	1.4	Bed	6.0			
TU10	40-50	20	626	*C. virginica*	4.3	3.1	1.4	Bed	7.0	shucked		shucked
TU10	40-50	20	626	*C. virginica*	2.5	1.8	1.4	Bed	0.5			
TU10	40-50	20	626	*C. virginica*	6.4	4.6	1.4	Bed	24.0			
TU10	40-50	20	626	*C. virginica*	3.9	2.8	1.4	Bed	5.0			
TU10	40-50	20	626	*C. virginica*	4.6	3.3	1.4	Bed	8.0			
TU10	40-50	20	626	*C. virginica*	5.3	3.8	1.4	Bed	13.0			
TU10	40-50	20	626	*C. virginica*	6.7	4.8	1.4	Bed	17.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	6.7	4.8	1.4	Bed	14.0			
TU10	40-50	20	626	*C. virginica*	2.1	1.5	1.4	Bed	0.5			
TU10	40-50	20	626	*C. virginica*	2.1	1.5	1.4	Bed	0.4			
TU10	40-50	20	626	*C. virginica*	6.2	4.4	1.4	Bed	21.0	hacked/cracked?	barnacle	possibly hacked/cracked, with barnacle colonization
TU10	40-50	20	626	*C. virginica*	5.5	3.9	1.4	Bed	13.0	hacked/cracked	barnacle	hacked/cracked with barnacle colonization
TU10	40-50	20	626	*C. virginica*	4.8	3.4	1.4	Bed	11.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	6.5	4.6	1.4	Bed	18.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	5.8	4.1	1.4	Bed	18.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	7.1	5.0	1.4	Bed	18.0	shucked	barnacle	shucked
TU10	40-50	20	626	*C. virginica*	5.4	3.8	1.4	Bed	15.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	5.7	4.0	1.4	Bed	16.0	shucked?		possibly shucked at end
TU10	40-50	20	626	*C. virginica*	7.0	4.9	1.4	Bed	22.0	hacked/cracked	barnacle	hacked/cracked with barnacle colonization
TU10	40-50	20	626	*C. virginica*	3.0	2.1	1.4	Bed	1.0			
TU10	40-50	20	626	*C. virginica*	4.0	2.8	1.4	Bed	4.0		barnacle	lots of barnacle colonization
TU10	40-50	20	626	*C. virginica*	5.0	3.5	1.4	Bed	10.0	hacked/cracked?	barnacle	possibly hacked/cracked with barnacle colonization
TU10	40-50	20	626	*C. virginica*	3.0	2.1	1.4	Bed	3.0			
TU10	40-50	20	626	*C. virginica*	5.3	3.7	1.4	Bed	11.0			
TU10	40-50	20	626	*C. virginica*	3.3	2.3	1.4	Bed	3.0			
TU10	40-50	20	626	*C. virginica*	3.3	2.3	1.4	Bed	3.0			
TU10	40-50	20	626	*C. virginica*	4.9	3.4	1.4	Bed	6.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	6.2	4.3	1.4	Bed	16.0	shucked?		possibly shucked

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU10	40-50	20	626	*C. virginica*	6.2	4.3	1.4	Bed	14.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	6.5	4.5	1.4	Bed	11.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	5.2	3.6	1.4	Bed	15.0		barnacle	very eroded
TU10	40-50	20	626	*C. virginica*	2.6	1.8	1.4	Bed	0.5			
TU10	40-50	20	626	*C. virginica*	2.6	1.8	1.4	Bed	0.5			
TU10	40-50	20	626	*C. virginica*	5.5	3.8	1.4	Bed	14.0	hacked/cracked		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	2.9	2.0	1.5	Bed	2.0			
TU10	40-50	20	626	*C. virginica*	6.1	4.2	1.5	Bed	18.0			
TU10	40-50	20	626	*C. virginica*	6.7	4.6	1.5	Bed	19.0			
TU10	40-50	20	626	*C. virginica*	5.7	3.9	1.5	Bed	15.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	6.0	4.1	1.5	Bed	11.0	shucked, hacked/cracked		shucked, hacked/cracked
TU10	40-50	20	626	*C. virginica*	6.0	4.1	1.5	Bed	17.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	6.3	4.3	1.5	Bed	26.0	hacked/cracked	sponge predation?	hacked/cracked; possible sponge predation; spat activity
TU10	40-50	20	626	*C. virginica*	4.7	3.2	1.5	Bed	8.0			
TU10	40-50	20	626	*C. virginica*	5.0	3.4	1.5	Bed	10.0	shucked?		possibly shucked
TU10	40-50	20	626	*C. virginica*	7.8	5.3	1.5	Bed	15.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	5.6	3.8	1.5	Bed	14.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	5.9	4.0	1.5	Bed	16.0			
TU10	40-50	20	626	*C. virginica*	6.2	4.2	1.5	Bed	20.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	6.2	4.2	1.5	Bed	12.0		polychaete worm	oyster attached
TU10	40-50	20	626	*C. virginica*	3.1	2.1	1.5	Bed	2.0			
TU10	40-50	20	626	*C. virginica*	6.8	4.6	1.5	Bed	17.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	3.4	2.3	1.5	Bed	3.0		barnacle	
TU10	40-50	20	626	*C. virginica*	4.6	3.1	1.5	Bed	9.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	6.4	4.3	1.5	Bed	17.0			
TU10	40-50	20	626	*C. virginica*	7.3	4.9	1.5	Bed	26.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	7.5	5.0	1.5	Bed	21.0			
TU10	40-50	20	626	*C. virginica*	4.5	3.0	1.5	Bed	6.0			
TU10	40-50	20	626	*C. virginica*	5.4	3.6	1.5	Bed	9.0			
TU10	40-50	20	626	*C. virginica*	5.1	3.4	1.5	Bed	10.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	5.4	3.6	1.5	Bed	15.0	shucked?		possibly shucked
TU10	40-50	20	626	*C. virginica*	4.5	3.0	1.5	Bed	3.0			
TU10	40-50	20	626	*C. virginica*	1.8	1.2	1.5	Bed	0.3			
TU10	40-50	20	626	*C. virginica*	2.1	1.4	1.5	Bed	0.5			
TU10	40-50	20	626	*C. virginica*	6.2	4.1	1.5	Bed	20.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	5.9	3.9	1.5	Bed	7.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	5.9	3.9	1.5	Bed	13.0	shucked?	barnacle	possibly shucked with barnacle colonization
TU10	40-50	20	626	*C. virginica*	5.0	3.3	1.5	Bed	12.0		barnacle	barnacle colonization
TU10	40-50	20	626	*C. virginica*	5.0	3.3	1.5	Bed				
TU10	40-50	20	626	*C. virginica*	5.0	3.3	1.5	Bed	7.0			
TU10	40-50	20	626	*C. virginica*	3.8	2.5	1.5	Bed	4.0			
TU10	40-50	20	626	*C. virginica*	3.8	2.5	1.5	Bed	3.0	shucked?		possibly shucked

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU10	40-50	20	626	*C. virginica*	6.4	4.2	1.5	Bed	14.0	shucked	barnacle/encrusting ectoproct	barnacle and encrusting ectoproct
TU10	40-50	20	626	*C. virginica*	6.1	4.0	1.5	Bed	10.0			
TU10	40-50	20	626	*C. virginica*	6.1	4.0	1.5	Bed	15.0	shucked?		possibly shucked; partial pearl activity?
TU10	40-50	20	626	*C. virginica*	8.7	5.7	1.5	Bed	52.0	shucked?		possibly shucked
TU10	40-50	20	626	*C. virginica*	2.9	1.9	1.5	Bed	2.0			
TU10	40-50	20	626	*C. virginica*	5.5	3.6	1.5	Bed	9.0	shucked		shucked
TU10	40-50	20	626	*C. virginica*	5.5	3.6	1.5	Bed	13.0			
TU10	40-50	20	626	*C. virginica*	7.2	4.7	1.5	Bed	37.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	2.0	1.3	1.5	Bed	1.0			
TU10	40-50	20	626	*C. virginica*	2.0	1.3	1.5	Bed	0.5			
TU10	40-50	20	626	*C. virginica*	6.0	3.9	1.5	Bed	19.0	hacked/cracked		hacked/cracked; spat activity
TU10	40-50	20	626	*C. virginica*	5.7	3.7	1.5	Bed	8.0			
TU10	40-50	20	626	*C. virginica*	5.4	3.5	1.5	Bed	10.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	5.4	3.5	1.5	Bed	15.0			
TU10	40-50	20	626	*C. virginica*	3.4	2.2	1.5	Bed	3.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	6.8	4.4	1.5	Bed	23.0			
TU10	40-50	20	626	*C. virginica*	4.8	3.1	1.5	Bed	10.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	4.5	2.9	1.6	Bed	5.0			
TU10	40-50	20	626	*C. virginica*	2.8	1.8	1.6	Bed	1.0			
TU10	40-50	20	626	*C. virginica*	3.9	2.5	1.6	Bed	6.0			
TU10	40-50	20	626	*C. virginica*	7.8	5.0	1.6	Bed	26.0			
TU10	40-50	20	626	*C. virginica*	5.0	3.2	1.6	Bed	8.0		barnacle	barnacle colonization
TU10	40-50	20	626	*C. virginica*	3.6	2.3	1.6	Bed	3.0			
TU10	40-50	20	626	*C. virginica*	5.7	3.6	1.6	Bed	8.0			
TU10	40-50	20	626	*C. virginica*	7.0	4.4	1.6	Bed	18.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	3.5	2.2	1.6	Bed	2.0			
TU10	40-50	20	626	*C. virginica*	5.1	3.2	1.6	Bed	8.0			
TU10	40-50	20	626	*C. virginica*	5.6	3.5	1.6	Bed	13.0			highly preyed upon, may have been dead at collection
TU10	40-50	20	626	*C. virginica*	4.0	2.5	1.6	Bed	4.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	4.0	2.5	1.6	Bed	3.0		barnacle	
TU10	40-50	20	626	*C. virginica*	7.2	4.5	1.6	Bed	19.0	shucked, hacked/cracked?		possibly shucked, hacked/cracked
TU10	40-50	20	626	*C. virginica*	7.2	4.5	1.6	Bed	37.0		polychaete worm	polychaete worm predation
TU10	40-50	20	626	*C. virginica*	6.1	3.8	1.6	Bed	13.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	7.1	4.4	1.6	Bed	13.0			
TU10	40-50	20	626	*C. virginica*	5.5	3.4	1.6	Bed	8.0	shucked		shucked
TU10	40-50	20	626	*C. virginica*	6.5	4.0	1.6	Bed	13.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	3.1	1.9	1.6	Bed	2.0			
TU10	40-50	20	626	*C. virginica*	3.6	2.2	1.6	Bed	4.0			
TU10	40-50	20	626	*C. virginica*	6.4	3.9	1.6	Bed	14.0	hacked/cracked?	polychaete worm	possibly hacked/cracked with polychaete worm on inner and outer shell
TU10	40-50	20	626	*C. virginica*	6.4	3.9	1.6	Bed	14.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	7.4	4.5	1.6	Bed	19.0	hacked/cracked		hacked/cracked

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU10	40-50	20	626	*C. virginica*	5.6	3.4	1.6	Bed	12.0			spat on inner shell; possibly dead at harvest?
TU10	40-50	20	626	*C. virginica*	5.6	3.4	1.6	Bed	13.0			
TU10	40-50	20	626	*C. virginica*	2.8	1.7	1.6	Bed	1.0			
TU10	40-50	20	626	*C. virginica*	6.6	4.0	1.7	Bed	18.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	5.3	3.2	1.7	Bed	11.0			
TU10	40-50	20	626	*C. virginica*	5.8	3.5	1.7	Bed	14.0			
TU10	40-50	20	626	*C. virginica*	8.3	5.0	1.7	Bed	30.0	hacked/cracked	many attachments (spat?)	hacked/cracked with many attachments (spat?)
TU10	40-50	20	626	*C. virginica*	6.0	3.6	1.7	Bed	7.0	shucked?	barnacle	possibly shucked with barnacle colonization
TU10	40-50	20	626	*C. virginica*	6.0	3.6	1.7	Bed	13.0		barnacle	barnacle colonization
TU10	40-50	20	626	*C. virginica*	6.5	3.9	1.7	Bed	21.0	shucked, hacked/cracked		shucked, hacked/cracked
TU10	40-50	20	626	*C. virginica*	2.0	1.2	1.7	Bed	0.3			
TU10	40-50	20	626	*C. virginica*	7.7	4.6	1.7	Bed	25.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	5.7	3.4	1.7	Bed	10.0			
TU10	40-50	20	626	*C. virginica*	5.9	3.5	1.7	Bed	9.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	5.9	3.5	1.7	Bed	16.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	2.7	1.6	1.7	Bed	0.5			
TU10	40-50	20	626	*C. virginica*	6.6	3.9	1.7	Bed	15.0	hacked/cracked	polychaete worm	possibly hacked/cracked with polychaete worm predation
TU10	40-50	20	626	*C. virginica*	6.1	3.6	1.7	Bed	10.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	6.8	4.0	1.7	Bed	11.0			
TU10	40-50	20	626	*C. virginica*	7.5	4.4	1.7	Bed	16.0			
TU10	40-50	20	626	*C. virginica*	5.8	3.4	1.7	Bed	10.0			
TU10	40-50	20	626	*C. virginica*	4.1	2.4	1.7	Bed	4.0			
TU10	40-50	20	626	*C. virginica*	4.1	2.4	1.7	Bed	2.0			
TU10	40-50	20	626	*C. virginica*	6.5	3.8	1.7	Bed	22.0			
TU10	40-50	20	626	*C. virginica*	6.0	3.5	1.7	Bed	12.0		barnacle	barnacle colonization
TU10	40-50	20	626	*C. virginica*	4.3	2.5	1.7	Bed	5.0		barnacle	
TU10	40-50	20	626	*C. virginica*	5.0	2.9	1.7	Bed	6.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	7.6	4.4	1.7	Bed	24.0	hacked/cracked		hacked/cracked, with lots of spat activity
TU10	40-50	20	626	*C. virginica*	5.2	3.0	1.7	Bed	7.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	8.5	4.9	1.7	Bed	20.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	6.6	3.8	1.7	Bed	9.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	4.0	2.3	1.7	Bed	3.0			
TU10	40-50	20	626	*C. virginica*	6.3	3.6	1.8	Bed	17.0		barnacle	barnacle colonization
TU10	40-50	20	626	*C. virginica*	2.1	1.2	1.8	Bed	0.4			
TU10	40-50	20	626	*C. virginica*	5.8	3.3	1.8	Bed	13.0			
TU10	40-50	20	626	*C. virginica*	6.0	3.4	1.8	Bed	18.0	shucked?		possibly shucked
TU10	40-50	20	626	*C. virginica*	6.9	3.9	1.8	Bed	23.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	8.7	4.9	1.8	Bed	16.0	shucked?		possibly shucked
TU10	40-50	20	626	*C. virginica*	6.4	3.6	1.8	Bed	11.0	shucked?		possibly shucked; hole in shell
TU10	40-50	20	626	*C. virginica*	1.6	0.9	1.8	Bed	0.3			

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU10	40-50	20	626	*C. virginica*	5.0	2.8	1.8	Bed	4.0			hole in shell (2)
TU10	40-50	20	626	*C. virginica*	8.6	4.8	1.8	Bed	34.0	shucked?	barnacle	possibly shucked
TU10	40-50	20	626	*C. virginica*	7.2	4.0	1.8	Bed	13.0			
TU10	40-50	20	626	*C. virginica*	6.2	3.4	1.8	Bed	7.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	3.1	1.7	1.8	Bed	1.0			
TU10	40-50	20	626	*C. virginica*	6.4	3.5	1.8	Bed	10.0			
TU10	40-50	20	626	*C. virginica*	6.4	3.5	1.8	Bed	11.0			
TU10	40-50	20	626	*C. virginica*	5.5	3.0	1.8	Bed	5.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	7.9	4.3	1.8	Bed	24.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	6.8	3.7	1.8	Bed	14.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	2.4	1.3	1.8	Bed	0.4			
TU10	40-50	20	626	*C. virginica*	6.3	3.4	1.9	Bed	13.0			
TU10	40-50	20	626	*C. virginica*	6.5	3.5	1.9	Bed	13.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	2.6	1.4	1.9	Bed	1.0			
TU10	40-50	20	626	*C. virginica*	8.0	4.3	1.9	Bed	21.0	hacked/cracked		h
TU10	40-50	20	626	*C. virginica*	4.3	2.3	1.9	Bed	4.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	7.5	4.0	1.9	Bed	28.0			
TU10	40-50	20	626	*C. virginica*	6.2	3.3	1.9	Bed	11.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	4.7	2.5	1.9	Bed	7.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	6.4	3.4	1.9	Bed	19.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	10.0	5.3	1.9	Bed	29.0	shucked		shucked
TU10	40-50	20	626	*C. virginica*	5.5	2.9	1.9	Bed	6.0	shucked?		possibly shucked
TU10	40-50	20	626	*C. virginica*	7.4	3.9	1.9	Bed	21.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	5.7	3.0	1.9	Bed	8.0	hacked/cracked?	barnacle	possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	6.1	3.2	1.9	Bed	6.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	6.0	3.1	1.9	Bed	16.0	shucked?		possibly shucked
TU10	40-50	20	626	*C. virginica*	3.1	1.6	1.9	Bed	2.0			
TU10	40-50	20	626	*C. virginica*	3.3	1.7	1.9	Bed	1.0			
TU10	40-50	20	626	*C. virginica*	7.2	3.7	1.9	Bed	16.0			
TU10	40-50	20	626	*C. virginica*	6.7	3.4	2.0	Channel	19.0			
TU10	40-50	20	626	*C. virginica*	6.8	3.4	2.0	Channel	8.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	6.4	3.2	2.0	Channel	14.0			spat on inside of shell - possibly dead at harvest?
TU10	40-50	20	626	*C. virginica*	5.4	2.7	2.0	Reef	8.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	4.0	2.0	2.0	Reef	2.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	3.6	1.8	2.0	Reef	2.0			
TU10	40-50	20	626	*C. virginica*	2.8	1.4	2.0	Reef	0.5			
TU10	40-50	20	626	*C. virginica*	1.6	0.8	2.0	Reef	0.1			
TU10	40-50	20	626	*C. virginica*	7.2	3.5	2.1	Channel	20.0	shucked		shucked
TU10	40-50	20	626	*C. virginica*	3.5	1.7	2.1	Reef	2.0	shucked?		possibly shucked
TU10	40-50	20	626	*C. virginica*	3.5	1.7	2.1	Reef	1.0			
TU10	40-50	20	626	*C. virginica*	6.4	3.1	2.1	Channel	10.0	shucked		shucked
TU10	40-50	20	626	*C. virginica*	6.4	3.1	2.1	Channel	7.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	9.1	4.4	2.1	Channel	27.0		polychaete worm	polychaete worm predation
TU10	40-50	20	626	*C. virginica*	2.9	1.4	2.1	Reef	1.0			
TU10	40-50	20	626	*C. virginica*	8.1	3.9	2.1	Channel	14.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	4.8	2.3	2.1	Reef	5.0			

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU10	40-50	20	626	*C. virginica*	9.4	4.5	2.1	Channel	33.0	shucked, hacked/cracked		shucked, hacked/cracked
TU10	40-50	20	626	*C. virginica*	9.4	4.5	2.1	Channel	25.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	8.8	4.2	2.1	Channel	20.0		barnacle	barnacle colonization
TU10	40-50	20	626	*C. virginica*	8.2	3.9	2.1	Channel	14.0	hacked/cracked	barnacle	hacked/cracked with barnacle colonization
TU10	40-50	20	626	*C. virginica*	1.9	0.9	2.1	Reef	0.3			
TU10	40-50	20	626	*C. virginica*	1.7	0.8	2.1	Reef	0.1			
TU10	40-50	20	626	*C. virginica*	6.4	3.0	2.1	Channel	8.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	7.7	3.6	2.1	Channel	12.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	7.7	3.6	2.1	Channel	17.0		polychaete worm	polychaete worm predation
TU10	40-50	20	626	*C. virginica*	4.5	2.1	2.1	Reef	3.0	hacked/cracked	barnacle	hacked/cracked with barnacle colonization
TU10	40-50	20	626	*C. virginica*	8.8	4.1	2.1	Channel	21.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	8.0	3.7	2.2	Channel	13.0	hacked/cracked	barnacle	hacked/cracked with barnacle colonization
TU10	40-50	20	626	*C. virginica*	9.1	4.2	2.2	Channel	19.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	7.8	3.6	2.2	Channel	17.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	3.7	1.7	2.2	Reef	2.0			
TU10	40-50	20	626	*C. virginica*	8.5	3.9	2.2	Channel	29.0	shucked?		possibly shucked
TU10	40-50	20	626	*C. virginica*	9.0	4.1	2.2	Channel	13.0			
TU10	40-50	20	626	*C. virginica*	5.5	2.5	2.2	Reef	5.0			
TU10	40-50	20	626	*C. virginica*	2.2	1.0	2.2	Reef	0.5			
TU10	40-50	20	626	*C. virginica*	7.5	3.4	2.2	Channel	12.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	8.2	3.7	2.2	Channel	15.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	7.1	3.2	2.2	Channel	13.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	8.0	3.6	2.2	Channel	14.0	shucked		shucked
TU10	40-50	20	626	*C. virginica*	7.8	3.5	2.2	Channel	10.0	shucked		shucked
TU10	40-50	20	626	*C. virginica*	3.8	1.7	2.2	Reef	2.0			
TU10	40-50	20	626	*C. virginica*	8.3	3.7	2.2	Channel	11.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	6.3	2.8	2.3	Channel	11.0	shucked?		possibly shucked
TU10	40-50	20	626	*C. virginica*	6.3	2.8	2.3	Channel	7.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	7.7	3.4	2.3	Channel	17.0			
TU10	40-50	20	626	*C. virginica*	6.6	2.9	2.3	Channel	12.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	6.4	2.8	2.3	Channel	11.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	6.4	2.8	2.3	Channel	5.0	shucked?		possibly shucked
TU10	40-50	20	626	*C. virginica*	8.5	3.7	2.3	Channel	14.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	4.4	1.9	2.3	Reef	4.0			
TU10	40-50	20	626	*C. virginica*	5.1	2.2	2.3	Reef	3.0			
TU10	40-50	20	626	*C. virginica*	6.5	2.8	2.3	Channel	12.0		barnacle	
TU10	40-50	20	626	*C. virginica*	6.8	2.9	2.3	Channel	11.0			
TU10	40-50	20	626	*C. virginica*	8.0	3.4	2.4	Channel	10.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	2.6	1.1	2.4	Reef	1.0			
TU10	40-50	20	626	*C. virginica*	7.8	3.3	2.4	Channel	10.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	6.9	2.9	2.4	Channel	9.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	9.9	4.1	2.4	Channel	21.0	hacked/cracked?	polychaete worm	hacked/cracked with polychaete worm

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU10	40-50	20	626	*C. virginica*	4.6	1.9	2.4	Reef	3.0			
TU10	40-50	20	626	*C. virginica*	8.3	3.4	2.4	Channel	20.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	5.4	2.2	2.5	Reef	7.0			
TU10	40-50	20	626	*C. virginica*	5.2	2.1	2.5	Reef	6.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	3.0	1.2	2.5	Reef	1.0			
TU10	40-50	20	626	*C. virginica*	10.3	4.1	2.5	Channel	24.0	shucked?	polychaete worm	possibly shucked
TU10	40-50	20	626	*C. virginica*	8.1	3.2	2.5	Channel	13.0	shucked, hacked/cracked?		possibly shucked, hacked/cracked
TU10	40-50	20	626	*C. virginica*	3.3	1.3	2.5	Reef	0.5			
TU10	40-50	20	626	*C. virginica*	9.4	3.7	2.5	Channel	20.0	shucked	barnacle	shucked
TU10	40-50	20	626	*C. virginica*	10.7	4.2	2.5	Channel	26.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	4.4	1.7	2.6	Reef	2.0			
TU10	40-50	20	626	*C. virginica*	10.1	3.9	2.6	Channel	20.0	hacked/cracked?	barnacle	possibly hacked/cracked with barnacle colonization
TU10	40-50	20	626	*C. virginica*	7.6	2.9	2.6	Channel	13.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	6.3	2.4	2.6	Channel	9.0		barnacle	barnacle colonization on inside of shell - possibly dead at harvest
TU10	40-50	20	626	*C. virginica*	12.4	4.7	2.6	Channel	35.0			
TU10	40-50	20	626	*C. virginica*	9.7	3.6	2.7	Channel	19.0	shucked?		possibly shucked
TU10	40-50	20	626	*C. virginica*	10.0	3.6	2.8	Channel	19.0	shucked?		possibly shucked
TU10	40-50	20	626	*C. virginica*	7.5	2.7	2.8	Channel	7.0	hacked/cracked		hacked/cracked
TU10	40-50	20	626	*C. virginica*	10.9	3.9	2.8	Channel	25.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	8.5	3.0	2.8	Channel	15.0			
TU10	40-50	20	626	*C. virginica*	9.7	3.4	2.9	Channel	16.0	shucked?	polychaete worm	possibly shucked with polychaete worm predation
TU10	40-50	20	626	*C. virginica*	10.3	3.6	2.9	Channel	27.0			
TU10	40-50	20	626	*C. virginica*	3.6	1.2	3.0	Reef	1.0			
TU10	40-50	20	626	*C. virginica*	12.4	4.1	3.0	Channel	33.0	shucked	barnacle	shucked
TU10	40-50	20	626	*C. virginica*	11.2	3.7	3.0	Channel	22.0	shucked, hacked/cracked		shucked, hacked/cracked
TU10	40-50	20	626	*C. virginica*	11.3	3.6	3.1	Channel	24.0	shucked, hacked/cracked		shucked, hacked/cracked
TU10	40-50	20	626	*C. virginica*	12.0	3.8	3.2	Channel	34.0	shucked		shucked
TU10	40-50	20	626	*C. virginica*	11.5	3.6	3.2	Channel	23.0	shucked?		possibly shucked
TU10	40-50	20	626	*C. virginica*	11.2	3.5	3.2	Channel	26.0	hacked/cracked?		possibly hacked/cracked
TU10	40-50	20	626	*C. virginica*	15.1	4.7	3.2	Channel	46.0	hacked/cracked?	barnacle	possibly hacked/cracked; barnacle predation
TU10	40-50	20	626	*C. virginica*	5.1	4.2	1.2	Sand	14.0		barnacle	barnacle colonization
TU10	40-50	20	626	*C. virginica*	5.4	1.6	3.4	Reef	5.0			
TU10	40-50	20	626	*C. virginica*	6.6	3.7	1.8	Bed	11.0		barnacle	
TU12c	10-11	26	702	*C. virginica*	2.9	3.1	0.9	Sand	2.0			
TU12c	10-11	26	702	*C. virginica*	1.7	1.8	0.9	Sand	0.7			
TU12c	10-11	26	702	*C. virginica*	3.3	3.3	1.0	Sand	4.5	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	4.6	4.5	1.0	Sand	8.0			
TU12c	10-11	26	702	*C. virginica*	3.3	3.1	1.1	Sand	4.0			
TU12c	10-11	26	702	*C. virginica*	2.7	2.5	1.1	Sand	1.0			
TU12c	10-11	26	702	*C. virginica*	2.5	2.3	1.1	Sand	1.1			

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU12c	10-11	26	702	*C. virginica*	3.1	2.8	1.1	Sand	2.8			
TU12c	10-11	26	702	*C. virginica*	4.1	3.7	1.1	Sand	4.0			
TU12c	10-11	26	702	*C. virginica*	2.9	2.6	1.1	Sand	1.8			
TU12c	10-11	26	702	*C. virginica*	3.6	3.2	1.1	Sand	3.7		barnacle	
TU12c	10-11	26	702	*C. virginica*	3.5	3.1	1.1	Sand	2.3			
TU12c	10-11	26	702	*C. virginica*	3.2	2.8	1.1	Sand	2.0			
TU12c	10-11	26	702	*C. virginica*	4.4	3.8	1.2	Sand	13.6		barnacle	
TU12c	10-11	26	702	*C. virginica*	2.9	2.5	1.2	Sand	1.7			
TU12c	10-11	26	702	*C. virginica*	3.6	3.1	1.2	Sand	2.5			
TU12c	10-11	26	702	*C. virginica*	4.5	3.8	1.2	Sand	7.3			
TU12c	10-11	26	702	*C. virginica*	4.5	3.8	1.2	Sand	6.0			
TU12c	10-11	26	702	*C. virginica*	4.7	3.9	1.2	Sand	8.8			
TU12c	10-11	26	702	*C. virginica*	5.6	4.6	1.2	Sand	10.0			
TU12c	10-11	26	702	*C. virginica*	3.8	3.1	1.2	Sand	5.2			
TU12c	10-11	26	702	*C. virginica*	4.8	3.9	1.2	Sand	11.7			
TU12c	10-11	26	702	*C. virginica*	6.9	5.6	1.2	Sand	16.8			
TU12c	10-11	26	702	*C. virginica*	3.7	3.0	1.2	Sand	2.0			
TU12c	10-11	26	702	*C. virginica*	3.7	3.0	1.2	Sand	2.0			
TU12c	10-11	26	702	*C. virginica*	5.7	4.6	1.2	Sand	14.7	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	3.1	2.5	1.2	Sand	3.3			
TU12c	10-11	26	702	*C. virginica*	5.1	4.1	1.2	Sand	10.8			
TU12c	10-11	26	702	*C. virginica*	3.5	2.8	1.3	Bed	4.0	shucked; hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	6.0	4.8	1.3	Bed	19.1	shucked		
TU12c	10-11	26	702	*C. virginica*	4.4	3.5	1.3	Bed	5.5			
TU12c	10-11	26	702	*C. virginica*	2.9	2.3	1.3	Bed	1.0			
TU12c	10-11	26	702	*C. virginica*	4.3	3.4	1.3	Bed	4.0			
TU12c	10-11	26	702	*C. virginica*	3.3	2.6	1.3	Bed	2.0			
TU12c	10-11	26	702	*C. virginica*	3.3	2.6	1.3	Bed	2.0			
TU12c	10-11	26	702	*C. virginica*	5.6	4.4	1.3	Bed	10.0			
TU12c	10-11	26	702	*C. virginica*	5.6	4.4	1.3	Bed	14.0	hacked/cracked	barnacle	
TU12c	10-11	26	702	*C. virginica*	4.2	3.3	1.3	Bed	6.2	shucked		
TU12c	10-11	26	702	*C. virginica*	5.1	4.0	1.3	Bed	10.0			
TU12c	10-11	26	702	*C. virginica*	3.2	2.5	1.3	Bed	2.4			
TU12c	10-11	26	702	*C. virginica*	5.0	3.9	1.3	Bed	11.2			
TU12c	10-11	26	702	*C. virginica*	3.6	2.8	1.3	Bed	6.4			
TU12c	10-11	26	702	*C. virginica*	5.8	4.5	1.3	Bed	13.0	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	4.9	3.8	1.3	Bed	7.0		sponge	predation on inner shell - dead at harvest
TU12c	10-11	26	702	*C. virginica*	4.4	3.4	1.3	Bed	10.9			
TU12c	10-11	26	702	*C. virginica*	6.1	4.7	1.3	Bed	19.4			
TU12c	10-11	26	702	*C. virginica*	3.9	3.0	1.3	Bed	4.8			
TU12c	10-11	26	702	*C. virginica*	4.7	3.6	1.3	Bed	8.8			
TU12c	10-11	26	702	*C. virginica*	4.7	3.6	1.3	Bed	5.0		barnacle	
TU12c	10-11	26	702	*C. virginica*	3.4	2.6	1.3	Bed	3.0			
TU12c	10-11	26	702	*C. virginica*	6.3	4.8	1.3	Bed	15.8	shucked		
TU12c	10-11	26	702	*C. virginica*	6.2	4.7	1.3	Bed	15.4	shucked		
TU12c	10-11	26	702	*C. virginica*	4.1	3.1	1.3	Bed	5.4			
TU12c	10-11	26	702	*C. virginica*	4.1	3.1	1.3	Bed	6.6			
TU12c	10-11	26	702	*C. virginica*	4.5	3.4	1.3	Bed	12.4	shucked		
TU12c	10-11	26	702	*C. virginica*	2.4	1.8	1.3	Bed	0.7			
TU12c	10-11	26	702	*C. virginica*	4.0	3.0	1.3	Bed	3.0			
TU12c	10-11	26	702	*C. virginica*	5.2	3.9	1.3	Bed	7.0	shucked		

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU12c	10-11	26	702	*C. virginica*	3.5	2.6	1.3	Bed	2.4			
TU12c	10-11	26	702	*C. virginica*	3.1	2.3	1.3	Bed	1.0			
TU12c	10-11	26	702	*C. virginica*	6.2	4.6	1.3	Bed	14.0	shucked; hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	2.7	2.0	1.4	Bed	1.3			
TU12c	10-11	26	702	*C. virginica*	4.6	3.4	1.4	Bed	6.5			
TU12c	10-11	26	702	*C. virginica*	4.2	3.1	1.4	Bed	7.5	shucked		
TU12c	10-11	26	702	*C. virginica*	3.8	2.8	1.4	Bed	3.2			
TU12c	10-11	26	702	*C. virginica*	4.9	3.6	1.4	Bed	4.0	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	4.1	3.0	1.4	Bed	2.0	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	6.7	4.9	1.4	Bed	13.0			
TU12c	10-11	26	702	*C. virginica*	2.6	1.9	1.4	Bed	0.5			
TU12c	10-11	26	702	*C. virginica*	4.8	3.5	1.4	Bed	7.0	shucked; hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	5.9	4.3	1.4	Bed	14.0	shucked	barnacle	
TU12c	10-11	26	702	*C. virginica*	2.2	1.6	1.4	Bed	0.5			
TU12c	10-11	26	702	*C. virginica*	3.3	2.4	1.4	Bed	2.1			
TU12c	10-11	26	702	*C. virginica*	4.4	3.2	1.4	Bed	3.1			
TU12c	10-11	26	702	*C. virginica*	5.1	3.7	1.4	Bed	7.0		barnacle	
TU12c	10-11	26	702	*C. virginica*	5.8	4.2	1.4	Bed	13.6		barnacle	
TU12c	10-11	26	702	*C. virginica*	3.2	2.3	1.4	Bed	3.9			
TU12c	10-11	26	702	*C. virginica*	4.6	3.3	1.4	Bed	7.5	shucked		very eroded
TU12c	10-11	26	702	*C. virginica*	4.6	3.3	1.4	Bed	9.0		barnacle	
TU12c	10-11	26	702	*C. virginica*	5.3	3.8	1.4	Bed	7.7			
TU12c	10-11	26	702	*C. virginica*	2.8	2.0	1.4	Bed	1.7			
TU12c	10-11	26	702	*C. virginica*	3.5	2.5	1.4	Bed	3.9			
TU12c	10-11	26	702	*C. virginica*	5.9	4.2	1.4	Bed	11.3	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	5.2	3.7	1.4	Bed	8.0	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	5.5	3.9	1.4	Bed	11.0			
TU12c	10-11	26	702	*C. virginica*	4.8	3.4	1.4	Bed	7.1			
TU12c	10-11	26	702	*C. virginica*	5.1	3.6	1.4	Bed	15.6		barnacle	
TU12c	10-11	26	702	*C. virginica*	4.4	3.1	1.4	Bed	4.2			
TU12c	10-11	26	702	*C. virginica*	5.4	3.8	1.4	Bed	8.6	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	3.7	2.6	1.4	Bed	2.5			
TU12c	10-11	26	702	*C. virginica*	5.7	4.0	1.4	Bed	9.9			
TU12c	10-11	26	702	*C. virginica*	2.0	1.4	1.4	Bed	0.6			
TU12c	10-11	26	702	*C. virginica*	4.0	2.8	1.4	Bed	2.5			
TU12c	10-11	26	702	*C. virginica*	5.0	3.5	1.4	Bed	7.0	shucked	barnacle	
TU12c	10-11	26	702	*C. virginica*	6.3	4.4	1.4	Bed	15.2			
TU12c	10-11	26	702	*C. virginica*	3.3	2.3	1.4	Bed	2.0	shucked		
TU12c	10-11	26	702	*C. virginica*	3.3	2.3	1.4	Bed	1.0			
TU12c	10-11	26	702	*C. virginica*	5.6	3.9	1.4	Bed	4.0		barnacle	
TU12c	10-11	26	702	*C. virginica*	2.3	1.6	1.4	Bed	0.9			
TU12c	10-11	26	702	*C. virginica*	4.6	3.2	1.4	Bed	5.8			
TU12c	10-11	26	702	*C. virginica*	6.9	4.8	1.4	Bed	33.7		barnacle	barnacle and spat on inner shell - dead at harvest
TU12c	10-11	26	702	*C. virginica*	3.6	2.5	1.4	Bed	3.0			
TU12c	10-11	26	702	*C. virginica*	2.6	1.8	1.4	Bed	1.0			
TU12c	10-11	26	702	*C. virginica*	3.9	2.7	1.4	Bed	2.0			
TU12c	10-11	26	702	*C. virginica*	5.5	3.8	1.4	Bed	10.5			
TU12c	10-11	26	702	*C. virginica*	5.5	3.8	1.4	Bed	16.6	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	4.2	2.9	1.4	Bed	3.1			

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU12c	10-11	26	702	*C. virginica*	4.2	2.9	1.4	Bed	7.0		barnacle	
TU12c	10-11	26	702	*C. virginica*	2.9	2.0	1.5	Bed	2.0			
TU12c	10-11	26	702	*C. virginica*	6.1	4.2	1.5	Bed	11.1			
TU12c	10-11	26	702	*C. virginica*	6.1	4.2	1.5	Bed	18.0		barnacle	
TU12c	10-11	26	702	*C. virginica*	4.8	3.3	1.5	Bed	5.3			
TU12c	10-11	26	702	*C. virginica*	7.0	4.8	1.5	Bed	17.1			
TU12c	10-11	26	702	*C. virginica*	5.4	3.7	1.5	Bed	14.3	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	5.4	3.7	1.5	Bed	14.1			
TU12c	10-11	26	702	*C. virginica*	3.8	2.6	1.5	Bed	3.0	shucked		
TU12c	10-11	26	702	*C. virginica*	6.0	4.1	1.5	Bed	16.1			
TU12c	10-11	26	702	*C. virginica*	6.0	4.1	1.5	Bed	8.0			
TU12c	10-11	26	702	*C. virginica*	6.3	4.3	1.5	Bed	10.0	shucked; hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	5.0	3.4	1.5	Bed	10.0	shucked	barnacle	
TU12c	10-11	26	702	*C. virginica*	5.6	3.8	1.5	Bed	7.0	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	6.5	4.4	1.5	Bed	12.0			
TU12c	10-11	26	702	*C. virginica*	7.1	4.8	1.5	Bed	17.1	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	4.0	2.7	1.5	Bed	3.7	shucked		
TU12c	10-11	26	702	*C. virginica*	4.0	2.7	1.5	Bed	2.4			
TU12c	10-11	26	702	*C. virginica*	4.3	2.9	1.5	Bed	4.4		barnacle	barnacle on inner shell - dead at harvest
TU12c	10-11	26	702	*C. virginica*	4.3	2.9	1.5	Bed	4.6			
TU12c	10-11	26	702	*C. virginica*	4.6	3.1	1.5	Bed	3.5			
TU12c	10-11	26	702	*C. virginica*	5.2	3.5	1.5	Bed	9.0		barnacle	
TU12c	10-11	26	702	*C. virginica*	5.5	3.7	1.5	Bed	9.3	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	5.5	3.7	1.5	Bed	11.5			
TU12c	10-11	26	702	*C. virginica*	5.8	3.9	1.5	Bed	12.6		sponge	
TU12c	10-11	26	702	*C. virginica*	5.8	3.9	1.5	Bed	11.0	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	7.0	4.7	1.5	Bed	14.0			
TU12c	10-11	26	702	*C. virginica*	7.3	4.9	1.5	Bed	13.0	hacked/cracked	barnacle	
TU12c	10-11	26	702	*C. virginica*	4.8	3.2	1.5	Bed	9.9	shucked		
TU12c	10-11	26	702	*C. virginica*	4.8	3.2	1.5	Bed	5.0			
TU12c	10-11	26	702	*C. virginica*	3.6	2.4	1.5	Bed	3.7	shucked		
TU12c	10-11	26	702	*C. virginica*	3.6	2.4	1.5	Bed	2.0			
TU12c	10-11	26	702	*C. virginica*	3.6	2.4	1.5	Bed	4.0			
TU12c	10-11	26	702	*C. virginica*	3.9	2.6	1.5	Bed	2.0			
TU12c	10-11	26	702	*C. virginica*	5.4	3.6	1.5	Bed	7.0	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	4.2	2.8	1.5	Bed	2.0		barnacle	
TU12c	10-11	26	702	*C. virginica*	6.2	4.1	1.5	Bed	6.0	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	5.6	3.7	1.5	Bed	5.0	hacked/cracked	barnacle	
TU12c	10-11	26	702	*C. virginica*	5.6	3.7	1.5	Bed	11.0			
TU12c	10-11	26	702	*C. virginica*	5.3	3.5	1.5	Bed	6.1	shucked	barnacle	
TU12c	10-11	26	702	*C. virginica*	4.7	3.1	1.5	Bed	7.2			
TU12c	10-11	26	702	*C. virginica*	4.1	2.7	1.5	Bed	3.6			
TU12c	10-11	26	702	*C. virginica*	3.8	2.5	1.5	Bed	3.7			
TU12c	10-11	26	702	*C. virginica*	3.8	2.5	1.5	Bed	2.0	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	3.5	2.3	1.5	Bed	1.0			
TU12c	10-11	26	702	*C. virginica*	3.2	2.1	1.5	Bed	1.6			
TU12c	10-11	26	702	*C. virginica*	3.2	2.1	1.5	Bed	1.2			
TU12c	10-11	26	702	*C. virginica*	6.1	4.0	1.5	Bed	11.0			
TU12c	10-11	26	702	*C. virginica*	2.9	1.9	1.5	Bed	1.4			
TU12c	10-11	26	702	*C. virginica*	5.8	3.8	1.5	Bed	6.4			predation on inner shell - dead at harvest

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU12c	10-11	26	702	*C. virginica*	5.8	3.8	1.5	Bed	10.0			
TU12c	10-11	26	702	*C. virginica*	5.5	3.6	1.5	Bed	9.4			
TU12c	10-11	26	702	*C. virginica*	5.5	3.6	1.5	Bed	4.0			
TU12c	10-11	26	702	*C. virginica*	5.2	3.4	1.5	Bed	6.0			
TU12c	10-11	26	702	*C. virginica*	6.3	4.1	1.5	Bed	11.0	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	5.7	3.7	1.5	Bed	11.0	shucked		
TU12c	10-11	26	702	*C. virginica*	3.4	2.2	1.5	Bed	1.8		barnacle	
TU12c	10-11	26	702	*C. virginica*	6.5	4.2	1.5	Bed	25.0		sponge	
TU12c	10-11	26	702	*C. virginica*	6.5	4.2	1.5	Bed	11.0			
TU12c	10-11	26	702	*C. virginica*	6.2	4.0	1.6	Bed	17.5	shucked		
TU12c	10-11	26	702	*C. virginica*	6.2	4.0	1.6	Bed	8.0	shucked		
TU12c	10-11	26	702	*C. virginica*	6.2	4.0	1.6	Bed	15.0			
TU12c	10-11	26	702	*C. virginica*	8.4	5.4	1.6	Bed	33.5			burned
TU12c	10-11	26	702	*C. virginica*	3.9	2.5	1.6	Bed	2.0			
TU12c	10-11	26	702	*C. virginica*	6.4	4.1	1.6	Bed	13.0	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	7.2	4.6	1.6	Bed	17.2	shucked		
TU12c	10-11	26	702	*C. virginica*	4.7	3.0	1.6	Bed	6.4			
TU12c	10-11	26	702	*C. virginica*	6.9	4.4	1.6	Bed	22.2			
TU12c	10-11	26	702	*C. virginica*	6.6	4.2	1.6	Bed	15.2			spat on inner shell - dead at harvest
TU12c	10-11	26	702	*C. virginica*	4.1	2.6	1.6	Bed	6.2			
TU12c	10-11	26	702	*C. virginica*	4.9	3.1	1.6	Bed	6.9			
TU12c	10-11	26	702	*C. virginica*	4.9	3.1	1.6	Bed	14.0			
TU12c	10-11	26	702	*C. virginica*	5.7	3.6	1.6	Bed	10.0			
TU12c	10-11	26	702	*C. virginica*	5.7	3.6	1.6	Bed	6.0	shucked; hacked/cracked	barnacle	
TU12c	10-11	26	702	*C. virginica*	5.4	3.4	1.6	Bed	11.2	shucked		
TU12c	10-11	26	702	*C. virginica*	3.5	2.2	1.6	Bed	2.1			
TU12c	10-11	26	702	*C. virginica*	7.8	4.9	1.6	Bed	27.5	shucked		
TU12c	10-11	26	702	*C. virginica*	5.9	3.7	1.6	Bed	10.0			
TU12c	10-11	26	702	*C. virginica*	5.3	3.3	1.6	Bed	9.7	shucked		
TU12c	10-11	26	702	*C. virginica*	5.3	3.3	1.6	Bed	5.3			
TU12c	10-11	26	702	*C. virginica*	4.5	2.8	1.6	Bed	4.2			
TU12c	10-11	26	702	*C. virginica*	4.5	2.8	1.6	Bed	6.0	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	4.5	2.8	1.6	Bed	3.0			
TU12c	10-11	26	702	*C. virginica*	6.6	4.1	1.6	Bed	9.0			
TU12c	10-11	26	702	*C. virginica*	2.9	1.8	1.6	Bed	1.3	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	5.5	3.4	1.6	Bed	5.0		barnacle	lots of barnacle predation
TU12c	10-11	26	702	*C. virginica*	4.7	2.9	1.6	Bed	8.6	shucked	barnacle	
TU12c	10-11	26	702	*C. virginica*	3.9	2.4	1.6	Bed	2.5			
TU12c	10-11	26	702	*C. virginica*	5.2	3.2	1.6	Bed	8.5	shucked		
TU12c	10-11	26	702	*C. virginica*	7.0	4.3	1.6	Bed	17.0			
TU12c	10-11	26	702	*C. virginica*	6.2	3.8	1.6	Bed	11.0		polychaete worm	
TU12c	10-11	26	702	*C. virginica*	5.9	3.6	1.6	Bed	12.9	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	4.1	2.5	1.6	Bed	4.0			
TU12c	10-11	26	702	*C. virginica*	2.8	1.7	1.6	Bed	2.2			
TU12c	10-11	26	702	*C. virginica*	2.8	1.7	1.6	Bed	0.9		barnacle	
TU12c	10-11	26	702	*C. virginica*	6.1	3.7	1.6	Bed	14.3	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	6.6	4.0	1.7	Bed	14.4	shucked		
TU12c	10-11	26	702	*C. virginica*	6.6	4.0	1.7	Bed	16.0	shucked		
TU12c	10-11	26	702	*C. virginica*	9.1	5.5	1.7	Bed	28.2	shucked		

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU12c	10-11	26	702	*C. virginica*	4.8	2.9	1.7	Bed	7.4			
TU12c	10-11	26	702	*C. virginica*	5.3	3.2	1.7	Bed	9.7	shucked		
TU12c	10-11	26	702	*C. virginica*	5.8	3.5	1.7	Bed	14.4	shucked; hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	3.0	1.8	1.7	Bed	2.0			
TU12c	10-11	26	702	*C. virginica*	4.5	2.7	1.7	Bed	6.4	shucked		
TU12c	10-11	26	702	*C. virginica*	4.5	2.7	1.7	Bed	5.3	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	7.0	4.2	1.7	Bed	27.6	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	5.0	3.0	1.7	Bed	6.6			
TU12c	10-11	26	702	*C. virginica*	5.5	3.3	1.7	Bed	12.4			
TU12c	10-11	26	702	*C. virginica*	7.5	4.5	1.7	Bed	17.6			
TU12c	10-11	26	702	*C. virginica*	5.2	3.1	1.7	Bed	6.4			
TU12c	10-11	26	702	*C. virginica*	5.2	3.1	1.7	Bed	5.0			
TU12c	10-11	26	702	*C. virginica*	7.4	4.4	1.7	Bed	13.0	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	5.9	3.5	1.7	Bed	11.0	shucked	barnacle	
TU12c	10-11	26	702	*C. virginica*	5.9	3.5	1.7	Bed	11.7			
TU12c	10-11	26	702	*C. virginica*	4.9	2.9	1.7	Bed	8.0	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	7.3	4.3	1.7	Bed	3.3		sponge	
TU12c	10-11	26	702	*C. virginica*	4.6	2.7	1.7	Bed	6.6			
TU12c	10-11	26	702	*C. virginica*	5.8	3.4	1.7	Bed	8.2			
TU12c	10-11	26	702	*C. virginica*	3.6	2.1	1.7	Bed	2.9			
TU12c	10-11	26	702	*C. virginica*	5.5	3.2	1.7	Bed	9.2			
TU12c	10-11	26	702	*C. virginica*	5.5	3.2	1.7	Bed	9.0			
TU12c	10-11	26	702	*C. virginica*	4.3	2.5	1.7	Bed	4.0	shucked		
TU12c	10-11	26	702	*C. virginica*	3.1	1.8	1.7	Bed	2.0			
TU12c	10-11	26	702	*C. virginica*	5.0	2.9	1.7	Bed	5.8		barnacle	
TU12c	10-11	26	702	*C. virginica*	5.7	3.3	1.7	Bed	6.6			
TU12c	10-11	26	702	*C. virginica*	4.5	2.6	1.7	Bed	2.7			
TU12c	10-11	26	702	*C. virginica*	7.1	4.1	1.7	Bed	17.8		barnacle	
TU12c	10-11	26	702	*C. virginica*	6.6	3.8	1.7	Bed	12.2	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	7.3	4.2	1.7	Bed	14.7	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	4.7	2.7	1.7	Bed	9.7		barnacle	
TU12c	10-11	26	702	*C. virginica*	6.1	3.5	1.7	Bed	6.6	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	5.6	3.2	1.8	Bed	6.0			
TU12c	10-11	26	702	*C. virginica*	4.2	2.4	1.8	Bed	4.3			
TU12c	10-11	26	702	*C. virginica*	4.2	2.4	1.8	Bed	3.8			
TU12c	10-11	26	702	*C. virginica*	7.2	4.1	1.8	Bed	15.0	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	6.5	3.7	1.8	Bed	7.0	shucked; hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	5.1	2.9	1.8	Bed	9.5			
TU12c	10-11	26	702	*C. virginica*	4.4	2.5	1.8	Bed	3.5	shucked		
TU12c	10-11	26	702	*C. virginica*	6.7	3.8	1.8	Bed	17.0			
TU12c	10-11	26	702	*C. virginica*	4.6	2.6	1.8	Bed	3.0			
TU12c	10-11	26	702	*C. virginica*	6.2	3.5	1.8	Bed	13.3	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	3.9	2.2	1.8	Bed	4.0			
TU12c	10-11	26	702	*C. virginica*	6.4	3.6	1.8	Bed	11.1			
TU12c	10-11	26	702	*C. virginica*	4.3	2.4	1.8	Bed	2.0			
TU12c	10-11	26	702	*C. virginica*	5.2	2.9	1.8	Bed	4.0	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	8.1	4.5	1.8	Bed	15.0	shucked; hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	6.7	3.7	1.8	Bed	14.4	shucked	barnacle	
TU12c	10-11	26	702	*C. virginica*	6.7	3.7	1.8	Bed	7.0			
TU12c	10-11	26	702	*C. virginica*	2.9	1.6	1.8	Bed	0.8			

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU12c	10-11	26	702	*C. virginica*	2.9	1.6	1.8	Bed	1.3			
TU12c	10-11	26	702	*C. virginica*	8.7	4.8	1.8	Bed	22.4			
TU12c	10-11	26	702	*C. virginica*	4.0	2.2	1.8	Bed	2.1			
TU12c	10-11	26	702	*C. virginica*	6.0	3.3	1.8	Bed	8.4			
TU12c	10-11	26	702	*C. virginica*	6.0	3.3	1.8	Bed	7.0			
TU12c	10-11	26	702	*C. virginica*	7.1	3.9	1.8	Bed	18.4			
TU12c	10-11	26	702	*C. virginica*	5.1	2.8	1.8	Bed	3.5			
TU12c	10-11	26	702	*C. virginica*	5.3	2.9	1.8	Bed	6.1	shucked		
TU12c	10-11	26	702	*C. virginica*	3.3	1.8	1.8	Bed	1.4			
TU12c	10-11	26	702	*C. virginica*	5.5	3.0	1.8	Bed	6.5			
TU12c	10-11	26	702	*C. virginica*	5.5	3.0	1.8	Bed	4.7			
TU12c	10-11	26	702	*C. virginica*	4.4	2.4	1.8	Bed	2.9		barnacle	
TU12c	10-11	26	702	*C. virginica*	6.8	3.7	1.8	Bed	10.5			
TU12c	10-11	26	702	*C. virginica*	5.0	2.7	1.9	Bed	9.3			
TU12c	10-11	26	702	*C. virginica*	5.0	2.7	1.9	Bed	3.8	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	6.3	3.4	1.9	Bed	15.0	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	3.9	2.1	1.9	Bed	1.9		barnacle	
TU12c	10-11	26	702	*C. virginica*	5.4	2.9	1.9	Bed	8.0			
TU12c	10-11	26	702	*C. virginica*	6.9	3.7	1.9	Bed	14.7	shucked		
TU12c	10-11	26	702	*C. virginica*	8.4	4.5	1.9	Bed	13.0			
TU12c	10-11	26	702	*C. virginica*	4.3	2.3	1.9	Bed	2.0	shucked		
TU12c	10-11	26	702	*C. virginica*	8.6	4.6	1.9	Bed	24.2			
TU12c	10-11	26	702	*C. virginica*	7.0	3.7	1.9	Bed	7.0		sponge	very eroded
TU12c	10-11	26	702	*C. virginica*	3.6	1.9	1.9	Bed	1.9			
TU12c	10-11	26	702	*C. virginica*	6.1	3.2	1.9	Bed	8.4	shucked		
TU12c	10-11	26	702	*C. virginica*	6.3	3.3	1.9	Bed	11.2			
TU12c	10-11	26	702	*C. virginica*	4.4	2.3	1.9	Bed	4.6			
TU12c	10-11	26	702	*C. virginica*	4.4	2.3	1.9	Bed	2.0			
TU12c	10-11	26	702	*C. virginica*	5.8	3.0	1.9	Bed	10.9			
TU12c	10-11	26	702	*C. virginica*	5.8	3.0	1.9	Bed	7.7			
TU12c	10-11	26	702	*C. virginica*	3.3	1.7	1.9	Bed	1.3			
TU12c	10-11	26	702	*C. virginica*	6.8	3.5	1.9	Bed	7.0			
TU12c	10-11	26	702	*C. virginica*	3.5	1.8	1.9	Bed	1.4			
TU12c	10-11	26	702	*C. virginica*	3.5	1.8	1.9	Bed	1.8			
TU12c	10-11	26	702	*C. virginica*	3.7	1.9	1.9	Bed	1.9			
TU12c	10-11	26	702	*C. virginica*	3.7	1.9	1.9	Bed	2.4			
TU12c	10-11	26	702	*C. virginica*	4.3	2.2	2.0	Reef	3.9			
TU12c	10-11	26	702	*C. virginica*	4.5	2.3	2.0	Reef	3.8		barnacle	
TU12c	10-11	26	702	*C. virginica*	5.7	2.9	2.0	Reef	6.6	shucked	barnacle	
TU12c	10-11	26	702	*C. virginica*	6.1	3.1	2.0	Channel	6.4	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	6.3	3.2	2.0	Channel	17.9			
TU12c	10-11	26	702	*C. virginica*	6.3	3.2	2.0	Channel	12.3	shuckec		
TU12c	10-11	26	702	*C. virginica*	6.5	3.3	2.0	Channel	9.4			spat on inner shell - dead at harvest
TU12c	10-11	26	702	*C. virginica*	7.3	3.7	2.0	Channel	13.0	hacked/cracked	barnacle	
TU12c	10-11	26	702	*C. virginica*	8.9	4.5	2.0	Channel	18.8	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	6.0	3.0	2.0	Channel	8.0	shucked		
TU12c	10-11	26	702	*C. virginica*	6.2	3.1	2.0	Channel	9.6			
TU12c	10-11	26	702	*C. virginica*	6.6	3.3	2.0	Channel	15.4			
TU12c	10-11	26	702	*C. virginica*	7.0	3.5	2.0	Channel	13.0	shucked		
TU12c	10-11	26	702	*C. virginica*	4.8	2.4	2.0	Reef	3.9			
TU12c	10-11	26	702	*C. virginica*	5.8	2.9	2.0	Reef	7.3			

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU12c	10-11	26	702	*C. virginica*	8.3	4.1	2.0	Channel	17.7		barnacle and spat	barnacle and spat on inner shell - dead at harvest
TU12c	10-11	26	702	*C. virginica*	8.1	4.0	2.0	Channel	12.1			
TU12c	10-11	26	702	*C. virginica*	7.1	3.5	2.0	Channel	8.0			
TU12c	10-11	26	702	*C. virginica*	6.7	3.3	2.0	Channel	13.0			
TU12c	10-11	26	702	*C. virginica*	6.1	3.0	2.0	Channel	9.3		barnacle	
TU12c	10-11	26	702	*C. virginica*	5.7	2.8	2.0	Reef	7.0			
TU12c	10-11	26	702	*C. virginica*	5.5	2.7	2.0	Reef	6.1	shucked		
TU12c	10-11	26	702	*C. virginica*	5.1	2.5	2.0	Reef	4.9			
TU12c	10-11	26	702	*C. virginica*	4.5	2.2	2.0	Reef	2.3		barnacle	
TU12c	10-11	26	702	*C. virginica*	3.9	1.9	2.1	Reef	2.0	shucked		
TU12c	10-11	26	702	*C. virginica*	3.7	1.8	2.1	Reef	2.0	shucked		
TU12c	10-11	26	702	*C. virginica*	7.0	3.4	2.1	Channel	10.0			
TU12c	10-11	26	702	*C. virginica*	3.1	1.5	2.1	Reef	1.5			
TU12c	10-11	26	702	*C. virginica*	8.3	4.0	2.1	Channel	13.4		polycheate worm	
TU12c	10-11	26	702	*C. virginica*	6.5	3.1	2.1	Channel	12.0			
TU12c	10-11	26	702	*C. virginica*	6.3	3.0	2.1	Channel	11.5			
TU12c	10-11	26	702	*C. virginica*	6.1	2.9	2.1	Channel	13.0		barnacle	
TU12c	10-11	26	702	*C. virginica*	5.9	2.8	2.1	Reef	6.9			
TU12c	10-11	26	702	*C. virginica*	3.8	1.8	2.1	Reef	1.1			
TU12c	10-11	26	702	*C. virginica*	3.6	1.7	2.1	Reef	1.9			
TU12c	10-11	26	702	*C. virginica*	6.0	2.8	2.1	Channel	7.0			
TU12c	10-11	26	702	*C. virginica*	7.5	3.5	2.1	Channel	13.1		barnacle	
TU12c	10-11	26	702	*C. virginica*	8.6	4.0	2.2	Channel	26.0			
TU12c	10-11	26	702	*C. virginica*	4.3	2.0	2.2	Reef	2.0			
TU12c	10-11	26	702	*C. virginica*	9.1	4.2	2.2	Channel	32.9		barnacle	
TU12c	10-11	26	702	*C. virginica*	3.9	1.8	2.2	Reef	2.5			
TU12c	10-11	26	702	*C. virginica*	5.0	2.3	2.2	Reef	8.1			
TU12c	10-11	26	702	*C. virginica*	5.9	2.7	2.2	Reef	9.2			spat on inner shell - dead at harvest
TU12c	10-11	26	702	*C. virginica*	9.4	4.3	2.2	Channel	24.7			predation on inner shell - dead at harvest
TU12c	10-11	26	702	*C. virginica*	7.3	3.3	2.2	Channel	10.4			
TU12c	10-11	26	702	*C. virginica*	3.1	1.4	2.2	Reef	1.6			
TU12c	10-11	26	702	*C. virginica*	4.0	1.8	2.2	Reef	2.5		barnacle	
TU12c	10-11	26	702	*C. virginica*	5.8	2.6	2.2	Reef	6.0	shucked		
TU12c	10-11	26	702	*C. virginica*	6.7	3.0	2.2	Channel	15.8			
TU12c	10-11	26	702	*C. virginica*	6.5	2.9	2.2	Channel	15.2			
TU12c	10-11	26	702	*C. virginica*	7.7	3.3	2.3	Channel	1.7			
TU12c	10-11	26	702	*C. virginica*	5.6	2.4	2.3	Reef	5.0			spat on inner shell - dead at harvest
TU12c	10-11	26	702	*C. virginica*	8.2	3.5	2.3	Channel	16.0	shucked; hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	5.4	2.3	2.3	Reef	3.0			
TU12c	10-11	26	702	*C. virginica*	7.3	3.1	2.4	Channel	11.8			predation on inner shell - dead at harvest
TU12c	10-11	26	702	*C. virginica*	5.9	2.5	2.4	Reef	3.7			
TU12c	10-11	26	702	*C. virginica*	4.6	1.9	2.4	Reef	2.0			
TU12c	10-11	26	702	*C. virginica*	5.6	2.3	2.4	Reef	4.0			
TU12c	10-11	26	702	*C. virginica*	3.9	1.6	2.4	Reef	2.0			

TU	Lv	Feat	FS#	Taxon	Ht (cm)	Lgth (cm)	Ratio	Class	Wt (g)	Modified	Predation	Comments
TU12c	10-11	26	702	*C. virginica*	8.8	3.6	2.4	Channel	17.9		barnacle	barnacle on inner shell - dead at harvest
TU12c	10-11	26	702	*C. virginica*	6.9	2.8	2.5	Channel	10.1			
TU12c	10-11	26	702	*C. virginica*	7.1	2.7	2.6	Channel	8.8			
TU12c	10-11	26	702	*C. virginica*	4.3	3.9	1.1	Sand	6.0		barnacle	
TU12c	10-11	26	702	*C. virginica*	4.2	3.8	1.1	Sand	7.0	hacked/cracked		
TU12c	10-11	26	702	*C. virginica*	6.4	2.4	2.7	Channel	17.1			
TU12c	10-11	26	702	*C. virginica*	4.6	1.7	2.7	Reef	2.3			
TU12c	10-11	26	702	*C. virginica*	6.0	2.1	2.9	Channel	7.3			

APPENDIX C – MARINE CATFISH OTOLITH ANALYSIS

Otolith data from Test Unit 10, Rollins Shell Ring, Ft. George Island, FL.

Provenience	Field Specimen#	ID	Description	Terminal Band	Season of Capture	Age
Test Unit 10	605.28a	1	*Arius felis*	translucent	summer	15
Test Unit 10	605.28b	2	*Arius felis*	translucent	summer	6
Test Unit 10	605.28c	3	*Arius felis*	translucent	summer	3
Test Unit 10	605.28d	4	*Bagre marinus*	translucent	summer	11
Test Unit 10	605.28e	5	*Bagre marinus*	translucent	summer	11
Test Unit 10	605.28f	6	*Bagre marinus*	translucent	summer	12
Test Unit 10	608.14a	7	*Arius felis*	translucent	summer	23
Test Unit 10	608.14b	8	*Arius felis*	translucent	summer	17
Test Unit 10	608.14c	9	*Arius felis*	translucent	summer	7
Test Unit 10	608.14d	10	*Arius felis*	translucent	summer	5
Test Unit 10	608.14e	11	*Arius felis*	translucent	summer	17
Test Unit 10	608.14f	12	*Arius felis*	translucent	spring	7
Test Unit 10	608.14g	13	*Arius felis*	translucent	summer	12
Test Unit 10	608.14h	14	*Arius felis*	translucent	spring	4
Test Unit 10	608.14i	15	*Arius felis*	translucent	spring	4
Test Unit 10	608.14j	16	*Arius felis*	translucent	spring	4
Test Unit 10	608.14k	17	*Arius felis*	translucent	summer	3
Test Unit 10	608.14l	18	*Arius felis*	translucent	summer	2
Test Unit 10	746.10a	19	*Arius felis*	translucent	summer	14
Test Unit 10	746.10b	20	*Arius felis*	translucent	summer	11
Test Unit 10	746.10c	21	*Arius felis*	translucent	summer	18
Test Unit 10	746.10d	22	*Arius felis*	translucent	summer	5
Test Unit 10	746.10e	23	*Arius felis*	translucent	summer	5
Test Unit 10	746.10f	24	*Arius felis*	translucent	summer	7
Test Unit 10	746.10g	25	*Bagre marinus*	translucent	summer	32
Test Unit 10	746.10h	26	*Bagre marinus*	translucent	summer	15
Test Unit 10	746.10i	27	Undetermined	translucent	summer	5

Otolith data from Test Unit 11, Rollins Shell Ring, Ft. George Island, FL.

Provenience	Field Specimen#	ID	Description	Terminal Band	Season of Capture	Age
Test Unit 11	635.07a	28	*Arius felis*	translucent	summer	17
Test Unit 11	635.07b	29	*Arius felis*	translucent	summer	9
Test Unit 11	635.07c	30	*Arius felis*	translucent	summer	6
Test Unit 11	635.07d	31	*Arius felis*	translucent	summer	8
Test Unit 11	635.07e	32	*Arius felis*	translucent	spring	6
Test Unit 11	635.07f	33	*Arius felis*	translucent	summer	9
Test Unit 11	635.07g	34	*Arius felis*	translucent	spring	4
Test Unit 11	635.07h	35	*Arius felis*	translucent	summer	3
Test Unit 11	635.07i	36	*Arius felis*	translucent	summer	3
Test Unit 11	635.07j	37	*Arius felis*	translucent	summer	2
Test Unit 11	655.11a	38	*Arius felis*	translucent	summer	19
Test Unit 11	655.11b	39	*Arius felis*	translucent	summer	19
Test Unit 11	655.11c	40	*Arius felis*	translucent	summer?	22
Test Unit 11	655.11d	41	*Arius felis*	translucent	summer	8
Test Unit 11	655.11e	42	*Arius felis*	translucent	summer	8
Test Unit 11	655.11f	43	*Arius felis*	translucent	summer	3
Test Unit 11	655.11g	44	*Arius felis*	translucent	summer	2
Test Unit 11	655.11h	45	*Arius felis*	translucent	summer	2
Test Unit 11	679.23a	46	*Arius felis*	translucent	summer	20
Test Unit 11	679.23b	47	*Arius felis*	translucent	summer	32
Test Unit 11	679.23c	48	*Arius felis*	translucent	summer	23
Test Unit 11	679.23d	49	*Arius felis*	translucent	summer	22
Test Unit 11	679.23e	50	*Arius felis*	translucent	summer	6
Test Unit 11	679.23f	51	*Arius felis*	translucent	summer?	19
Test Unit 11	679.23g	52	*Arius felis*	translucent	summer?	22
Test Unit 11	679.23h	53	*Arius felis*	translucent	summer	20
Test Unit 11	679.23i	54	*Arius felis*	translucent	summer	21
Test Unit 11	679.23j	55	*Arius felis*	translucent	summer	18
Test Unit 11	679.23k	56	*Arius felis*	translucent	summer	15
Test Unit 11	679.23l	57	*Arius felis*	translucent	summer	23
Test Unit 11	679.23m	58	*Arius felis*	translucent	summer	11
Test Unit 11	679.23n	59	*Arius felis*	translucent	summer	8
Test Unit 11	679.23o	60	*Arius felis*	translucent	summer	9
Test Unit 11	679.23p	61	*Arius felis*	translucent	summer	18
Test Unit 11	679.23q	62	*Arius felis*	translucent	summer	7
Test Unit 11	679.23r	63	*Arius felis*	translucent	summer	4
Test Unit 11	679.23s	64	*Arius felis*	translucent	summer	3
Test Unit 11	679.23t	65	*Arius felis*	translucent	summer	5
Test Unit 11	722.10a	66	*Arius felis*	translucent	summer	13
Test Unit 11	722.10b	67	*Arius felis*	translucent	summer	14
Test Unit 11	722.10c	68	*Arius felis*	translucent	summer	11
Test Unit 11	722.10d	69	*Arius felis*	translucent	summer	8
Test Unit 11	722.10e	70	*Arius felis*	translucent	summer	5
Test Unit 11	722.10f	71	*Arius felis*	translucent	summer	3

Otolith data from Test Unit 12c, Rollins Shell Ring, Ft. George Island, FL.

Provenience	**Field Specimen#**	**ID**	**Description**	**Terminal Band**	**Season of Capture**	**Age**
Test Unit 12c	687.08a	72	*Arius felis*	translucent	summer	14
Test Unit 12c	687.08b	73	*Arius felis*	translucent	spring	9
Test Unit 12c	687.08c	74	*Arius felis*	translucent	summer	8
Test Unit 12c	687.08d	75	*Arius felis*	translucent	spring	5
Test Unit 12c	689.05a	76	*Arius felis*	translucent	summer	6
Test Unit 12c	689.05b	77	*Arius felis*	translucent	summer	3
Test Unit 12c	693.04a	78	*Arius felis*	translucent	summer	6
Test Unit 12c	700.07a	79	*Arius felis*	translucent	summer	8
Test Unit 12c	704.01a	80	*Arius felis*	translucent	summer	7
Test Unit 12c	744.01a	81	*Arius felis*	translucent	summer	7

VITA

Julie Ann Doucet was born August 1960, in New Roads, Louisiana. She attended Louisiana State University (LSU) as a non-traditional student and received an undergraduate degree in Anthropology in May 1994. After graduation, she worked in the Louisiana Division of Archaeology before joining the Archaeology Division of Coastal Environments, Inc. (CEI), a cultural resource management firm in Baton Rouge, Louisiana. At CEI she held positions as laboratory manager and conservator, and performed field work and artifact analysis. In 2002 she returned to LSU, initially as grants administrator then research associate in Biological Sciences, then in 2009 she began her master's in Anthropology on a part-time basis. She received a National Science Foundation Graduate Fellowship in April 2010, and subsequently continued graduate school full time. Julie participated in the LSU 2010 Caylán Archaeological Project, in Nepeña, Peru. As a senior graduate student on the project with previous archaeological laboratory experience, she assisted in the supervision of the laboratory at the site, which included artifact processing and initial analyses, in addition to participating in field work.

The NSF Graduate Fellowship will provide support for her through the initial coursework of a doctoral degree from Geography and Anthropology at LSU.