COASTAL SUBSISTENCE AND SETTLEMENT SYSTEMS ON THE NORTHERN GULF OF MEXICO, USA

by

CARLA JANE SCHMID HADDEN

(Under the Direction of Elizabeth J. Reitz)

ABSTRACT

This research presents a synthesis of the zooarchaeology and site seasonality data for the northern Gulf of Mexico from the Late Archaic through Woodland periods (ca. 5000 B.C. to A.D. 1100). Three questions are addressed: (1) Was the coast occupied on a seasonal basis? (2) Were there one or many coastal subsistence strategies? (3) Were coastal economies and ecosystems stable over the scale of millennia? Archaeological data suggest the coastal zone was not wholly abandoned during any season of the year, although sites varied throughout the year in terms of population density, intensity of site use, or intensity of fishing and shellfishing efforts. There were at least three patterns of animal exploitation on the Gulf Coast: specialized estuarine shellfishing, generalized estuarine fishing, and generalized marine shellfishing. Specialized estuarine shellfishing, a pattern focused on intensive exploitation of oysters, was an early and long-lived adaptation to highly productive salt marsh habitats. Subsistence strategies diversified during the Woodland period, shifting from intensive exploitation of salt marshes to extensive exploitation of an array of estuarine and marine habitats. Marked variability among contemporaneous sites over small geographic scales suggests that coastal dwellers had access to different resources by virtue of their proximity to habitats and resource patches, perhaps reflecting cultural attitudes towards access rights, ownership, and territoriality. Different resources also required different procurement techniques and technologies, and had different potential uses. These distinctions likely influenced the formation of place-based social identities, as well as involvements in local and regional exchange networks. Pre-European fisheries exhibited mild symptoms of decline, but persisted for thousands of years nonetheless. People were potentially impacting Gulf Coast fisheries from the beginning of human history in that area. However, measures of fisheries health indicate that the rate of decline of modern commercial fisheries is over a hundred times faster than in traditional subsistence fisheries.

INDEX WORDS: Zooarchaeology, Weeden Island, Seasonality, Fisheries, Landscape

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DEDICATION

For Bill and Phil

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INTRODUCTION

Coastal societies occupy a distinct position, both culturally and ecologically. Living on the coast shapes the principles, dispositions, and practices that contribute to a distinctly coastal identity (Astuti 1995:36). Coastal environments influence the very nature of travel, transport, subsistence, and concepts of time (O'Sullivan 2003; Thompson and Worth 2011). Anthropologists now recognize that a diversity of sociopolitical and economic trajectories are possible in coastal environments. Some coastal hunter-gatherers were organized in small, highly mobile kin groups (e.g., Grenda and Altschul 1994; Kennett and Voorhies 1996; Ricklis 1996, 2004). Others, so-called "complex hunter-gatherer" populations, were organized in large, sedentary societies with complex sociopolitical structures (e.g., Ames 1985; Arnold 1987, 1992, 1996; Habu 2008; Higham and Thosarat 1994; Keene 2004; Marquardt 1988, 1992a; Marquardt and Walker 2013; Moseley 1975; Perlman 1980; Quitmyer et al. 1997; Reitz 1988a, 1988b; Sanoja and Vargas Arenas 1999; Thompson and Andrus 2011; Thompson and Worth 2011; Widmer 1988; Yesner 1980). For this reason, studies of coastal societies and ecosystems are now at the forefront of theoretical research on the emergence of social complexity.

We still know little about basic elements of pre-European coastal livelihoods for many areas of the Southeast, including most of the Gulf of Mexico. Within the Gulf Coast region, two coastal societies are relatively well-studied archaeologically: the Karankawa of coastal Texas and the Calusa of southern Florida. Ethnohistoric and archaeological evidence suggest that these groups differed dramatically from one another in terms of social organization and population mobility (e.g., Marquardt and Walker 2013; Ricklis 1996). Both groups relied predominantly on wild coastal resources, but while the Calusa lived in permanent villages and were one of the largest paramount chiefdoms in southeastern history, members of the Karankawa practiced a seasonally-mobile lifestyle and lived in small egalitarian social units.

Coastal societies from what is now Texas and southern Florida had access to a broadly similar suite of resources, but the extent to which the use of specific habitats, resource patches, and taxa varied across time and space is unknown. For decades, debates on aquatic resource bases focused on the nutritional value of shellfish and the labor involved in their processing and procurement (e.g., Bailey 1978; Cohen 1977; Osborn 1977; Parmalee and Klippel 1974). This approach fails to capture the complex and diverse behaviors that underlie resource decisions in coastal environments. Anthropological perspectives on the economic roles of shellfish gathering, compared to fishing, hunting, and farming, are entangled with a number of other issues of interest including management of resources, differential access, gendered labor, and ritual feasting, not to mention issues of preservation and recovery. Understanding the different ways coastal resources were used across the Gulf Coast may contribute to our broader understanding of the various forms of social identity, population mobility, and sociopolitical organization that existed as well.

Many aspects of human life are tied to population mobility, resource schedules, and seasonality of site use. These include ritual and harvest cycles, population demographics, and political and economic organizations, among many others. For many areas of the coastal Southeast, early models of population mobility assumed seasonal migrations between the coast and the interior (e.g., Crook 1986; Curren 1976; Milanich 1994, 2002; Thomas and Campbell 1993). Such models remain largely untested for the northern Gulf Coast region. We still do not know whether year-round resident populations occupied the northern Gulf Coast, how coastal resources fit into seasonal resource schedules, or the nature of interactions across environmental zones.

Archaeological studies of coastal resource use also contribute to our understanding of long-term changes in marine ecosystems. Fisheries researchers have identified a global crisis in commercial fisheries since the mid-twentieth century (Cheung et al. 2007; Jackson et al. 2001; Pauly et al. 1998; Sheppard 1995). These, however, lack a deep historical perspective for evaluating the magnitude and potential impacts over larger time scales. This problem is termed the “shifting baseline syndrome” (Pauly 1995), in which each generation of fisheries scientists tends to take the stock size and species composition that occurred at the beginning of their careers as the baseline against which changes are evaluated. Commercial landings records and fisheries surveys allow researchers to evaluate such changes in marine fisheries primarily from the twentieth century to the present. The zooarchaeological record of coastal resource use has the potential to extend the fisheries record back thousands of years.

Goals and Research Questions

The research presented here has three goals. The first goal is to use traditional zooarchaeological methods to investigate resource use and evidence of seasonal site usen at one coastal locale over the span of approximately 800 years, nested within a broad regional synthesis of coastal resource use on the northern Gulf of Mexico over the span of approximately 5,000 years. The study focuses on zooarchaeological datasets that include both vertebrate and invertebrate fauna, developed using fine-screen recovery techniques, to document variability in coastal resource use across time and space in this region. The second goal is to evaluate the human-mediated movement of commodities between coastal and interior communities as evidence for human mobility and/or exchange networks. A pilot study using light stable isotopes of deer bones recovered from both coastal and inland locales are used to suggest whether deer products such as venison, hides, or bone tools were transferred between coastal and interior communities. The third goal is to evaluate long-term trends in the health of the coastal resource base. This has important implications for sociopolitical developments in the past, as well as for understanding long-term cycles of crisis and recovery of coastal fisheries. Many other aspects of seasonality, settlement, mobility, and climate change are not addressed explicitly because the goal is to characterize coastal lifeways in this region as a case study and foundation for future research.

The research questions elaborate upon two major themes: diversity among coastal livelihoods and persistence of coastal ecosystems and economies. These themes are addressed at multiple scales of analysis. One scale focuses continuity and change in coastal resources and coastal economies during the Woodland period (ca. 3200–1400 B.P.) at a single locale on the coast of northern Florida. The second scale addresses diversity and persistence of coastal economies at a larger spatiotemporal scale, based on a comparative synthesis of 12 zooarchaeological datasets from the Mobile Delta, Florida Panhandle, and Big Bend regions of the northern Gulf of Mexico (Figure 1.1) spanning several millennia (6300–1100 B.P.). All dates are reported in calibrated radiocarbon years unless otherwise noted.

Was the coastal zone occupied on a seasonal rather than continuous basis?

Subsistence strategies require decisions not only about *where* and *what* and *how* to hunt, gather, or collect, but also *when* these various activities fit into the annual resource schedule. Resource schedules represent a negotiation of competing needs and obligations, and are closely related to human population mobility (Binford 1980; Jochim 1976). The availability and distribution of resources is seasonal in some regions, where they are closely linked to harvest and feasting cycles, rituals and rites of passage, as well as human population size and density, and political and economic organization (Kelly 1992:57; Waselkov 2012:201).

Globally, ethnographic and archaeological evidence suggest that coastal foragers considered both lunar and annual cycles in their foraging decisions (e.g., Carré et al. 2009; Claassen 1986; Meehan 1982:80; Moss 1993:634; Waselkov 1987:111–113). In some areas of the coastal Southeast, evidence for year-round occupation of the coastal zone has been interpreted as evidence for reduced population mobility and is thought to play a central role in the emergence of political and economic complexity. In other coastal areas, such as the northern Gulf Coast region, models that emphasize mobility between the coast and interior (e.g., Curren 1976; Milanich 1994, 2002; Thomas and Campbell 1993) continue to hold sway for many scholars.

Zooarchaeological evidence on the seasonal aspects of vertebrate and invertebrate resource acquisition are used to evaluate the hypothesis that the northern Gulf Coast was occupied seasonally, rather than continuously throughout the year. Archaeological evidence for the seasonal aspects of coastal life generally come from plant and animal remains. Often, season of resource capture, use, and site occupation are extrapolated from just a handful of specimens from one or two species. Even when evidence related to site seasonality is abundant, and all seasons are represented, documenting year-round coastal sedentism is difficult. We typically lack the temporal resolution needed to determine whether a site was occupied continuously throughout the year, or episodically over many years. On the other hand, highly seasonal, patterned use of coastal resources and coastal sites, which would be consistent with a transient or migratory human population, is a testable, falsifiable hypothesis.

What was the basis of coastal subsistence?

Coastal subsistence strategies have proven problematic for classification schemes. The terms fisher-hunter-gatherer, hunter-fisher-gatherer, fisher-gatherer-hunter, coastal forager, maritime hunter, and others underlie an uncertainty about the roles of different aquatic resources (Ames 2002; Bailey and Milner 2002). Throughout this research I use the term “fishers” to refer to people for whom hunting, gathering, and collecting coastal resources was a routine part of life, subsuming a wide range of resources other than fishes within this term. In addition to fishes and shellfishes, coastal dwellers routinely used other animals such as mammals, birds, and turtles, as well as plants and algae (e.g., Dillehay et al. 2008).

Zooarchaeological data from multiple sites across the northern Gulf Coast region are used to investigate the relative contributions of various resources (e.g., fishes versus shellfishes), habitats (e.g., terrestrial, marine, and freshwater), and techniques and technologies (e.g., individual- versus mass-capture fishing techniques), and to evaluate whether a single subsistence strategy was shared throughout the region, or whether multiple strategies co-existed. Whether one or many patterns of resource use existed has important economic implications related to former environments and the distributions of resources, differential access to resources, catchment areas, population mobility, management strategies, and long-distance exchange.

Certain characteristics of many coastal resources means that they can be monitored and managed. The question of whether shellfish were marginal or central resources is an important one because many species of shellfishes, compared to other animals, are largely immobile and occur in patches. The patchy distribution of molluscs means that access to these resources could be monitored and controlled (Thomas 2014; Whitaker 2008). Likewise, a fishery that emphasized mass-capture techniques such as weirs and nets could be regulated and managed through ownership of technologies and facilities. At small scales, resource management can signify cooperation (Campbell and Butler 2010), but control over resources is also a mechanism by which individuals or groups may achieve status or power (Dietler 1996; Wiessner 1996).

Is instability of coastal ecosystems a modern phenomenon?

Population declines in marine fauna (Hutchings and Reynolds 2004), changes in growth patterns (Morita and Fukuwaka 2007; Rijnsdorp and van Leeuwen 1992), and shifts in community structure (Cheung et al. 2007; Jørgensen et al. 2007; Myers and Worm 2003) are evidence that global marine fisheries are in crisis. Humans have been impacting marine ecosystems for millennia, and it is now widely appreciated that even "small-scale" or artisanal harvesting can have a major impact on target populations (Jennings et al. 1995; Jennings and Polunin 1996; Milner 2013; Wing and Wing 2001).

Commercial harvest data suggested that changes in trophic structure and intrinsic vulnerability of marine fisheries (*sensu* Cheung et al. 2007) observed in the late-twentieth century were the result of recent overexploitation, and are warning signs of global declines (e.g., Cheung et al. 2007; Pauly et al. 1998). Fisheries scientists have called for a greater appreciation of historical data such as written records, zooarchaeological data, genetic data, and other evidence of past fishing efforts in order to examine trends in marine ecosystems that predate conventional fisheries datasets such as survey data and commercial harvest records (Baisre 2010; Pinnegar and Engelhard 2008).

The research presented here uses assemblages of animal remains from coastal shell midden sites to document stability and change in the trophic structure and intrinsic vulnerability of marine fisheries prior to intensive commercial exploitation of the Gulf of Mexico. Shell middens in the coastal Southeast developed through a variety of anthropogenic formation processes, and include both rapid and gradual accumulations of shell intermixed with various amounts of bone, pottery, lithics, charcoal, soils, and sediments (Russo 2014). Despite the range and variety of sites and site types included in this study, a common activity at all of them was collecting and processing seafood. Thus, they all provide ecological and subsistence data that contribute to an understanding of coastal economies and ecosystems in the past (Jackson et al. 2001).

Organization

This dissertation is organized in seven chapters. Chapter 1 specifies the research questions and their significance in southeastern archaeology and in global anthropology. Chapter 2 describes the environmental, historical, and theoretical contexts of the study. Chapter 3 describes the zooarchaeological methods, including methods for stable isotope analyses. Chapter 4 presents the results of zooarchaeological analysis for each analytical unit, including identified taxa, relative abundances, and various indices related to faunal abundances, diversity, trophic level dynamics, and intrinsic vulnerability. Chapter 5 is a discussion of the subsistence and settlement systems at one locale, the East Peninsula of the Florida Panhandle, over a period of approximately 800 years. It focuses on the habitats and subsistence strategies used, the social and political contexts of production, seasonality of resource and site use, and evidence for resource stress or intensification at the East Peninsula locale. Chapter 6 approaches the same issues from a different spatiotemporal scale. It reinterprets the East Peninsula dataset in the context of broad regional patterns over the span of approximately 5,000 years, and describes qualitatively and quantitatively different coastal subsistence sub-systems in the northern Gulf Coast region. Chapter 6 also includes a discussion of population mobility and interaction along the coast and between the coast and the interior. Chapter 7 summarizes the conclusions of this study and offers suggestions for future research.

Chapter Summary

Three basic research questions are essential to understanding cultures and ecosystems of the northern Gulf Coast: (1) Was the coastal zone used on a seasonal basis? (2) What was the basis of coastal subsistence? and (3) Is instability of coastal ecosystems a modern phenomenon? These research questions elaborate upon two major themes: diversity among coastal livelihoods and resilience of coastal ecosystems and economies. The research addresses these themes at two scales of analysis: one scale focuses on aspects of continuity and change in coastal resources and coastal economies during the Woodland period (ca. 3200–1400 B.P.) at one locale on the coast of northern Florida; the other scale is a comparative synthesis of zooarchaeological data from the Mobile Delta, Florida Panhandle, and Big Bend regions of the northern Gulf of Mexico to document patterns of fisheries health and resource use over several millennia (6300–1100 B.P.). Chapter 2 contextualizes the research question through a review of the literature on the environmental setting and cultural history of the northern Gulf of Mexico, and the theoretical perspectives that inform this research.

CHAPTER 2:

ENVIRONMENTAL, CULTURAL, AND THEORETICAL CONTEXT

This chapter describes the context of the research and is organized in five sections. The first section defines the study area and describes the environmental setting of the northern Gulf of Mexico, including relevant information on the climate, geomorphology, vegetation, and fauna of the region. The second section briefly summarizes the cultural history of the northern Gulf Coast and adjacent areas to situate the present study of human/environmental interactions within a broader trajectory of cultural development. The third section reviews the major theoretical perspectives that inform this study. The fourth section discusses the archaeological implications of the research questions with reference to the environmental, cultural, and theoretical context. The final section is a brief summary of the Chapter 2.

Environmental Context

The geographic focus of this study is along the Alabama and Florida Gulf coast, collectively referred to as the “Panhandle” region (Figure 2.1). Additional data are from the marshy “Big Bend” region of Florida, and the “Mobile Delta” region, which is located north of Mobile Bay and is dominated by intermittently brackish swamp and bottomland forests (Figure 2.1). The term “coast” refers to the sea–land interface, including nearshore environments, extending to the upriver extent of the influence of seawater, and adjacent lands. Nearshore refers to the region influenced by wave action, between the shoreline the offshore zone (Svendsen 2006:1). Estuaries are the bodies of water in which fresh water and sea water combine, and define the upriver extent of the coastal landscape. An estuary is defined as

> *… a semi-enclosed coastal body of water that extends to the effective limit of tidal influence, within which sea water entering from one or more free connections with the open sea, or any other saline coastal body of water, is significantly diluted with fresh water derived from land drainage, and can sustain euryhaline biological species from either part or the whole of their life cycle* (Perillo 1995:26).

Estuaries are characterized by brackish waters, with salinity gradients ranging from 0.5 ppt at the head of the estuary (the oligohaline zone), to fully marine sea water of 30.0–35.0 ppt at the mouth of the estuary and open ocean (the marine or euhaline zone). Estuarine systems are further subdivided into mesohaline (5.0–18 ppt) and polyhaline (18.0–30.0 ppt) zones (Carriker 1967; Odum 1988). The locations of salinity zones shift in response to seasonal rainfall and streamflow, with extreme variations occurring during floods and droughts. It is therefore impossible to define the upper extent of estuaries, and of marine-influenced environments in general, as static boundaries. Today, for example, tidal influence and salt water intrusion regularly extend approximately 20 km upriver from the head of Mobile Bay, into the Mobile Delta, but as much as 45 km upriver during periods of low freshwater river discharge (Chadwick and Feminella 2001:533). The Panhandle region experiences small, diurnal tides, with less than a meter difference between high- and low-tide. The Big Bend has small, semidiurnal tides, with two high-tides and two low-tides of different sizes each day (Lanza Espino and Gómez Rojas 2004).

Rivers change their course; landforms drift, erode, emerge, and disappear; and sea level rises and falls (e.g., Anderson et al. 2012; Rich et al. 2014; Roberts 1997; Stewart and Gorsline 1962; White 2014:86). Hydrological and geomorphological changes such as these alter the hydrodynamics of associated estuarine systems, further complicating static delineations between brackish and fresh water, and coastal and non-coastal environments. For the purpose of this study, archaeological sites yielding evidence of association with former marine or estuarine environments, i.e., those yielding abundant estuarine and marine archaeofauna, are considered coastal sites, regardless of the modern salinity regime; terrestrial areas yielding coastal archaeological sites are considered coastal also. Conversely, archaeological sites with abundant terrestrial and freshwater fauna are considered non-coastal or interior sites.

Climate

Seasonal climate patterns influence the reproduction, growth, and distribution of coastal plants and animals, and are therefore of central importance to human subsistence and settlement systems. Today, the northern Gulf Coast has a humid, subtropical climate. Air temperatures range from an average low of approximately 6°C in winter (December through February) to an average of 33°C in summer (June through September) (Chen and Gerber 1990; Livingston 1990:556), with 240 frost-free days per year on average (Sanford 2008). Temperatures over 37°C are not unusual in the summer (Sanford 2008), and daily temperature fluctuations may be extreme. In some areas, and during certain times, daily temperature ranges may exceed the average annual ranges (Chen and Gerber 1990:11).

The region is typically wet, with average precipitation of approximately 1,600 mm per year (Sanford 2008). In the Panhandle and Big Bend regions, there is a marked seasonal shift from a warm, rainy season, characterized by heavy afternoon rains from June to September, to a cool, dry season from October to May (Black 1993; Chen and Gerber 1990:11). These areas receive an average of approximately 180 mm of rainfall per month in the rainy season, and 80 mm per month in the dry season (Chen and Gerber 1990:Figure 2.5). Precipitation is distributed evenly throughout the year within the Mobile Delta region (Riccio et al. 1973).

Mean annual sea surface temperatures (SSTs) are approximately 25°C, ranging from an average of 18°C during the winter (January–March) to 28°C during the summer (July–September) (Boyer et al. 2009). Water temperatures can be a primary limiting factor in growth and productivity in nearshore areas. Oysters (*Crassostrea virginica*), for example, cease growth in water temperatures in excess of 28°C (Surge et al. 2001), and lightning whelks (*Busycon sinistrum*) cease growing during the coolest months of the year (Harke et al. 2015).

Climates are dynamic, and we do not know how analogous the modern climate of the northern Gulf Coast is to that between 3000 B.C. and A.D. 1300, the period of greatest interest in the present study. Proxy records for the greater Gulf of Mexico demonstrated well-defined climatic cycles over the past 5,000 years (Table 2.3). The mid-Holocene hypsithermal, also called the interglacial maximum, brought conditions that were warmer and wetter than today (Poore et al. 2003). Modern SSTs and seasonal rainfall patterns, and the summer rainy season in particular, developed after the Roman Warm Period, but prior to the onset of the Little Ice Age (Table 2.3) (Surge and Walker 2005). The Little Ice Age was a major climatic shift associated with decreased SSTs, increased winter precipitation, and a reduction in the extent of the dry season (Lozano-García et al. 2007). Sea-level records also demonstrated cycles of rise and fall, possibly oscillating between higher- and lower-than-present stands several times over the past 5,000 years (see Widmer 2005:Figure 3.3 for alternative models).

Seasonal and long-term climatic cycles also are punctuated by extreme events such as droughts, wildfires, and tropical storms. These events can have long-lasting effects on coastal and interior ecosystems. Even small rainfall deficits during early spring can cause severe damage to plant communities (Chen and Gerber 1990:19). The northern Gulf Coast has the highest number of thunderstorm days in the continental United States (Chen and Gerber 1990:26). The combination of hot summer temperatures, episodic droughts, and the high frequency of lightning ensures sporadic exposure to wildfires (Mitchener and Parker 2005). Wildfires, in turn, control the composition and stature of plant communities in scrub and pine communities (Myers 1990:Table 6.1).

Today, the Gulf Coast is prone to hurricanes during the summer and fall, especially during September and October, when ocean temperature and humidity are highest (Chen and Gerber 1990:23). Hurricanes are an episodic but normal part of the climate regime, bringing large nutrient influxes, reconfiguring shorelines and drainage systems, replenishing fresh water supplies, and increasing productivity (Conner et al. 1989). They also can pose short-term risks to human communities by inundating coastal freshwater lakes with salt water, causing massive flood- and wind-damage, and increasing the likelihood and intensity of wildfire (Chen and Gerber 1990; Liu et al. 2008; Myers and van Lear 1998). The Panhandle region is particularly hurricane-prone, with an expected return rate of one hurricane every six to eight years (Simpson and Riehl 1981). In comparison, the Big Bend region has an expected rate of one hurricane every 12 to 17 years (Chen and Gerber 1990:23). Sediment cores suggested that the Panhandle region may have experienced a “hyperactive” period of catastrophic hurricanes in the first millennium A.D., with Category 5 hurricanes making landfall more frequently than today (Liu and Fearn 2000a, 2000b).

Geomorphology and Hydrology

The northern Gulf of Mexico has a wide and shallow continental shelf, ranging from 80 to 240 km wide (Curray 1960) and generally less than 180 m below sea level (Monreal-Gomez et al. 2004). The surface sediments of the northern Gulf Coast are alluvial and coastal, forming low terraces consisting of Holocene and undifferentiated Quaternary sediment of quartz sand, carbonate sand and mud, and organic matter (USGS 2005). Sandy beaches and barrier islands are common in the Panhandle region and are composed of quartz sand, sometimes appearing as parallel sets of ridges and swales formed through wave action during repeated episodes of progradation (Johnson and Barbour 1990:434). Many extant barrier islands have occupied their current positions for 3,000 to 5,000 years (Johnson and Barbour 1990). Although most of the northern Gulf Coast has experienced net erosion over the past century (Johnson and Barbour 1990), several new barrier islands have emerged in historic times (Shepard and Wanless 1971). The lands of the coast, including the numerous long, narrow barrier islands, are almost uniformly low-lying and prone to flooding (Livingston 1990:550).

Inland from the coast, the interior uplands exceed 60 m in elevation (Livingston 1990:550). Surface sediment on the mainland overlie early Paleogene to Neogene limestone and dolomite, which form part of the Florida Aquifer. Surface waters percolate into breaks and cavities in the limestone, and are transmitted to wells and springs through the underground rivers that constitute the aquifer system (Brown et al. 1990:36; Livingston 1990:552). Pressure heads in the aquifer force water to the surface and produce artesian springs (Nordlie 1990:393). Springs and spring-fed wetland systems provide potable water sources for both humans and animals and are essential to coastal and non-coastal ecosystems (Austin et al. 2009; Faught and Carter 1998; Hancock et al. 2008). Springs are particularly common in the Big Bend region, where limestone formations are close to the surface (Mattson et al. 2006; USGS 2005).

Rivers are numerous in the northern Gulf Coast region, and vary in velocity, substratum, temperature, and drainage area. Rivers are sources of drinking water and serve as highways between the coast and the interior. Most alluvial river systems originate in the coastal plain of Georgia and Alabama (Livingston 1990:550). Two notable exceptions have their headwaters in northern Georgia and Alabama (Figure 2.1): the Apalachicola–Chattahootchee–Flint (ACF) river system, which drains an area of over 50,000 km^2 (Nordlie 1990:395), and the Mobile River Basin, which drains over 100,000 km^2 (USGS 1998). Rivers primarily flood in winter (January–March) (Curren 1976; Mattson et al. 2006).

Estuaries are important hydrological features of the northern Gulf Coast. Different geological processes produce estuaries with different characteristics. Those of the northern Gulf Coast are generally drowned-river and/or bar-built types, or combinations thereof (Pritchard 1967:4). They include combinations of salt wedge, partially mixed, and vertically and/or sectionally homogeneous estuaries (Schroeder and Wiseman 1999). Most are fed by rivers, but some receive only small or seasonal fresh water inputs from streams or terrestrial run-off (e.g., Brown 2009; Stewart and Gorsline 1962).

Within the present study area, the drowned-river valley estuary type is exemplified by the Mobile, Pensacola, and Choctawhatchee bay systems (Figure 2.1) (Clayton 2012). Mobile Bay is the largest bay in the study area and the sixth largest estuary in the United States (Mobile Bay NEP 2008). The bay is extremely shallow, with an average depth of about 3 m, and covers an area of over 1,000 km^2 (Smith 1988). Salinity within the bay is highly variable, with fresh water inflow from the Mobile Delta mixing with salt water from the Gulf of Mexico. The bay thus supports aquatic habitats with variable salinity regimes.

The Mobile Delta is a drowned alluvial plain and valley formed through the coalescence of at least two major stream systems above Mobile Bay (Smith 1988). Today, the alluvial plain is coursed by many streams, which constitute the delta's distributary system. During periods of low flow (July through December), a salt wedge frequently intrudes as far as 45 km upstream from the head of Mobile Bay, into the northern reaches of the delta (Chadwick and Feminella 2001; Schroeder 1978).

Other estuaries of the northern Gulf Coast region are of the broad, shallow, bar-built type (Schroeder and Wiseman 1999:12), also called coastal lagoons (Perillo 1995:30). These form along low-relief coasts, where barrier islands or sand spits rise above sea level and enclose river valleys with small tidal ranges and small river discharges (Perillo 1995:30). Most of the bar-built estuaries in the study area date to the last 5,000 years (e.g., Livingston 1984:10; Salsman et al. 1966). Bar-built estuaries are normally shallow, microtidal systems, often running parallel to the coast. They are bordered on the landward side by tidal flats, a former (earlier) coastline, or salt marshes (Biachi 2007:31; Perillo 1995:30). Wind is an important mixing mechanism, and tidal action often is considerably reduced compared to drowned-river estuaries (Patrick 1994:8; Pritchard 1967:5). Total freshwater input is generally small, although multiple rivers and streams may enter the estuary (Patrick 1994:7; Pritchard 1967:5). Examples of bar-built estuaries in the study area include the Apalachicola Bay and St. Joseph Bay systems (Figure 2.1) (Clayton 2012).

The Apalachicola Bay system consists of six hydrologically linked subdivisions covering over 600 km^2. It is a shallow (2–3 m), wind- and tide-dominated system (Livingston 1984). The bay is fed by the ACF river system, and is well-mixed vertically. Subdivisions within the bay range from oligohaline to euhaline conditions depending on proximity to the mouth of the river, river flow, local rainfall, wind speed and direction, and water currents (Livingston 1984:16–17). Tidal influence usually extends approximately 40 km upriver (Livingston 1984:2). Three barrier islands fringing the bay limit the outflow of the low-salinity water to the Gulf of Mexico.

Although the general structure of the bay system formed 10,000 years ago, the barrier islands are approximately 3,000 years old (Livingston 1984:10).

St. Joseph Bay is a mostly shallow (< 2 m) basin surrounded to the south and east by a 24 km-long cuspate spit, the St. Joseph Peninsula (Bologna and Heck 1999; White 2014), which formed via longshore drift from the ACF river system ca. 5,000 years ago (Stewart and Gorsline 1962). The bay covers an area of approximately 120 km^2, and is not markedly influenced by the influx of fresh water (Stewart and Gorsline 1962). Today, only two small freshwater creeks empty into the bay (White 2014), but terrestrial run-off can be substantial, resulting in salinities ranging from 22 ppt to 35 ppt (Bologna and Heck 1999).

St. Andrews Bay, and Tyndall Air Force Base (TAFB) in particular, is a major focus of this study (Figure 2.2). The St. Andrew Bay system has characteristics of both drowned-river and bar-built estuaries. The estuary formed approximately 5,000 years ago. As sea level rose during the Holocene, ocean waves and longshore currents built up a barrier island across the mouth of a now-extinct river, creating an embayment (Salsman et al. 1966). Today, the St. Andrew Bay system includes four hydrologically linked bays—West Bay, North Bay, East Bay, and St. Andrew Bay proper—with a combined area of approximately 243 km^2 (FLDEP 2012). TAFB occupies a 5 km-wide peninsula, called East Peninsula, between the Gulf of Mexico and East Bay. The bay system has an average depth of 4 m, with a maximum depth of 12 m (Conmy 2010). Because of the depth and minimal tidal range, and a lack of freshwater inputs, the bay is highly saline and poorly flushed (FLDEP 2012). St. Andrews Bay is a high-salinity system, that is not considered a true estuary by some (e.g., Brown 2009:17). St. Andrews Sound is an adjacent coastal lagoon, on the south side of East Peninsula, and not directly connected to St. Andrews Bay (Figure 2.2).

Biogeography

The climatic, geomorphologic, and hydrologic patterns on the northern Gulf Coast interact to create unique combinations of terrestrial and aquatic habitat types, which often grade into one another. Human communities occupying this region in the past had access to a diverse suite of resources owing to the productivity and patchiness of these coastal ecosystems.

Marine life is concentrated on the continental shelf (Odum and Barrett 2005:415). Nearshore marine (euhaline) and estuarine (oligohaline, mesohaline, and polyhaline) habitats are physically stressed (i.e., rapidly changing), but also are highly productive sanctuaries or nursery grounds for numerous species of fishes and shellfishes (Livingston 1990:559; Odum and Barrett 2005:421–422). Physical factors such as waves, tides, currents, salinity, temperature, and light influence the bottom substrates and the distributions of biological communities (Odum and Barrett 2005:414), resulting in dynamic and diverse coastal ecosystems (Table 2.1; Livingston 1990:559).

Nearshore environments, including bays and estuaries, consist of numerous ecosystems that have ecological characteristics of their own. Some of the ecosystems most important to coastal human communities are seagrass beds, oyster reefs, salt marshes, and tidal flats (Myers and Ewel 1990). Seagrass beds are submerged aquatic plant communities found in low-energy (i.e., weak waves) nearshore marine and estuarine environments. Seagrass beds are vital to coastal ecology. They are important sources of primary production, offering complex habitats that are critical to aquatic wildlife (Table 2.1) and a biomechanism for improving water quality (Dawes et al. 2004; Livingston 1990:562). They occur either in patches or as continuous meadows. Patches and meadows are found in sheltered areas in the Panhandle region, usually behind barrier islands (Dawes et al. 2004). The geologic and hydrographic conditions of the Big

Bend create an immense area of shallow, clear, low-energy water which allows for the growth of extensive seagrass meadows in the absence of barrier islands (Mattson et al. 2006).

Oyster reefs, or oyster bars, are common submerged habitats in estuaries and are composed of successive generations of eastern oysters which form reef-like structures. Oyster reefs provide many ecological services, improving water quality, stabilizing bottom areas, and providing complex habitats for hundreds of other species of bivalves, gastropods, shrimps (Table 2.1), and fishes (Table 2.2)(Livingston 1990:563–564). They are especially common in brackish waters less than 10 m deep, such as estuarine river mouths in the Panhandle and Big Bend regions (Livingston 1990:563).

Salt marshes are vegetated coastal ecosystems dominated by salt-tolerant plants. They occupy the intertidal zone, particularly low-lying sedimented depressions where they are inundated with salt water at least occasionally (Montague and Wiegert 1990:481; Wiegert and Freeman 1990:1). The salinity gradient and depth/duration of inundation determine the plant and animal communities that develop (Wiegert and Freeman 1990). These communities develop between terrestrial and low-energy marine environments, resulting in biologically diverse communities that are adapted for harsh environmental conditions including desiccation, flooding, and extreme temperature and salinity fluctuations (Montague and Wiegert 1990:495). Salt marshes have characteristics of both marine and terrestrial ecosystems, and are critical to both marine and terrestrial food webs (Wiegert and Freeman 1990:1). They function as nurseries for many marine species, especially fishes and molluscs, but terrestrial animals such as birds, deer (*Odocoileus virginianus*), and raccoons (*Procyon lotor*) also forage in the marsh (Table 2.1) (Montague and Wiegert 1990:482). Salt marshes are particularly abundant in the Big Bend region, but occur in low-energy and sheltered intertidal areas throughout the Panhandle and Delta regions as well.

Tidal or mud flats are unvegetated soft-sediment habitats, located in estuaries and other low-energy marine environments where mud, clay, sand, and detritus settle. Tidal flats are highly productive habitats, supporting a high biomass of organisms which live on (epibenthic) or within (infaunal) the soft substrate (Livingston 1990:565). Epibenthic and infaunal communities are dominated by detritivores, deposit feeders, and filter feeders (Table 2.1). Macrobenthic infaunal organisms, such as molluscs and crustaceans, are often referred to as ecosystem engineers because they affect the structure and chemistry of their own environments by burrowing (Paterson et al. 2009). Tidal flats often occur on the seaward side of intertidal marshes. They are distributed in patches in the Delta and Panhandle regions and occur more-or-less continuously along the Big Bend coast (FWC 2009).

Sandy beaches and dunes lie at the interface between the land and the ocean. These habitats are continuously disturbed and reshaped by coastal winds, wave action, tides, and frequent, extreme disturbance events, especially hurricanes, and therefore are continuously recolonized (Johnson and Barbour 1990:44). Relatively few animal species are permanent residents of these environments, although they serve as feeding grounds and/or nesting areas for many species of wildlife including birds, sea turtles (Cheloniidae), and terrestrial mammals (Table 2.1) (FNAI 2010; Johnson and Barbour 1990). Sandy beaches are common in the Panhandle region, less common in the Big Bend, and absent in the Mobile Delta.

The plant communities of more stable dunes transition into maritime forests. Maritime forests support a diversity of terrestrial and even aquatic fauna (Table 2.1), with species composition depending on the frequency and timing of saltwater inundation (Whitaker et al.

2009). Most maritime forests consist of evergreen hardwoods, shrubs, pines, and oaks, and resemble the vegetation of the interior zone (Johnson and Barbour 1990:458). Pine flatwoods are fire-tolerant communities between wetter bottomlands and drier uplands, and are intermixed with bayheads, swamps, and freshwater marshes. Swamps are low-lying, regularly inundated forested wetlands, forming a border along large rivers, creeks, and lakes. Cypress and other freshwater-tolerant trees and shrubs generally dominate swamps and bottomland forests. Hardwood swamps are found throughout the study area, but are characteristic of the Mobile Delta region (Chaplin 2001). Habitats within the delta are spatially complex, including seasonally flooded bottomland hardwood forests, dense marshes, and submerged aquatic vegetation (Table 2.1). Coastal hydric hammocks are a type of forested wetland. They occur at low elevations on the landward site of salt marshes along the Big Bend region, in areas with higher-than-average ground-water levels (Vince et al. 1989). Hydric hammocks are irregularly inundated forests, which stabilize the timing of freshwater inflow and attenuate peak flows into adjoining estuaries (Vince et al. 1989:70).

The various combinations and co-occurrences of habitats on the northern Gulf Coast provide access to a broad suite of resources for humans that require an equally diverse repertoire of collection strategies and technologies. Coastal adaptations require specialized knowledge about climatic and hydrological cycles and their relationships to plant and animal productivity. The rhythms of daily life of coastally adapted human populations likely were in tune with these cycles.

Culture History

Coastally adapted human populations are a cultural phenomenon of great antiquity. Shell midden sites are a common feature of coastal landscapes around the globe, most dated to the onset of the Holocene and thereafter (ca. 11,500 B.P.). Binford (1968) hypothesized that the apparently sudden appearance of shell midden sites, followed by the domestication of plant foods around the Mediterranean basin at the Pleistocene/Holocene transition, had a single cause: scarcity of land and a reduction of preferred foods. Binford's (1968) "post-Pleistocene adaptation" hypothesis reflected the viewpoint that aquatic foods, particularly shellfish, were less desirable or less nutritious than large terrestrial game, or were starvation foods (e.g., Bailey 1978; Cohen 1977; Osborn 1977; Parmalee and Klippel 1974). Shellfishing was perceived by many earlier scholars to be a desperate, lowly form of existence (Darwin 1860:213; Ryder 1963:311; Uhle 1907:31).

To the contrary, scholars now generally recognize that coasts and coastal subsistence strategies did not emerge as a post-Pleistocene adaptation to increased human population pressure. Instead, coastal adaptations were central to the development and dispersal of modern humans (Bailey and Milner 2002; Bicho et al. 2011; Erlandson 2001). Archaic *Homo sapiens* and Neanderthals (*H. sapiens neanderthalensis*) included marine resources in their subsistence strategies at least 150,000 years ago (Cortés-Sánchez et al. 2011; Marean et al. 2007). Marine resources were important to the economies of early foragers on both sides of the Pacific (e.g., Erlandson et al. 2008; Habu et al. 2011; Reitz et al. 2015; Sandweiss et al. 1998; Szabó and Amesbury 2011), and maritime technologies may have played a role in the rapid dispersal of human populations along the Pacific Coast of North America (Erlandson 2002).

Precisely when and how humans first migrated into southeastern North America is a point of debate. Anderson and Sassaman (2012:38) hypothesized that the first colonists were coastally-adapted populations acquainted with the use of watercraft. The earliest known sites and artifacts in the Southeast date to the late Pleistocene and are assigned to the Paleoindian period

(Table 2.3). However, the Pleistocene coastline of the Gulf of Mexico is now underwater due to fluctuations in sea level, therefore evidence for a Pleistocene occupation of that coastal zone would be underwater as well (Faught 2002).

The northern Gulf Coast region has received less attention from archaeologists compared to other areas of the coastal Southeast such as the Georgia coast and southwestern Florida (Thompson and Worth 2011). As such, the historical context that follows is broad and necessarily tentative.

Archaic period

The earliest archaeological evidence for coastal dwellers on the northern Gulf of Mexico dates to the Middle Archaic (7850–5800 B.P.) period (Table 2.3). Zooarchaeological data from three shell midden sites, Meig’s Pasture (8OK102), Mitchell River 1 (8WL1278), and the submerged J&J Hunt (8JE740) site, demonstrate the intensive use of estuarine fishes and shellfishes by the Middle Archaic in the Florida Panhandle and Big Bend regions (Curren 1987; Faught 2002; Mikell and Saunders 2007). By this time, and possibly earlier, people began influencing marine ecosystems in this region.

Whether the northern Gulf Coast region was occupied by year-round sedentary populations or by highly mobile transient groups during the Archaic period has not been resolved. However, the possibility of early sedentism in this region should not be discounted. The earliest villages occupied by sedentary societies in the Southeast are found in coastal and aquatic environments. Faunal remains from Horr’s Island, in southwestern Florida, suggest that coastal dwellers lived at that locale year-round by 5000 B.P., long before sedentary villages were previously thought to have existed in the Southeast (Russo 1994). In the northern Gulf Coast region the number and density of shell midden sites increased from the Middle to Late Archaic, suggesting an increase in the density of the coastal human population (Russo et al. 2006). The number of large base camps likewise increased, possibly housing some residents year-round, as populations concentrated near aquatic resources (Bense 1994:90).

A distinct type of coastal shellwork site known as shell rings appeared during the Late Archaic (5800–3200 B.P.) period (Table 2.3). Shell ring sites are circular, C-, or U-shaped deposits of shell, typically 1–6 m in height, surrounding a relatively shell-free central plaza (Russo et al. 2009:105). Coastal shell rings are found from northern Florida to South Carolina on the Atlantic coast, a region known as the Georgia Bight, and from southwestern Florida to Mississippi on the Gulf coast (Anderson and Sassaman 2012:82). Five shell rings are attributed to the Late Archaic Elliott’s Point archaeological culture in the Florida Panhandle region: Horseshoe Bayou (8WL36), Meig’s Pasture (8OK102), Buck Bayou (8WL90), and 8SR1415 (Russo et al. 2006:69). An unknown number of shell rings on the Gulf Coast may have been lost due to inundation.

Researchers do not agree on the processes by which shell ring sites formed, nor on their functions, although most would agree that they were places where people came together. Seasonal macroband camps, feasting locales, sedentary villages, and/or monumental structures are among the more plausible functions (Anderson et al. 2007:470; Colaninno 2012; Marquardt 2010a, 2010b; Russo 2004; Sanger and Thomas 2010; Saunders 2004; Thompson 2007; Thompson and Andrus 2011; Thompson and Worth 2011; Trinkley 1985; Waring and Larson 1968; White 2004). Several shell ring sites on the Atlantic coast yielded evidence for multi-season or year-round occupation (e.g., Colaninno 2010; Thompson and Andrus 2011). Although sites of this type may have served multiple or changing functions during their use-histories, all yield evidence of intensive exploitation of estuarine shellfishes, predominantly oysters (Russo 1991, 2014; Saunders 2004), as well as estuarine and marine fishes (Colaninno 2010).

Plants, of course, were an important component of livelihoods both on the coast and the interior. People used plants for food, medicine, fuel, and raw materials. The shift toward food production began in the Eastern Woodlands, but apparently not on the coast, during the Archaic period with the domestication of marshelder (*Iva annua*), chenopod (*Chenopodium berlandieri*), squash (*Cucurbita pepo*), and sunflower (*Helianthus annuus*) (Smith 2006). Archaeological sites in the coastal Southeast yield evidence of extensive use of wild plant foods including grape (*Vitus* spp.), elderberry (*Sambucus canadensis*), prickly pear (*Opuntia* spp.), persimmon (*Diospyros virginiana*), mulberry (*Morus rubra*), wild plum (*Prunus* spp.), hickory (*Carya* spp.), chestnut (*Castanea* spp.), acorn (*Quercus* spp.), knotweed (*Polygonum* spp.), cabbage palm (*Sabal palmetto*), and saw palmetto (*Serenoa repens*) (Newsom 2002; Tuross et al. 1994).

Woodland period

The Woodland period chronology in the Gulf Coast region is being revised (Smith 2014). Archaeologists working on the Woodland Gulf Coast report radiocarbon dates that are inconsistent with the generally accepted regional timeline, with Middle and Late Woodland material culture occurring much later in that region than elsewhere in the Southeast (e.g., Price 2008, 2009; Russo et al. 2006, 2009). Pending a synthetic revision, the Woodland chronological dates included in Table 2.3, and in the discussion below, follow the standard regional chronologies. The reader should note that the dates used in this section are broad generalizations and approximations, at best, and that radiocarbon dates presented in Chapter 3, rather than the regional chronology summarized here, take precedence in my interpretations.

Ring middens are a site type associated with Woodland (3200–1020 B.P.) period cultures of the Southeast (Table 2.3). Ring middens differ from shell rings in size, composition, and, presumably, function. Ring middens are similar to shell rings in that they are circular or semi-circular deposits. Where shell rings tend to be composed of heaps of shell, primarily oyster, ring middens typically are low-lying or subsurface deposits, and shell need not make up the bulk of the midden (Russo 2014). When present, shells typically represent multiple shellfish species, rather than being predominantly oyster (Russo 2014). Darkened soils associated with ring middens suggest large amounts of organic matter such as charcoal and other plant materials, animal remains, and other waste. In addition to darkly stained organic soils and variable amounts of shell, ring middens (as well as shell rings) also contain pottery, lithics, and tools of bone and shell. Ring middens are typically interpreted as resulting from the gradual accumulation of daily activities (Russo 2014:26). Ring middens are thought to represent villages with a circular settlement pattern.

Ring middens were identified first in non-coastal areas of the Southeast, where shell inclusions were minor or absent (Milanich 1974; Milanich et al. 1997:54). Ring middens, both with and without shell, often are associated with burial mounds (Russo et al. 2006:Table 8.2). Although the functions of ring midden sites are not fully understood, they are typically interpreted as circular settlements or villages (Percy and Brose 1974) where both sacred and profane activities took place (Russo 2014; Russo et al. 2009:105–106). As such, animal remains from ring midden sites likely reflect a variety of subsistence activities. It is rarely easy to distinguish animal remains derived from the ordinary or mundane processing of resources from specialized uses, such as sacrifices or feasting.

The coast was a locus of population expansion during the Woodland period. The number of coastal settlements increased during the Early Woodland (3200–2200 B.P.) period (Table 2.3), and included large villages or multi-family residential sites as well as smaller, presumably short-term, satellite camps (Stephenson et al. 2002:330). Coastal base camps or villages were usually located in maritime hammocks near salt marsh habitats (Milanich 1973:56). Examples of Gulf Coast ring middens with Early Woodland components include Bear Point Complex (8BY49) and Hurlburt Horseshoe (8OK380). Interior villages also were located in ecotones, but between upland forests and freshwater marshes or river bottoms (Tesar 1980:589). People were apparently placing their settlements strategically, to facilitate access to a variety of habitat types, thereby increasing the variety of available resources.

Early Woodland (Gulf Deptford) subsistence involved a variety of technologies for exploiting wild resources (Milanich 1973; Stephenson et al. 2002). Thick shell middens developed through long-term or repeated occupation of coastal base and special activity camps (Russo et al. 2006:16). The coastal Deptford faunal complex demonstrates sub-regional variability, presumably reflecting variability in local habitats. For example, sites located near the upper reaches of estuaries yield evidence for extensive use of marsh clams (*Rangia cuneata*), with few oysters, whereas oysters dominate sites near more saline habitats (Byrd 1997:50; White 2004, 2014). This indicates a possible diversification in shellfishing strategies from the Archaic to Woodland periods, from a single strategy focused on oysters, to multiple strategies tied to different places within the landscape.

Coastal sites dating to the Middle Woodland (2200–1500 B.P.) period were larger and more numerous than those of previous periods, suggesting further population growth. Sites associated with the Swift Creek and Santa Rosa−Swift Creek archaeological cultures are concentrated in the coastal zone in the Florida Panhandle, with fewer interior sites (Bense 1998:256–257). Middle Woodland ring middens are large, about 100 m in diameter, and often are associated with mounds and “site clusters,” possibly reflecting a camp–satellite settlement pattern (Bense 1998). The largest Middle Woodland sites are thought to have been occupied by perhaps a few hundred permanent residents (Kohler 1978; Milanich et al. 1997:89; Pluckhahn 2003:191). Smaller sites, such as Bernath Place (8SR986), probably consisted of six to eight households with a total population of perhaps 30 to 60 people (Pluckhahn 2003:191). Mound/village complexes in the Florida Panhandle with Middle Woodland components include the Harrison Ring (8BY1359), Baker’s Landing (8BY26), Bayview (8BY137), Third Gulf Breeze (8SR8), and Bernath Place.

Milanich (1998:59) argued that with a growing population, greater competition for resources and naturally circumscribed territories necessitated social institutions to promote intra- and intergroup cooperation. Incipient forms of social stratification possibly emerged during this time as a mechanism for allocating resources and promoting cooperative relations. “Self-made leaders” possibly resided at the largest site in a cluster, and were buried in the mound when they died (Bense 1998:271). The Middle Woodland mortuary complex was centered on mound burials, often located near but separate from the settlement area of the village. The Yent−Green Point mortuary complex of the Gulf Coast Swift Creek sub-region was characterized by conical or dome-shaped burial mounds with elaborate grave goods, including panpipes, earspools, plummets, gorgets, and exotic materials (Bense 1994:161).

During the Middle Woodland period at least some communities on the Gulf Coast were connected to the broader region through participation in the interaction networks of the Hopewell Interaction Sphere (Caldwell 1964). The Hopewell Interaction Sphere is characterized as a trade network (Struever 1964); a mortuary cult (Prufer 1964); a religion (Caldwell 1964); an artistic style (Willey 1971); a form of social organization (Seeman 1995); a network of peer polities (Braun 1986); and an ecological adaptation (Braun 1986). More recently, it has been recognized not as a unitary phenomenon but as multiple and various interaction networks which can be deconstructed into constituent parts involving: (1) shared cultural and material contents; (2) geographic regions over which these things are shared; and (3) mechanisms of distribution (Carr 2006).

Carr (2006:53) defined "Interregional Hopewell" as "a composite of multiple, diverse kinds of practices, ideas, and symbols, which had their origins in multiple, differing regional traditions and were shared or operated at multiple, different supraregional scales." Swift Creek cultures were on both "the giving and receiving ends of material exchanges and influence" (Wallis 2011:40), although the height of the Interregional Hopewell (ca. 2200–1550 B.P.) predated many of the Swift Creek cultures on the Gulf Coast (Wallis 2011:41). The numerous "conch" shells (probably lightning whelk [Kozuch 1998; Romain 2009:185–186]), alligator (*Alligator mississippiensis*) and shark (Elasmobranchii) teeth, and an articulated roseate spoonbill (*Ajaia ajaja*) in midcontinental sites likely originated on the Gulf and Atlantic coasts of the Southeast, including Florida. Possible mechanisms for their distribution in the Midwest include vision or power quests; pilgrimage to a place in nature; travel to a center of learning; purchase of religious prerogatives; and elite exchange (Carr 2006:Table 16.2).

The distribution of Swift Creek sites was possibly shaped to some extent by a panregional demand for marine goods, particularly lightning whelks, and the routes over which commodities could flow between the coast and the interior (Anderson 2002:279). Regional ceremonial centers such as Kolomoki (Pluckhan 2003), Mandeville (Smith 1979), McKeithen (Milanich et al. 1997), and Crystal River (Pluckhahn et al. 2010) possibly served as meeting places for establishing and maintaining intergroup alliances and as gateways for trade within the regional interaction sphere (Knight 2001; Pluckhahn 2003). These centers may have gained prestige as middlemen in panregional exchange networks (Anderson 2002:279). If regional centers mediated the flow of goods such as lightning whelk shells (Anderson 2002:279), then differential access to materials at the source also had important implications for the relationships and interactions among people on the coast and the interior. In prestige economies, individuals or groups foster social and economic dependencies and communicate prestige by controlling access to such resources, at the same time strengthening the sense of social identity through reference to the "other" (Claassen and Sigmann 1993; Muller 1997; Trubitt 2000, 2003).

The Middle Woodland period was associated with the growth of the Lower Mississippi Valley and Gulf Coast cultures in terms of panregional influence (Anderson and Sassaman 2012:126). On the northern Gulf Coast, Late Woodland (1500–1020 B.P.) period mound traditions and civic-ceremonial centers associated with Weeden Island archaeological cultures flourished (Table 2.3). Artifacts identified as the Weeden Island ceramic complex are found as far west as Mobile Bay, as far south as Tampa Bay, and up to 250 km inland, into modern-day Georgia and Alabama (Bense 1994:167; Lolley 2003; Milanich 2002). Contemporaneous pottery styles found in coastal Alabama, Mississippi, and Louisiana are so similar to those of northwestern Florida that type names, which generally follow modern state boundaries, may obscure the cultural relationships and interactions within this region (J. Brown 1982:24; Saunders and Stoltman 1999).

Despite superficial similarities in material culture, many and diverse communities lived in this vast region. As with earlier Woodland settlements, people who occupied different places on the landscape had access to different resources and, by extension, were engaged in different "ensembles of tasks" (Ingold 2000:195) that constituted daily life. The shared experiences of engaging with particular places and doing particular things within the environment nurtured a place-based sense of identity and community that was tied to the landscape (Ingold 2000:148). Although some aspects of sociopolitical and religious traditions were shared across a broad geographic area as described below (e.g., Milanich 2002:352), the local, place-based identity probably superseded any regional identity on the scale of what we call "Weeden Island."

People across the Weeden Island culture area continued the Swift Creek tradition of placing elaborate grave goods in burial mounds. Burial mounds were conical or flat-topped sand structures, generally associated with large ring middens formed from households arranged around a circular plaza. Some settlements had more than one mound (Anderson and Sassaman 2012:127; Russo et al. 2009:25). Sigler-Lavelle posed a model of social organization for Weeden Island cultures in northern Florida (Milanich et al. 1997:188–189) which envisions villages as interacting segments within a larger kinship system. When a village outgrew a comfortable population size, a group would "bud off" and start a new settlement, yet still retain ties to the previous settlement. Burial in mounds signaled permanent membership in a lineage and facilitated the physical centralization of ritual obligations for descendants (Milanich 1994:169–170). As ancestral shrines and public symbols, mounds also were "a means of codifying the power and importance of lineages" (Widmer 2004:251).

Weeden Island-period burial mounds held caches of distinctive mortuary pottery, exotic burial goods, and, in northwestern Florida and surrounding regions, offerings or burial cappings of marine shell (e.g., Moore 1902, 1918; Willey 1949). Although marine shells also are found in sacred contexts far from the coast (e.g., Claassen and Sigmann 1993), some coastal burials are distinguished by what Moore (1902:92) described as “masses” of unworked shells including oysters, conchs, and whelks. The inclusion of mollusc shells in burial contexts suggest that shells had a deeper meaning beyond their economic utility. The symbolism of shells in general, and of lightning whelks in particular, to Southeastern peoples has been discussed by a number of scholars. Claassen (2010) interpreted shells as symbols of both death and the underworld, fertility and birth. Kozuch (1998) drew comparisons between the unusual sinistral spiral of lightning whelks and the movement of the sun, which was frequently portrayed as a spiral in Southeastern ritual practices and iconography. As I will argue later, the use of shells as burial accouterments may also relate to or reflect an identity tied not only to what a person did in life, but also to their place within the landscape.

Weeden Island society probably was composed of equally ranked kin groups, with leaders occasionally or temporarily emerging to direct large-scale construction projects (Bense 1994:175). Broadly speaking, coastal subsistence continued to be based on wild plants and animals, with most protein sources being aquatic. Because the distribution of marine resources was bounded and well defined, at some point village fissioning ceased to be a realistic strategy for accommodating population growth. Management of resources, which presumably relied on cooperation during the Middle Woodland period, became increasingly competitive (Milanich 2002:368), possibly leading to increased political hierarchy and social inequality.

Weeden Island sites are found on the coast and farther inland, raising the question of how coastal communities articulated with interior communities. Weeden Island sites in the Mobile Delta and the interior coastal plain yield evidence for the adoption of maize (*Zea mays*) by ca. 1200 B.P., the earliest major use of maize known to the region thus far (e.g., Lolley 2003; Milanich 1974; Morgan 2003). The Gulf Coast generally is not ideal for cultivation due to its poorly drained, leached, sandy substrate and paucity of organic soils (Duffee et al. 1984). Pests and plant diseases also are greater hazards on the coast compared to the interior (Lemmon 2006:123). Curren (1976) and Morgan (2003) suggested that human populations in lower Alabama migrated between the lower bay, the delta, and the adjacent uplands on a seasonal basis to facilitate farming. Increased dependence on farming may have led to changes in settlement in these areas, as soils depleted quickly and family groups forced to relocate every few years, making nucleated village life impossible (Milanich 2002:362). In contrast, Percy and Brose (1974) argued that people occupied the coastal zone of the Florida Panhandle and Big Bend regions at least during the summer and fall, if not year-round. Evidence for maize is scarce in this region prior to the Mississippian period (Marrinan and White 2007:297).

Mississippian period

Three archaeologically distinct culture areas dating to the Mississippian period are recognized in the study area (Table 2.3): the Pensacola culture area extends from Louisiana to Choctawhatchee Bay in the Florida Panhandle, including Mobile Bay and the Mobile Delta. The Fort Walton culture area spans from Choctawhatchee Bay to Apalachee Bay, and Late Safety Harbor, from Apalachee Bay to the Tampa Bay area (Figure 2.1) (Bense 1994:217). The reader should note that these culture areas should not be thought of as internally homogenous social units. As in earlier times, social identities were probably reckoned at local scales based on kinship and the shared experiences of daily life.

Two of the most notable developments of the broader Mississippian pattern were the emergence of complex chiefdoms, including paramount chiefdoms, and the widespread reliance on cultivated plants (Walthall 1980:197). Throughout much of eastern North America, large chiefdoms were supported by domesticated plant foods including maize, beans (*Phaseolus* *vulgaris*), and squash (*Cucurbita pepo*). Groups who cultivated continued to use wild plants and animals, as well. Plants were domesticated thousands of years prior to the Mississippian period in this region. The Mississippian pattern reflects both an increasing reliance on domesticated foods as well as a shift in lifeways that facilitated intensive cultivation. This was manifest in changing patterns of settlement and land-use. Mississippian settlement patterns consisted of a hierarchy of settlement types, including farmsteads, hamlets, and major centers. Mississippian farmers took advantage of the annually replenished soils of floodplains to improve crop yields and facilitate extended use of the same fields over multiple years (Marrinan and White 2007). Major centers were the physical, social, and political nexuses of regions.

Ethnohistoric and archaeological evidence suggest that by the time of European contact stratified societies had emerged, wherein social, political, and economic status were based on kinship, gender, age, and ability (e.g., Marquardt 2014; Swanton 1911). Chiefdoms were centrally organized, regionally integrated groups of communities, controlled by a class of ruling elite. Tribute was paid to the community leaders in the form of food or material goods, which supported the ruling elite and specialists and allowed for centralized control and redistribution of goods during times of shortage and surplus (Bense 1994:192). Bottle Creek (1BA2), a Pensacola culture site in the Mobile Delta, served as the principal center for the region in terms of politics, religion, and trade (Brown 2003:2). Bottle Creek was a gateway community at the boundary between fresh and salt water, at a bottleneck along the route between the coast and the interior (Blitz and Mann 2000:105; Brown 2003:211; Quitmyer 2003:155). The elite and their retainers at Bottle Creek were provisioned with plant foods, including maize, which were brought to the principal center by an underclass of farmers (Scarry 2003:126). Non-local animals recovered at

Bottle Creek suggest interactions with coastal groups farther south, as well as upriver groups from north-central Alabama (Quitmyer 2003:155).

Farther east, in the Panhandle region, the Late Weeden Island (Wakulla) material culture suggested interaction with emerging Mississippian groups upriver, which later developed into the Mississippian-period Fort Walton culture of the Apalachicola River valley (Blitz and Lorenz 2002). Several mound/village centers, including some with multiple mounds, are known in this region (Marrinan and White 2007). The Lake Jackson site (8LE1) is a large, multi-mound and village complex near modern-day Tallahassee, Florida (Figure 2.1). Six pyramidal, flat-topped mounds at Lake Jackson exemplify the truncated temple mounds typical of Mississippian centers. The subsistence strategy centered around maize cultivation, hunting, and aquatic resources such as freshwater fishes and turtles (Jones 1982).

There is no evidence for maize cultivation within approximately 60 km of the coast. Instead, people continued using wild resources as their predecessors had done (Marrinan and White 2007:297; White 1994). Coastal Fort Walton communities were thought to be small and relatively mobile groups (Marrinan and White 2007), although data from coastal Fort Walton sites suggest possible year-round occupation of the coast (Harke et al. 2015). Pierce Mounds (8FR14), at the mouth of the Apalachicola River, likely functioned as the principal center for coastal dwellers in that region. Whether chiefdom societies on the coast should, or should not, be considered Mississippian is a point of debate due to the lack of evidence for a maize-based economy, which is thought to be central to the Mississippian way of life (Bense 1994:234; Marrinan and White 2007).

At the time of the first Spanish entradas, the Apalachee people, descendants of the Fort Walton culture, occupied the Tallahassee Hills region of the eastern Florida Panhandle and Big

Bend region, between the Aucilla and Ochlocknee rivers (Milanich 1995:93). Hearing tales of gold and abundant food stores in Apalachee Province, Spanish explorers headed north along the coast of Florida, where they were frequently, perhaps intentionally, misguided by their captive guides who consistently led them away from the Apalachee capital (Milanich 1998:141). Spaniards found a great deal of maize, but hostile populations (Cabeza de Vaca 1905:26–32). One man survived to tell of his encounters with coastal natives along the Florida Panhandle, Mobile Bay, and coastal Texas, referring to them as "…indians who fished and were poor and wretched people" (Cabeza de Vaca 1905:42). Despite the clearly biased perspective of Cabeza de Vaca (1905), his reports were consistent with a dichotomous model of fishing-based coastal and farming-based inland economies.

Theoretical Context

This research presents an historical perspective on the trajectory of resource- and land-use on the northern Gulf of Mexico from multiple spatial and temporal scales of analysis. Knowledge of the evolution of a landscape is critical for contextualizing ecological and social outcomes of modern resource use and for developing management strategies for the future. Historical ecology provides a framework for understanding human/environmental dynamics (Balée and Erickson2006; Crumley 2004; Thompson 2013). Historical ecology begins with the assumptions that: (1) most, if not all, of the nonhuman biosphere has been affected by human activity; (2) anthropogenic impacts can, but do not necessarily, lead to degradation of the biosphere; (3) different kinds of economies have different kinds of impacts on the biosphere; and (4) human communities, cultures, and the landscapes with which they interact can be understood as "total phenomena" (Baleé 1998).

As a total phenomenon, simply living on the coast shapes people's perception of the world, including concepts about time, mobility, nature, and what constitutes proper modes of subsistence, settlement, and social behavior. Coastal dwellers are united by the shared experience of living at the water's edge. The daily rhythms, the knowledge and traditions, and ultimately a worldview, or a "coastal ethos" (following Zedeño 2013), form the basis of a place-based coastal identity. Because such an identity is defined by daily practices and shared experiences, it transcends ethnic and familial lines (Astuti 1995:36; Ingold 2000:148; Zedeño 2013:143). Focusing on practice and tradition, rather than descent, as the defining markers of social identity facilitates the analysis of social relations from an ecological perspective.

Subsistence strategies are fundamental to the coastal experience and are the primary means by which people engage with their environment. These include procurement decisions and technologies, and the social, economic, political, and ritual contexts of resource acquisition and distribution. Just as environments contribute towards shaping social and political systems, people shape the landscape through practices and traditions and influence the distribution, abundance, and behavior of wildlife (e.g., Kay 2007; Kay and Simmons 2002; Lepofsky et al. 2015; Rick and Erlandson 2008). Zooarchaeological approaches provide a means of describing important components of coastal subsistence strategies, the ecological impacts of those strategies, and the so-called "entanglements" among humans and animals (*sensu* Hodder 2014).

Understanding how access to and the use of resources varied across time and space along the northern Gulf of Mexico can further our understanding of the development of cultural identities and social institutions in coastal settings in this region and elsewhere. Distributions of resources vary across time and space. This rather obvious but important point plays a critical role in what Ingold (2000) calls a "dwelling perspective" of landscapes. In this view, a landscape is not simply a space or substrate that serves as a backdrop for human activity; rather, it is “the world as it is known to those who dwell therein” (Ingold 2000:193). The landscape is an interconnected network of places that exist in contrast to and with reference to one another, based on the ways in which people interact with it. The landscape embodies the pattern of activities that take place across time and space (Ingold 2000:198).

The northern Gulf Coast was imbued with meaning through human engagement with its environs. For the people living there in the past, this is the place where they collected oysters; that is the place where they stalked deer; here is where they casted their nets; this is where they buried their dead; this is where they slept. But the landscape was more than simply a cognitive map of where tasks were carried out. It also embodied the social, political, spiritual, and temporal contexts of those tasks. The landscape consisted of the varied activities of daily life and the places where those activities were carried out. Places as well as activities were imbibed with social meaning.

Ethnographic examples illustrate when, why, how, and by whom various subsistence activities are carried out, and how these tasks held different meanings to people. In coastal and riverine settings, shellfishing was a routine part of daily life for many (Meehan 1982), usually when the tide was low each day (Waselkov 1987:96). Everyone could participate because the activity provides a reliable source of protein and requires little skill, no specialized equipment, and poses little danger to the collector. Among some cultures, shellfish are associated with laziness because they pose no challenge to the collector, unlike hunting or fishing (Moss 1993:641). Ethnographically, women and children are the primary shellfishers in subsistence economies (Meehan 1982). For women, shellfishing may have been an important part of social life. For children, it may have been a time to play and learn about the environments in which they lived (Bird and Bliege Bird 2000; Meehan 1982).

Hunting deer, on the other hand, was difficult and dangerous. Ritual precautions were taken both before and after the hunt, both to ensure success and to protect the hunter from vengeful animal spirits (I. Brown 1982:74; Hudson 1976:346; Ingold 2000:122). A deer killed without its consent (Ingold 2000:122) or without being begged for forgiveness (Hudson 1976:346) could cause death or illness to the hunter. Stalking game requires a keen eye and deep knowledge about the behavior of the prey (Alexander 1976:Plate XXV), as well as the proper tools, technologies, and technical skill needed to execute the kill (MacCauley 1887:512). A hunt could involve few or many people (Alexander 1976:Plate XXV; de la Vega 1961:194), but involved mostly men (Bird 1999). The places where people collected shellfish, and where they hunted deer, were both embedded with meaning related to time, economy, status, gender, spirituality, and sociality.

Coastal resources of the northern Gulf of Mexico generally are (and were) abundant, diverse, and reliable. However, many types of coastal resources occur in concentrated patches such as shellfish beds and schools or shoals of fishes, and there is considerable heterogeneity in the distribution of these patches. Marked variability exists even at small geographic scales. This is exemplified by the East Peninsula on the Gulf Coast of Florida (Figure 2.2), and its mosaic of sandy beaches, salt marshes, seagrass beds, oyster reefs, tidal flats, and maritime forests. From a behavioral ecology standpoint (e.g., Cashdan 1992), people could have potentially satisfied both their economic and nutritional needs, as well as their desire for variety (Jochim 1976), without needing to travel very far. Communities living on the gulf side of the peninsula, with greater access to marine habitats, conceivably engaged in different tasks on a day-to-day basis than did communities on the bay-side, just a few kilometers away. These communities existed within a broader social landscape involving negotiations of boundaries, alliances, and kinship.

Differences in the use of resources, particularly at small geographical scales such East Peninsula, provide clues about how differences in the physical landscape were embodied in social relationships. Resources can be held under four different kinds of regimes: open access (no property rights), private property, communal property (local group management), and state property (Feeny et al. 1990). Only the first three forms are of interest here. In some traditional fisheries the sea is considered common property, while in others either individuals or communities establish ownership of resources or resource patches (Acheson 1981). Even at small geographical scales, traditional sea tenure regimes are context-dependent, varying with respect to historical settlement patterns, the specific fishing strategies used, and attitudes regarding outsiders (Aswani 2005). The extent to which communities on the northern Gulf of Mexico did, or did not, recognize property rights has important implications for both the social and ecological impacts of resource use in that region.

Humans have been impacting marine ecosystems for millennia, and it is now widely appreciated that even small-scale or artisanal fishing can have major impacts on target populations (Erlandson and Rick 2008; Jennings et al. 1995; Jennings and Polunin 1996; Wing and Wing 2001). In an extreme scenario, known as the “tragedy of the commons,” individual agents acting in rational self-interest are capable of depleting open access resources without regard for sustainable use (Hardin 1968). At local scales, ownership of collection areas or facilities such as fish traps and weirs at the village- or household-level may limit harvest pressure simply by limiting the number of collectors (Wessen 2005). Alternatively, communal management may involve more formal rules and regulations regarding who has the right to fish, when, and where, as well as a means of enforcement (Aswani 2005). However, cooperative conservational behaviors should be limited by the extent to which people were aware of their adverse impacts, as well as their ability to mitigate those impacts (Campbell and Butler 2010).

An alternative motive for managing resources focuses on social, rather than ecological imperatives. Political economy is a theory of social wealth that emphasizes the social, political, as well as environmental contexts of the acquisition and distribution of resources (Muller 1997:2). A central feature of political economy is the strategic accumulation of resources (Hirth 1996:221). Individuals or social groups acting in their own self-interest can gain prestige by amassing and controlling surpluses through control of production, redistribution, and/or exchange (Hayden 1998; Hirth 1996). Territorial behaviors serve the purpose of defending access to patchy or highly valued resources to the exclusion others (Begossi 1995). As Clark (2014: 99) argued, “chronic and routinized differences,” in economic success in this case, could lead to changing perceptions about personhood and social worth, or become a source of power to the political actor (Blanton et al. 1996). Environments play a critical role in political economy, as the source of raw materials and the media for social engagement.

Traditional zooarchaeological approaches to resource depression, intensification, and overexploitation draw upon predictions from human behavioral ecology. This perspective assumes that humans are hard-wired to make decisions to optimize a goal that improves fitness (Bettinger 2009; Winterhalder and Smith 2000). Specifically, optimal foraging theory predicts that diet breadth will increase, and foraging efficiency will decrease, as higher-ranked resources become scarce. In terms of what can be measured zooarchaeologically, this would present as a shift from large- to small-bodied fauna, as well as an increase in richness and diversity, as lower-ranked prey were added to the diet.

It is difficult to disentangle anthropogenic and non-anthropogenic causes of changes in resource use due to equifinality. The term "generalized resource stress" refers to a suite of symptoms that suggests resource depression and/or intensification (Murawski 2000) regardless of whether they were caused by anthropogenic or non-anthropogenic events. The symptoms that can be evaluated from zooarchaeological evidence include reduced diversity, increased by-catch, reduced mean trophic level (Pauly et al. 1998; Reitz 2004), reduced foraging efficiency (Allen 2012; Broughton 1994a, 1994b, 1997; Butler 2001; Butler and Campbell 2004; Chatters 1987; Reitz 2014); or a shift in emphasis, such as a shift from terrestrial to aquatic animals (Broughton 1994a, 1994b, 1995, 1997), or from shellfishes to fishes (Braje et al. 2007; Erlandson et al. 2009).

In addition to these traditional approaches, new approaches derived from fisheries science focus on the ecological effects of fishing on aquatic ecosystems, rather than individual species. Ecosystem-level approaches, including analyses of mean Trophic Level (TL) and Vulnerability Index (VI), allow zooarchaeological data to be translated into a format that is directly comparable to current management tools (Reitz 2004).

Using historical fishery landings records for FAO Fishing Areas 21 and 31, which includes the Gulf of Mexico, Pauly and colleagues (Pauly et al. 1998, 2000) argued that significant changes in the structure of the marine food web occurred during the last half of the twentieth century. They documented a decline in mean Trophic Level, a phenomenon they call "fishing down the food web." Pauly et al. (1998) argued that a shift from high-trophic-level, long-lived piscivorous species, to low-trophic-level invertebrates and small pelagic fishes was a response to changes in prey abundance, with ecosystem-level impacts. Reitz and colleagues (Quitmyer and Reitz 2006; Reitz 2004) used a similar approach, adapted for zooarchaeological data, to argue that fishing along the Georgia Bight regularly occurred at even higher levels in the past.

The Vulnerability Index of the total catch measures the intrinsic vulnerability of the total fishing strategy to overexploitation based on life-history traits of individual species, including the maximum rate of population growth; the strength of density-dependent factors related to body size, longevity, and fecundity; and spatial behaviors such as aggregation (Cheung et al. 2005; Turner et al. 2003). As with mean Trophic Level, changes in the mean Vulnerability Index of total fishery landings are thought to reflect ecosystem responses to overfishing (Cheung et al. 2007). Globally, the Vulnerability Index of marine fisheries has declined since the 1950s as less vulnerable species became increasingly abundant relative to more vulnerable species (Cheung et al. 2007). In other words, as large-bodied, long-lived, vulnerable fishes were brought to commercial extinction, they were replaced by less-vulnerable, short-lived fishes (Cheung et al. 2007). To date, the intrinsic vulnerabilities of pre-industrial fisheries have not been evaluated.

The benefits of these approaches to the current research are two-fold: first, they facilitate the seamless integration of archaeological and historical records (e.g., commercial landings data), making zooarchaeological data relevant to modern fisheries scientists. Second, indices of modern fisheries, and particularly rates of change of these indices, provide benchmarks against which archaeological trends can be evaluated.

Archaeological Implications

In the preceding discussion I argued that social identity is inextricably linked with landscape through action. Thus, because the ensemble of tasks in which people were engaged on the coast were fundamentally different from those of inland dwellers, there existed a place-based coastal identity that set such groups apart. I further argued that coastal identities were not homogenous across the northern Gulf of Mexico owing to the diversity and distribution of environs in that region. Instead, the archaeological concepts of culture areas subsume a mosaic of lifeways which resulted from the intertwining of social and ecological variables. Drawing from this perspective, I return to the research questions posed in Chapter 1 and offer predictions.

Was the coastal zone occupied on a seasonal rather than continuous basis?

Coastal adaptations were central to the development and dispersal of modern humans (Bailey and Milner 2002; Bicho et al. 2011; Erlandson 2001), and the first occupants of the coastal Southeast were possibly aquatically oriented groups. Evidence from southwestern Florida and coastal Georgia suggest that settled village life developed early in the coastal zone, and the northern Gulf Coast probably was no exception. People probably were using the coastal zone of the northern Gulf Coast year-round by the Late Archaic period, if not earlier.

Such a view does not preclude mobility of individuals between the coast and the interior, nor along the coast, at either seasonal or irregular intervals. To the contrary, the Gulf Coast region was integrated with a broader panregional interaction sphere through kinship ties, religious practitioners, and so-called traveler-diplomats (Moore and Thompson 2012). As such populations should not be envisioned as fixed, isolated, or static. Populations of individual sites likely varied over seasonal or other intervals.

It is almost impossible to prove that people were at a given site continuously through the year, over multiple years. Often, we must be satisfied with extrapolating seasonality of resource use and site occupation from just a handful of plant or animal remains, representing just one or two species. Even when evidence related to seasonality is more abundant, and all seasons are represented, we generally lack the temporal resolution needed to determine whether the site was occupied continuously throughout the year, or episodically over many years. Another problem that obscures our understanding of the seasonal rhythms of the past is the fact that people could have collected a resource during one season and stored it for use in another. Ecological analogies used to interpret seasonal aspects of plant and animal physiologies may be inappropriate because climates, ecosystems, and organisms are dynamic and have undoubtedly changed over the study period. Evidence of environmental change can be misinterpreted as evidence for seasonal patterns of human behavior and vice versa. However, highly seasonal, patterned use of coastal resources and coastal sites, which would be consistent with a transient or migratory human population, is a testable, falsifiable hypothesis. Archaeological data are expected to reflect use of coastal resources during multiple seasons, rather than a single season (i.e., winter).

What was the economic basis of Woodland coastal subsistence?

Owing to the diversity and abundance of resources on the northern Gulf Coast, as well their patchy distribution, I expect that multiple and diverse subsistence strategies existed on the northern Gulf Coast. Zooarchaeologists working in the coastal Southeast are aware that variability exists among sites, and attribute that variability to local habitats (e.g., Mikell 2012; Nanfro 2004; Orr 2007). Though I agree with this assessment, it is also important to recognize that similar resources were not equivalent in the eyes of coastal dwellers. Different species of shellfish differ in taste and texture, and their shells have different properties that make them useful (or not) for making tools or ornaments. They also had different habits and required different knowledge and techniques for successful collection. People were aware of these differences. Within the broader social landscape, villages or lineages negotiated access to certain resource patches, areas, or facilities, either formally or informally. Thus, people living in geographically close proximity potentially had access to different resources. These differences could have affected many other practices and traditions including procurement methods, cuisine, crafts, and exchange.

Currently, we lack an adequate framework for describing variability in the zooarchaeological record that is both useful for identifying local and regional patterns and that can engage non-specialists also. Wing's (1977) "Subsistence Systems in the Southeast" was the first to explicitly address variability in coastal subsistence strategies, differentiating between Gulf Coast and Atlantic strategies, and between sea turtle harvesting and specialized fishing sites. However, that system did not take into account invertebrate resources, particularly molluscs, nor did it address the variability in the use of marine and estuarine fishes adequately. In practice, the dichotomy between coastal and specialized fishing strategies is too broad to be useful. On the other hand, many archaeologists hold a normative view of coastal subsistence practices, leaving little room for discussion of how subsistence strategies, identities, and social institutions interacted in the past. One goal of this study is to expand upon Wing's (1977) work by seeking patterned variability within the broader coastal and specialized fishing strategies as frameworks for furthering such discussions.

Is instability of coastal ecosystems a modern phenomenon?

Globally, humans have been impacting marine ecosystems for millennia, and I expect that the northern Gulf Coast was no different. Rather than focusing on whether pre-European fisheries were stable over the scale of millennia (the answer is a resounding no), in the analysis that follows I focus on long-term trends and rates of change. In particular, I suggest that nearshore fisheries were not necessarily stable, but that ecosystem-level changes were not perceptible over the scale of an individual lifetime. Shifts in resource use should be influenced not by ecosystem-scale phenomena, but by local and short-term fluctuations in the real or perceived availability of resources. The origins of resource management practices and proprietorship should be sought in social, as well as ecological causes.

Chapter Summary

The goal of this research is to investigate patterns in subsistence/settlement systems and economies in relation to the landscape of the northern Gulf Coast. The northern Gulf of Mexico is a mosaic of ecosystems and resource patches that provide the raw materials that shape the daily practices, traditions, and place-based social identities. Historical ecology provides a theoretical framework for understanding cultural and environmental systems as total phenomena (Baleé 1998). I focus on fisheries because they are fundamental to the coastal experience and are one of the primary means by which people interacted with the biosphere. Coastal landscapes and resources are the sources of raw materials and the media for social engagement in local and regional economies.

This research explores the relationships among coastal resources and social identity, cooperative behavior, and resource management. Clarifying how coastal subsistence strategies, including access to resources, varied across time and space along the northern Gulf of Mexico can further our understanding of the development of cultural identities and institutions in coastal settings. Acknowledging that most, if not all, of the nonhuman biosphere has been affected by human activity, and that different economic strategies have different ecological impacts, I use the ecological concepts of vulnerability, resistance, and resilience to evaluate continuity and change in coastal resource exploitation at multiple spatial and temporal scales.

Specifically, this research aims to clarify three points about coastal subsistence/settlement systems: (1) Establishing a timeline for trends residential population mobility. The concepts of mobility and sedentism are critical to the understanding of complex sociopolitical systems in both inland and coastal contexts. Studies of the seasonal aspects of spaces and resources have disproportionately focused on certain times and places. The nature of population mobility is poorly known for the northern Gulf Coast, limiting investigations of landscape use and social trajectories in that region. (2) Understanding the habitats, technologies, and sociopolitical contexts of resource procurement and how they contributed to the development of coastal traditions, practices, and identities. (3) Evaluating the health, stability, and rates of change of pre-European fisheries from an historical perspective. Resource depression, and the need to manage or control resources, is thought to be one of the prime movers of cultural change in coastal environments. Whether pre-European nearshore fisheries were stressed, either from anthropogenic or non-anthropogenic causes, is central to understanding cultural change and continuity in this region.

Table 2.1. Representative Biotic Communities of the Northern Gulf Coast.

Habitat	**Representative Plants**	**Representative Animals**
Seagrass bed	Turtlegrass (*Thalassia testudinum*)	West Indian manatee (*Trichechus manatus*)
	Manateegrass (*Syringodium filiforme*)	Bottlenose dolphin (*Tursiops truncatus*)
	Tape-grasses (*Halophila* spp.)	Sea turtles (Cheloniidae)
		Shrimps (*Panaeus* spp.)
		Bay scallops (*Argopecten* spp.)
		Lighting whelks (*Busycon sinistrum*)
		Arks (Arcidae)
		Marine/brackish fishes
Oyster reef	Unvegetated	Eastern oyster (*Crassostrea virginica*)
		Oyster drills (*Urosalpinx* spp., *Eupleura caudata*)
		Lighting whelks
		Marine/brackish fishes
Salt marsh	Smooth cordgrass (*Spartina alterniflora*)	Osprey (*Pandion haliaetus*)
	Rushes (*Juncus* spp.)	Wood stork (*Mycteria americana*)
		Raccoon (*Procyon lotor*)
		Rabbits (*Sylvilagus* spp.)
		Diamondback terrapin (*Malaclemys terrapin*)
		Blue crabs (*Callinectes* spp.)
		Fiddler crabs (*Uca* spp.)
		Marsh periwinkle (*Littorina irrorata*)
		Ribbed mussels (*Geukensia demissa*)
		Marine/brackish fishes
Tidal flat	Unvegetated	Wading birds, gulls, terns
		Raccoon
		Fiddler crabs
		Horseshoe crab (*Limulus polyphemus*)
		Angelwing (*Cyrtopleura costata*)
		Quahogs (*Mercenaria* spp.)
		Tulips (*Tulipa* spp.)
		Marine/brackish fishes
Beach/dune	Beach cordgrass *(Spartina patens)*	Egrets (Ardeidae)
	Panic grass (*Panicum amarum*)	Gulls (Laridae)
	Sea oats (*Uniola paniculata)*	Sea turtles (Cheloniidae)
		Lettered olive (*Oliva sayana*)
		Coquina *(Donax variablis)*
Forests	Oaks (*Quercus* spp.)	Turkey (*Meleagris gallopavo*)
	Hickory (*Carya* spp.)	Red-shouldered hawk (*Buteo lineatus*)
	Magnolia (*Magnolia virginiana*)	White-tailed deer (*Odocoileus virginianus*)
	Pines (*Pinus* spp.)	Squirrels (*Sciurus* spp.)
	Palms (*Sabal* spp.)	Rabbits (*Sylvilagus* spp.)
	Holly (*Ilex* spp.)	Raccoon (*Procyon lotor*)
		Opossum (*Didelphis virginiana*)
		Vipers (Viperidae)
		Colubrid snakes (Colubridae)

Table 2.1. Representative Biotic Communities of the Northern Gulf Coast. (cont.)

Habitat	**Representative Plants**	**Representative Animals**
		Box turtle (*Terrapene carolina*)
Upper estuaries, rivers and swamps	Cypresses (*Taxodium* spp.)	Bald eagle (*Haliaeetus leucaocephalus*)
	Red maple (*Acer rubrum*)	Wood duck (*Aix sponsa*)
	Magnolia (*Magnolia virginiana*)	Alligator (*Alligator mississippiensis*)
	Tupelo (*Nyssa* spp.)	Snapping turtle (*Chelydra serpentina*)
		Pond turtles (Emydidae)
		Crayfish (Cambaridae)
		Freshwater mussels (Unionidae)
		Marsh clam (*Rangia cuneata*)
		Freshwater/brackish-tolerant fishes

Table 2.2. Representative Fish Communities of the Northern Gulf Coast.

Salinity Zone	**Representative Fishes**
Marine	Blue runner (*Caranx crysos*) Mackerels (*Scomberomorus* spp.) Boxfishes (Ostraciidae) Burrfish (*Chilomycterus schoepfii*) Dolphinfish (*Coryphaena* spp.)
Marine/Brackish	Cownose ray (*Rhinoptera bonasus*) Ladyfish (*Elops saurus*) Herrings and shads (Clupeidae) Hardhead catfish (*Ariopsis felis*) Gafftopsail catfish (*Bagre marinus*) Mullets (*Mugil* spp.) Killifishes (Cyprinodontidae) Jacks (*Caranx* spp.) Sheepshead (*Archosargus probatocephalus*) Pinfish (*Lagodon rhomboides*) Seatrout (*Cynoscion* spp.) Atlantic croaker (*Micropogonias undulatus*) Spot (*Leiostomus xanthurus*) Black drum (*Pogonias cromis*) Flounders (Paralichthyidae)
Brackish/Freshwater	Gars (Lepisosteidae) Sturgeon (Acipenseridae)
Freshwater	Bowfin (*Amia calva*) Shiners (*Notemigonus* spp.) Freshwater catfishes (Ictaluridae) Sunfishes (*Lepomis* spp.) Largemouth bass (*Micropterus salmoides*) Black crappie (*Pomoxis nigromaculatus*) Freshwater drum (*Aplodinotus grunniens*)

Table 2.3. Cultural Sequence and Timescale for Gulf Coast Archaeology.

Calendrical (Approx.)	**Cal Yr (BP)**	**Uncal (rc)**	**Period**	**Culture Complex**	**Climatic Events**
AD 1950	50	0	Modern		Warming
				Industrial Revolution	Little Ice Age ends
AD 1700	300	250			
AD 1500	500	450	Colonial	European Colonization	
AD 1350	600	600			Little Ice Age begins
AD 1050	950	1000	Mississippian	Fort Walton, Pensacola, Safety Harbor	
AD 930	1020	1100			Medieval Warm Period
AD 550	1400	1500	Late Woodland	Weeden Island	
AD 225	1725	1800			
			Middle Woodland	Swift Creek, Santa Rosa–Swift Creek	Subatlantic Roman Warm Period
300 BC	2225	2200			
			Early Woodland	Deptford	
1200 BC	3200	3000			
1800 BC	3800	3500		Elliott's Point	
2500 BC	4500	4000	Late Archiac		Sub-Boreal
3800 BC	5800	5000			
					Hypsithermal ends
4350 BC	6300	5500			
4900 BC	6850	6000	Middle Archaic	Stem-based bifaces	Atlantic
5900 BC	7850	7000			Hypsithermal begins
6900 BC	8900	8000			
8200 BC	10,100	9000	Early Archaic		
				Corner notched bifaces	Boreal
9550 BC	11,500	10,000		Side notched bifaces	HOLOCENE
					PLEISTOCENE
9950 BC	11,900	10,200			Younger Dryas ends
10,500 BC	12,450	10,500	Late Paleoindian	Unfluted lanceolates	
10,950 BC	12,850	10,900	Middle Paleoindian	Clovis fluted lanceolates	Younger Dryas begins
11,050 BC	13,000	11,100			Allerød
					Inter-Allerød Cold
12,000 BC	14,000	12,000			Allerød
			Early Paleoindian	Pre-Clovis	Older Dryas
12,850 BC	14,800	12,500			Bølling
19,700 BC	21,700	18,000			Last Glacial Maximum

Notes: Adapted from Anderson and Sassaman (2012:Table 1-1) and Faught (2002–2004:Table 1). Calibrations from CalPal online with 50-year standard deviation.

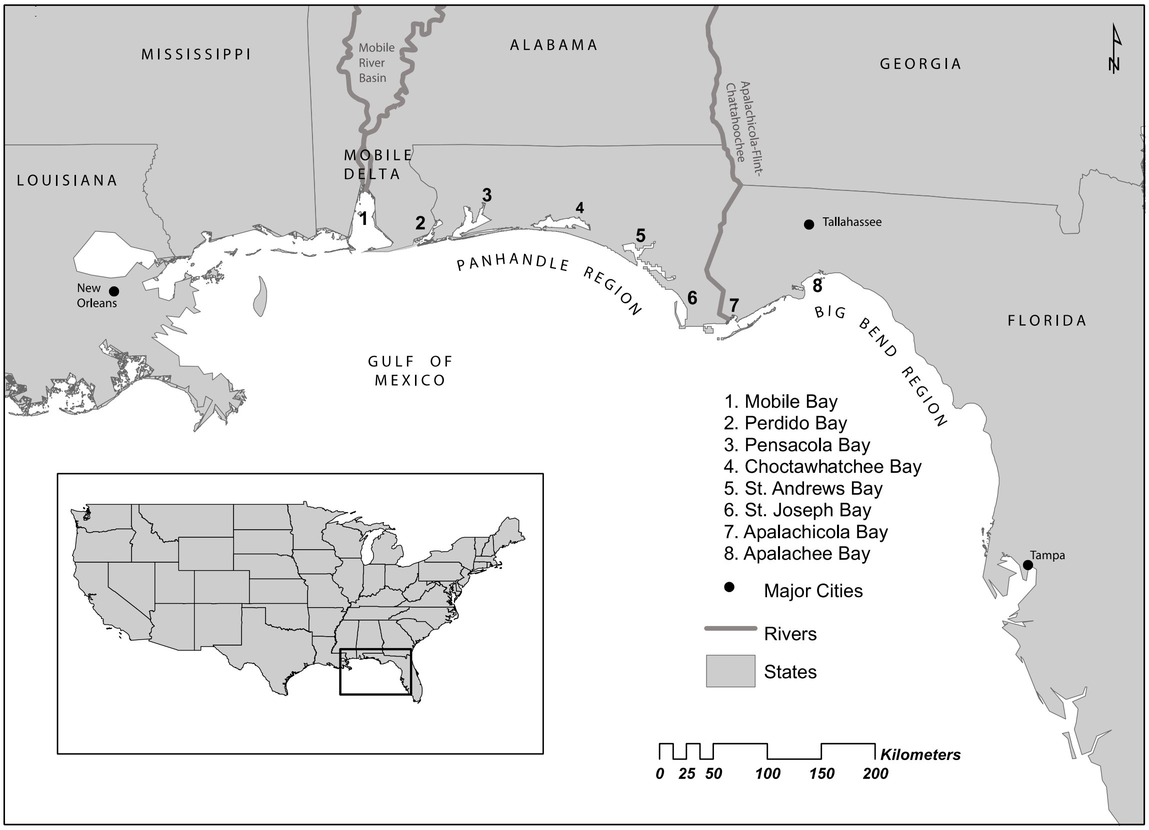

Figure 2.1. Map of northern Gulf of Mexico.

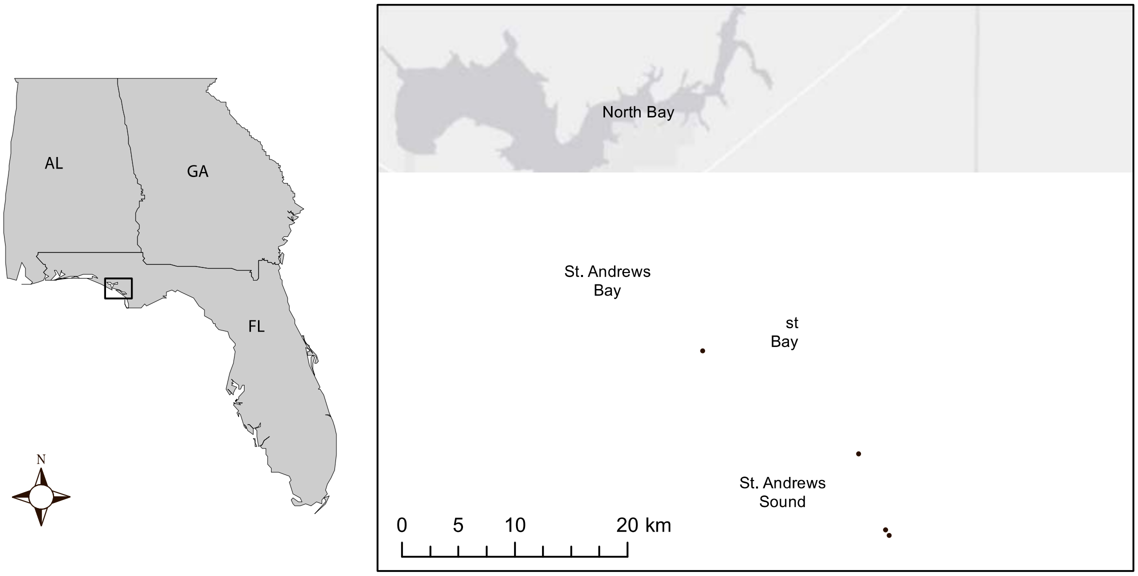

Figure 2.2. Map of Tyndall Air Force Base (TAFB) and East Bay.

CHAPTER 3:

MATERIALS AND METHODS

This study investigates diachronic trends in coastal resource use at two scales. The first scale focuses on ca. 800 years at a single locale in the Florida Panhandle region, and includes two sites on the East Peninsula at Tyndall Air Force Base (TAFB). This case study is based on original zooarchaeological research and includes three temporal analytical units, collectively referred to as the "East Peninsula Sequence." A fourth analytical unit is from a location within Hare Hammock Ring Midden thought to be associated with high-status phenomena (Russo et al. 2009). This fourth unit is used to evaluate possible differences in access to resources within the Hare Hammock community. The second scale re-interprets the East Peninsula Sequence within the context of a larger, regional database consisting of 10 additional sites, spanning over 5,000 years of occupation of the Mobile Delta, Panhandle, and Big Bend sub-regions of the northern Gulf Coast.

This chapter is presented in three sections. The first section describes the materials and zooarchaeological methods used to analyze the four East Peninsula analytical units. The second section describes how the comparative zooarchaeological data are compiled, standardized, and analyzed. The final section describes the stable isotope methods used to investigate the human-mediated movement of deer (*Odocoileus virginianus*) products between the coast and the interior.

The East Peninsula Dataset

The East Peninsula dataset consists of four analytical units from the Hare Hammock and Harrison ring middens in Bay County, Florida (Figures 2.2 and 3.1). Together, they span the Middle and Late Woodland periods. The zooarchaeological materials were dry-screened through nested 6.35-mm (1/4 in) and 1.58-mm (1/16 in) screens in the field. The 1.58-mm fractions were re-screened at the Georgia Museum of Natural History (GMNH) using 3.18-mm (1/8 in) screen. Two size fractions are reported here. Materials caught in the 6.35-mm and 3.18-mm screens were analyzed separately but are combined analytically for the purpose of this study, except where otherwise noted.

Materials

The Harrison Ring Midden (8BY1359) is a ring-shaped Middle Woodland midden of soil, pottery, and shell (Figure 3.1) located on the southeastern end of East Peninsula. The ring midden surrounds a relatively sterile interior plaza. A sand burial mound (8BY31) is located less than 20 m southeast of the ring midden (Figure 3.1). The site is located ca. 400 m from the shore of St. Andrew Sound and 1 km from the Gulf of Mexico. Saunders directed large-scale excavations at the Harrison Ring and plaza during the 2012 Louisiana State University (LSU) archaeological field school (Dengel et al. 2012). Materials from the midden excavations were loaned to GMNH for analysis (Appendix A). Calibrated radiocarbon dates from the Harrison Ring span the period A.D. 500 to 930 (Table 3.1). The Harrison Ring sample is the earliest assemblage of the East Peninsula sequence.

Approximately 60 m northwest of the Harrison Ring Midden is a larger ring midden that dates to the Late Woodland period (Figure 3.1). The Hare Hammock Ring Midden (8BY1347) is a ring-shaped midden of dark soil and patchy deposits of shell. Shell deposits are densest along a terrace edge that runs parallel to the shoreline of St. Andrew Sound, along the southwestern side of the ring (Figure 3.1). The reconstructed remnant of a sand burial mound (8BY30) is associated with the site (Figure 3.1). Both the Harrison and Hare Hammock ring middens and associated mounds were mapped by Russo and the National Park Service Southeast Archeological Center (NPS-SEAC) (Russo et al. 2009). Hadden and Russo excavated shell-bearing portions of the Hare Hammock Ring Midden in 2012 to obtain samples for zooarchaeological analyses (Appendix A). Calibrated radiocarbon dates from the Hare Hammock Ring span the period A.D. 610 to 1190 (Table 3.1).

The radiocarbon date ranges for the two ring midden sites clearly overlap, thus treating the entire Harrison assemblage as earlier than the Hare Hammock assemblage is a simplifying assumption. However, the material culture support this relative chronology also. The ceramic assemblage associated with the Harrison Ring is dominated by Swift Creek series ceramics. Ninety-seven percent of the pottery sherds that could be assigned to a formal type were assigned to the Swift Creek series (99 percent by weight) (Russo et al. 2009:Table 5). It is important to note that the Swift Creek pottery types can be associated with both the Swift Creek and early Weeden Island cultures (Willey 1949). The near-absence of Weeden Island series ceramics at the Harrison Ring supports its temporal association.

The overlapping radiocarbon dates probably reflect a combination of factors including the duration of site use, as well as site formation processes, recovery methods, and site delineation. The radiocarbon dates presented in Table 3.1 were obtained from a variety of contexts and materials, not necessarily from the same contexts studied zooarchaeologically, and include samples from the area in between the two rings. The boundary between sites was necessarily somewhat arbitrarily defined (Russo et al. 2009:Figure 6), and the people who used the site in the past almost certainly recognized no such distinction. In general the radiocarbon dates from Harrison Ring were earlier than are those from the Hare Hammock Ring, with mean calibrated ages of 1327 ± 60 cal B.P. and 1102 ± 143 cal B.P., respectively (see Figure 3.4). Whether the two sites were actually occupied at the same time at any point is a question of important anthropological and social significance, but is beyond the scope of this research.

This analysis reports on three distinct analytical units from the Hare Hammock site, designated as the Hare Hammock Early, Hare Hammock Late, and Hare Hammock House Mound assemblages, in addition to a fourth analytical unit from the Harrison Ring (Appendix A). Within the Hare Hammock Ring, relative ages of analytical units were based on established ceramic chronologies for the region (Willey 1949), as well as stratigraphic positions, as described below. The descriptions refer to the locations of analytical units in terms of excavation units (EU) and levels (LV), reflecting their location at the site in terms of a Cartesian grid, and their stratigraphic positions therein, respectively.

The Hare Hammock Early assemblage is from EU4 LV5, located along a relic terrace edge in the dense shell midden on the southwestern edge of the ring (Figure 3.1). Unfortunately, radiocarbon dates were not available from this analytical unit. The faunal sample was associated with predominantly Weeden Island (37 percent) and Swift Creek (6 percent) pottery types by weight, with only 2 percent of the pottery weight from the later Wakulla category (Hadden 2016). This analytical unit is therefore considered a relatively early deposit in the context of the Hare Hammock Ring Midden (Willey 1949).

The Hare Hammock Late sample includes materials from EU4 LV2 and EU6 LV3, also in the dense shell midden along the terrace edge (Figure 3.1). The Hare Hammock Late materials were associated with predominantly Wakulla Check Stamp ceramics (46 percent by weight), with only minor amounts of Swift Creek (2 percent) and other Weeden Island (11 percent) ceramic types (Hadden 2016). The materials from EU4 LV2, which are part of the Hare Hammock Late analytical unit, were stratigraphically superior to the level from the Hare Hammock Early assemblage from the same excavation unit. Taken together, the ceramic and stratigraphic evidence suggest this analytical unit is later than the Hare Hammock Early assemblage (Willey 1949).

A single radiocarbon date was measured from residue recovered from a Wakulla Check Stamp sherd from EU6 LV3, part of the Hare Hammock Late analytical unit (PRI-12-110-63.001, Table 3.1). The calibrated age (A.D. 820 ± 30) may not be reliable, however. The charred pot residues analyzed by Yost and Cumming (2012) probably included organic materials from a combination of marine, terrestrial, and freshwater environments, in unknown proportions. This complicates calibration because multiple radiocarbon reservoirs, and reservoir effects, are likely involved (Bowman 1990).

The Hare Hammock House Mound assemblage was associated only with Weeden Island ceramic styles (6 percent by weight), with no Swift Creek or Wakulla styles present (Hadden 2016), and is therefore considered roughly contemporaneous with the Hare Hammock Early sample. Though contemporaneous, the two analytical units represent different areas of the site and were perhaps associated with different social groups or individuals of different status (Russo et al. 2009). The Early and House Mound assemblages are compared to investigate differential access to resources within the Hare Hammock community. The House Mound area of the site represents a possible dwelling area of higher status on the northern side of the ring midden (EUs 2 and 5 in Figure 3.1). Ceramic distribution analyses indicated that so-called elite styles were more common in this area compared to other areas of the ring midden (Russo et al. 2009:Figure

32). This portion of the site was referred to as a “dwelling site” by Moore (1902:553), and contained fewer, but more discrete patches of shell (Figure 3.1). If someone of special status used this area of the site, then socioeconomic inequalities should be manifest in terms of access to resources represented by the animal remains recovered.

A total of five species lists are presented for Hare Hammock: (1) Hare Hammock Early, (2) Hare Hammock Late, (3) Hare Hammock House Mound (3.18- and 6.35-mm fractions combined); (4) an aggregated species list that includes the Early, Late, and House Mound assemblages combined (3.18- and 6.35-mm fractions combined), which is used in the regional dataset; and (5) an aggregated large-fraction species list which includes the 6.35-mm fractions from the previously described species list in addition to a selection of large fraction (6.35-mm) samples from the terrace edge shell midden (EUs 8, 9, 10, and 12 on Figure 3.1). The additional 6.35-mm samples are included to increase the breadth of the sampling area and to facilitate future research, and are presented in aggregated form, combined with the 6.35-mm fractions from the Hare Hammock study from the Early, House Mound, and Late analytical units (see Appendix A).

Methods

Identifications were made using the comparative collection at the GMNH Zooarchaeology Laboratory. For vertebrates, all specimens were identified to the lowest possible taxonomic level. I followed standard zooarchaeological methods in the identification and quantification of vertebrate fauna (Reitz and Wing 2008). These methods were modified slightly for invertebrate fauna, the primary difference being that mollusc identifications focused on non-repeating elements (Table 3.2). Shell fragments that were not specified in the sorting protocol were sorted to higher taxonomic levels: the Indeterminate Invertebrate, Indeterminate Mollusca, Indeterminate Bivalve, and Indeterminate Gastropod categories.

Several primary data classes were recorded during identification. The Number of Identified Specimens (NISP) was determined, with cross-mending specimens counted as one specimen. The symmetry and the portion of the element represented by each specimen were recorded, and age, sex, and modifications were noted when observed. All specimens were weighed to provide additional information about the relative abundance of the taxa identified. Specimens in the Indeterminate Vertebrate, Indeterminate Invertebrate, Indeterminate Mollusca, Indeterminate Bivalve, and Indeterminate Gastropod categories were weighed but not counted.

Where preservation allowed, measurements were taken of selected specimens (Figure 3.2). Measurements of mammal and bird specimens followed the guidelines published by Driesch (1976). For fishes, the anterior centrum width of atlases, and the greatest length, width, and thickness of fish otoliths were measured. Dimensions measured for sea catfish (Ariidae) otoliths and pectoral spines are shown in Figure 3.2 also. For bivalves, only valve heights (VH) of scallops (*Argopecten* spp.) were measured. For gastropods, shell heights (SH) of complete lightning whelks (*Busycon sinistrum*) and Florida fighting conchs (*Strombus alatus*) were measured. Lip thickness (LT) was measured for fighting conchs. Because the majority of lightning whelks were broken, I also measured the greatest lengths of the columellae of nearly complete specimens (those with at least 75 percent of the original length present) as a rough estimate of the minimum length of the shell. Measurements are presented in Appendices B (Harrison Ring Midden) and C (Hare Hammock Ring Midden). Mean sizes are reported as 95 percent confidence intervals (CI).

The Minimum Number of Individuals (MNI) is the smallest number of individuals that is necessary to account for all of the specimens of a particular species in an analytical unit (Shotwell 1955:330). MNI was estimated based on symmetry, portion (non-repeating elements), size, and age. Ladyfishes (*Elops saurus*) were identified entirely from vertebrae. To estimate MNI, the number of vertebrae identified was divided by 40, a conservative number derived from counting vertebrae in several comparative specimens. Scallops were identified to genus only from hinges and hinge fragments with auricles present. Auricles are the "ears" on either side of a scallop umbo (see Figure 3.2). Each scallop has a total of four auricles: two posterior and two anterior. To estimate MNI for scallops, the total number of anterior or posterior auricles, whichever was greater, was divided by two.

In most cases, MNI was estimated for the lowest taxonomic level, i.e. species, rather than genus or family. Occasionally, more individuals were estimated if all specimens identified to a family were considered together, rather than if specimens identified to a lower taxonomic level were considered separately. For example, more individuals were estimated if all materials identified as herring (Clupeidae) and yellowfin menhaden (*Brevoortia smithi*) were considered together rather than considering only those specimens identified as yellowfin menhaden for estimating MNI. In these cases, MNI was estimated for both taxonomic levels, and the larger estimate used in subsequent calculations. The lower MNI estimate was included in the species lists in parentheses for information only and was not included in the total for each list or in subsequent calculations.

Although MNI is a standard zooarchaeological quantification measure, it has several problems (Reitz and Wing 2008:205–210). MNI emphasizes small species over larger ones. For example, 35 yellowfin menhaden (a small fish) in a hypothetical assemblage documents considerable interest in this fish, although a single deer might supply more meat if the entire carcass was used. One possible solution would be to normalize MNI estimates as a function of biomass of the live animal. To do so would assume that the entire carcass was used. This assumption presents another set of problems that will be addressed shortly.

Another problem with MNI is that some elements are inherently more readily identifiable than others. The taxa represented by these elements may therefore be incorrectly perceived as more significant to the diet than animals with less distinctive elements. Hardhead catfish (*Ariopsis felis*) pectoral spines, readily identified from very small fragments, exemplify this situation. On the other hand, some taxa are represented by large numbers of specimens but may present few paired or non-repeating elements, and hence the number of individuals for these species may be underestimated. Gars (*Lepisosteus* spp.) and turtles are good examples of last problem. MNI for these animals will usually be under-estimated relative to the number of specimens.

Basic to MNI is the assumption that the entire individual was used at the site. From ethnographic evidence, it is known that this is not always true (Perkins and Daly 1968). This is particularly the case for larger individuals, animals used for special purposes, and where food exchange was an important economic activity (Thomas 1971; White 1953). In some cases only portions of a carcass were brought to a consumption site, in others the meat was redistributed, used more frequently by members of select social groups, used in rituals, or portions were valued as by-products regardless of the amount of meat adhering to the bone or shell.

Additionally, MNI is influenced by the manner in which data from archaeological proveniences are aggregated during analysis. The aggregation of separate proveniences into one analytical whole, the “minimum distinction” method, results in a conservative estimate of MNI

(Grayson 1973). The “maximum distinction” method, used when analysis discerns discrete archaeological contexts, produces a much larger MNI estimate. Increasing the number of analytical units generally increases the estimated number of individuals, whereas decreasing the number of analytical units generally decreases the number of individuals estimated. For the purpose of intrasite comparison at the Hare Hammock Ring Midden, animal remains from spatially and/or temporally discrete activity areas were treated as separate analytical units as described in the Materials section, and MNI was estimated for each analytical unit. For the purpose of comparison with other sites in the region (the regional dataset), animal remains were aggregated into one analytical unit per site, and MNI was re-estimated following the minimum distinction method. This greatly underestimates the number of individuals estimated for each site.

The presence or absence of elements in an archaeological collection may provide information on butchering practices, transportation decisions, and other site formation processes (Lyman 1994; Reitz and Wing 2008:213–232). Deer elements were summarized into categories by body parts. The Head category included all material from specimens associated with the cranium and mandible. Elements from the head may indicate either the consumption of brain or tongue, or the discard of unused refuse. The Vertebra/rib/sternum category (Axial) included the atlas, axis, cervical, thoracic, lumbar, and caudal vertebrae, but not the sacral vertebrae. The Forequarter category included the scapula, humerus, ulna, and radius. Forefoot included carpals and metacarpals. The Hindquarter category included the innominate, sacrum, femur, and tibia. Hindfoot included the tarsals and metatarsals. The Foot category contained specimens identified only as metapodials and phalanges that could not be assigned to other categories. The Forefoot, Hindfoot, and Foot specimens are elements that do not contain much meat and may be evidence of nearby slaughter, skinning refuse, use of the feet for broth, or a cache of material from which tools or ornaments would eventually be made. The elements identified as deer also are presented visually to illustrate their number and location in a carcass. Specimens identified only as sesamoids, metapodiae, podials, or phalanges are illustrated on the right hindfoot.

The relative age of deer at death was estimated based on observations of the degree of epiphyseal fusion for diagnostic elements and relative wear patterns on teeth (Reitz and Wing 2008:72). The area of growth between the shaft (diaphysis) and the proximal or distal ends of an element (the epiphysis) is not fused when animals are young. This line fuses when growth is complete. Although many factors influence the actual age at which fusion is complete, elements fuse in a regular temporal sequence (e.g., Gilbert 1980; Purdue 1983; Schmid 1972). During analysis, identified specimens were recorded in one of three general categories based on whether fusion occurs early in life (early-fusing), when adult status is achieved (late-fusing), or somewhere in the middle (middle-fusing). This was most informative for unfused specimens that fuse in the first year or so of life and for fused specimens that complete growth at three or four years of age. Intermediate specimens are more difficult to interpret. An element that fuses by 12 months of age and is found fused archaeologically could be from an animal that died immediately after fusion was complete or any time thereafter. The ambiguity inherent in age grouping was somewhat reduced by recording each specimen under the oldest category possible. In summarizing these data, juveniles were considered to be animals that died before 20 months of age, subadults were ones that died prior to 26-29 months of age, and adults died after 26-42 months of age.

Modifications to specimens can indicate site formation processes (Reitz and Wing 2008:123–143, 242–244). Although NISP for specimens attributed to Indeterminate Invertebrate or Indeterminate Vertebrate were not included in the species lists, modified indeterminate specimens were counted and included in the modification tables. Modifications were classified as cut, hacked, burned, calcined, or worked.

Some modifications are related to the dismembering of carcasses and other uses of bones. Hack marks are large, wide incisions across the surface of specimens. They may indicate use of a large chopping tool to dismember carcasses. Cuts are small, shallow incisions across the surface of specimens. These marks were probably made by small tools as meat was removed from the bone before or after the meat was cooked. Cuts may also be left behind by attempts to disarticulate the carcass at joints. Some marks that appear to be made by human tools may actually be abrasions occurring after the specimens were discarded (Shipman and Rose 1983), but distinguishing this source of small cuts requires access to higher magnification than was available during this study. Worked specimens showed evidence of human modification for reasons probably not associated with butchery.

Burned and calcined specimens were the result of exposure to fire when a cut of meat is roasted or if specimens were burned intentionally or unintentionally after discard, such as might happen when trash or a structure burns (Reitz and Wing 2008:132–134). Burned specimens result from the carbonization of bone collagen and were identified by their charred-black coloration (Lyman 1994:384–385). Burning at extreme temperatures(≥ 600 °C) can cause calcination and is usually indicated by blue-gray discoloration (Lyman 1994:385–386). However, calcination can also occur by leaching of calcite from shell deposits. Both types of calcination probably occurred in this assemblage, but no attempt was made to distinguish between them. Experimental studies indicated that the color of specimens is a poor indicator of the type of modification because it is difficult to describe color variation precisely, and other factors may alter color (Lyman 1994:385–386).

Estimates of biomass compensate for some of the problems encountered with MNI and provide information on the quantity of meat supplied by the animal (Reitz et al. 1987; Reitz and Wing 2008:238–242). Allometry was used to predict kilograms of meat represented by kilograms of bone or shell. This is a conservative estimate of meat and other soft tissues obtained from the faunal materials actually recovered from the site. The term “biomass” is used to refer to the results of this calculation. Biomass reflects the probability that only certain portions of the animal were used at the site. This would be the case where preserved and/or redistributed meats were consumed or where only part of the carcass was discarded within the excavated area.

Biomass estimates were based on the allometric principle that the proportions of body mass, skeletal mass, and skeletal dimensions change with increasing body size. This scale effect results from a need to compensate for weakness in the basic structural materials, in this case bone and shell. A given specimen weight represents a predictable amount of tissue following an allometric relationship. The relationship between body weight and skeletal weight is described by the allometric equation:

$$Y = aX^b$$

(Simpson et al. 1960:397). This same relationship holds true for linear dimensions (e.g., otolith and atlas length) and body size. In this equation, X is the skeletal weight or a linear dimension of the specimen, Y is the estimate of biomass or body size, b is the constant of allometry (the slope of the line), and a is the Y-intercept for a log-log plot using the method of least squares linear regression and the best fit line (Reitz and Wing 2008:238–242). Values for a and b were calculated from data obtained from modern comparative specimens at the Florida Museum of Natural History and GMNH. The allometric constants are presented in Table 3.3.

MNI and biomass estimates were summarized into categories defined by taxonomic or functional classes in order to contrast the percentages of groups of taxa in the assemblages. These categories were: Bivalves, Gastropods, Crabs, Invertebrate Commensal Taxa, Cartilaginous and Bony Fishes, Turtles, Birds, Deer, Other Wild Mammals, and Vertebrate Commensal Taxa. The term "fishes" is used throughout this report to refer to both cartilaginous (Chondrichthyes) and bony or ray-finned (Actinopterygyii) fishes. Only biomass for those taxa for which MNI was estimated were included in these summaries. For example, biomass for Bivalvia was not included in the summary tables, but biomass for ribbed mussel (*Geukensia demissa*) was.

The commensal category included small barnacles, land snails, and other animals that are commonly associated with human-built environments, but not usually thought of as food resources used by people (Reitz and Wing 2008:137–138). Terrestrial snails (e.g., Polygyridae, Zonitidae, *Euglandina rosea*) and small rodents (Sigmodontinae, *Oryzomys palustris*, *Peromyscus* spp., *Sigmodon hispidus*) are attracted to loosened soil, bushy areas, gardens, and stored foods. Lizards (Lacertilia, *Anolis carolinensis*) and snakes (Colubridae) may have been attracted to house areas by small mammals as well as by small amphibians (Anura, *Anaxyrus* spp.). These commensal animals probably were not part of the resource base either as food or as a source of raw materials. Most are associated with terrestrial or marshy habitats, especially those that are disturbed or are near stored foods typical of human residences. The type and abundance of commensal animals may, however, provide insights into human behaviors such as the rate of midden accumulation.

Non-commensal taxa, which presumably were part of the resource base, were the basis of coastal subsistence systems. Following Wing (1977), constellations of major and minor resources were used to refine Wing's definition of the "coastal and specialized fisherman" subsistence system, because Wing's original classification did not include invertebrate resources, nor did it discriminate among specialized or generalized fishing strategies. Major resources were defined as those that constituted 10 percent or more of the non-commensal faunal assemblage, in terms of either MNI or biomass. Minor resources are defined as those that constituted between 2–10 percent of the assemblage.

The richness, diversity, and equitability of the assemblages were used to assess the degree of specialization of resource use (Reitz and Wing 2008:245–247). Richness is defined as the number of taxa for which MNI is estimated. The Shannon-Weaver index (H') is a measure of the diversity of species present in terms of richness and evenness. More precisely, it measures entropy. Equitability (V) measures the degree of dependence on the used resources and the effective variety of species used at the site based on the even, or uneven, use of individual species. These indices allow discussion of food habits in terms of the variety of animals used at the site and the evenness with which species were used. When the terms "diversity" and "equitability" are unqualified, they refer to the total assemblage; "fish and invertebrate diversity" refers to fishes and non-commensal invertebrates; "invertebrate diversity" to non-commensal molluscs and crustaceans, and "fish diversity" to fishes. Except for total diversity and equitability, invertebrates interpreted as commensal were excluded from analysis.

H' was developed as a mathematical theory of communication and is commonly referred to as the Shannon-Weaver index in zooarchaeological literature (after Shannon and Weaver 1949, in Reitz and Wing 2008:111), and Shannon's entropy in paleontological literature (after

Shannon 1948, in Holland 2010:1240). Both refer to the same formula (Shannon 1948:14; Shannon and Weaver 1949:61,63):

$$H' = -\sum p_i \log p_i$$

where p_i is the proportion of the ith species in the sample (Shannon 1948; Shannon and Weaver 1949). Diversity can be estimated using the logarithm of p_i to the base 2, e, or 10. Base e was used throughout this study.

To estimate equitability, the Sheldon Index was used (Sheldon 1969). Equitability was calculated using the formula:

$$V = \frac{H'}{\ln S}$$

where H' is diversity as calculated above, and $\ln S$ is the natural logarithm ($\log_e$) of the number of observed species (Sheldon 1969).

Diversity and equitability were estimated using both MNI and biomass. In the case of MNI, estimates of individuals were taken directly from the species lists. Biomass represents a different problem because biomass was estimated for more taxa than was MNI. For purposes of comparison, only those biomass estimates for taxa for which MNI was estimated were used in the biomass diversity and equitability estimates. For example, in calculating biomass diversity and equitability, biomass for pond turtles (*Pseudemys* spp.) was used rather than biomass for the family Emydidae. This ensures that when comparing MNI and biomass results, data from the same taxa were used in both cases and that MNI diversity and biomass diversity can be directly compared.

Diversity and equitability are closely related. Diversity (H’) is influenced both by the number of species used and how much each was used, because p_i are proportions related to the evenness of resource use. Diversity increases as both the number of species and the equitability of species use increases. A diversity index (H') of 5 is a high value. A collection with many species identified and in which the number of individuals slowly declines from most abundant to least abundant will be high in diversity. Diversity can be increased by adding a new taxon to the list, but if another individual of an already present taxon is added, diversity is decreased. A low diversity can be obtained either by having few species or by having a low equitability, where one species is considerably more abundant than others. A low equitability value indicates that one species was more heavily used than other species in the collection. A high equitability index, approaching 1, indicates an even distribution of species in the collection.

The mean trophic level (TL) of fishery landings is thought to reflect the trophic structure of the marine food web, in this case the human food web, and is one method by which environmental change can be assessed. Trophic Levels range between 1 and 5 and reflect the degree to which consumers feed directly on producers. Primary producers and detritus are at the base of the food chain, or TL1. Zooplankton, benthic herbivores, and detritivores occupy TL2. Carnivores occupy TLs 3 to 5. Changes in trophic organization of fishes likely responds to stresses of various sorts, including over-fishing (Livingston 1982, 1985).

Mean TL of fishery landings was estimated using the formula:

$$TL_i = \frac{\sum TL_{ij}\ \ Biomass_{ij}}{\sum Biomass_i}$$

to estimate the mean TL for the time period of interest (TL_i). The estimated trophic level (TL_{ij}) for each taxon (*j*) for the time period (*i*) was multiplied by the estimated $Biomass_{ij}$ of the taxon (*j*) for the time period (*i*). TL_{ij} was divided by the summed biomass for the time period ($Biomass_i$). Mean TL was also calculated based on MNI by simply substituting the MNI estimates for the biomass term. When mean TL estimates based on both biomass and MNI are compared, it is important that the same sampling universe is used in both calculations. Therefore only taxonomic levels for which both biomass and MNI were estimated were included. Fisheries dominated by shellfishes and detritivores have a low mean TL, between 2 and 3. High mean TL values, approximately 3.4 or higher, result when fisheries are dominated by top predators such as tunas and sharks.

In order to examine TL dynamics for the East Peninsula sequence, zooarchaeological estimates of MNI and biomass in the Harrison Ring and Hare Hammock assemblages were assigned to TLs obtained from FishBase 2014 (Froese and Pauly 2014). When the identifications in the archaeological data were insufficiently precise for FishBase 2014, TLs for close taxonomic categories were used or were estimated from similar species (Table 3.4). For molluscs, a value of 2.1 was assigned to herbivores, and 2.5 was assigned to carnivores. The value 2.5 was chosen because it is higher than herbivorous molluscs but lower than crabs (TL 2.6), which occasionally feed on small carnivorous snails. The formula was used to estimate the mean TL for the non-commensal invertebrates and fishes ("mean fish and invertebrate TL") in each assemblage and for fishes alone ("mean fish TL").

A related approach for estimating the mean vulnerability index (VI) for commercial fisheries was adapted here for archaeological applications. The mean VI was calculated using the formula:

$$VI_i = \frac{\sum(VI_{ij})(Biomass_{ij})}{\sum Biomass_i}$$

where the vulnerability index (VI_{ij}) of each taxon (j) for the time period (i) was multiplied by the estimated $Biomass_{ij}$ of the taxon (j) for the time period (i). VI_{ij} was divided by the total biomass for the period ($Biomass_i$). Mean VI was also calculated based on MNI by substituting the MNI for the biomass term, as with mean TL. VI for fish taxa were obtained from FishBase 2014 (Froese and Pauly 2014) and are presented in Table 3.4. High mean VI values, approximately 60 or higher, result when fisheries are dominated by large, long-lived fishes such as sharks, gars, and sturgeons. Low mean VI values, below 40, result when fisheries are dominated by small, highly fecund fishes such as herrings, killifishes (Cyprinodontidae), and small drums (e.g., *Leiostomus xanthurus*) (Table 3.4).

Abundance indices (AI) frequently are used to evaluate temporal trends in resource use. Highly ubiquitous taxa are those that are present in all or most of the studied assemblages. AIs for deer and for two highly ubiquitous fish taxa, sea catfishes and mullets (*Mugil* spp.), were calculated using the following formulas:

$$AI_{Seacatfish} = \frac{Biomass_{Sea\ catfish}}{\sum Biomass_{deer,\ \ high-ubiquity\ fishes}}$$

$$AI_{mullet} = \frac{Biomass_{mullet}}{\sum Biomass_{deer,\ \ high-ubiquity\ fishes}}$$

$$AI_{deer} = \frac{Biomass_{deer}}{\sum Biomass_{deer,\ \ high-ubiquity\ fishes}}$$

where $Biomass_{seacatfish}$ includes the total biomass estimates for sea catfishes (Ariidae, *Ariopsis felis*, and *Bagre marinus*), and $Biomass_{deer,\ high\text{-}ubiquity\ fishes}$ includes sea catfishes, mullets, deer, and other highly ubiquitous fishes (*Elops saurus*, all *Caranx* spp., all *Cynoscion* spp., and *Micropogonias undulatus*).

Analyses of fish body sizes in archaeological collections relate to fishing technologies and foraging efficiency. It is difficult to be precise about fish body sizes because many young, small-bodied fishes have the potential to mature into large-bodied adults. With maturity, their habits, habitat preferences, and TLs change as do the most productive capture locations and technologies (Reitz 2004; Reitz and Wing 2008:137, 266–272). Maturation sequences also are influenced by climatic variables, food availability, and harvesting pressure, among the many factors that affect growth habits. A mullet, for example, may be only be 40 or 50 mm in Total Length (length from the longest part of the tail to the anterior tip of the snout) when it was captured or it may be 610–760 mm, depending on the species represented, its age, and other variables (Hoese and Moore 1998:172–173). Simply identifying a mullet in a collection does not tell us whether the animal was large or small, where it was captured, how, or the conditions under which it lived.

Standards measurements of skeletal elements are important in assessing the size range of animals represented in an archaeological assemblage. Standard Lengths (SL) were estimated for members of the sea catfish, mullet, and drum families using allometric formulae developed for that purpose (see Table 3.3 for references). Standard Length is the length of the fish from the posterior end of the last vertebra (the base of the tail) to the anterior tip of the snout. Standard Length is preferred in zooarchaeology because often the tail of comparative specimens is damaged and Total Length cannot be recorded accurately, though converting Standard Length into Total Length, the preferred fish biology measure, makes direct comparisons of zooarchaeological data and fisheries data more difficult. A fish with a Total Length of 250 mm might have a Standard Length of 200 mm, though this is a rough estimate because of variations in tail shapes typical of each family.

The elements used to estimate Standard Length for members of these three families were the otolith and atlas, and for catfishes, the pectoral spine (Figure 3.2). Measurements of catfish otoliths followed the dimensions illustrated in Figure 3.2, and those of drums were the greatest length of the otolith. These measurements are reported in Appendices B and C. The atlas dimension is the greatest anterior width. Measurements of all sea catfishes were combined to estimate Standard Length for family Ariidae; measurements for all members of the drum family were combined to estimate Standard Length for family Sciaenidae. Members of each family were combined in this analysis because the objective was to assess the broader role of large- and small-bodied fishes in the fishing strategy at both sites.

Unfortunately, measurements were not available for all of the fishes in these assemblages. Until objective estimates of body size for all fish taxa are developed, it is necessary to use subjective classifications based on experience with these archaeological assemblages, knowing that these assignments are imprecise and can be incorrect in specific cases. To compensate for this, the fish taxa identified in the Harrison Ring and Hare Hammock assemblages were sorted into small- or large-bodied categories. Small fishes are those taxa whose adult Total Length is generally less than 250 mm in modern populations and large-bodied taxa are those whose present-day adult body size is generally larger. This classification does not necessarily mean that all of the specimens for the taxon in question were from either small or large individuals. Without measurements and body size estimates of all fishes at both sites, it is not possible to know which specific individuals were large or small unless they were individuals from inherently small taxa, such as silver perch. Classifications were based on familiarity with the specific assemblages and taxa under study, and sources such as Hoese and Moore (1998) and species profiles in FishBase 2014 (Froese and Pauly 2014).

Fish size is assumed to be related to fishing gear, which takes advantage of the habits and habitats of specific size/age cohorts. Very little direct evidence was available for the tool kits used at these sites, suggesting they were of ephemeral materials such as fibers and wood. As fishes grow, the appropriate capture technology and best fishing locations change. Small mullets, for example, might be taken in shallow weedy areas with a basketry scoop or a small dip net.

Large mullets, however, might be taken with cast or surround nets from the surf zone or in weirs across larger tidal streams. Small sharks may be captured with seine nets, for example.

For purposes of discussion, some fishes are more vulnerable to mass-capture techniques regardless of body size, and others are more likely to be taken individually, especially large-bodied carnivores. Thus, technology is reduced to a dichotomy between mass-capture techniques on the one hand and individual-capture techniques on the other. The fish taxa identified in the Harrison Ring and Hare Hammock assemblages were sorted into mass- or individual-capture categories. Gear such as poisons, nets, traps, rakes, and scoops are broadly considered mass-capture technologies, and devices such as leisters, harpoons, and hand-held hooks or gorges are visualized as individual-capture technologies. Facilities apply human energy indirectly to attract, contain, restrain, or redirect prey (Oswalt 1973:26). Weirs, nets, and fish traps of various sorts are mass-capture facilities that often are used in combination with other tools, such as hooks, gorges, and leisters (e.g., Bannerman and Jones 1999; Connaway 2007; O’Sullivan 2003; Tveskov and Erlandson 2003). These tools are not exclusive in terms of the types and sizes of fishes captured. Some individuals of all taxa could be taken either with mass-capture or individual-capture devices, at least occasionally.

Specimen count, MNI, biomass, and other derived measures are subject to several common biases (Grayson 1979, 1981; Reitz and Wing 2008; Wing and Brown 1979). In general, samples of at least 200 individuals or 1400 specimens are needed for reliable interpretations. Smaller samples frequently generate short species lists with undue emphasis on one species in relation to others. It is not possible to determine the nature or the extent of the bias, or correct for it, until the sample is made larger through additional work.

The Regional Dataset

Materials

This portion of the study is concerned with variability in resource use through space and time, and brings together zooarchaeological data from published species lists, theses, and unpublished gray literature (Table 3.5). This is not an exhaustive list of all zooarchaeological analyses carried out in this region to date. The datasets included here satisfied the following criteria: specimen weights were reported for all faunal classes, including invertebrates; materials were recovered using fine screen (3.18-mm or 1.59-mm) recovery methods; and total sample weight was greater than an arbitrary minimum of 4 kg. Several datasets were excluded from this analysis due to screen size, lack of specimen weights, or because invertebrate fauna either were not quantified or were quantified in a way that was not directly comparable to vertebrate fauna (e.g., Byrd 1994; Lawson 2005; Nanfro 2004).

For this portion of the study, analytical units are aggregated by site. The Harrison Ring data are included in the regional comparison without modification; the Hare Hammock Early, Hare Hammock Late, and House Mound samples are aggregated into a single analytical unit. Ten additional sites are included (Figure 3.3 and Table 3.5). Though the sites differ in size, age, location, function, taphonomic histories, recovery methods, and preservation, the faunal data nonetheless provide a cursory glimpse of the kinds of subsistence activities that were carried out at those locales.

At all twelve sites, faunal analysts focused on contexts that were most likely to provide insights on subsistence strategies; i.e., contexts in which faunal remains were abundant and well preserved. Despite the obvious benefits of this approach, it introduces certain biases into the analysis. In Florida, shell matrix sites neutralize the slightly acidic soils and promote the preservation of bone (Scudder 1993). Both bone and shell tend to preserve best in shell clusters 2–6 kg in size (Gunn 1995). These taphonomic biases have important implications because faunal remains that are not associated with shell are less likely to be preserved and recovered. Shellfish may be over-represented in these collections simply because shell-bearing contexts are more likely to be preserved, while shell-free faunal assemblages may decompose more quickly or more completely.

The size and accumulation rate of the assemblages have important implications also. In some cases, the faunal samples were taken from midden contexts, which presumably although not necessarily accumulated slowly. The middens are thus time-averaged representations of the use of animal resources at that site. The extent to which samples from the midden adequately represent the spatial distribution of activities, let alone the full range of behaviors at a site, is unknown. At other sites, faunal remains were recovered from archaeological features rather than midden contexts. Features are “non-portable artifacts” (Renfrew and Bahn 2015:42) within archaeological sites (e.g., hearths, postholes, storage pits). Those most relevant to this study are cooking and refuse pits, which often contain abundant plant and animal remains. Clearly, middens and features result from different kinds of behaviors. The kinds of materials that were discarded in middens need not be the same ones discarded in pits. Features also may represent short periods of time, in contrast to the time-averaging represented by column samples from a midden context.

In the case of both middens and features, it is entirely uncertain whether the behaviors they represent are representative of the site as a whole. They are but a small sample of the tasks that people carried out, and the animals that people used. For this analysis, samples from middens are preferred over features because the goal is to broadly characterize the range of activities related to human exploitation of animals at each site. Faunal data from features that specifically relate to food processing and discard, such as cooking and refuse pits, are included also, but are aggregated for each site to better reflect the range and relative importance of resources and tasks at that locale over time.

For a diachronic analysis of resource use it is, of course, necessary to place the zooarchaeological assemblages in a chronological order in some way. The simplest approach is to calculate a point estimate (e.g., mean, median, or mode) of the radiocarbon dates available for each site. However, a good point estimate of a single calibrated ^{14}C date does not exist (Michczyński 2007), let alone for an entire site’s worth of dates. The best method for presenting calibrated ^{14}C dates is to show the whole probability density functions (Michczyński 2007:401). Furthermore, relying on a point estimate for the age of a site ignores many important aspects of the histories of these sites, including the duration and intensity of use, as well as the number of radiocarbon assays available.

Acknowledging that any point estimate for the ages of these sites will be flawed, it is nonetheless clear that some sites were generally in use earlier, or later, than others. The summed probability distributions of the available radiocarbon ages for each site were modeled in OxCal 4.2 (Bronk Ramsey 2009a) and are presented in Figure 3.4. The summed probability distributions preserve the structures of the radiocarbon datasets and also facilitate the computation of summary statistics. I used the median age of the summed probability distributions to order the sites chronologically. The subsequent analyses based on the chronological ordering of sites were repeated using alternative methods for ordering the sites for comparison. These methods, which included the mean and median values of phase models for each site, resulted in slight reordering of sites but had no profound impact on the conclusions.

Uncalibrated and calibrated radiocarbon dates for each of the sites are reported in Table 3.1. Radiocarbon dates obtained from marine shell were excluded unless high-precision, local, species-specific ΔR corrections were available (e.g., Hadden and Cherkinsky 2015); or if other, non-shell, radiocarbon ages were unavailable for that site.

The radiocarbon dates for each site are described in greater detail below, along with brief descriptions of the site locations, contexts, and relevant zooarchaeological studies. The functions of the sites, as well as the intensity, duration, and seasonality of their occupation, are restated here based on the interpretations presented in the original reports. These interpretations must be considered with caution because many were founded upon sparse datasets and were influenced by the respective authors' own biases as well as the theoretical milieu of the time they were written. Russo and colleagues (2011:131), for example, question the attribution of Woodland-period linear and amorphous middens as villages, while other scholars use the term "village" without qualification. Although the sites almost certainly differed in terms of function, activities related to the procurement, processing, consumption, and/or discard of coastal resources are evident at all of the 12 sites included in this analysis.

Mitchell River 1 (8WL1278) is a Late Archaic site in Walton County, Florida, located ca. 2.6 km from the confluence of the Choctawhatchee River and the Choctawhatchee Bay. Mikell and Saunders excavated portions of the site in 1998 and 2001 as part of an NSF-sponsored investigation of early estuarine adaptations. A dense shell midden along a terrace edge and smaller, discrete patches of shell midden characterize the site (Mikell and Saunders 2007). The site was occupied intensively, if not continuously, through the Late Archaic, after which time it was not reoccupied until late Weeden Island times. Six radiocarbon dates from charcoal and soot (from Mikell and Saunders 2007:Table 3) ranged from 5340 to 1700 cal B.C. (Table 3.1). Six dates from shell were excluded because ΔR corrections vary among species on the northern Gulf Coast (Hadden and Cherkinsky 2015), and the species used were not specified in their report.

The site contains the oldest steatite vessels documented on the northern Gulf Coast. In addition to subsistence remains, materials recovered included fired clay objects or “cooking balls,” groundstone tools, projectile points, bone and antler tools, personal adornments, and nine human burials (Mikell and Saunders 2007:171–179). Resource procurement was clearly one of the major functions of this site, and was an activity that the dwellers of the site participated in on a daily basis. However, the diversity of materials recovered, particularly the human burials, suggested that Mitchell River 1 was the locus of many and varied activities, in addition to its use for the procurement and processing of fishes and shellfish. The zooarchaeological data from four column samples from shell midden contexts (Mikell and Saunders 2007:Table 6) are included in the present study, unmodified from the original report except for standardization of taxonomic nomenclature (e.g., Osteichthyes = Actinopterygii).

Meig’s Pasture (8OK102) is interpreted as a late-Middle Archaic shell ring site in Okaloosa County, Florida, southeast of Niceville, Florida. The site is located ca. 800 m from the present shore of Choctawhatchee Bay. The University of West Florida Office of Cultural and Archaeological Research excavated the site in 1987, under the supervision of Curren (1987). Only three radiocarbon dates were available from this site, all from fighting conch shells (Curren 1987:Table 32). Fighting conchs are unreliable materials for radiocarbon dating, yielding extremely variable ages within individual specimens (Hadden and Cherkinsky 2015; Luer and Loger 2014). They are reported here nonetheless because no other dates were reported for this site. The dates range from 1880 to 1790 cal B.C. (Table 3.1), with large error ranges reflecting the uncertainty of reservoir effects on this taxon (Hadden and Cherkinsky 2015). Other lines of evidence supporting the site's Archaic age include stemmed points and baked clay objects similar to those found at other Late Archaic sites, as well as a lack of ceramic vessels (Curren 1987:74).

Curren (1987) interpreted the site as a probably seasonal camp site used during the warmer months of the year. Less than 10 percent of the site was excavated as of the 1987 report. The semi-circular distribution of cooking and refuse pits, possibly adjacent to a former seep-spring (Curren 1987:78), and season-of-collection data from bivalves (Claassen, in Curren 1987), contributed to its interpretation as a short-term occupation. The pits were filled mostly with food remains, burned sand with charcoal, small quantities of stone tools, and baked clay objects. Each pit feature represents activities undertaken by a relatively small group of people over a relatively short period of time. Most of the material record from Meig's Pasture related to resource procurement and cooking. The vertebrate and invertebrate faunal remains from four features analyzed by Russo (Curren 1987:Tables 14–17) are aggregated for the present study. An arithmetic error in Curren (1987:Table 14) is corrected for inclusion in this study, and taxonomic nomenclature is standardized (e.g., Osteichthyes = Actinopterygii; Pelecypoda = Bivalvia).

Hawkshaw (8ES1287) was a multi-component site in Escambia County, Florida. The site was located on Pensacola Bay, in downtown Pensacola, Florida. The University of West Florida Office of Cultural and Archaeological Research excavated the site in 1984–1985 as a noncompliance, interdisciplinary investigation in advance of the redevelopment of an urban neighborhood known as Hawkshaw (Bense 1985). Approximately 80 percent of the site was excavated (Bense 1985:162). The Early Woodland component, which consisted of a midden and several features, was located along the edge of a bluff overlooking the bay. Eight uncorrected radiocarbon assays from charcoal from the Early Woodland component range from 50 cal B.C.

to cal A.D. 350 (Table 3.1). Because these radiocarbon assays were made before the need to correct for stable carbon isotope fractionation was recognized, ratios of stable carbon isotopes ($^{12}C/^{13}C$) were not measured and thus, correction is not possible.

These, and other Early Woodland sites in the region, were thought to be occupied “a few intense times” (Bense 1985:168). No human burials were reported. Many activities were carried out at the site, including resource procurement, processing, and consumption; ceramic manufacture and use; bone and shell tool production and maintenance; and stone tool maintenance (Bense 1985:162). Interaction with outside groups is documented through exchange of lithics and ceramic vessels (Bense 1985:162).

Quitmyer analyzed faunal remains from three features, reported as separate analytical units (Bense 1985:Appendix IV). These are aggregated for the present study, with the following modifications from the original published dataset: the taxonomic categories are standardized (e.g., UID vertebrate/Mollusca = Animalia); and the total sample weight is corrected for a minor arithmetic error in the original species list.

Plash Island (1BA134) was a predominantly Middle Woodland site on the eastern shore of Mobile Bay, in Baldwin County, Alabama. Waselkov of the University of South Alabama Center for Archaeological Studies (USA-CAS) excavated the site in its entirety in 2005 in advance of private development. The excavation revealed an arc of shell midden and hundreds of discrete pit features (Price 2008). The site sits on a arc-shaped ridge that was nearly completely surrounded by saltwater marsh and open water during its occupation, and probably accessed via canoe (Price 2008:388). Based on the variety of raw materials and an apparent lack of conservation of raw materials at Plash Island, the site occupants were either mobile enough to replenish their supply without needing to conserve what they had, or participated in long-distance trade and exchange networks (Price 2008:390). At least 27 human burials at Plash Island are thought to be associated with the Middle Woodland occupation of the site, although these remains were not dated directly. Over a thousand features were excavated, and almost all were either refuse/cooking pits or postholes. There is no evidence for permanent structures until the Mississippian-period occupation, which suggested a possible change in settlement patterns in terms of length as well as season of occupation (Price 2008:390).

Price (2008:Table 6-2) reported 11 radiocarbon dates from nutshell, and four additional radiocarbon dates from animal bones were reported by Reitz et al. (2013:Table 21). The 15 assays (Table 3.1) range from cal A.D. 370 to 1350. The late date (bone sample UGAMS-13931) is from the Mississippian component of the site. Zooarchaeological remains from seven pit features were included in an NSF-sponsored investigation of subsistence and seasonality on the Alabama Gulf Coast (Reitz et al. 2013:Tables 7 and 22). Table 7 from that report is included in the regional dataset, with no modifications. The majority of the material studied is associated with Middle Woodland dates and material culture, and the site is generally thought to be earlier than the nearby Bayou St. John site. The late date is included in the summed probability model (Figure 3.4) because faunal remains from the same feature that yielded the late date are included in the analysis.

Shell Mound (8LV42) is a multi-component site located on a small island of the same name in the Gulf of Mexico in Levy County, Florida, in the Big Bend region. A U-shaped ridge of shell, nearly 7 m high, characterizes the site, which is located near an ancient mortuary complex. The rate of midden accumulation, whether some or all of the ridge was constructed intentionally versus accumulated gradually, and whether it was constructed with architectural purpose are the subjects of ongoing investigations, but Sassman and colleagues (2012:67) tentatively suggest that it was a rapid accumulation. The site may also represent the "consolidation of a dispersed community into one large village" or "a place of occasional gathering for large groups" (Sassaman et al. 2012:68).

Sassaman of the University of Florida conducted limited excavations at Shell Mound in 2012 (Sassaman et al. 2012). Radiocarbon dates from wood charcoal from the Woodland-period features (Table 3.1) range from cal A.D. 520 to 680. Palmiotto analyzed the faunal samples from eight contexts at Shell Mound, all of which dated to the Woodland period of occupation, with the exception of a single Late Archaic-period feature (Palmiotto 2012:51). Zooarchaeological data for the seven Woodland contexts (Palmiotto 2012:Tables 4-2–4-8), which were collected from midden rather than features, are aggregated for the present study. Specimen weights listed as "<0.1" in the original report are treated as 0.001 g for the purpose of estimating biomass.

Mack Bayou (8WL101) is a multi-component site with occupation spanning the Late Archaic through the Mississippian periods. The site is located near the southern shore of Choctawhatchee Bay, on the western side of Mack Bayou. Panamerican Consultants, Inc. conducted excavations at the site in 2005 (Mikell and Shoemaker 2005a, 2005b). The single site designation encompasses a large Late Archaic shell mound, a series of discrete Early and Middle Woodland middens, a Weeden Island village, and a Mississippian-period cemetery and dispersed domestic middens (Mikell 2012:17).

Mikell's (2012) faunal analysis focused on Late Woodland (Weeden Island) contexts, and consisted of two column samples from the midden and two refuse-filled pit features (Mikell 2012:Table 3). Three radiocarbon dates from wood charcoal (Table 3.1), ranging from cal A.D. 560 to 770, were obtained from the midden deposits. The faunal data are included in the present study with the following modifications: taxonomic categories are standardized (e.g., Osteichthyes = Actinopterygii; Unidentfied shell = Invertebrata), and arithmetic and rounding errors are corrected from the original published species list.

Bayou St. John (1BA21) was a Late Woodland site near the town of Orange Beach in Baldwin County, Alabama. This site was located on the shore of Bayou St. Johns, ca. 2 km from the Gulf of Mexico. Waselkov and USA-CAS excavated the site in its entirety in 2004 in advance of private development (Price 2009). Price (2009:301) concluded that “the immediately adjacent waters of Bayou St. John must have been the main draw that attracted prehistoric people to this spot and led them to use the site for at least 700 years.” Price (2009:300–320) argued that the site was occupied repeatedly by small groups of people engaged sporadically in very intensive exploitation, but that the site was never a permanent village. In addition to the subsistence activities of everyday life, Bayou St. John may also have been the locus of mound-related ceremonial activity. Although no mound existed during the 2004 excavation, several lines of evidence suggested that a small sand mound excavated by Moore (1902) was located at what is now called Bayou St. John, including the discovery of an enormous borrow pit possibly related to the construction of a mound (Price 2009:306).

Price (2009:Table 5-4) reported 20 radiocarbon dates from carbonized nutshell, cane, and wood. Reitz and colleagues (2013:Table 21) reported ten additional radiocarbon dates obtained from animal bones. The radiocarbon dates range from cal A.D. 400 to 1070 (Table 3.1). As with Plash Island, hundreds of pit features were excavated at the site, and of those, 20 were included in the NSF-funded investigation of subsistence seasonality (Reitz et al. 2013:Tables 12 and 22). Table 12 from that report is included in the regional dataset, with no modifications.

Bayview (8BY137) is a Middle and Late Woodland ring midden site located on the north-central side of East Peninsula, on Tyndall Air Force Base (TAFB) in Bay County, Florida.

Bayview overlooks the East Bay of St. Andrews Bay, on the northern edge of the Bayview housing unit at TAFB. Russo (Russo 2014; Russo et al. 2006) interprets this and other ring midden sites as places of permanent or long-term habitation, emphasizing a “dual character” (Russo et al. 2006:101) that involves both daily maintenance and subsistence activities as well as sacred ceremonies, feasts, and celebrations.

The only available radiocarbon dates for the site are from two oyster shells (Table 3.1). The dates are calibrated using an arbitrary marine reservoir correction value of $\Delta R = 0 \pm 150$ because a correction has not been estimated for this species in the northern Gulf Coast region. This was equivalent to applying no correction, but has the effect of accounting for greater uncertainty in the calibrated age due to the unquantified marine reservoir effects (Bronk Ramsey 2009b). The calibrated dates ranged from cal A.D. 790 to 890. Russo and colleagues from NPS-SEAC investigated the site in 2004 (Russo et al. 2006). Russo analyzed a single faunal sample, a 10-cm level from a column sample within the midden, as part of that investigation (Russo et al. 2006:Table 7.1). Subsequently, Ellison (2009) analyzed additional column samples for her masters thesis. Only Russo’s (2006) data are included in this comparison because he analyzed a larger sample.

Strange’s Ring Midden (8BY1355) is a Late Woodland ring midden site located on the northeastern side of East Peninsula, on TAFB in Bay County, Florida. The site overlooks the East Bay of St. Andrews Bay. The ring midden is associated with the remnants of a sand burial mound (8BY26) that was previously excavated by Moore (1902), as well as an artifact scatter (8BY1356). As with other ring middens in this region, it is interpreted as a long-term habitation area with both sacred and secular functions (Russo et al. 2011).

The site was investigated most extensively by Russo and colleagues (2011), and was revisited by Hadden, Russo, and Little for the purpose of zooarchaeological sampling from shell-bearing portions of the ring midden. Four radiocarbon dates from animal bone and soot (Table 3.1) range from cal A.D. 700 to 1080. Fauna from a single excavation unit in the midden were analyzed by Little (2015) and those data are included in the present study, without modifications.

Bottle Creek (1BA2) is a multi-mound Mississippian complex in Baldwin County, Alabama. It is located in the intermittently brackish swamps of the Mobile Delta, some 30 km from the mouth of Mobile Bay and 80 km from the Gulf of Mexico. Brown, from the University of Alabama, directed major excavations at Bottle Creek in 1993–1994 (Brown 2003). The site is interpreted as the political, social, religious, and economic center of the region and a gateway between the coast and interior. The elite and their retainers were provisioned with plant foods, including maize (Scarry 2003:126), as well as with molluscs from both freshwater environs to the north and saltwater environs to the south (Quitmyer 2003:155).

Thirteen radiocarbon dates from charred plant samples (Table 3.1) range from cal A.D. 930 to 1520. Quitmyer analyzed the vertebrate and invertebrate fauna from three mound contexts (Quitmyer 2003:Tables 7.3, 7.7, and 7.8), which are included in the regional dataset with the following modifications from the original published dataset: human (*Homo sapiens*) remains are excluded; commensals are included in the total sample weight; weights listed as “0.00 g” are changed to <0.01 g in the species list and are entered as 0.001 for the purpose of estimating biomass. A minor arithmetic error is corrected from the original species list.

Methods

Ideally, all zooarchaeological analyses included in this synthesis would use identical methods for sorting and quantifying fauna. In reality, differences in research questions, time and budgetary constraints, and analyst preferences introduced methodological inconsistencies that complicated direct comparisons of the datasets. Two main issues emerged: (1) differences attributed to the use of the minimum versus maximum distinction methods in estimating MNI, and (2) the use of different criteria for sorting and quantifying invertebrate fauna.

The consequence of the first issue is that MNI estimates that were calculated using the maximum distinction method, wherein MNI was calculated for individual contexts within a site, cannot be aggregated through simple addition to estimate MNI for the entire studied assemblage. To illustrate this problem with a hypothetical case, MNI is estimated for hardhead catfish for two separate contexts within a site. In the first context, the most abundant non-repeating element is the left pectoral spine (*n* = 12). In the second context, the most abundant element is the right pectoral spine (*n* = 14). The MNI for the total assemblage is not simply the sum of the two contexts (12 + 14 = 26) because a live hardhead catfish has two pectoral spines, one left and one right. Fourteen individuals account for this simple hypothetical assemblage. In the context of the regional dataset, re-estimating MNI for Shell Mound, Hawkshaw, and Meig’s Pasture assemblages would require the re-assessment of element portion, side, age indicators, etc., which were not published. This means that MNI cannot be estimated for the total studied assemblages for these sites, nor can it be used as a measure of taxonomic abundance for comparing sites, or to estimate diversity, equitability, mean Trophic Level, or the Vulnerability Index.

The second issue means that NISP cannot be used as a measure of taxonomic abundance either. Some analysts sorted and counted every shell fragment to the lowest possible taxonomic level, while others did not sort or count very small fragments, or those that could not be identified to lower taxonomic levels. In the previous section, I described the sorting protocol I used for the invertebrate fauna for the East Peninsula materials. The consequence of preferentially sorting and counting only non-repeating elements is that invertebrate taxa are under-represented in terms of NISP. Consequently, it would be impossible to determine whether taxon-level differences among assemblages are the result of differences in methodologies or to differences in site formation processes.

For these reasons, biomass is used as the primary measure of taxonomic abundance in this study. Like MNI, biomass estimates are not additive, but recalculating biomass from the aggregated specimen weights is a straightforward solution. Biomass estimates are recalculated for each site using the allometric constants listed in Table 3.3. This ensures that consistent methods are used in estimating biomass from specimen weights. Consequently, the biomass values presented in this study are slightly different from those given in the original reports. The weights and biomasses for each site are aggregated into a master species list, and the ubiquity index (UI) is calculated for each taxonomic category. Ubiquity is calculated by dividing the number of units containing a specified taxon by the total number of analytical units (sites). Highly ubiquitous taxa are those that are present in most or all of the studied assemblages (UI > 0.8).

Relying on biomass alone as the measure of taxonomic abundance is not ideal. Every measure used in zooarchaeology has biases, and reporting and comparing several measures helps mitigate the biases of any single method. However, biomass estimates are the best measure to use in this case due to the idiosyncrasies of the individual datasets. Abandoning MNI has several consequences. The preferred method for calculating summary data, richness, diversity, equitability, TL, etc., is to base these measures on the MNI estimates recorded on the species list, and then recalculate those same measures using biomass estimates only for those taxa for which MNI is estimated also. This ensures that when comparing biomass and MNI results for diversity, for example, exactly the same observations are used in both cases. Using biomass as the only measure of abundance and for subsequent calculations obviates the need to adhere to this standard, since MNI data are not available for several case studies. However, it is necessary to develop other standards to ensure that the measured variables reflect the target variables as accurately as possible. These are described below.

Richness is typically defined as the number of taxa for which MNI is estimated. Instead, richness in this part of the study is the number of mutually exclusive taxa. Mutually exclusive taxa are non-overlapping categories in the taxonomic hierarchy within the context of the studied collection. Identifications to the species level are always mutually exclusive because an animal or specimen can never belong to more than one species. For example, *Ariopsis felis* (hardhead catfish), and *Bagre marinus* (gafftopsail catfish) are mutually exclusive species within the family Ariidae (sea catfishes). More generally, the lowest categories identified in a taxonomic hierarchy are considered mutually exclusive taxa. In this example, Ariidae is not a mutually exclusive category because a specimen identified as *A. felis* is also in the family Ariidae by definition; and a specimen identified to Ariidae could be either *A. felis* or *B. marinus*. These are overlapping categories. However, the family Ostraciidae is considered a mutually exclusive taxon in this study because it is the lowest taxonomic category used in that hierarchy (i.e., identifications are not made to genus or species). No lower-level categories overlap with it.

The taxonomic categories used to estimate richness are the same categories used in all subsequent measures to ensure that derived data are based on the same sampling universe. For each collection, diversity, richness, and evenness are calculated as described previously for: (1) the Total collection *excluding* invertebrate commensal taxa; (2) Fishes; (3) Invertebrates, including crabs; and (4) Other. The Other category includes all mammals, birds, and reptiles, including commensal vertebrates. Vertebrate and invertebrate commensal taxa are included in the species list, but invertebrate commensals (land snails and barnacles) are excluded from all secondary measures because of inter-analyst variation in the identification of these animals. Biomass estimates also are summarized into these same categories to compare the relative abundances of these categories. Abundance indices (AI) are calculated from mutually exclusive taxa as described in the previous section.

For Fishes, mean TL and VI are calculated for mutually exclusive taxa as described previously. Mean TL of the total fishery is estimated from Fishes and Invertebrates combined (Table 3.4). To test for change through time in species diversity, mean TL, and mean VI, the `MannKendall()` function in the 'kendall' package version 2.2 is used for R (McLeod 2011). R is a language and environment for statistical computing and graphics (R Core Team 2014).

The approach described above breaks with convention out of necessity. While these methods are applied consistently within this study, the derived values are calculated using slightly different methods than the norm and are not directly comparable to values calculated by conventional methods. For this same reason, the values for the Harrison and Hare Hammock assemblages included in the regional dataset differ slightly from those in the case studies that focused specifically on those assemblages, because both MNI and biomass were used in the latter.

Sites with similar resource constellations (*sensu* Wing 1977) are identified using hierarchical, agglomerative cluster analyses by site (Q-mode) in R using the `agnes()` function in the 'cluster' package 2.0.3 (Maechler et al. 2015). Hierarchical, agglomerative cluster analyses begin by treating each individual site as a unique cluster with a single member. The closest two clusters are then joined to form a larger cluster, and so on, until a single large cluster that includes all sites is achieved.

Cluster analyses are conducted using relative taxonomic abundances of major and minor resources using relative biomass as input variables. Relative biomass is calculated as a percentage of total biomass for each site. Not all taxa are included as variables. Only taxa with relative biomass exceeding 2 percent of total biomass for at least one site are included. In some cases, the original analysts used different taxonomic categories to refer to the same or similar animals. For example, some analysts identified all seatrout remains to genus (*Cynoscion* spp.), while others used both genus-level and species-level identifications (e.g., *C. arenarius*, *C. nebulosus,* and *C. nothus*). This could reflect differences in access to comparative specimens, analyst experience or expertise, or the particular elements present in various assemblages. For the purpose of cluster analysis, the total biomass estimates for seatrouts (including *Cynoscion* spp., *C. arenarius, C. nebulosus,* and *C. nothus*) are aggregated to genus-level within each assemblage. Collapsing these overlapping categories into a single variable at a higher taxonomic level simplifies the analysis at the expense of fine-grained environmental data represented by multiple species. (See Table 4.28 for variables (taxa) included in this analysis; taxa that are aggregated into higher taxonomic levels are marked in bold.)

The outcomes of cluster analyses are sensitive to the methods used for measuring the (dis)similarity among sites. The Bray-Curtis (Bray and Curtis 1957) and related non-parametric measures are used widely for comparing ecological data such as species composition of assemblages (Clarke et al. 2006). The Bray-Curtis measure is related to the Sørensen index, using abundances rather than simple presence or absence of species. The Bray-Curtis similarity measure is calculated in pair-wise fashion using `vegdist(method=“bray”)`in the

Community Ecology Package ‘vegan’ version 2.3 (Oksanen et al. 2015) for R. The output is a matrix of Bray-Curtis values representing pair-wise comparisons of each assemblage. The index is a value between zero (identical samples) and one (no species in common).

The method selected for determining which sites should be joined, and in what order, also influences the cluster output. Dendrograms produced using four different linkage methods are compared. The specification `agnes(method=“average”)` links clusters based on the average distance between all the members. Specifying `agnes(method=“single”)`, the nearest-neighbor method, joins clusters using the smallest dissimilarity between a point in the first cluster and a point in the second cluster, in contrast to `agnes(method=“complete”)`, the farthest-neighbor method, which uses the largest dissimilarity between a point in the first cluster and a point in the second cluster. Finally, `agnes(method=“ward”)` produces compact clusters by maximizing the variance among clusters and minimizing the variance within clusters.

The cluster outputs are compared against an ordination of the dataset also. Non-metric multidimensional scaling (MDS) is related to a variety of ordination techniques, including principle components analysis (PCA), factor analysis (FA), and correspondence analysis (CA), which consist of a series of statistical procedures that reduce the dimensionality of a complex, multidimensional dataset into fewer dimensions to produce a “map of variation” (Orchard and Clark 2005:89). Orchard and Clark (2005) successfully applied MDS to 21 faunal assemblages from the Pacific Northwest region, revealing both functional and regional variability and demonstrating the utility of this statistical approach in zooarchaeology.

MDS differs from other ordination techniques in several important ways. Firstly, most ordination techniques are analytical, producing a single unique solution for a set of data. MDS is a numerical technique that seeks an optimal solution (i.e., minimizes “stress”) through an iterative computation process. As such, re-analyses of the same dataset will likely lead to slightly different results. Second, many ordinations involve eigenvalue-eigenvector techniques that ordinate the data such that axis 1 explains the greatest amount of variance, axis 2 explains the second greatest, and so on. There are as many axes of variation as there were variables, although only a few axes are viewed. In MDS, a small number of axes are explicitly chosen prior to the analysis, and the data are fitted to those dimensions.

The solutions of the cluster analysis are compared against a non-metric multidimensional scaling ordination using the `metaMDS()` function in the Community Ecology Package 'vegan' version 2.3 (Oksanen et al. 2015). Like cluster analyses, MDS relies on a distance metric, and non-metric MDS seeks non-parametric monotonic relationships between cases in the similarity matrix. The data are fitted to a two-axis solution using the same Bray-Curtis similarity matrix calculated for the cluster analyses. The procedure is completed in both R-mode and Q-mode to explore similarities among variables (taxa) and samples (assemblages), respectively.

Deer Stable Isotope Study

Materials

This portion of the study focuses on the human-mediated movement of commodities between the coast and the interior. This pilot study includes 66 deer specimens (Table 3.6) from 13 sites on the Gulf Coast, Atlantic Coast, and the interior coastal plain of the southeastern United States (Figure 3.5). This includes 35 specimens gleaned from extant literature, and 31 specimens analyzed specifically for this study (Table 3.6).

Eighteen specimens are from coastal sites that are described in the previous section. These include three worked bone tools from Bayou St. John, and one worked bone from Hare Hammock (Figure 3.5). Thirteen specimens are from other sites (Table 3.6 and Figure 3.5) that are not included in the regional zooarchaeological dataset. These include the Corps site, which is located within the Mobile Delta, Singer-Moye, a Mississippian-period mound center in southern Georgia, and Mound Field and Bird Hammock, which are both coastal sites located in the Big Bend region of Florida. The specific sites were chosen by virtue of access to collections through established collaborations among research institutions. Materials from the Corps site are curated at USA-CAS; Singer-Moye materials at UGA; and Mound Field and Bird Hammock materials at NPS-SEAC. In many cases the specimens were previously selected for radiocarbon dating by other researchers, and collagen extracted for that purpose could additionally be analyzed for stable carbon and nitrogen isotopes. This is intended to be an on-going project as additional funds and materials become available. The final outcome will be a regional database that can be used to address numerous questions of anthropological, ecological, and historical interest.

In isotopic research of this nature it is ideal to select a single, non-repeating skeletal element for analysis to ensure that the same animal is not analyzed twice. Owing to the low recovery rate and the variability in the preservation of deer bones from these coastal sites, such a sampling strategy was not feasible. For the coastal sites, well-preserved specimens were selected from different spatial and temporal contexts based on stratigraphy, ceramic associations, and direct radiocarbon dating of deer bones. Deer are more abundant in the inland Singer-Moye assemblage; non-repeating elements were selected in that instance.

Methods

Specimens analyzed at the Center for Applied Isotope Studies (CAIS) (see Table 3.6) were cleaned with a wire brush to remove surface contaminants. Collagen samples were prepared from partially crushed bone following CAIS standard laboratory protocol. The bones were crushed to approximately 2 mm fragments and treated with 1N HCl at 4°C for 24 hours to remove the inorganic component of the sample slowly, without dissolving the collagen. The residues were filtered, rinsed in deionized water, and treated with 1N NaOH at room temperature for 1 minute to remove humic acids. The residues were then rinsed in deionized water, treated with 1N HCl at room temperature for 1 minute, rinsed again with deionized water, and transferred to Erlenmeyer flasks. The residues were then heated at 80° C for 12 hours under acid conditions ($\text{pH} = 3$) to dissolve collagen. The collagen solutions were then filtered to isolate pure collagen and dried. Excess collagen samples were archived with the zooarchaeological collections.

The sample $^{13}C/^{12}C$, $^{15}N/^{14}N$, and C/N ratios were measured using an EA-Delta V spectrometer system housed at CAIS. Both stable carbon isotope ratios ($\delta^{13}C$) and stable nitrogen isotope ratios ($\delta^{15}N$) were reported according to the equation [$\delta = (R_{sample} - R_{standard})/R_{standard}$ x1000]. Analytical standards were acetanilide and protein (casein). Data were reported to the nearest 0.1‰.

Collagens were screened for diagenetic alteration based on carbon concentration (percent C), nitrogen concentration (percent N), atomic C/N ratio, and collagen yield. Samples with low collagen yields are not necessarily compromised, and samples with high collagen yields do not necessarily indicate the absence of post-depositional alteration. Following Ambrose (1990:447), samples with nitrogen concentrations below 1 percent and carbon concentrations below 1.7 percent were rejected as diagenetically altered. Atomic C/N ratios were calculated using the formula $\frac{\%C/12}{\%N/14}$. Following DeNiro (1985), C/N ratios within the range of 2.9–3.6 are considered acceptable for archaeological bone. Ratios greater than 3.6 reflect contamination by humic acids, while ratios smaller than 2.9 suggest microbial degredation. Samples with ratios outside of the acceptable range were excluded from summary statistics.

$\delta^{13}C$ in animals largely reflects the $\delta^{13}C$ values of the plants they consume, particularly the relative contributions of C_3 versus C_4 plants. In the coastal zone, many common forage species follow the C_4 synthetic pathway. These include cordgrasses (*Spartina* spp.), wiregrasses (*Aristida* spp.), and little bluestem (*Schizachyrium scoparium*). The proportions of C_4 forage in the diets of deer were estimated using the equation

$$\%C_4 = \frac{(\delta_c - \delta_3 + \Delta_{dc})}{(\delta_4 - \delta_3)} \text{ x } 100$$

developed by White and Schwarcz (1989). In this equation δ_c is the measured $\delta^{13}C$ value, δ_3 and δ_4 are the empirically derived $\delta^{13}C$ endpoints for C_3 and C_4 plants in the local area, respectively, and Δ_{dc} is the diet–collagen offset (estimated at 5 ‰). Endpoints of -13.7 ‰ for C_4 plants and -28.1 ‰ for C_3 plants were used based on isotopic data from St. Catherines Island, Georgia (Reitsema et al. 2015).

White-tailed deer have small home-ranges, less than 2 km^2 on average (Harestad and Bunnel 1979; Kilgo et al. 1998), therefore their stable isotopic values should reflect the plant $\delta^{13}C$ and $\delta^{15}N$ values within an equally small area. Deer originating on the coast are expected to be enriched in $\delta^{13}C$ and $\delta^{15}N$ compared to inland deer because coastal plants are expected to be enriched relative to inland ones. C_4 plants in general are common in the coastal Southeast. Coastal plants may be further enriched in $\delta^{13}C$ due to the influence of salinity (Stevens et al. 2006). Finally, coastal deer can and will forage in the marsh, incorporating marine plants in their diet. Marine plants are generally higher in both $\delta^{13}C$ and $\delta^{15}N$ than are terrestrial plants.

The Kruskal-Wallis rank sum test, a non-parametric analysis of variance (ANOVA) test, is used to determine if differences exist among regions, followed by post hoc Kruskal Numenyi tests to determine which groups are different. Statistical analyses are conducted using the `kruskal.test()`and `posthoc.kruskal.nemenyi.test()`functions in the ‘pmcmr’ package version 1.1 (Pohlert 2014) for R (R Core Team 2014).

Bone subsamples from 13 of the coastal specimens were submitted to the Massachusetts Institute of Technology (MIT) stable isotope lab for $^{87}Sr/^{86}Sr$ analysis via the TIMS system. Data are reported to the nearest 0.0001‰, with analytical precision of ± 0.00001. Following Slater et al. (2014), I defined the baseline range for Gulf Coast $^{87}Sr/^{86}Sr$ values based on the mean and 2σ range of the 13 data points. Outliers within the dataset (samples outside of the baseline range) are considered potentially non-local.

Chapter Summary

The goal of this research is to investigate broad patterns in subsistence/settlement systems and economies in relation to the landscape of the northern Gulf Coast at two spatiotemporal scales. The first scale focuses on a single locale on the Florida Panhandle over the span of ca. 800 years. For this portion of the study, zooarchaeological identification and quantification of the East Peninsula sequence provide evidence for coastal subsistence, site seasonality, and status differentiation within the context of the Harrison and Hare Hammock ring middens. The second scale is a comparative synthesis of zooarchaeological data from the Mobile Delta, Florida Panhandle, and Big Bend regions of the northern Gulf of Mexico. This regional dataset also is used to document patterns of fisheries health, site seasonality, and resource use over several millennia. Finally, the deer isotope pilot study focuses on the human-mediated movement of commodities between the coast and the interior. This dataset complements the site seasonality data to provide another perspective on coastal/inland mobility and interaction.

Table 3.1. Radiocarbon Dates from the Harrison and Hare Hammock Sites.

Lab ID	Material	^{14}C Age ± 2σ, yr BP	δ^{13}C, o/oo	Cal Age ± 2σ	Reference
Mitchell River 1 (8WL1278)					
BETA-139264	Soot	6260 ± 40	-25.2	5340 ± 60 BC	Mikell and Saunders 2007:Table 3
BETA-143030	Charcoal	5950 ± 70	-26.1	4840 ± 90 BC	Mikell and Saunders 2007:Table 3
WK-9645	Charcoal	4178 ± 48	-25.5	2760 ± 80 BC	Mikell and Saunders 2007:Table 3
WK-9648	Charcoal	3878 ± 48	-25.3	2360 ± 80 BC	Mikell and Saunders 2007:Table 3
WK-9689	Charcoal	3523 ± 49	-25.9	1850 ± 70 BC	Mikell and Saunders 2007:Table 3
BETA-139437	Charcoal	3390 ± 80	-25.0	1700 ± 100 BC	Mikell and Saunders 2007:Table 3
Meig's Pasture (8OK102)					
BETA-21253	Shell, fighting conch	4100 ± 80	-1.0[a]	1880 ± 390 BC[d]	Curren 1987:Table 32
BETA-21254	Shell, fighting conch	4070 ± 80	-1.0[a]	1840 ± 390 BC[d]	Curren 1987:Table 32
BETA-21255	Shell, fighting conch	4030 ± 90	-1.0[a]	1790 ± 390 BC[d]	Curren 1987:Table 32
Hawkshaw (8ES1287)					
BETA-9410	Charcoal	1950 ± 60	—[b]	50 ± 70 BC	Bense 1985:Table 15
BETA-12575	Charcoal	1950 ± 50	—[b]	50 ± 60 BC	Bense 1985:Table 15
BETA-9411	Charcoal	1790 ± 60	—[b]	AD 240 ± 80	Bense 1985:Table 15
BETA-12578	Charcoal	1770 ± 70	—[b]	AD 260 ± 90	Bense 1985:Table 15
BETA-12576	Charcoal	1750 ± 70	—[b]	AD 280 ± 90	Bense 1985:Table 15
BETA-12574	Charcoal	1730 ± 60	—[b]	AD 300 ± 70	Bense 1985:Table 15
BETA-12573	Charcoal	1700 ± 60	—[b]	AD 340 ± 80	Bense 1985:Table 15
BETA-12577	Charcoal	1690 ± 60	—[b]	AD 350 ± 80	Bense 1985:Table 15
Plash Island (1BA134)					
BETA-230752	Nut shell	1670 ± 40	-24.7	AD 370 ± 60	Price 2008:Table 6-2
BETA-230749	Nut shell	1640 ± 40	-21.4	AD 420 ± 60	Price 2008:Table 6-2
BETA-235011	Nut shell	1600 ± 40	-25.6	AD 470 ± 50	Price 2008:Table 6-2
BETA-235009	Nut shell	1550 ± 40	-28.7	AD 500 ± 50	Price 2008:Table 6-2
UGAMS-13921	Bone collagen, deer	1550 ± 20	-21.6	AD 490 ± 40	Reitz et al. 2013:Table 21
BETA-230753	Nut shell	1510 ± 40	-25.4	AD 540 ± 60	Price 2008:Table 6-2
BETA-235007	Nut shell	1500 ± 40	-28.5	AD 550 ± 60	Price 2008:Table 6-2
BETA-230750	Nut shell	1460 ± 40	-26.5	AD 600 ± 40	Price 2008:Table 6-2
BETA-230754	Nut shell	1460 ± 40	-25.2	AD 600 ± 40	Price 2008:Table 6-2
BETA-230755	Nut shell	1450 ± 40	-25.0	AD 600 ± 40	Price 2008:Table 6-2
UGAMS-13923	Bone collagen, deer	1450 ± 20	-22.0	AD 610 ± 20	Reitz et al. 2013:Table 21
UGAMS-13922	Bone collagen, deer	1420 ± 20	-21.9	AD 630 ± 30	Reitz et al. 2013:Table 21
BETA-235008	Nut shell	1400 ± 40	-26.1	AD 630 ± 30	Price 2008:Table 6-2
BETA-235010	Nut shell	1380 ± 40	-25.7	AD 650 ± 30	Price 2008:Table 6-2
UGAMS-13931,	Bone collagen, deer	590 ± 25	-22.4	AD 1350 ± 30	Reitz et al. 2013:Table 21
Shell Mound (8LV42)					
BETA-321182	Charcoal	1530 ± 30	-25.8	AD 520 ± 50	Sassaman et al. 2012:Appendix B
BETA-321184	Charcoal	1480 ± 30	-26.6	AD 590 ± 30	Sassaman et al. 2012:Appendix B
BETA-321185	Charcoal	1440 ± 30	-25.7	AD 620 ± 20	Sassaman et al. 2012:Appendix B
BETA-321183	Charcoal	1420 ± 30	-24.6	AD 630 ± 20	Sassaman et al. 2012:Appendix B
BETA-321186	Charcoal	1340 ± 30	-25.5	AD 680 ± 30	Sassaman et al. 2012:Appendix B
Harrison Ring Midden (8BY1359)					
BETA-315539	Shell, lightning whelk	1840 ± 30	1.1	AD 550 ± 50[e]	SEAC 2015
BETA-333530	Shell, lightning whelk	1770 ± 30	1.0	AD 620 ± 40[e]	SEAC 2015

Table 3.1. Radiocarbon Dates from the Harrison and Hare Hammock Sites. (cont.)

Lab ID	Material	^{14}C Age ± 2σ, yr BP	δ^{13}C, o/oo	Cal Age ± 2σ	Reference
Harrison Ring Midden cont.)					
BETA-333532	Soot	1550 ± 30	-24.5	AD 500 ± 40	SEAC 2015
BETA-306017	Charcoal	1460 ± 30	-27.1	AD 600 ± 30	SEAC 2015
BETA-316479	Bone collagen, turtle	1410 ± 30	-19.8	AD 630 ± 20	SEAC 2015
BETA-333531	Bone collagen, turkey	1320 ± 30	-19.2	AD 700 ± 40	SEAC 2015
BETA-305253	Bone collagen, turtle	1290 ± 30	-18.7	AD 720 ± 40	SEAC 2015
BETA-305252	Bone collagen, turtle	1120 ± 30	-18.7	AD 930 ± 40	SEAC 2015
Mack Bayou (8WL101)					
BETA-207131	Charcoal	1480 ± 70	—[c]	AD 560 ± 70	Mikell 2012:Table 1
BETA-204669	Charcoal	1430 ± 80	—[c]	AD 600 ± 80	Mikell 2012:Table 1
BETA-204156	Charcoal	1260 ± 60	—[c]	AD 770 ± 70	Mikell 2012:Table 1
Bayou St. John (1BA21)					
BETA-208097	Carbonized wood	1650 ± 40	—[c]	AD 400 ± 60	Price 2009:Table 5-4
BETA-208095	Carbonized wood	1580 ± 40	—[c]	AD 480 ± 50	Price 2009:Table 5-4
BETA-208100	Carbonized wood	1570 ± 40	—[c]	AD 490 ± 50	Price 2009:Table 5-4
BETA-251722	Carbonized wood	1310 ± 40	—[c]	AD 710 ± 40	Price 2009:Table 5-4
BETA-208098	Carbonized wood	1300 ± 40	—[c]	AD 720 ± 40	Price 2009:Table 5-4
UGAMS-13927	Bone collagen, bear	1300 ± 20	-19.6	AD 710 ± 30	Reitz et al. 2013:Table 21
BETA-208101	Carbonized wood	1260 ± 40	—[c]	AD 750 ± 60	Price 2009:Table 5-4
BETA-208102	Carbonized wood	1250 ± 40	—[c]	AD 760 ± 60	Price 2009:Table 5-4
UGAMS-13929	Bone collagen, deer	1230 ± 20	-21.6	AD 780 ± 50	Reitz et al. 2013:Table 21
BETA-251729	Carbonized wood	1230 ± 40	—[c]	AD 790 ± 60	Price 2009:Table 5-4
UGAMS-13930	Bone collagen, deer	1220 ± 20	-21.2	AD 810 ± 50	Reitz et al. 2013:Table 21
UGAMS-13928	Bone collagen, deer	1220 ± 20	-21.4	AD 810 ± 50	Reitz et al. 2013:Table 21
BETA-208099	Carbonized wood	1210 ± 40	—[c]	AD 810 ± 60	Price 2009:Table 5-4
UGAMS-8557	Bone collagen, deer	1210 ± 25	-21.18	AD 820 ± 50	Reitz et al. 2013:Table 21
BETA-251724	Carbonized wood	1200 ± 40	—[c]	AD 820 ± 60	Price 2009:Table 5-4
UGAMS-13924	Bone collagen, deer	1190 ± 20	-21.5	AD 830 ± 40	Reitz et al. 2013:Table 21
BETA-251731	Carbonized wood	1190 ± 40	—[c]	AD 830 ± 60	Price 2009:Table 5-4
BETA-208103	Carbonized wood	1170 ± 40	—[c]	AD 860 ± 60	Price 2009:Table 5-4
UGAMS-13932,	Bone collagen, deer	1160 ± 20	-21.16	AD 870 ± 50	Reitz et al. 2013:Table 21
BETA-208096	Carbonized wood	1150 ± 40	—[c]	AD 880 ± 60	Price 2009:Table 5-4
BETA-251725	Carbonized wood	1150 ± 40	—[c]	AD 880 ± 60	Price 2009:Table 5-4
UGAMS-13925	Bone collagen, deer	1130 ± 20	-21.3	AD 930 ± 30	Reitz et al. 2013:Table 21
BETA-208094	Carbonized wood	1130 ± 40	—[c]	AD 910 ± 60	Price 2009:Table 5-4
UGAMS-10140	Bone collagen, deer	1120 ± 25	-21.59	AD 930 ± 40	Reitz et al. 2013:Table 21
BETA-251730	Carbonized wood	1120 ± 40	—[c]	AD 920 ± 60	Price 2009:Table 5-4
BETA-251728	Carbonized wood	1100 ± 40	—[c]	AD 940 ± 50	Price 2009:Table 5-4
BETA-251727	Carbonized wood	1100 ± 40	—[c]	AD 940 ± 50	Price 2009:Table 5-4
BETA-251726	Carbonized wood	1070 ± 40	—[c]	AD 960 ± 40	Price 2009:Table 5-4
BETA-251723	Carbonized wood	1030 ± 40	—[c]	AD 1010 ± 50	Price 2009:Table 5-4
UGAMS-13926	Bone collagen, deer	980 ± 20	-19.7	AD 1070 ± 40	Reitz et al. 2013:Table 21
Hare Hammock Ring Midden (8BY1347)					
BETA-245473	Shell, lightning whelk	1550 ± 50	-0.3	AD 840 ± 70[e]	Russo et al. 2009:Table 17
CAIS-12522	Shell, lightning whelk	1530 ± 25	-1.5	AD 850 ± 50[e]	SEAC 2015
CAIS-12010	Soot	1450 ± 25	-19.1	AD 610 ± 20	SEAC 2015

Table 3.1. Radiocarbon Dates from the Harrison and Hare Hammock Sites. (cont.)

Lab ID	Material	^{14}C Age ± 2σ, yr BP	δ^{13}C, o/oo	Cal Age ± 2σ	Reference
Hare Hammock Ring Midden (cont.)					
PRI-12-110-54.0	Pot residue	1295 ± 15	—[c]	AD 710 ± 30	Yost and Cummings 2012
BETA-197295	Pot residue	1270 ± 40	-22.9	AD 740 ± 50	Russo et al. 2009:Table 17
CAIS-12009	Soot	1230 ± 25	-24.5	AD 790 ± 50	SEAC 2015
CAIS-12012	Soot	1210 ± 25	-22.4	AD 820 ± 50	SEAC 2015
CAIS-12013	Soot	1210 ± 25	-25.2	AD 820 ± 50	SEAC 2015
PRI-12-110-63.0	Pot residue	1205 ± 15	—[c]	AD 820 ± 30	Yost and Cummings 2012
BETA-360014	Bone collagen, deer	1170 ± 30	-21.5	AD 850 ± 50	SEAC 2015
CAIS-12008	Soot	1110 ± 25	-25.1	AD 940 ± 30	SEAC 2015
CAIS-14014	Soot	980 ± 25	-25.0	AD 1070 ± 50	SEAC 2015
CAIS-12011	Soot	850 ± 25	-26.0	AD 1190 ± 30	SEAC 2015
Strange's Ring Midden (8BY1355) and Scatter (8BY1356)					
CAIS 03288	Soot	1320 ± 25	-23.1	AD 700 ± 30	Russo et al 2011:Table 4
CAIS 13322	Bone collagen, deer	1190 ± 20	-20.4	AD 830 ± 40	SEAC 2015
CAIS 13605	Bone collagen, deer	1170 ± 20	-21.8	AD 850 ± 50	SEAC 2015
CAIS 13604	Bone collagen, deer	970 ± 25	-20.8	AD 1080 ± 40	SEAC 2015
Bayview (8BY137)					
BETA-245472	Shell, oyster	1510 ± 40	0.2	AD 890 ± 160[f]	SEAC 2015
BETA-245471	Shell, oyster	1620 ± 60	-1.9	AD 790 ± 170[f]	SEAC 2015
Bottle Creek (1BA2)					
BETA-79681	"Charred material"	1090 ± 70	—[c]	AD 930 ± 80	Brown 2003:Appendix B
BETA-79686	"Charred material"	1030 ± 80	—[c]	AD 1010 ± 100	Brown 2003:Appendix B
BETA-79680	"Charred material"	740 ± 80	—[c]	AD 1260 ± 80	Brown 2003:Appendix B
BETA-79679	"Charred material"	730 ± 60	—[c]	AD 1280 ± 60	Brown 2003:Appendix B
BETA-79683	"Charred material"	720 ± 60	—[c]	AD 1290 ± 60	Brown 2003:Appendix B
BETA-79682	"Charred material"	660 ± 50	—[c]	AD 1330 ± 40	Brown 2003:Appendix B
BETA-71155	"Charred material"	650 ± 60	—[c]	AD 1340 ± 40	Brown 2003:Appendix B
BETA-79685	"Charred material"	630 ± 60	—[c]	AD 1340 ± 40	Brown 2003:Appendix B
BETA-71156	"Charred material"	610 ± 60	—[c]	AD 1350 ± 40	Brown 2003:Appendix B
BETA-71153	"Charred material"	580 ± 60	—[c]	AD 1360 ± 40	Brown 2003:Appendix B
BETA-79684	"Charred material"	560 ± 60	—[c]	AD 1370 ± 40	Brown 2003:Appendix B
BETA-71154	"Charred material"	490 ± 60	—[c]	AD 1420 ± 60	Brown 2003:Appendix B
BETA-71152	"Charred material"	410 ± 60	—[c]	AD 1520 ± 70	Brown 2003:Appendix B

Notes: See Figure 3.4 for phases for each site. Lab ID codes: BETA = Beta Analytic; CAIS = UGAMS = UGA Center for Applied Isotope Studies; PRI = PaleoResearch Institute; WK = University of Waikato. All dates calibrated using Oxcal 4.2 (Bronk Ramsey 2009) with IntCal13 calibration curve, except for shell dates which were calibrated using the Marine13 curve (Reimer et al. 2013). [a]Reported value is assumed, not measured (see Curren 1987:70 for justification); [b]Not measured, no correction applied; [c]Not reported, but correction was applied; [d]ΔR = 257 ± 287 used for *Strombus alatus* from Hadden and Cherkinsky (2015). [e] ΔR value = -9 ± 25 used for *Busycon sinistrum* from Hadden and Cherkinsky (2015); [f]ΔR value has been estimated empirically for oysters for this region, and the value of 0 ± 150 was used to account for the additional uncertainty in marine reservoir effects in oysters.

Table 3.2. Sorting Criteria for Mollusc Non-repeating Elements.

Taxon	**Criteria for Identification**
Conchs (Strombidae), tulips (Fasciolariidae), and whelks (Melongenidae)	Columellae > 50% complete
Moonsnails (Naticidae)	Umbilicus present
Murex (Muricidae)	Siphonal canal present
Other snails (Gastropoda)	Individual > 50% complete
Scallops (*Argopecten* spp.)	Auricle(s) present
Oysters (*Crassostrea virginica*)	Chondrophore present
Other bivalves (Bivalvia)	Umbo > 50% present

Table 3.3. Allometric Values Used to Derive Biomass and Standard Length Estimates.

Faunal Category	**N**	**Y-Intercept**	**Slope (b)**	**r^2**
Specimen Weight (kg) to Body Weight (kg)				
Chondrichthyes	17	1.68	0.86	0.85
Actinopterygii	393	0.90	0.81	0.80
Non-Perciform Fish	119	0.85	0.79	0.88
Lepisosteidae	26	1.13	0.87	0.96
Siluriformes	36	1.15	0.95	0.87
Perciformes	274	0.93	0.83	0.76
Centrarchidae	38	0.76	0.84	0.80
Carangidae	17	1.23	0.88	0.86
Haemulidae	25	0.84	0.82	0.42
Sparidae	22	0.96	0.92	0.98
Sciaenidae	99	0.81	0.74	0.73
Pleuronectiformes	21	1.09	0.89	0.95
Turtle	26	0.51	0.67	0.55
Snake	26	1.17	1.01	0.97
Bird	307	1.04	0.91	0.97
Mammal	97	1.12	0.90	0.94
Shell Weight (g) to Meat Weight (g)				
Gastropoda	135	-0.16	0.92	0.89
Strombus alatus	26	-0.68	0.88	0.86
Neverita duplicata	16	0.38	0.55	0.81
Melongena corona	100	-0.43	0.88	0.79
Busycon sinistrum	100	-0.75	1.14	0.91
Busycotypus canaliculatus	17	-1.07	1.53	0.93
Fasciolaria lilium hunteria	21	-0.86	1.35	0.98
Fasciolaria tulipa	26	0.11	1.00	0.94
Pleuroploca gigantea	42	-0.71	1.15	0.99
Bivalvia	80	0.02	0.68	0.83
Anadara lienosa	62	-1.05	1.24	0.73
Geukensia demissa	100	-0.22	0.80	0.86
Crassostrea virginica	100	-0.77	0.97	0.97
Mercenaria mercenaria	40	-0.50	0.94	0.95
Callinectes sapidus	11	0.99	0.82	0.58
Otolith Breadth (mm) to Standard Length (mm)				
Ariidae	214	1.35	1.06	0.65
Otolith Length (mm) to Standard Length (mm)				
Ariidae	212	1.34	1.03	0.70
Sciaenidae	154	1.48	0.82	0.71
Otolith Thickness (mm) to Standard Length (mm)				
Ariidae	214	1.84	0.85	0.68
Otolith Width (mm) to Standard Length (mm)				
Ariidae	214	1.35	1.10	0.76
Atlas Width (mm) to Standard Length (mm)				
Mugil spp.	55	1.80	0.85	0.96
Sciaenidae	152	1.93	0.61	0.65
Pectoral Spine Pad Width (mm) to Standard Length (mm)				
Ariidae	250	1.55	1.04	0.98

Note: See Figure 3.2 for dimensional measurement points. Formula is $Y = aX^b$; where *Y* is the dimension measured; *X* is the dimension being estimated; *a* is the *Y*-intercept; *b* is the slope of the line; and *N* is the number of observations (Colaninno 2010:477; Hale et al. 1987; Quitmyer 1985:40; Quitmyer and Reitz 2006; Reitz et al. 1987; Reitz and Wing 2008:68). Invertebrate estimates are converted to kilograms in the species lists.

Table 3.4. Trophic Levels (TL) and Intrinsic Vulnerability Index (VI) Values.

Taxa	**Common Name**	**TL**	**VI**
Pleurocera canaliculata	Silty hornsnail	2.1	—
Elimia hydei	Gladiator elimia	2.1	—
Turbo castanea	Chestnut turban	2.5	—
Neritidae	Nerites	2.1	—
Neritina reclivata	Olive nerite	2.1	—
Neritina spp.	Nerites	2.1	—
Littorina irrorata	Marsh periwinkle	2.1	—
Littorina spp.	Periwinkles	2.1	—
Modulus cf. *modulus*	Button snail	2.1	—
Modulus modulus	Button snail	2.1	—
Cerithium atratum	Dark cerith	2.1	—
Cerithium eburneum	Ivory cerith	2.1	—
Cerithium spp.	Ceriths	2.1	—
Seila adamsi	Seila	2.1	—
Crepidula aculeata	Spiny slippersnail	2.1	—
Crepidula fornicata	Atlantic slippersnail	2.1	—
Crepidula spp.	Slippersnails	2.1	—
Strombus alatus	Florida fighting conch	2.1	—
Naticidae/*Neverita*/*Polinices*	Moonsnails	2.5	—
Muricidae	Rock snails and murexes	2.5	—
Chicoreus cf. *pomum*	Apple murex	2.5	—
Chicoreus spp.	Murex	2.5	—
Thais haemastoma floridana	Florida rock snail	2.5	—
Urosalpinx cinerea	Atlantic oyster drill	2.5	—
Urosalpinx perrugata	Gulf oyster drill	2.5	—
Urosalpinx tampaensis	Tampa oyster drill	2.5	—
Eupleura sulcidentata	Thick lipped oyster drill	2.5	—
Anachis floridana	Dove shell	2.5	—
Anachis spp.	Dove shell	2.5	—
Melongena corona	Crown conch	2.5	—
Busycon sinistrum	Lightning whelk	2.5	—
Busycotypus canaliculatus	Channeled whelk	2.5	—
Busycotypus spiratus	Pear whelk	2.5	—
Busycotypus spp.	Whelks	2.5	—
Nassarius vibex	Bruised nassa	2.5	—
Fasciolariidae	Spindles, tulips, and latiruses	2.5	—
Fasciolaria lilium	Banded tulip	2.5	—
Fasciolaria spp.	Tulips	2.5	—
Fasciolaria tulipa	True tulip	2.5	—
Pleuroploca gigantea	Horse conch	2.5	—
Olividae	Olives	2.5	—
Marginella apicina	Atlantic marginella	2.1	—
Marginella spp.	Marginellas	2.1	—
Boonea impressa	Impressed odostome	2.5	—
Melampus bidentatus	Common marsh snail	2.1	—
Anadara ovalis	Blood ark	2.1	—

Table 3.4. Trophic Levels (TL) and Intrinsic Vulnerability Index (VI) Values. (cont.)

Taxa	**Common name**	**TL**	**VI**
Anadara spp.	Arks	2.1	—
Noetia ponderosa	Ponderous ark	2.1	—
Mytilidae	Saltwater mussels	2.1	—
Brachiodontes exustus	Scorched mussel	2.1	—
Geukensia demissa	Ribbed mussel	2.1	—
Chlamys spp.	Scallops	2.1	—
Argopecten irradians	Bay scallop	2.1	—
Argopecten spp.	Bay and callico scallops	2.1	—
Ostrea equestris	Crested oyster	2.1	—
Ostreidae	Oysters	2.1	—
Crassostrea virginica	Eastern oyster	2.1	—
Lopha frons	Frons oyster	2.1	—
Chamidae	Jewelboxes	2.1	—
Fusconaia ebena	Ebonyshell	2.1	—
Quadrula apiculata	Southern mapleleaf	2.1	—
Quadrula spp.	Mapleleafs	2.1	—
Unionidae	Freshwater mussels	2.1	—
Cardiidae	Cockles and pricklycockles	2.1	—
Dinocardium robustum	Atlantic giant cockle	2.1	—
Trachycardium egmontianum	Florida pricklycockle	2.1	—
Trachycardium muricatum	Yellow pricklycockle	2.1	—
Trachycardium spp.	Pricklycockles	2.1	—
Mactra fragilis	Fragile surf clam	2.1	—
Spisula solidissima	Atlantic surf clam	2.1	—
Rangia cuneata	Atlantic rangia	2.1	—
Tellina spp.	Tellins	2.1	—
Donax variabilis	Coquina	2.1	—
Polymesoda carolina	Carolina marsh clam	2.1	—
Chione cancellata	Cross-barred venus	2.1	—
Mercenaria spp.	Quahog	2.1	—
Macrocallista nimbosa	Sunray venus	2.1	—
Dosinia discus	Disk dosinia	2.1	—
Cyrtopleura costata	Angelwing	2.1	—
Pholadidae	Angelwings	2.1	—
Decapoda/Brachyura	Crabs	2.6	—
Callinectes sapidus	Blue crab	2.6	—
Menippe spp.	Stone crabs	2.6	—
Menippe mercenaria	Florida stone crab	2.6	—
Chondrichthyes	Indeterminate cartilaginous fishes	3.2	60
Squaliformes	Dogfish sharks	4.0	60
Carcharinidae	Requiem sharks	4.0	60
Carcharhinus spp.	Requiem sharks	4.0	60
Sphyrinidae	Hammerhead sharks	4.0	60
Rajiformes	Skates and rays	3.2	60
Dasyatidae	Stingrays	3.2	60
Myliobatiformes	Rays	3.2	60

Table 3.4. Trophic Levels (TL) and Intrinsic Vulnerability Index (VI) Values. (cont.)

Taxa	**Common name**	**TL**	**VI**
Myliobatidae	Eagle rays	3.2	60
Rhinoptera bonasus	Cownose ray	3.2	60
Acipenseridae	Sturgeons	3.4	85
Acipenser oxyrhynchus	Atlantic sturgeon	3.4	85
Lepisosteidae/*Lepisosteus*	Gars	4.2	80
Amia calva	Bowfin	3.8	50
Anguilla rostrata	American eel	3.7	67
Elops saurus	Ladyfish	3.5	38
Clupeidae	Herring, menhadens, and shads	2.6	30
Alosa spp.	Shad	3.8	51
Alosa mediocris	Hickory shad	4.1	41
Brevoortia spp.	Yellowfin menhaden	2.3	30
Opisthonema oglinum	Threadfin herring	4.5	24
Engraulidae	Anchovies	3.4	15
Notemigonus spp.	Golden shiner	2.7	31
Siluriformes	Catfishes	3.0	40
Ictaluridae	North American freshwater catfishes	2.6	39
Ariidae	Sea catfishes	3.3	42
Ariopsis felis	Hardhead catfish	3.2	42
Bagre marinus	Gafftopsail catfish	3.5	41
Opsanus spp.	Toadfishes	3.7	50
Mugil spp.	Mullets	2.5	53
Mugil cephalus	Grey mullet	2.5	53
Belonidae	Needlefishes	3.2	63
Strongylura spp.	Needlefishes	3.2	63
Cyprinodontidae	Killifishes and pupfishes	3.3	13
Fundulus spp.	Killifishes	3.4	10
Fundulus grandis	Gulf killifish	3.4	10
Triglidae	Searobins	4.1	10
Prionotus spp.	Searobins	4.1	10
Centrarchidae	Sunfishes	3.4	35
cff. *Ambloplites* spp.	Shadow bass	3.4	16
Lepomis spp.	Sunfishes	3.3	20
Lepomis auritus	Redbreast sunfish	3.2	37
Lepomis macrochirus	Bluegill	3.2	33
Lepomis microlophus	Redear sunfish	3.4	22
Micropterus spp.	Black basses	3.8	45
Micropterus salmoides	Largemouth bass	3.8	45
Pomoxis nigromaculatus	Black crappie	3.8	53
Pomatomus saltatrix	Bluefish	4.5	58
Coryphaena spp.	Dolphinfishes and dorados	4.4	49
Carangidae	Jacks, permits, and pompanos	3.9	44
Caranx spp.	Jacks	4.2	55
Caranx crysos	Blue runner	4.1	34
Caranx hippos	Crevalle jack	3.6	52
Caranx latus	Horse-eye jack	4.2	55

Table 3.4. Trophic Levels (TL) and Intrinsic Vulnerability Index (VI) Values. (cont.)

Taxa	**Common name**	**TL**	**VI**
Chloroscombrus chrysurus	Atlantic bumper	3.5	29
Selene vomer	Lookdown	4.3	26
Trachinotus spp.	Pompanos	3.5	36
Lutjanus spp.	Snappers	4.3	44
Haemulidae	Grunts	3.4	42
Orthopristis chrysoptera	Pigfish	3.4	42
Sparidae	Porgies	3.4	33
Archosargus probatocephalus	Sheepshead	3.5	36
Calamus spp.	Porgy	3.7	24
Lagodon rhomboides	Pinfish	4.4	34
Sciaenidae	Drums	3.7	42
Aplodinotus grunniens	Freshwater drum	3.4	37
Bairdiella chrysoura	Silver perch	3.2	21
Cynoscion spp.	Seatrouts and corvinas	4.1	44
Cynoscion arenarius	Sand seatrout	4.2	36
Cynoscion nebulosus	Spotted seatrout	4.0	58
Cynoscion nothus	Silver seatrout	4.0	38
Larimus fasciatus	Banded drum	3.6	16
Leiostomus xanthurus	Spot	3.2	29
Menticirrhus spp.	Kingfishes	3.6	26
Menticirrhus littoralis	King croaker	3.9	26
Micropogonias undulatus	Atlantic croaker	4.0	34
Pogonias cromis	Black drum	3.9	62
Sciaenops ocellatus	Red drum	3.7	43
Stellifer lanceolatus	Stardrum	3.5	10
Trichiuridae	Cutlass fishes	4.4	51
cf. *Scomberomorus* spp.	Mackerels	4.4	69
Peprilus spp.	Harvest fishes	4.1	16
Paralichthyidae	Sand flounders	3.5	35
Paralichthys spp.	Sand flounders	3.5	35
cf. Mullidae	Goat fishes	3.4	23
Ostraciidae	Boxfishes, cowfishes, and trunkfishes	3.0	32
Diodontidae	Porcupinefish	3.5	15
Chilomycterus schoefii	Striped burrfish	3.5	15
Diodon spp.	Porcupinefish	3.5	15
Tetraodontidae	Pufferfish	3.5	21
Sphoeroides spp.	Pufferfish	3.5	21

Note: Values from FishBase 2014 (Froese and Pauly 2014).

Table 3.5. Summary of Archaeological Sites and Faunal Assemblages in Regional Dataset.

Map ID	Site Name	Site Number	Period	Screen Size, mm	Wt., g	Biomass, kg	Reference
1	Mitchell River 1	8WL1278	Late Archaic	1.59	35,264.503	7.50	Mikell and Saunders 2007:Table 6
2	Meig's Pasture	8OK102	Late Archaic	1.59	27,757.80	4.61	Curren 1987:Tables 14-17
3	Hawkshaw	8ES1287	Early Woodland	1.59	108,224.19	35.61	Bense 1985:Appendix IV Tables L, M, N
4	Plash Island	1BA134	Middle Woodland	1.59	56,790.001	25.69	Reitz et al. 2013:Table 7
5	Shell Mound	8LV42	Archaic–Woodland	3.18	38,308.10	6.68	Palmiotto 2012:Tables 4.2–4.8
6	Harrison Ring Midden	8BY1359	Middle Woodland	3.18	11,616.145	10.62	This dissertation:Table 4.2
7	Mack Bayou	8WL101	Late Woodland	1.59	28,786.923	22.03	Mikell 2012:Table 3
8	Hare Hammock Ring Midden	8BY1347	Late Woodland	3.18	45,029.888	27.50	This dissertation:Table 4.21
9	Bayou St. John	1BA21	Late Woodland	3.18	56,794.405	47.91	Reitz et al. 2013:Table 12
10	Strange's Ring Midden	8BY1355	Late Woodland	3.18	4,359.164	4.24	Little 2015:Table 4
11	Bayview	8BY137	Late Woodland	1.59	11,635.570	4.17	Russo et al. 2006:Table 7.1 and 7.2
12	Bottle Creek	1BA2	Mississippian	1.59	9,754.865	3.85	Quitmyer 2003:Tables 7.3, 7.7, 7.8

Note: See Figure 3.3 for site locations. See text for explanations of discrepancies between total weights reported here and those in original references.

Table 3.6. Summary of Archaeological Samples Included in Deer Isotope Study.

Map ID	Site Name	Site Number	Period	Region	Sample Size	Facility	Reference
1	Mission Refugio	41RF1	Colonial	Texas coast	3	a	Hard and Katzenberg 2011
2	Olmos Dam	41BX1	Late Archaic	Texas inland	3	a	Hard and Katzenberg 2011
3	Leonard K	41AU37	Middle Archaic–Late Prehistoric	Texas inland	3	a	Hard and Katzenberg 2011
4	Corps site	1CK56	Late Woodland	Delta	4	b	Reitz et al. 2013
5	Plash Island	1BA134	Middle Woodland	Panhandle	4	b	Reitz et al. 2013
6	Bayou St. John	1BA21	Late Woodland	Panhandle	9	b	Reitz et al. 2013
7	Hare Hammock Ring Midden	8BY1347	Late Woodland	Panhandle	3	b	This study
8	Harrison Ring Midden	8BY1359	Middle Woodland	Panhandle	1	b	This study
9	Strange's Ring Midden	8BY1355	Late Woodland	Panhandle	1	c	This study
10	Bird Hammock	8WA30	Late Woodland	Big Bend	4	c	This study
11	Mound Field	8WA8	Late Woodland	Big Bend	2	c	This study
12	Singer-Moye	9SW2	Mississippian	Georgia inland	3	b	This study
13	St. Catherines Island	9LI21; 9LI207; 9LI229; 9LI230; 9LI637; 9LI8; 9LI274; AMNH680	Late Archaic–Colonial	Georgia coast	26	d	Bergh 2012

Note: See Figure 3.4 for site location. Sample size refers to the number of deer specimens analyzed for stable isotopes from each site. Facility codes: a = Isotope Science Lab, University of Calgary; b =UGA Center for Applied Isotope Studies; c = BETA Analytic; d = Odum School of Ecology Stable Isotope Lab, University of Georgia.

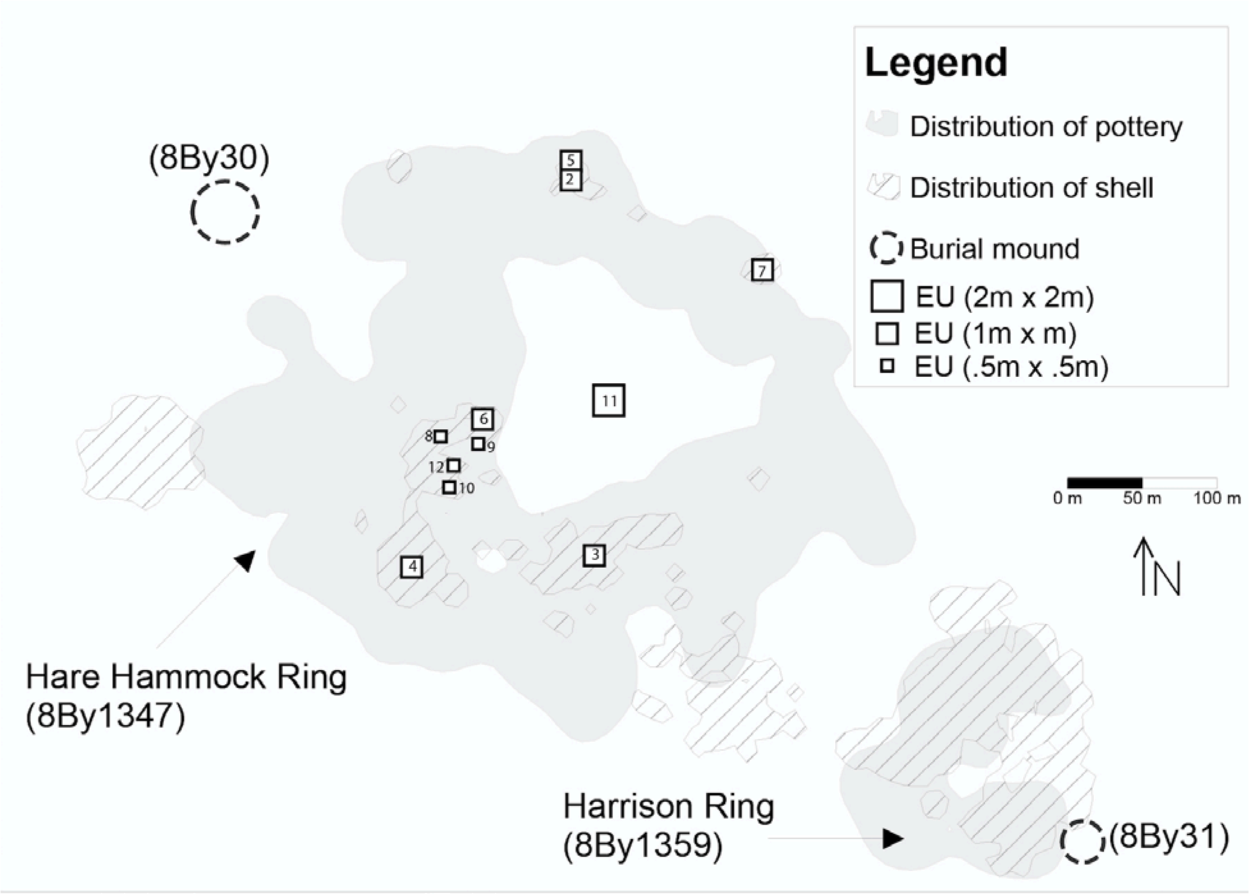

Figure 3.1. Plan view of Harrison and Hare Hammock Ring Middens.

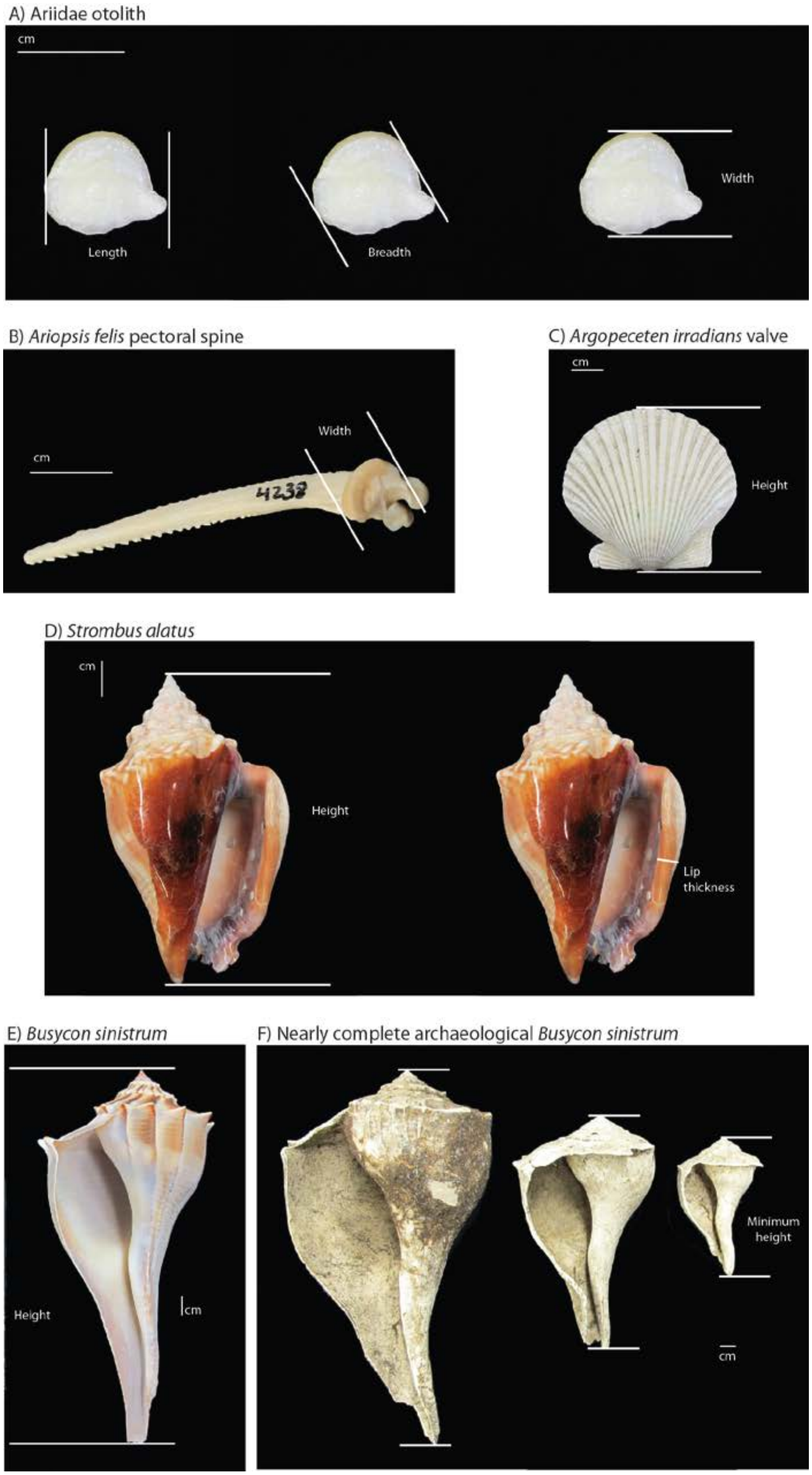

Figure 3.2 Morphometric landmarks.

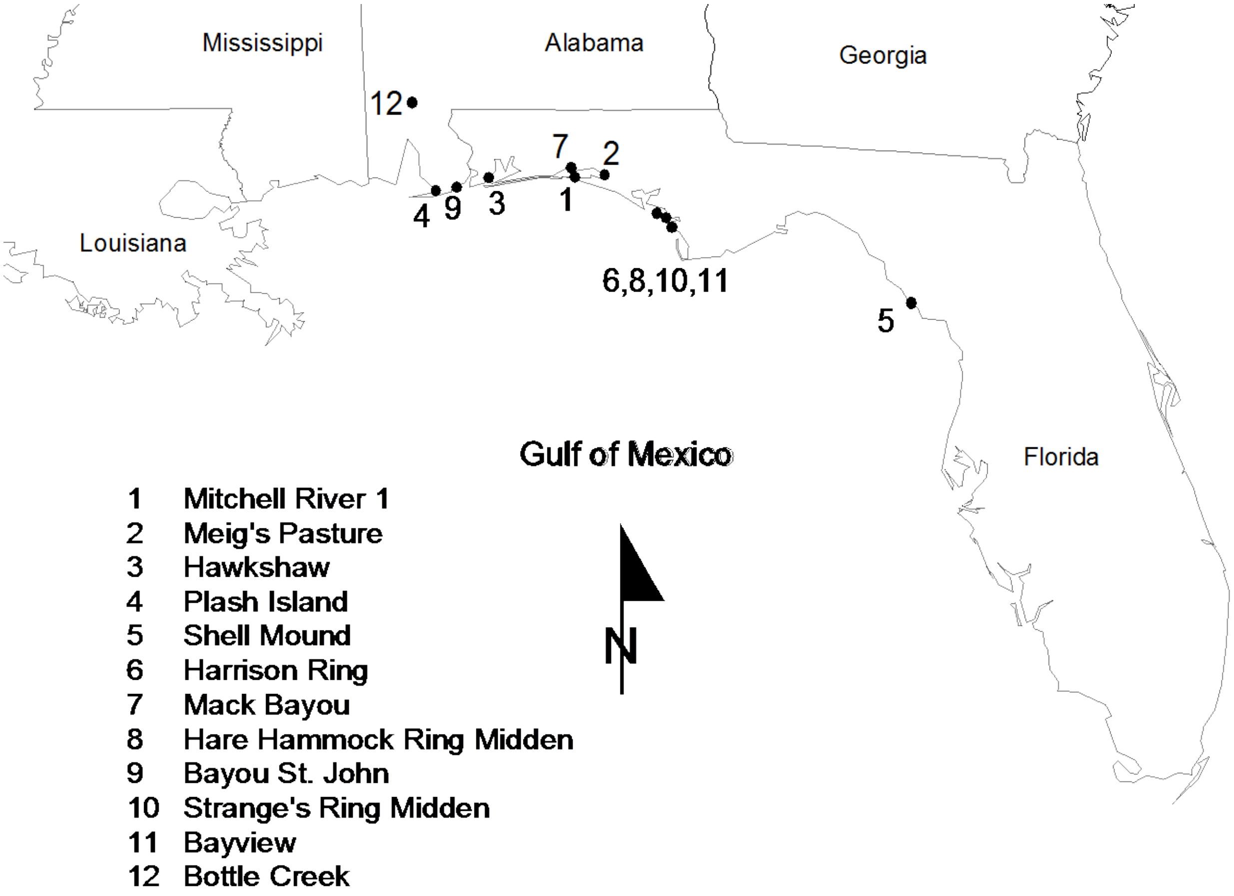

Figure 3.3. Sites included in regional zooarchaeological synthesis.

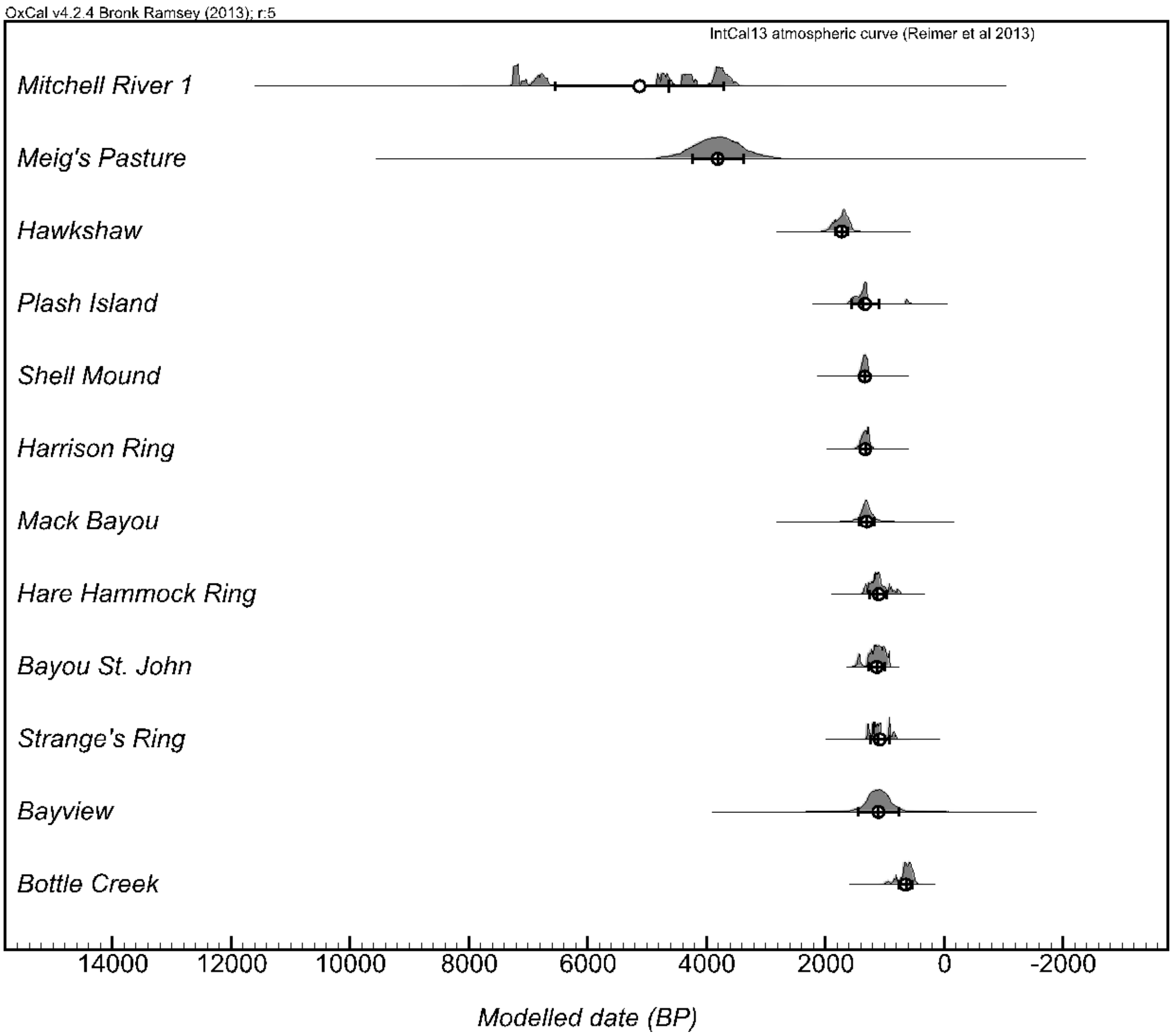

Figure 3.4. Summed probabilities and median radiocarbon ages for sites included in regional dataset.

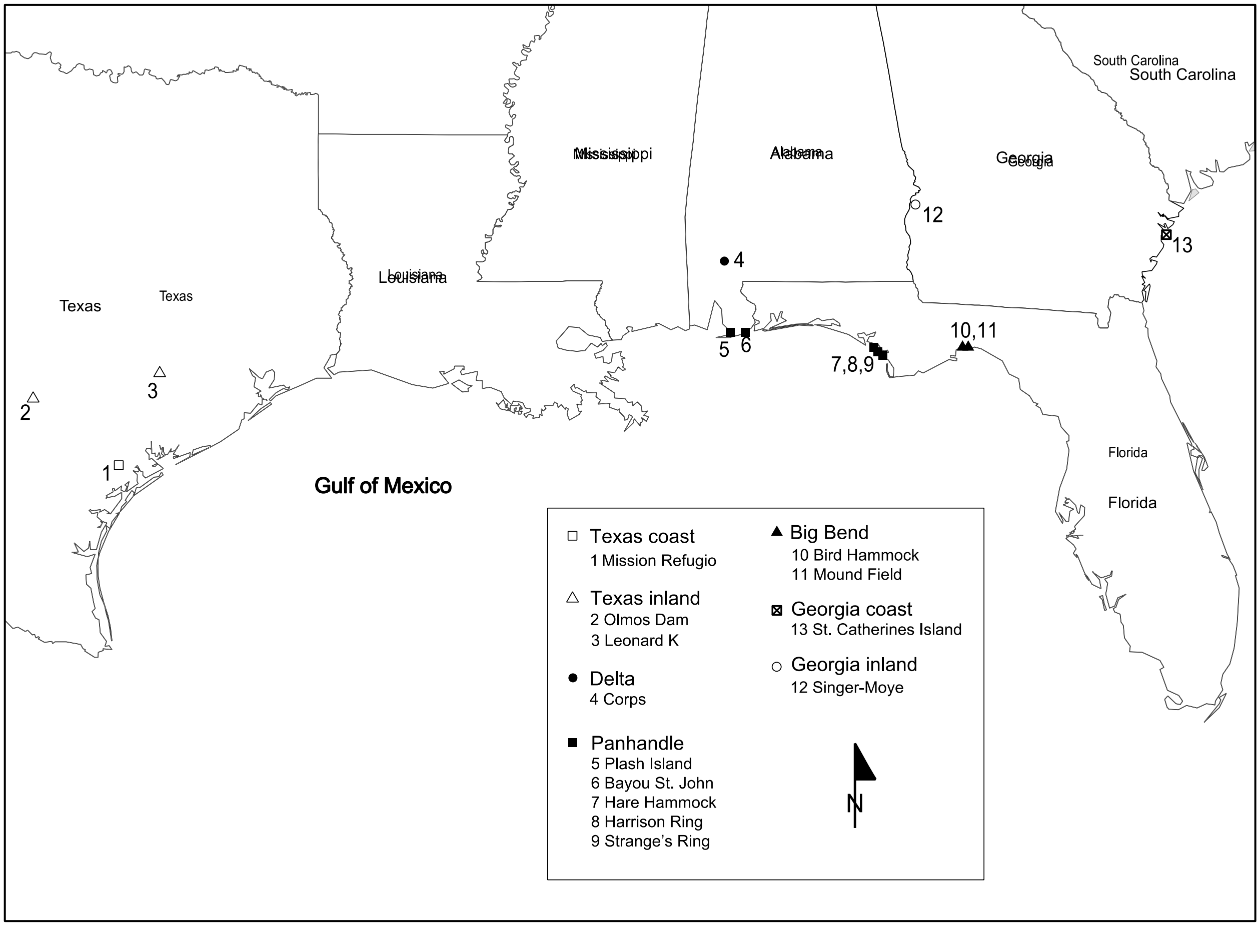

Figure 3.5. Sources of deer bone specimens included in stable isotope study.

CHAPTER 4:

RESULTS

This chapter presents the results in three major sections that correspond to the major sections outlined in Chapter 3: the East Peninsula Dataset, the Regional Dataset, and the Deer Stable Isotope Study.

Zooarchaeological Results: East Peninsula Dataset

This section presents the zooarchaeological results of the East Peninsula dataset as six analytical units. These correspond to the four spatiotemporal analytical units (Harrison, Hare Hammock Early, Hare Hammock Late, and Hare Hammock House Mound), the Hare Hammock Aggregated (3.18-mm) dataset, and the Hare Hammock Aggregated (6.35-mm) dataset. Data from the Hare Hammock Early, Late, or House Mound units are included in the aggregated datasets. Summary data for all six analytical units are presented in Table 4.1.

The Harrison Ring Midden

The Harrison Ring assemblage consists of 17,097 specimens representing a minimum of 807 individuals. The sample includes 11.6 kg of bone and shell, and an estimated 10.6 kg of biomass (Table 4.2). The total assemblage is characterized by high taxonomic richness and diversity, and moderately high equitability (Table 4.1). Major resources in the Harrison Ring assemblage are dominated by shellfishes: bay scallops (*Argopecten* spp.) and lightning whelks (*Busycon sinistrum*). Minor resources include fighting conchs (*Strombus alatus*), pear whelks (*Busycotypus spiratus*), true tulips (*Fasciolaria tulipa*), horse conchs (*Pleuroploca gigantea*), marginellas (*Marginella apicinum*), mullets (*Mugil* spp.), and white-tailed deer (*Odocoileus virginianus*).

Non-commensal molluscs dominate the assemblage, accounting for 70 percent of MNI and 62 percent of biomass (Table 4.3). Thirteen of the non-commensal molluscan taxa are gastropods, eight are bivalves, and one is an indeterminate species of crab. Gastropods contribute more MNI, and far more biomass, than do bivalves. The dominant gastropods are Atlantic slippersnails (*Crepidula fornicata*) and lightning whelks, and the dominant bivalves are scallops. Commensal invertebrates include five genera of terrestrial snails and one barnacle genus. Shellfishing was relatively specialized, as indicated by the low diversity and equitability values (Table 4.1). Shellfish measurements (Figure 3.2) are reported in Appendix B, and valve heights (VH) and shell heights (SH) for complete bay scallops, fighting conchs, and lightning whelks are presented in Table 4.4. On average, complete fighting conchs are slightly larger than are complete lightning whelks, although a larger range of lightning whelk sizes is observed. The complete lightning whelks in this sample are relatively small individuals of the species.

Non-commensal vertebrates, which include fishes, birds, reptiles, and mammals, contribute 15 percent of the individuals and 48 percent of biomass (Table 4.3). Twenty-eight of the non-commensal vertebrate taxa are fishes and ten are reptiles, birds, and mammals (Table 4.2). Fishes alone contribute 14 percent of individuals and 30 percent of biomass. Mullets are the dominant fish taxon, followed by toadfishes (*Opsanus* spp.) and black drums (*Pogonias cromis*). The drum family (Sciaenidae) is represented by six species, which together contribute 4 percent of individuals and 4 percent of biomass. The fishing strategy was less specialized (more generalized) than the shellfishing strategy. Fishing targeted a more diverse suite of animals, and these were used more evenly than were shellfish taxa (Table 4.1). Fishing targeted relatively high trophic levels, although the mean trophic level of the total fishery was much lower due to the abundance of low-TL invertebrates (Table 4.1). The fishing strategy had a low mean VI in terms of MNI, but higher in terms of biomass, indicating that most of the individual fishes had low intrinsic vulnerabilities, but individuals with higher intrinsic vulnerabilities contributed more biomass.

Vertebrate measurements are presented in Appendix B, and fish Standard Length estimates are presented in Table 4.4. Mullet size ranges from 179 mm to 285 mm in SL with an average of 250 mm, estimated from atlas width, and are therefore classified as “large” fish in Table 4.5. Sea catfishes range in size from 88 mm to 259 mm in SL, with an average SL of 138 mm (pectoral spine pad width), and are therefore classified as “small” fish (Table 4.5). In terms of MNI, fishes classified as small- and large-bodied are represented approximately equally, with slightly more small fishes, although large-bodied fishes dominate the assemblage in terms of biomass (Table 4.5). Overall, slightly more mass-captured fishes are present than are individually captured ones, but the two fishing strategies contributed equal percentages of biomass (Table 4.6).

Deer contribute less than 1 percent of individuals but over 13 percent of biomass. Deer specimens identified in the Harrison assemblage are summarized in Table 4.7 and Figure 4.1. The majority (55 percent) of deer specimens are from the head, and another 41 percent are from the foot and hindfoot. One specimen (5 percent) is from the hindquarter. Degree of epiphyseal fusion could only be determined for one specimen, a fused proximal metatarsal. This element fuses before birth in deer. Teeth are unworn, indicating a young animal. No determination of deer sex can be made from the identified specimens.

Modifications are observed on 1,755 specimens, or about 11 percent of all vertebrate NISP (Table 4.8). By far the most common modification is burning (70 percent of modifications). About 9 percent of all identified fish specimens are burned or calcined, as were 26 percent of reptile specimens, 27 percent of deer specimens, and 22 percent of other mammal specimens. One deer bone, a proximal metatarsal (FS#196; GMNH2660061) was cut. A metatarsal shaft (FS#238; GMNH2660135) had a ground, worked surface.

Hare Hammock Early

The Hare Hammock Early assemblage consists of 18,298 specimens representing 791 individuals. The sample includes 14.6 kg of bone and shell representing 9.9 kg of biomass (Table 4.9). The assemblage has relatively low taxonomic richness, and moderately high diversity and equitability (Table 4.1). The major resources in the Hare Hammock Early assemblage include fighting conchs, lightning whelks, bay scallops, and hardhead catfish (*Ariopsis felis*); minor resources include horse conchs, mullets, spots (*Leiostomus xanthurus*), and deer (Table 4.9). As at Harrison Ring, the constellation of major resources is dominated by shellfish taxa.

Non-commensal molluscs dominate the assemblage in terms of MNI compared to non-commensal vertebrates (Table 4.10). Eleven of the non-commensal mollucan taxa are gastropods and seven are bivalves (Table 4.9). Gastropods contribute more individuals, and far more biomass, than do bivalves (Table 4.10). The dominant gastropods are fighting conchs, lightning whelks, and Atlantic slippersnails, and the dominant bivalves are scallops (Table 4.9). Commensal invertebrates include seven genera of terrestrial snails and one genus of barnacle (Table 4.9). The invertebrate assemblage has low diversity and evenness, indicating a highly specialized shellfishing strategy (Table 4.1). Shell measurements are in Appendix C. Valve heights and shell heights for complete bay scallops and fighting conchs are presented in Table

4.4. No complete lightning whelks are present in this sample. Complete fighting conchs are slightly smaller than the Harrison Ring sample.

Non-commensal vertebrates contribute 14 percent of the individuals and 56 percent of biomass; commensal vertebrates contribute 0.4 percent of individuals and less than 0.1 percent of biomass (Table 4.10). Eighteen of the non-commensal vertebrate taxa are fishes. Fishes contribute 14 percent of individuals, but 48 percent of assemblage biomass (Table 4.10). The dominant fishes are mullets and hardhead catfish. The drum family is represented by four species, which together account for 3 percent of individuals and 1 percent of biomass (Table 4.9). Based on diversity and equitability indices (Table 4.1), the fishing strategy was relatively specialized, though more generalized than the shellfishing strategy, and the mean trophic level of the total fishery and of fishes in particular were low (Table 4.1). Mean vulnerability for fishes is moderately low in terms of both MNI and biomass, as was mean TL (Table 4.1).

Vertebrate measurements are presented in Appendix C, and estimated fish SL values are presented in Table 4.4. Mullets SL range in size from 184 to 414 mm in SL, and are large on average (280 mm in SL estimated from atlas width). Sea catfish are small, with SL ranges from 95 mm to 333 mm, and an average of 211 mm (pectoral spine pad width). Small-bodied, mass-captured fishes dominate the assemblage in terms of both MNI and biomass (Tables 4.5 and 4.6).

Reptiles, birds, and mammals are represented by six taxa. Deer contribute less than 1 percent of individuals but 6 percent of the assemblage biomass. Deer specimens are few, and are summarized in Table 4.11 and Figure 4.2. The majority (67 percent) of deer specimens are from the head, and the remaining 33 percent are from the foot. Two fused distal metapodial condyles are from individual(s) that were at least sub-adults (over 26–29 months of age). Tooth wear is consistent with that of an adult animal.

Modifications are present on 549 specimens, or about 3 percent of all vertebrate specimens (Table 4.12). Over 75 percent of the modifications are burned; the remaining 25 percent are calcined. About 3 percent of all fish specimens are burned or calcined, as are 23 percent of the reptile specimens and 7 percent of other mammal specimens (Table 4.12). No butchery marks or other evidence of modification are observed.

Hare Hammock House Mound

The Hare Hammock House Mound assemblage consists of 10,089 specimens representing 283 individuals. The sample includes 4.3 kg of bone and shell representing about 8.8 kg of biomass (Table 4.13). The assemblage is characterized by relatively low taxonomic richness (Table 4.1). It is highly diverse in terms of MNI, but has low diversity in terms of biomass (Table 4.1). Major resources include scallops and sea catfishes, and are supplemented by a large suite of minor resources, which include fighting conchs, lightning whelks, oysters (*Crassostrea virginica)*, sunray venus, mullets, spots, black drums, and deer (Table 4.13). Non-commensal invertebrates contribute over 50 percent of individuals but only 15 percent of biomass, compared to non-commensal vertebrates, which contribute 43 percent of individuals and 85 percent of biomass (Table 4.14).

Unlike the other analytical units, molluscs are not the dominant source of biomass in the House Mound assemblage. Molluscs are represented by 13 non-commensal gastropods, four species of bivalves, and two species of commensal terrestrial snails (Table 4.13). The shellfishing strategy was relatively more diverse than other analytical units, and shellfish taxa are represented more evenly (Table 4.1). Gastropods contribute 30 percent of individuals and 11 percent of biomass, compared to bivalves, which contribute 23 percent of individuals and 4 percent of biomass (Table 4.14). The most abundant gastropods are slippersnails, fighting conchs, and lightning whelks. The dominant bivalves are scallops and oysters. The relative abundance of oysters is notable (Table 4.13). None of the fighting conchs or lightning whelks could be measured.

Non-commensal vertebrates are dominated by fishes. Fishes are represented by 25 mutually exclusive taxa, and constitute 40 percent of individuals and 72 percent of assemblage biomass (Table 4.14). Fish diversity is moderately low, and fish equitability is moderate, similar to the Hare Hammock Early assemblage. The mean TL and vulnerability of fishes is moderately low (Table 4.1). The dominant fishes by far are hardhead catfish, followed by spots and mullets. The drum family is represented by six species, which together contribute 10 percent of individuals and 5 percent of biomass (Table 4.13).

Vertebrate measurements are presented in Appendix C, and estimated fish SL values are presented in Table 4.4. Mullets are large, with SLs ranging from 227 mm to 279 mm SL as estimated from atlas width, with an average SL of 252 mm (Table 4.4). Sea catfishes are larger than in the other samples in the East Peninsula dataset, ranging from 78 mm to 306 mm with an average of 244 mm (atlas width), but are smaller than the 250 mm threshold for “large” fishes. Small-bodied, mass-captured fishes dominate the assemblage in terms of both MNI and biomass (Tables 4.5 and 4.6), although individually captured fishes are slightly more abundant compared to the Hare Hammock Early assemblage.

Reptiles, birds, and mammals are represented by a total of seven taxa, including one commensal taxon (Table 4.1). Deer contribute less than 1 percent of individuals but 10 percent of biomass. Deer specimens identified in the Hare Hammock House Mound assemblage are summarized in Table 4.15 and Figure 4.3. The majority (71 percent) of deer specimens are from the head, and the remaining 29 percent are from the hindfoot and foot. Degree of epiphyseal fusion could not be determined for any of the identified specimens, nor could sex be determined for any specimens. Tooth wear is consistent with a sub-adult or adult.

Modifications are observed on 1,797 specimens, or 18 percent of all identified vertebrate specimens (Table 4.16). The most common modification is burning (70 percent of modifications). About 17 percent of all fish specimens are burned or calcined, as are 37 percent of reptile specimens. Sixty percent of deer specimens are burned or calcined, and one (7 percent) is hacked. Half of all other mammal specimens are burned or calcined.

Hare Hammock Late

The Hare Hammock Late assemblage consists of 9,032 specimens representing 792 individuals, and 26.1 kg of shell and bone representing 11.5 kg of biomass (Table 4.17). Total diversity is comparatively low, as is equitability (Table 4.1). Non-commensal molluscs dominate the assemblage, accounting for 82 percent of the individuals and 65 percent of the biomass (Table 4.18). In comparison, non-commensal vertebrates contribute 13 percent of individuals and 35 percent of biomass (Table 4.18). Major resources include lightning whelks, fighting conchs, and scallops, which were supplemented by a diversity of minor resources including sunray venus, hardhead catfish, mullets, box turtles (*Terrapene carolina*), and deer.

Non-commensal molluscs are represented by 13 gastropod taxa and eight bivalve taxa, (Tables 4.17). Invertebrate diversity and evenness are low (Table 4.1), indicating a highly specialized shellfishing strategy that was focused on a few taxa. These include fighting conchs, lightning whelks, scallops, and sunray venus. Commensal invertebrates include six genera of land snails and one genus of barnacle (Table 4.17). Shell measurements are listed in Appendix C. Measurable fighting conchs are numerous and slightly smaller than in other samples, but are on average much smaller than lightning whelks. Lightning whelks range from 82 mm to 234 mm SH (Table 4.4).

Non-commensal vertebrates are dominated by fishes, which are represented by 24 taxa (Tables 4.1). Fish diversity is moderate, but fish equitability is moderately high. Mean fish TL is a relatively low (Table 4.6). The dominant fishes are mullets (3 percent of MNI and 3 percent of biomass), followed by hardhead catfish (2 percent of MNI and 4 percent of biomass)(Table 4.21). Drums are represented by five taxa, which contribute less than 2 percent of individuals and 3 percent of biomass (Table 4.21).

Vertebrate measurements are presented in Appendix C, and estimated fish SL values are presented in Table 4.4. In this sample, both mullets and sea catfishes are small (< 250 mm SL). Mullets are categorized as “large” fishes in Table 4.5 nonetheless for the sake of comparison among samples. Mass-captured fishes dominate the assemblage, but large- and small-bodied fishes are represented approximately equally (Tables 4.5 and 4.6).

Together, reptiles, birds, and mammals are represented by eight taxa and account for 1 percent of MNI and 12 percent of biomass (Table 4.18). Deer contribute less than 1 percent of individuals but 7 percent of biomass. Deer specimens are summarized in Table 4.19 and Figure 4.4. Only five specimens are identified, and most (60 percent) are from the foot. Degree of epiphyseal fusion can only be determined for two specimens. The first is a fused proximal metatarsal, which fuses before birth in deer. The second is a fused distal tibia, which indicates the individual was at least 20–23 months at the time of death. Sex can not be determined for any specimens.

A total of 596 modifications are recorded (Table 4.20). The most common modification is burning, which accounts for 82 percent of all modifications. About 6 percent of fish specimens are burned or calcined, as are 13 percent of reptiles, and 40 percent of mammals. Two deer specimens are cut, and two are hacked, but none of the deer specimens are burned or calcined.

Hare Hammock Aggregated (3.18-mm)

The aggregated assemblage includes 37,419 specimens representing 1,802 individuals, and consists of 45 kg of bone and shell representing about 27.6 kg of biomass (Table 4.21). The results are discussed here only briefly, because the aggregate assemblage is in most measures intermediate between the Hare Hammock Early, Late, and House Mound assemblages.

The total assemblage is moderately diverse (Table 4.1). The suite of major resources for the aggregated assemblage consists of lightning whelks, bay scallops, and hardhead catfish, with minor resources that include fighting conchs, horse conchs, mullets, spots, and deer (Table 4.21).

The assemblage is dominated by non-commensal molluscs, particularly gastropods (Table 4.22). Bivalves are major contributors of individuals but not of biomass (Table 4.21). Shellfishing was more specialized than fishing, and focused on a few key resources (Table 4.1). Fishes were second in abundance to molluscs (Table 4.22). Fishes are represented by 29 taxa, including six species of drums (Table 4.21). Overall, the fishing strategy was moderately diverse, with a few taxa contributing to biomass substantially, and many other taxa contributing little to biomass and individuals.

Reptiles are represented by four turtle genera, one species of lizard, and one snake taxon (Table 4.21). Three bird taxa are present, and three species of mammal, including deer. Deer contribute less than 1 percent of individuals and 5 percent of biomass in the aggregated assemblage (Table 4.22).

Hare Hammock Aggregated (6.35-mm)

The Hare Hammock Aggregated (6.35-mm) assemblage includes 8,263 specimens representing 1,830 individuals, and consists of 51.5 kg of bone and shell representing about 24.3 kg of biomass (Table 4.24). The data are presented here to facilitate future comparisons and are not germane to the discussion in the following chapters, except in cases where highly seasonal animals (i.e., sea turtles, Cheloniidae) contribute to the discussion of seasonality of site use.

Gastropods dominate the assemblage (Table 4.25), especially lightning whelks and fighting conchs (Table 4.23). Fishes are represented by 23 taxa, including six species of drums (Table 4.24). The most abundant fishes are hardhead catfish, followed by mullets (Table 4.23). Reptiles are represented by six species of turtle, including sea turtles (Table 4.23). Three bird taxa are present, and five species of mammal, including deer. Deer contribute less than 1 percent of individuals but over 7 percent of biomass (Table 4.24).

Overall, the large-screen (Aggregated 6.35-mm) is less diverse than the fine-screen (Aggregated 3.18-mm) assemblage, and large-bodied animals such as deer and turtles are more abundant (Tables 4.1 and 4.24). The rank order of taxonomic groups remains unchanged: molluscs dominate, followed by fishes, and other animals.

Zooarchaeological Results: Regional Dataset

Species weights and biomass estimates for all 12 assemblages are summarized in Table 4.25. It also includes the ubiquity index of each taxon in the regional dataset. Relative biomass, species richness, diversity, equitability, trophic level, vulnerability, and abundance indices are summarized in Table 4.26. The regional dataset documents 154 mutually exclusive taxa, excluding land snails.

There are marked differences in the taxa present among the archaeological sites, complicating attempts to evaluate temporal trends because temporal and spatial variability are conflated in the regional dataset. Nonetheless, the regional dataset may contribute to an understanding of changes in Gulf Coast fisheries metapopulations over time. A metapopulation is a group of genetically similar local populations that influence each other through reproduction and dispersal (Kritzer and Sale 2004:132). The spatial scales of metapopulations are species-specific, relating to the length of the larval period, the mobility of individuals, and the degree of physical isolation (Shaklee and Bentzen 1998). Several species of interest in this study are genetically homogeneous over large areas of the Gulf of Mexico. These include sea catfishes and toadfishes (Avise et al. 1987), mullets (Crosetti et al. 1993), oysters (Hoover and Gaffney 2005), and scallops (Wilbur et al. 2005). Other taxa, such as busyconine whelks, are not (Berlocher 2000).

Total diversity (H') in the regional dataset ranges from 1.07 (Shell Mound), representing a highly specialized subsistence strategy, to 2.75 (Harrison Ring), a more generalized strategy. There is a statistically significant trend toward increasing diversity over time (Table 4.27 and Figure 4.5). The change is small, however, from 1.62 to 2.39 over a span of 4,700 years (Table 4.26), or an increase of approximately 0.1 per millennium.

The relative abundances of fishes to shellfishes vary widely across sites (Table 4.26). Fishes contribute from 5 to 72 percent of biomass, and shellfishes contribute between 13 and 84 percent of biomass (Table 4.26). Oysters and mullets are present in all studied assemblages (UI = 1.00), albeit in varied abundances. Other high-ubiquity taxa (UI = .92) include ladyfishes (*Elops saurus*), hardhead catfish, seatrouts (*Cynoscion* spp.), Atlantic croakers (*Micropogonias undulatus*), and deer.

The fisheries targeted moderately vulnerable fish taxa, with an overall mean VI of 45–51 (95 percent confidence interval [CI]) across sites. In other words, there is 95 percent confidence that the true VI for pre-European Gulf Coast fisheries is between 45 and 51. The total fishery was not dominated by taxa with high intrinsic vulnerabilities to overfishing. On average, fishes from trophic levels 3.4–3.5 were targeted (95 percent CI) (Table 4.26), which is a high value. Fish TL decreased slightly over time (Table 4.27 and Figure 4.5), from 3.6 to 3.3, or a rate of less than 0.1 TL per millennium. As a point of comparison, Pauly et al. (1998:863) reported a rate of decline in modern commercial fisheries of approximately 0.1 *per decade*.

Invertebrates contribute between 13 and 84 percent of biomass, with an average of 32–61 percent (95 percent CI). Invertebrate assemblages are generally less diverse than are fish assemblages, with an average H’ index of 0.7–1.2 (95 percent CI). However, invertebrate diversity varies widely, from 0.2 (Hawkshaw) to 1.6 (Strange’s Ring).

The four different methods for linking sites within the cluster analysis produce similar results (Figure 4.6). The clusters are based on the relative abundances of the 23 taxa in the regional dataset that contribute at least 2 percent of the biomass in at least one site. All solutions place the following sites together on a major branch of the dendrogram: Mitchell River 1, Meig’s Pasture, Bayview, Hawkshaw, Plash Island, and Shell Mound (Cluster 1). Harrison Ring and Hare Hammock are consistently clustered together also (Cluster 2). Mack Bayou, Bayou St. John, Strange’s Ring cluster together (Cluster 3), with Bottle Creek (Cluster 4) splitting off from Cluster 3 in most solutions (Figure 4.6).

Figure 4.7 is a non-parametric multidimensional scaling (MDS) of the same dataset and depicts the similarity of sites, designated by numbers, and the taxonomic variables that are included in the analysis. In this diagram the physical proximity of points represents the degree of similarity in terms of the input variables. Sites that are similar appear close to one another on the diagram, and sites that are dissimilar plot farther away from each other. Likewise, variables (taxa) with similar distributions plot together, and those with dissimilar distributions plot far apart. Taken together, this diagram visualizes the (dis)similarity of sites and the important variables that contribute to the structure of those groupings. Groups of sites that are identified in the cluster analyses plot together in the ordination, also, lending support to the cluster groupings described above.

Table 4.28 lists the variables and input data that are used in this analysis, along with summary statistics for each of the clusters described above. In all Cluster 1 assemblages oyster is the largest source of biomass. Cluster 2 sites stand apart in terms of the abundances of marine gastropods, especially lightning whelks but also fighting conchs, tulips, and horse conchs. Cluster 3 assemblages generally lack a single dominant taxon (Table 4.28). Cluster 3 assemblages also tend to have more mullet, flounder, and sheepshead than do other assemblages included in the analysis. Finally, the Bottle Creek site (Cluster 4) alone is dominated by rangia clams, with an additional emphasis on gars and deer.

In short, these groupings suggest the following: (1) variability in resource use was patterned; (2) the subsistence strategies at the Harrison and Hare Hammock sites were dissimilar to other sites in the regional dataset; (3) the sites on East Peninsula (Harrison Ring, Hare Hammock, Bayview, and Strange’s Ring) exhibit different subsistence strategies over small geographic scales, and among roughly contemporaneous sites; and (4) the variability may be better conceived as gradients, as visualized in Figure 4.7, rather than discrete groupings such as clusters (Figure 4.6). However, treating them as clusters facilitates the discussion of the social and economic implications of different types of subsistence-related tasks. I will return to these clusters and their implications in Chapter 6.

Deer Stable Isotope Study

The results of the stable isotope analyses are presented in Figure 4.8 and Table 4.29. Deer specimens in this pilot study range from -23.2 to -19.4‰ in δ^{13} (Table 4.29), suggesting the proportion of C_4 plants in deer diets ranged from approximately 69 to 95 percent. δ^{15}N values in deer collagens range from 2.6 to 8.5‰ (Table 4.29). These animals exhibit considerable variability in stable isotopic composition, but the coastal deer are not systematically enriched in either δ^{13}C or δ^{15}N compared to inland deer (Table 4.29 and Figure 4.8).

The majority of the groups overlap, with considerable ranges of values within groups (Figure 4.8). Kruskal-Wallis tests indicate small but statistically significant differences among some groups in terms of δ^{13}C ($p < .01$). The inland Texas group is greater than 1‰ enriched in δ^{13}C compared to the Big Bend ($p = .02$), Georgia coast ($p = .02$), and Delta ($p < .01$) groups, contrary to expectations. The Delta group is 2‰ depleted in δ^{13}C compared to the Texas coast ($p = .04$) group. For δ^{15}N, the inland Georgia group is enriched by 2.5‰ compared to the Big Bend ($p = .05$) and coastal Georgia ($p = .05$) groups, while the Panhandle group also is enriched by 1‰ over the coastal Georgia group ($p = .01$).

Within the Panhandle group ($n = 16$), two isotopic outliers (more than 2σ from the mean) are noted. One is UGAMS13926, which is more enriched in δ^{13}C compared to the rest of the group. The other is UGAMS13925, which is an outlier for ^{87}Sr/^{86}Sr. For the coastal Georgia group, there is one outlier that is enriched in δ^{13}C (specimen # O-05), and another that is enriched in δ^{15}N (specimen # O-23). No other outliers are identified within groups. The results suggest that light stable isotopes do exhibit regional patterning. However, the regional values observed in the pilot study are insufficiently precise for use in sourcing studies. Large samples consisting of a much greater number of individuals would be required for paleodietary, paleoecological, and sourcing studies.

Chapter Summary

This chapter describes the results of the zooarchaeological investigations of subsistence/settlement systems and economies at two spatiotemporal scales. The first scale, represented by the East Peninsula sequence, focuses on a single locale on the Florida Panhandle over the span of ca. 800 years. The assemblages that constitute the East Peninsula sequence demonstrate continuity in the reliance on marine and estuarine fauna, particularly gastropods and small-bodied, mass-capture fishes. Chapter 5 focuses on the habitats and subsistence strategies used, the social and political contexts of production, seasonality of resource and site use, and evidence for resource stress or intensification at the East Peninsula locale.

The second scale is a comparative synthesis of 12 zooarchaeological datasets from the Mobile Delta, Florida Panhandle, and Big Bend regions of the northern Gulf of Mexico. The datasets demonstrate both spatial and temporal variability, including trends toward increasing total diversity (H’), and decreasing fish trophic level (TL). These trends, though statistically significant, are minor. Cluster analyses and MDS techniques suggest patterned variability in the use of resources across the northern Gulf Coast. The abundances of shellfish taxa, namely oysters, rangia, and marine gastropods, are major sources of variability among groups.

The deer isotope study indicates differences in light stable isotopes among some, but not all, coastal and interior regions. Larger numbers of individuals are necessary to establish baseline data for sourcing and paleoecological studies. Two isotopic outliers may reflect human-mediated transportation of deer products across environmental zones. Chapter 6 describes three qualitatively and quantitatively different coastal subsistence sub-systems identified in the regional dataset, discusses mobility models for the region based on the regional dataset as well as other sites in the coastal Southeast, and interprets the human-mediated movement of deer products between the coast and interior in the context of human mobility and exchange.

Table 4.1. Comparison of Vertebrate and Invertebrate Species Richness, Diversity, Equitability, Mean TL, and VI of the Harrison and Hare Hammock Assemblages.

Sample variable	**Harrison**		**Hare Hammock Early**		**Hare Hammock House Mound**		**Hare Hammock Late**		**Hare Hammock Aggregated 3.175-mm**		**Hare Hammock Aggregated 6.35-mm**	
MNI Richness												
Total	68		53		53		61		79		70	
Fish	28		18		25		24		29		23	
Invertebrate, non-commensal	22		19		18		22		28		28	
Invertebrate, commensal	6		8		3		6		9		5	
Other, non-commensal	10		4		6		6		9		13	
Other, commensal	2		4		1		2		4		1	
All vertebrates, non-commensal	38		22		31		30		38		36	
	MNI	**Biomass**	**MNI**	**Biomass**	**MNI**	**Biomass**	**MNI**	**Biomass**	**MNI**	**Biomass**	**MNI**	**Biomass**
Diversity (H' = 1–5)												
Total assemblage	2.93	2.63	2.52	2.36	3.12	2.35	2.31	2.11	2.64	2.32	2.16	2.27
Fish	2.82	2.54	2.16	1.61	2.21	1.71	2.49	2.26	2.28	1.87	2.04	1.80
Invertebrate, non-commensal	2.13	1.44	1.56	1.35	2.32	1.62	1.63	0.90	1.81	1.11	1.66	1.09
Other, non-commensal	2.27	1.04	1.39	0.78	1.79	0.92	1.79	0.98	2.10	0.77	2.54	1.20
All vertebrates, non-commensal	3.07	2.62	2.29	1.90	2.38	2.00	2.67	2.47	2.44	2.13	2.45	2.22
Equitability (V = 0–1)												
Total assemblage	0.69	0.63	0.64	0.60	0.78	0.60	0.56	0.52	0.60	0.54	0.51	0.54
Fish	0.84	0.76	0.75	0.56	0.69	0.53	0.78	0.71	0.68	0.55	0.65	0.57
Invertebrate, non-commensal	0.69	0.47	0.53	0.46	0.80	0.56	0.53	0.29	0.54	0.33	0.50	0.33
Other, non-commensal	0.99	0.45	1.00	0.56	1.00	0.51	1.00	0.55	0.95	0.34	0.99	0.47
All vertebrates, non-commensal	0.84	0.72	0.74	0.61	0.69	0.58	0.79	0.73	0.67	0.59	0.68	0.62
Mean TL (TL = 2–4.5)												
Fish	3.43	3.44	3.14	3.12	3.31	3.26	3.26	3.25	3.19	3.22	3.18	3.26
Fish and invertebrate, non-comm.	2.42	2.78	2.32	2.78	2.66	3.13	2.31	2.64	2.34	2.79	2.23	2.73
Mean vulnerability (VI = 0–100)												
Fish	39.60	46.67	42.17	43.22	43.50	45.28	42.43	45.76	42.70	44.34	44.11	45.11

Note: Commensal invertebrates include all terrestrial snails and barnacles. Vertebrate commensals include anurans, lizards, snakes, and cotton rats.

Table 4.2. Harrison Ring Species List.

			MNI			Biomass	
Taxa	**Common name**	**NISP**	**#**	**%**	**Weight, g**	**kg**	**%**
Mollusca	Indeterminate molluscs	—	—	—	1312.671	—	—
Gastropoda	Indeterminate snails	—	—	—	1880.287	0.712	6.7
Stylommatophora	Air-breathing terrestrial snails	85	85	10.5	1.202	0.001	<0.1
Anguispira strongyloides	Southeastern disc	4	4	0.5	0.134	0.0001	<0.1
Polygyra cereolus	Southern flatcoil	9	9	1.1	0.459	0.0003	<0.1
Triodopsis hopetonensis	Magnolia threetooth	2	2	0.2	0.094	0.0001	<0.1
Ventridens spp.	Dome snails	11	11	1.4	0.061	0.0001	<0.1
Zonitoides spp.	Gloss snails	2	2	0.2	0.051	0.00004	<0.1
Strombus alatus	Florida fighting conch	71	49	6.1	749.487	0.071	0.7
Crepidula spp.	Slippersnails	1	1	0.1	0.182	0.0001	<0.1
Crepidula aculeata	Spiny slippersnail	10	10	1.2	2.321	0.002	<0.1
Crepidula fornicata	Atlantic slippersnail	83	83	10.3	12.862	0.007	0.1
Naticidae	Moonsnails	14	10	1.2	63.680	0.032	0.3
Urosalpinx perrugata	Gulf oyster drill	18	18	2.2	5.910	0.004	<0.1
Chicoreus spp.	Murexes	6	6	0.7	14.138	0.008	0.1
Busycotypus spiratus	Pear whelk	26	26	3.2	170.300	0.078	0.7
Busycon sinistrum	Lightning whelk	196	69	8.6	2778.414	1.501	14.1
Melongena corona	Crown conch	4	4	0.5	38.883	0.009	0.1
Fasciolariidae	Spindles, tulips, and latiruses	5	5	0.6	15.962	0.009	0.1
Fasciolaria spp.	Tulips	29	11	1.4	73.391	0.036	0.3
Fasciolaria lilium	Banded tulip	4	4	0.5	40.609	0.020	0.2
Fasciolaria tulipa	True tulip	16	16	2.0	224.377	0.289	2.7
Pleuroploca gigantea	Horse conch	10	8	1.0	1169.296	0.658	6.2
Marginella apicina	Atlantic marginella	16	16	2.0	0.970	0.001	<0.1
Bivalvia	Indeterminate bivalves	—	—	—	1851.752	0.174	1.6
Argopecten spp.	Bay and callico scallops	789	202	25.0	424.629	0.064	0.6
Crassostrea virginica	Eastern oyster	7	6	0.7	49.040	0.007	0.1
Chamidae	Jewelboxes	1	1	0.1	0.156	0.0003	<0.1
Dinocardium robustum	Atlantic giant cockle	1	1	0.1	2.542	0.002	<0.1
Trachycardium spp.	Pricklycockles	3	—	—	1.628	0.001	<0.1
Trachycardium egmontianum	Florida pricklycockle	3	2	0.2	13.933	0.006	0.1
Trachycardium muricatum	Yellow pricklycockle	2	1	0.1	0.440	0.001	<0.1
Dosinia discus	Disk dosinia	1	1	0.1	0.289	0.0004	<0.1
Macrocallista nimbosa	Sunray venus	23	11	1.4	53.895	0.016	0.1
Decapoda	Crabs	4	1	0.1	1.728	0.015	0.1
Balanus spp.	Barnacles	46	8	1.0	1.696	—	—
Invertebrata	Indeterminate invertebrates	—	—	—	18.500	—	—
Chondrichthyes	Indeterminate cartilaginous fishes	1	—	—	0.010	0.002	<0.1
Carcharinidae	Requiem sharks	3	1	0.1	0.266	0.040	0.4
Actinopterygii	Indeterminate ray-finned fishes	13610	—	—	274.465	2.787	26.2
Amia calva	Bowfin	4	1	0.1	0.515	0.003	<0.1
Elops saurus	Ladyfish	7	1	0.1	0.171	0.007	0.1
Clupeidae	Herring, menhadens, and shads	9	1	0.1	0.214	0.009	0.1
Siluriformes	Catfishes	25	—	—	0.907	0.018	0.2
Ictaluridae	Freshwater catfishes	3	2	0.2	0.093	0.002	<0.1
Ariidae	Sea catfishes	2	—	—	0.251	0.005	0.1
Ariopsis felis	Hardhead catfish	128	8	1.0	6.309	0.115	1.1
Opsanus spp.	Toadfishes	211	13	1.6	9.224	0.165	1.6
Mugil spp.	Mullets	261	16	2.0	15.717	0.273	2.6
Cyprinodontidae	Killifishes and pupfishes	14	3	0.4	0.159	0.003	<0.1
Prionotus sp.	Searobins	1	1	0.1	0.107	0.004	<0.1
Lepomis sp.	Sunfishes	1	1	0.1	0.023	0.001	<0.1
Coryphaena sp.	Dolphinfishes and dorados	1	1	0.1	0.038	0.002	<0.1
Carangidae	Jacks, permits, and pompanos	7	—	—	1.514	0.056	0.5
Caranx spp.	Jacks	8	—	—	0.564	0.024	0.2
Caranx crysos	Blue runner	4	1	0.1	0.631	0.026	0.2
Caranx latus	Horse-eye jack	1	1	0.1	0.200	0.009	0.1

Table 4.2. Harrison Ring Species List. (cont.)

			MNI			Biomass	
Taxa	**Common name**	**NISP**	**#**	**%**	**Weight, g**	**kg**	**%**
Trachinotus spp.	Pompanos	9	1	0.1	0.618	0.025	0.2
Orthopristis chrysoptera	Pigfish	25	8	1.0	0.520	0.014	0.1
Archosargus probatocephalus	Sheepshead	3	1	0.1	0.355	0.006	0.1
Lagodon rhomboides	Pinfish	57	10	1.2	0.949	0.015	0.1
Sciaenidae	Drums	2	—	—	0.721	0.031	0.3
Bairdiella chrysoura	Silver perch	3	1	0.1	0.092	0.007	0.1
Cynoscion spp.	Seatrouts and corvinas	20	2	0.2	3.459	0.097	0.9
Cynoscion nebulosus	Spotted seatrout	11	3	0.4	2.936	0.086	0.8
Leiostomus xanthurus	Spot	24	13	1.6	0.532	0.024	0.2
Micropogonias undulatus	Atlantic croaker	23	9	1.1	2.559	0.078	0.7
Pogonias cromis	Black drum	61	2	0.2	8.713	0.193	1.8
Sciaenops ocellatus	Red drum	2	2	0.2	0.991	0.039	0.4
Paralichthyidae	Sand flounders	22	3	0.4	2.174	0.053	0.5
Ostraciidae	Boxfishes, cowfishes, trunkfishes	16	1	0.1	0.300	0.006	0.1
Chilomycterus schoepfi	Burrfishes	30	3	0.4	3.965	0.074	0.7
Tetraodontidae	Puffers	1	1	0.1	0.036	0.00001	<0.1
Anura	Frogs and toads	1	1	0.1	0.017	—	—
Testudines	Terrapins, tortoises, and turtles	565	—	—	57.735	0.479	4.5
Kinosternon subrubrum	Eastern mud turtle	16	2	0.2	3.455	0.073	0.7
Emydidae	Pond turtles and terrapins	3	—	—	1.333	0.038	0.4
Malaclemys terrapin	Diamondback terrapin	1	1	0.1	0.614	0.023	0.2
Terrapene carolina	Eastern box turtle	9	1	0.1	3.316	0.071	0.7
Colubridae	Non-venomous snakes	4	1	0.1	0.174	0.002	<0.1
Aves	Indeterminate birds	4	—	—	0.544	0.012	0.1
Anatidae	Ducks, geese, and swans	1	1	0.1	0.368	0.008	0.1
Mammalia	Indeterminate mammals	348	—	—	72.260	1.239	11.7
Didelphis virginiana	Virginia opossum	1	1	0.1	1.535	0.039	0.4
Sylvilagus sp.	Cottontail rabbits	1	1	0.1	0.091	0.003	<0.1
Rodentia	Indeterminate rodents	4	—	—	0.101	0.003	<0.1
Sciurus carolinensis	Gray squirrel	3	1	0.1	0.194	0.006	0.1
Sigmodon hispidus	Hispid cotton rat	1	1	0.1	0.031	0.001	<0.1
Procyon lotor	Raccoon	1	1	0.1	0.093	0.003	<0.1
Odocoileus virginianus	White-tailed deer	22	1	0.1	32.287	0.600	5.6
Vertebrata	Indeterminate vertebrates	—	—	—	125.730	—	—
Total		**17097**	**807**		**11616.145**	**10.62445**	

Note: MNI estimates for *Cynoscion* spp. and *C. nebulosus* are based on non-repeating elements and represent different individuals.

Table 4.3. Harrison Ring Summary Table.

	MNI		**Biomass**	
	#	**%**	**kg**	**%**
Aquatic gastropods	336	41.6	2.7251	54.0
Bivalves	225	27.9	0.0967	1.9
Decapods	1	0.1	0.015	0.3
Fishes	111	13.8	1.37601	27.3
Turtles	4	0.5	0.167	3.3
Wild birds	1	0.1	0.008	0.2
Deer	1	0.1	0.600	11.9
Other wild mammals	4	0.5	0.051	1.0
Invertebrate commensals	121	15.0	0.00164	<0.1
Vertebrate commensals	3	0.4	0.003	<0.1
Total	**807**		**5.04345**	

Note: Anurans and barnacles are included in the MNI estimate, but are not included in the biomass estimate because allometric values are not currently available.

Table 4.4. Summary of Standard Length (SL) Estimates for Fishes, Valve Height (VH) for Bivalves, and Shell Height (SH) for Gastropods, in mm.

Context	Taxon	Element	Dimension	N	Average	CI	Min	Max
Harrison Ring	*Lagodon rhomboides*	Atlas	Wth	10	119.57	10.14	95.30	145.90
	Mugil spp.	Atlas	Wth	4	250.09	48.66	178.87	285.33
	Sciaenidae	Atlas	Wth	12	186.51	26.99	118.49	300.07
		Otolith	Len	19	222.16	31.00	136.78	373.20
	Ariopsis felis	Pectoral spine	Wth	14	138.12	23.31	87.96	258.73
	Strombus alatus	Complete shell	SH	12	84.12	2.99	75.15	93.53
	Busycon sinistrum	Complete shell	SH	8	80.70	10.87	66.68	111.09
	Argopecten spp.	Valve, lt	VH	14	48.23	4.05	33.79	65.83
Hare Hammock Early	Ariidae	Otolith	Bth	18	234.08	12.22	198.06	279.43
		Otolith	Len	18	234.57	12.82	191.81	286.74
		Otolith	Th	18	243.06	8.03	212.78	275.87
		Otolith	Wth	18	248.73	13.04	206.29	289.60
	Ariopsis felis	Pectoral spine	Wth	21	211.20	24.13	95.21	333.41
	Mugil spp.	Atlas	Wth	18	279.39	28.88	184.28	414.23
	Sciaenidae	Atlas	Wth	11	174.25	5.77	156.36	185.93
	Sciaenidae	Otolith	Len	1	222.48	NA	222.48	222.48
	Strombus alatus	Complete shell	SH	62	80.13	1.17	71.36	92.04
	Argopecten spp.	Valve	VH	16	53.03	2.18	44.66	61.05
Hare Hammock House Mound	Ariidae	Otolith	Len	1	257.40	NA	257.40	257.40
		Otolith	Wth	1	255.91	NA	255.91	255.91
		Otolith	Th	1	256.40	NA	256.40	256.40
	Ariopsis felis	Pectoral spine	Wth	59	244.35	9.64	77.69	306.42
	Mugil spp.	Atlas	Wth	5	252.05	21.45	226.67	279.06
	Sciaenidae	Atlas	Wth	17	189.24	9.20	157.76	228.29
	Sciaenidae	Otolith	Len	2	291.34	207.08	185.68	396.99
	Argopecten spp.	Valve	VH	2	50.01	4.02	43.54	57.58
Hare Hammock Late	Ariidae	Otolith	Bth	6	199.02	46.65	131.14	305.51
		Otolith	Len	6	194.01	37.16	158.29	282.37
		Otolith	Th	6	212.66	38.78	175.52	306.00
		Otolith	Wth	6	213.08	51.30	134.96	321.76
	Ariopsis felis	Pectoral spine	Wth	14	206.62	16.04	169.27	273.52
	Mugil spp.	Atlas	Wth	10	235.68	19.64	185.18	283.24
	Sciaenidae	Atlas	Wth	4	164.14	18.42	139.20	182.12
	Sciaenidae	Otolith	Len	3	294.92	61.57	241.95	350.66
	Strombus alatus	Complete shell	SH	48	79.08	1.96	61.72	95.49
	Busycon sinistrum	Complete shell	SH	8	149.20	35.32	81.64	234.00
	Argopecten spp.	Valve	VH	7	51.95	4.04	41.01	57.34

Note: Bth = Breadth; Len = Length; Th = Thickness; Wth = Width. For illustrations of measurement landmarks see Figure 3.2

Table 4.5. Fish Taxa Listed by Body Size (MNI and Biomass).

	MNI				Biomass			
	Harrison	**HH Early**	**HH House**	**HH Late**	**Harrison**	**HH Early**	**House**	**HH Late**
% Large-bodied	46.8	46.3	33.3	46.3	66.6	34.9	34.4	49.6
% Small-bodied	53.2	53.7	66.7	53.7	33.4	65.1	65.6	50.4
Acipenseridae			1				0.045	
Archosargus probatocephalus	1		1		0.006		0.047	
Bagre marinus			1	1			0.018	0.004
Caranx spp.		1	1	1		0.001	0.090	0.006
Caranx latus	1				0.009			
Chondrichthyes			1				0.006	
Carcharhinidae	1				0.040			
Coryphaena spp.	1				0.002			
Cynoscion spp.	2			2	0.097			0.092
Cynoscion nebulosus	3	2	2		0.086	0.042	0.094	
Ictaluridae	2				0.002			
Lepisosteidae		1	1			0.051	0.006	
Lutjanus sp.			1				0.002	
Micropogonias undulatus	9	2	2	2	0.078	0.029	0.019	0.007
Mugil spp.	16	33	12	27	0.273	0.643	0.407	0.365
Myliobatidae				1				0.020
Orthopristis chrysoptera	8	6	2	3	0.014	0.006	0.006	0.004
Paralichthys spp.	3	3	1	2	0.053	0.175	0.054	0.040
Pogonias cromis	2	1	9	1	0.193	0.004	0.294	0.144
Pomatomus saltatrix			1	1			0.027	0.001
Rhinoptera bonasus				1				0.096
Sciaenops ocellatus	2		1	1	0.039		0.004	0.039
Trachinotus spp.	1	1	1	1	0.025	0.021	0.012	0.027
Total large-bodied	**52**	**50**	**38**	**44**	**0.917**	**0.972**	**1.131**	**0.845**
Amia calva	1			1	0.003			0.002
Ariopsis felis	8	23	48	14	0.115	1.441	1.850	0.484
Bairdiella chrysoura	1		1		0.007		0.004	
Caranx cf. *crysos*	1				0.026			
Lepomis spp.	1				0.001			
Chilomycterus schoefii	3	1	3	5	0.074	0.117	0.139	0.096
Clupeidae	1	2	1	2	0.009	0.061	0.002	0.033
Cyprinodontidae	3	4		1	0.003	0.013		0.005
Elops saurus	1	1	1	1	0.007	0.049	0.013	0.015
Lagodon rhomboides	10	6	2	9	0.015	0.016	0.005	0.009
Leiostomus xanthurus	13	16	13	7	0.024	0.052	0.030	0.018
Opsanus sp.	13	4	6	9	0.165	0.063	0.096	0.173
Ostraciidae	1	1	1	1	0.006	0.003	0.020	0.016
Prionotus spp.	1				0.004			
Tetraodontidae	1			1	0.00001			0.006
Total small-bodied	**59**	**58**	**76**	**51**	**0.45901**	**1.815**	**2.159**	**0.857**

Note: HH = Hare Hammock.

Table 4.6. Fish Taxa Listed by Capture Method (MNI and Biomass).

	MNI				**Biomass**			
	Harrison	**HH Early**	**HH House**	**HH Late**	**Harrison**	**HH Early**	**HH House**	**HH Late**
% Individually captured	42.3	18.5	28.1	31.6	50.9	16.8	25.7	38.8
% Mass-captured	57.7	81.5	71.9	68.4	49.1	83.2	74.3	61.2
Amia calva	1			1	0.003			0.002
Acipenseridae			1				0.045	
Archosargus probatocephalus	1		1		0.006		0.047	
Caranx spp.		1	1	1		0.001	0.090	0.006
Caranx latus	1				0.009			
Chondrichthyes			1				0.006	
Carcharhinidae	1				0.040			
Chilomycterus schoefii	3	1	3	5	0.074	0.117	0.139	0.096
Coryphaena spp.	1				0.002			
Lepisosteidae		1	1			0.051	0.006	
Lutjanus sp.			1				0.002	
Micropogonias undulatus	9	2	2	2	0.078	0.029	0.019	0.007
Myliobatidae				1				0.020
Opsanus sp.	13	4	6	9	0.165	0.063	0.096	0.173
Orthopristis chrysoptera	8	6	2	3	0.014	0.006	0.006	0.004
Paralichthys spp.	3	3	1	2	0.053	0.175	0.054	0.040
Pogonias cromis	2	1	9	1	0.193	0.004	0.294	0.144
Pomatomus saltatrix			1	1			0.027	0.001
Rhinoptera bonasus				1				0.096
Sciaenops ocellatus	2		1	1	0.039		0.004	0.039
Tetraodontidae	1			1	0.00001			0.006
Trachinotus spp.	1	1	1	1	0.025	0.021	0.012	0.027
Total individually captured	**47**	**20**	**32**	**30**	**0.70101**	**0.467**	**0.847**	**0.661**
Ariopsis felis	8	23	48	14	0.115	1.441	1.850	0.484
Bagre marinus			1	1			0.018	0.004
Bairdiella chrysoura	1		1		0.007		0.004	
Caranx cf. *crysos*	1				0.026			
Lepomis spp.	1				0.001			
Clupeidae	1	2	1	2	0.009	0.061	0.002	0.033
Cynoscion spp.	2			2	0.097			0.092
Cynoscion nebulosus	3	2	2		0.086	0.042	0.094	
Cyprinodontidae	3	4		1	0.003	0.013		0.005
Elops saurus	1	1	1	1	0.007	0.049	0.013	0.015
Ictaluridae	2				0.002			
Lagodon rhomboides	10	6	2	9	0.015	0.016	0.005	0.009
Leiostomus xanthurus	13	16	13	7	0.024	0.052	0.030	0.018
Mugil spp.	16	33	12	27	0.273	0.643	0.407	0.365
Ostraciidae	1	1	1	1	0.006	0.003	0.020	0.016
Prionotus spp.	1				0.004			
Total mass-captured	**64**	**88**	**82**	**65**	**0.675**	**2.320**	**2.443**	**1.041**

Note: HH = Hare Hammock.

Table 4.7. Harrison Ring Deer Element Distribution.

Portion	**NISP**
Head	12
Vertebra/Rib	0
Forequarter	1
Hindquarter	0
Forefoot	0
Hindfoot	3
Foot	6
Total	22

Table 4.8. Harrison Ring Modifications.

Taxa	**Hacked**	**Cut**	**Worked**	**Burned**	**Calcined**
Fishes				949	358
Birds					
Reptiles				109	48
Deer		1	1	6	
Other wild mammals				38	40
Indeterminate vertebrates				129	76
Total	0	1	1	1231	522

Table 4.9. Hare Hammock Early Species List.

			MNI			Biomass	
Taxa	**Common Name**	**NISP**	**#**	**%**	**Weight, g**	**kg**	**%**
Anthozoa	Indeterminate corals	3	—	—	0.569	—	—
Mollusca	Indeterminate molluscs	—	—	—	577.839	—	—
Gastropoda	Indeterminate snails	—	—	—	1162.900	0.458	4.6
Anguispira strongyloides	Southeastern disc	59	59	7.5	4.499	0.003	<0.1
Polygyra cereolus	Southern flatcoil	25	25	3.2	0.742	0.001	<0.1
Euglandina rosea	Rosey wolfsnail	6	6	0.8	10.657	0.006	0.1
Glyphyalina indentata	Carved glyph snail	6	6	0.8	0.044	0.00004	<0.1
Triodopsis tridentata	Northern threetooth	2	2	0.3	0.014	0.00001	<0.1
Ventridens spp.	Dome snails	31	31	3.9	0.537	0.0004	<0.1
Oligyra orbiculata	Globular drop snail	1	1	0.1	0.021	0.00002	<0.1
Strombus alatus	Florida fighting conch	193	193	24.4	6863.500	0.497	5.0
Crepidula spp.	Slippersnails	29	29	3.7	3.343	0.002	<0.1
Crepidula aculeata	Spiny slippersnail	1	1	0.1	0.046	0.00004	<0.1
Crepidula fornicata	Atlantic slippersnail	103	103	13.0	1.886	0.001	<0.1
Naticidae	Moonsnails	1	1	0.1	2.606	0.002	<0.1
Chicoreus spp.	Murexes	4	3	0.4	14.796	0.008	0.1
Busycotypus spiratus	Pear whelk	4	4	0.5	41.795	0.021	0.2
Busycon sinistrum	Lightning whelk	38	38	4.8	2480.800	1.319	13.3
Fasciolaria lilium	Banded tulip	3	3	0.4	30.291	0.014	0.1
Fasciolaria tulipa	True tulip	4	4	0.5	79.320	0.102	1.0
Pleuroploca gigantea	Horse conch	3	3	0.4	856.000	0.460	4.7
Marginella apicina	Atlantic marginella	1	1	0.1	0.091	0.0001	<0.1
Bivalvia	Indeterminate bivalves	—	—	—	1323.300	0.138	1.4
Anadara sp.	Arks	1	1	0.1	1.018	0.0001	<0.1
Argopecten spp.	Bay and callico scallops	523	150	19.0	541.839	0.075	0.8
Crassostrea virginica	Eastern oyster	4	2	0.3	53.336	0.008	0.1
Chamidae	Jewelboxes	2	1	0.1	2.025	0.002	<0.1
Dinocardium robustum	Atlantic giant cockle	1	1	0.1	2.626	0.002	<0.1
Chione cancellata	Cross-barred venus	1	1	0.1	0.015	0.0001	<0.1
Macrocallista nimbosa	Sunray venus	5	4	0.5	9.100	0.005	<0.1
Decapoda	Crabs	2	1	0.1	0.216	0.003	<0.1
Balanus spp.	Barnacles	6	1	0.1	0.166	—	—
Actinopterygii	Indeterminate ray-finned fishes	14983	—	—	278.266	2.818	28.5
Lepisosteus spp.	Gars	7	1	0.1	1.629	0.051	0.5
Elops saurus	Ladyfish	35	1	0.1	1.851	0.049	0.5
Clupeidae	Herring, menhadens, and shads	66	2	0.3	2.459	0.061	0.6
Brevoortia smithii	Yellowfin menhaden	1	(1)	—	0.058	0.003	<0.1
Siluriformes	Catfishes	262	—	—	12.733	0.224	2.3
Ariidae	Sea catfishes	38	—	—	9.443	0.168	1.7
Ariopsis felis	Hardhead catfish	755	23	2.9	90.488	1.441	14.6
Opsanus spp.	Toadfishes	42	4	0.5	2.530	0.063	0.6
Mugil spp.	Mullets	646	33	4.2	48.029	0.643	6.5
Cyprinodontidae	Killifishes and pupfishes	30	4	0.5	0.337	0.013	0.1
Carangidae	Jacks, permits, and pompanos	9	—	—	0.496	0.021	0.2
Caranx spp.	Jacks	1	1	0.1	0.019	0.001	<0.1

Table 4.10. Hare Hammock Early Summary Table.

	MNI		Biomass	
	#	**%**	**kg**	**%**
Aquatic gastropods	383	48.4	2.42614	42.0
Bivalves	160	20.2	0.0922	1.6
Decapods	1	0.1	0.003	<0.1
Fishes	108	13.7	2.787	48.2
Turtles	2	0.3	0.113	2.0
Wild birds	0	0.0	0.000	0.0
Deer	1	0.1	0.319	5.5
Other wild mammals	1	0.1	0.020	0.3
Invertebrate commensals	131	16.6	0.01047	0.2
Vertebrate commensals	4	0.5	0.002	<0.1
Total	**791**		**5.77281**	

Note: Anurans and barnacles are included in the MNI calculation, but are not included in the biomass calculation because allometric values are not currently available.

Table 4.11. Hare Hammock Early Deer Element Distribution.

Portion	**NISP**
Head	4
Vertebra/Rib	0
Forequarter	0
Hindquarter	0
Forefoot	0
Hindfoot	0
Foot	2
Total	6

Table 4.12. Hare Hammock Early Modifications.

Taxa	**Hacked**	**Cut**	**Worked**	**Burned**	**Calcined**
Fishes				377	127
Birds					
Reptiles				8	2
Deer					
Other wild mammals				2	
Indeterminate vertebrates				28	5
Total				415	134

Table 4.13. Hare Hammock House Mound Species List.

			MNI			Biomass	
Taxa	**Common Name**	**NISP**	**#**	**%**	**Weight, g**	**kg**	**%**
Mollusca	Indeterminate molluscs	—	—	—	285.750	—	—
Gastropoda	Indeterminate snails	—	—	—	910.438	0.365	4.1
Anguispira strongyloides	Southeastern disc	3	3	1.1	0.162	0.0001	<0.1
Polygyra cereolus	Southern flatcoil	4	4	1.4	0.058	0.0001	<0.1
Strombus alatus	Florida fighting conch	15	15	5.3	393.075	0.040	0.5
Crepidula spp.	Slippersnails	26	26	9.2	1.949	0.001	<0.1
Turbo castanea	Chestnut turban	2	1	0.4	0.478	0.0004	<0.1
Naticidae	Moonsnails	6	6	2.1	84.397	0.028	0.3
Urosalpinx perrugata	Gulf oyster drill	4	4	1.4	1.424	0.0001	<0.1
Chicoreus spp.	Murexes	9	9	3.2	28.805	0.015	0.2
Anachis spp.	Dove shell	2	2	0.7	0.082	0.0001	<0.1
Busycotypus spiratus	Pear whelk	1	1	0.4	10.910	0.006	0.1
Busycon sinistrum	Lightning whelk	14	14	4.9	763.775	0.344	3.9
Fasciolariidae	Spindles, tulips, and latiruses	1	1	0.4	5.738	0.003	<0.1
Fasciolaria lilium	Banded tulip	3	3	1.1	22.162	0.009	0.1
Fasciolaria tulipa	True tulip	1	1	0.4	22.698	0.029	0.3
Pleuroploca gigantea	Horse conch	1	1	0.4	28.919	0.009	0.1
Marginella apicina	Atlantic marginella	2	2	0.7	0.293	0.0002	<0.1
Bivalvia	Indeterminate bivalves	—	—	—	488.780	0.070	0.8
Geukensia demissa	Ribbed mussel	1	1	0.4	0.230	0.0002	<0.1
Argopecten spp.	Bay and callico scallops	109	33	11.7	93.594	0.023	0.3
Crassostrea virginica	Eastern oyster	36	23	8.1	564.770	0.079	0.9
Macrocallista nimbosa	Sunray venus	16	10	3.5	45.355	0.014	0.2
Decapoda	Crabs	6	1	0.4	1.325	0.012	0.1
Balanus spp.	Barnacles	3	1	0.4	0.065	—	—
Chondrichthyes	Indeterminate cartilaginous fishes	1	1	0.4	0.027	0.006	0.1
Actinopterygii	Indeterminate ray-finned fishes	6500	—	—	204.275	2.194	24.9
Acipenser oxyrhynchus	Atlantic sturgeon	2	1	0.4	1.637	0.045	0.5
Lepisosteus spp.	Gars	3	1	0.4	0.139	0.006	0.1
Elops saurus	Ladyfish	12	1	0.4	0.360	0.013	0.2
Brevoortia smithii	Yellowfin menhaden	1	1	0.4	0.031	0.002	<0.1
Siluriformes	Catfishes	799	—	—	30.693	0.516	5.8
Ariidae	Sea catfishes	301	—	—	22.877	0.390	4.4
Ariopsis felis	Hardhead catfish	1278	48	17.0	117.705	1.850	21.0
Bagre marinus	Gafftopsail catfish	2	1	0.4	0.872	0.018	0.2
Opsanus spp.	Toadfishes	56	6	2.1	4.340	0.096	1.1
Mugil spp.	Mullets	368	12	4.2	26.872	0.407	4.6
Pomatomus saltatrix	Bluefish	8	1	0.4	0.960	0.027	0.3
Carangidae	Jacks, permits, and pompanos	34	—	—	3.702	0.123	1.4
Caranx hippos	Crevalle jack	2	1	0.4	2.595	0.090	1.0
Trachinotus spp.	Pompanos	5	1	0.4	0.268	0.012	0.1
Lutjanus spp.	Snappers	1	1	0.4	0.051	0.002	<0.1
Orthopristis chrysoptera	Pigfish	6	2	0.7	0.176	0.006	0.1
Sparidae	Porgies	2	—	—	0.162	0.003	<0.1
Archosargus probatocephalus	Sheepshead	2	1	0.4	3.278	0.047	0.5

Table 4.13. Hare Hammock House Mound Species List. (cont.)

			MNI			**Biomass**	
Taxa	**Common Name**	**NISP**	**#**	**%**	**Weight, g**	**kg**	**%**
Lagodon rhomboides	Pinfish	16	2	0.7	0.279	0.005	0.1
Sciaenidae	Drums	3	—	—	0.045	0.004	<0.1
Bairdiella chrysoura	Silver perch	2	1	0.4	0.043	0.004	<0.1
Cynoscion spp.	Seatrouts and corvinas	16	—	—	1.552	0.054	0.6
Cynoscion nebulosus	Spotted seatrout	8	2	0.7	3.315	0.094	1.1
Leiostomus xanthurus	Spot	33	13	4.6	0.715	0.030	0.3
Micropogonias undulatus	Atlantic croaker	8	2	0.7	0.379	0.019	0.2
Pogonias cromis	Black drum	27	9	3.2	15.367	0.294	3.3
Sciaenops ocellatus	Red drum	1	1	0.4	0.047	0.004	<0.1
Paralichthyidae	Sand flounders	25	1	0.4	2.241	0.054	0.6
Ostraciidae	Boxfishes, cowfishes, trunkfishes	30	1	0.4	0.608	0.020	0.2
Chilomycterus schoepfi	Burrfishes	68	3	1.1	6.895	0.139	1.6
Testudines	Terrapins, tortoises, and turtles	122	—	—	23.194	0.260	2.9
Chelydra serpentina	Snapping turtle	3	1	0.4	2.101	0.052	0.6
Kinosternidae	Mud and musk turtles	3	—	—	0.411	0.017	0.2
Kinosternon subrubrum	Eastern mud turtle	2	1	0.4	1.030	0.032	0.4
Emydidae	Pond turtles and terrapins	3	—	—	0.197	0.011	0.1
Terrapene carolina	Eastern box turtle	6	1	0.4	2.627	0.060	0.7
Colubridae	Non-venomous snakes	3	1	0.4	0.075	0.001	<0.1
Aves	Indeterminate birds	1	—	—	0.036	0.001	<0.1
Anatidae	Ducks, geese, and swans	1	1	0.4	0.104	0.003	<0.1
Mammalia	Indeterminate mammals	45	—	—	14.210	0.287	3.2
Sciurus carolinensis	Gray squirrel	1	1	0.4	0.068	0.002	<0.1
Odocoileus virginianus	White-tailed deer	14	1	0.4	20.176	0.393	5.3
Vertebrata	Indeterminate vertebrates	—	—	—	32.563	—	—
Total		**10089**	**283**		**4304.530**	**8.7412**	

Table 4.14. Hare Hammock House Mound Summary Table.

	MNI		**Biomass**	
	#	**%**	**kg**	**%**
Aquatic gastropods	86	30.4	0.4848	10.6
Bivalves	67	23.7	0.1162	4.1
Decapods	1	0.4	0.012	0.3
Fishes	114	40.3	3.290	71.6
Turtles	3	1.1	0.144	3.1
Wild birds	1	0.4	0.003	0.1
Deer	1	0.4	0.469	10.2
Other wild mammals	1	0.4	0.002	0.1
Invertebrate commensals	8	2.8	0.0002	<0.1
Vertebrate commensals	1	0.4	0.001	<0.1
Total	**283**		**4.5222**	

Note: Anurans and barncales are included in the MNI estimate, but are not included in the biomass estimate because allometric values are not currently available.

Table 4.15. Hare Hammock House Mound Deer Element Distribution.

Portion	**NISP**
Head	10
Vertebra/Rib	0
Forequarter	0
Hindquarter	0
Forefoot	0
Hindfoot	3
Foot	1
Total	14

Table 4.16. Hare Hammock House Mound Modifications.

Taxa	**Hacked**	**Cut**	**Worked**	**Burned**	**Calcined**
Fishes				1158	451
Birds					
Reptiles				24	18
Deer	1			7	2
Other wild mammals				10	13
Indeterminate vertebrates				60	53
Total	1			1259	537

Table 4.17. Hare Hammock Late Species List.

			MNI			Biomass	
Taxa	**Common Name**	**NISP**	**#**	**%**	**Weight, g**	**kg**	**%**
Mollusca	Indeterminate molluscs	—	—	—	1658.463	—	—
Gastropoda	Indeterminate snails	—	—	—	4299.710	1.524	13.2
Stylommatophora	Air-breathing terrestrial snails	7	7	0.9	0.025	0.00002	<0.1
Anguispira strongyloides	Southeastern disc	1	1	0.1	0.047	0.00004	<0.1
Polygyridae	Flatcoils	5	5	0.6	0.067	0.0001	<0.1
Polygyra cereolus	Southern flatcoil	5	5	0.6	0.261	0.0002	<0.1
Glyphyalina indentata	Carved glyph snail	3	3	0.4	0.017	0.00002	<0.1
Ventridens spp.	Dome snails	9	9	1.1	0.068	0.0001	<0.1
Zonitoides spp.	Gloss snails	2	2	0.3	0.020	0.00002	<0.1
Oligyra orbiculata	Globular drop snail	4	4	0.5	0.082	0.0001	<0.1
Strombus alatus	Florida fighting conch	344	344	43.5	11976.519	0.811	7.0
Crepidula fornicata	Atlantic slippersnail	23	23	2.9	1.802	0.001	<0.1
Turbo castanea	Chestnut turban	1	1	0.1	0.103	0.0001	<0.1
Naticidae	Moonsnails	12	12	1.5	80.407	0.027	0.2
Urosalpinx perrugata	Gulf oyster drill	4	4	0.5	1.036	0.001	<0.1
Muricidae	Rock snails and murexes	1	1	0.1	0.049	0.00004	<0.1
Chicoreus spp.	Murexes	1	1	0.1	2.613	0.002	<0.1
Busycotypus spiratus	Pear whelk	9	9	1.1	31.570	0.017	0.1
Busycon sinistrum	Lightning whelk	86	68	8.6	5850.190	3.507	30.4
Melongena corona	Crown conch	4	4	0.5	41.422	0.010	0.1
Fasciolariidae	Spindles, tulips, and latiruses	2	2	0.3	28.710	0.015	0.1
Fasciolaria spp.	Tulips	9	6	0.8	24.192	0.013	0.1
Fasciolaria lilium	Banded tulip	5	5	0.6	38.462	0.019	0.2
Fasciolaria tulipa	True tulip	7	7	0.9	96.542	0.124	1.1
Pleuroploca gigantea	Horse conch	3	3	0.4	256.359	0.115	1.0
Marginella apicina	Atlantic marginella	2	2	0.3	0.097	0.0001	<0.1
Bivalvia	Indeterminate bivalves	—	—	—	996.767	0.114	1.0
Argopecten spp.	Bay and callico scallops	440	111	14.0	191.046	0.037	0.3
Crassostrea virginica	Eastern oyster	3	2	0.3	38.834	0.006	0.1
Cardiidae	Cockles and pricklycockles	1	—	—	0.288	0.0004	<0.1
Dinocardium robustum	Atlantic giant cockle	2	2	0.3	0.944	0.001	<0.1
Trachycardium egmontianum	Florida pricklycockle	1	1	0.1	4.322	0.003	<0.1
Rangia cuneata	Atlantic rangia	13	8	1.0	25.001	0.009	0.1
Dosinia discus	Disk dosinia	1	1	0.1	0.127	0.0002	<0.1
Macrocallista nimbosa	Sunray venus	54	33	4.2	99.788	0.024	0.2
Mercenaria sp.	Quahog	1	1	0.1	9.115	0.003	<0.1
Decapoda	Crabs	1	1	0.1	0.087	0.001	<0.1
Balanus spp.	Barnacles	2	1	0.1	0.061	—	—
Chondrichthyes	Indeterminate cartilaginous fishes	10	—	—	0.258	0.039	0.3
Myliobatidae	Rays	1	1	0.1	0.116	0.020	0.2
Rhinoptera bonasus	Cownose ray	4	1	0.1	0.728	0.096	0.8
Actinopterygii	Indeterminate ray-finned fishes	5926	—	—	146.617	1.677	14.5
Amia calva	Bowfin	2	1	0.1	0.292	0.002	<0.1
Elops saurus	Ladyfish	16	1	0.1	0.412	0.015	0.1
Clupeidae	Herring, menhadens, and shads	76	2	0.3	1.110	0.033	0.3
Brevoortia smithii	Yellowfin menhaden	1	(1)	—	0.020	0.001	<0.1

Table 4.17. Hare Hammock Late Species List. (cont.)

			MNI			**Biomass**	
Taxa	**Common Name**	**NISP**	**#**	**%**	**Weight, g**	**kg**	**%**
Siluriformes	Catfishes	208	—	—	6.326	0.115	1.0
Ariidae	Sea catfishes	49	—	—	2.942	0.056	0.5
Ariopsis felis	Hardhead catfish	541	14	1.8	28.696	0.484	4.2
Bagre marinus	Gafftopsail catfish	2	1	0.1	0.169	0.004	<0.1
Opsanus spp.	Toadfishes	176	9	1.1	9.104	0.173	1.5
Mugil spp.	Mullets	467	27	3.4	23.457	0.365	3.2
Cyprinodontidae	Killifishes and pupfishes	11	1	0.1	0.111	0.005	<0.1
Pomatomus saltatrix	Bluefish	1	1	0.1	0.008	0.001	<0.1
Carangidae	Jacks, permits, and pompanos	15	—	—	2.040	0.073	0.6
Caranx spp.	Jacks	18	—	—	3.106	0.105	0.9
Caranx hippos	Crevalle jack	1	1	0.1	0.111	0.006	<0.1
Trachinotus spp.	Pompanos	4	1	0.1	0.648	0.027	0.2
Orthopristis chrysoptera	Pigfish	6	3	0.4	0.108	0.004	<0.1
Sparidae	Porgies	1	—	—	0.080	0.002	<0.1
Lagodon rhomboides	Pinfish	35	9	1.1	0.559	0.009	0.1
Cynoscion spp.	Seatrouts and corvinas	15	2	0.3	3.221	0.092	0.8
Leiostomus xanthurus	Spot	21	7	0.9	0.356	0.018	0.2
Micropogonias undulatus	Atlantic croaker	5	2	0.3	0.104	0.007	0.1
Pogonias cromis	Black drum	15	1	0.1	5.863	0.144	1.2
Sciaenops ocellatus	Red drum	3	1	0.1	1.008	0.039	0.3
Paralichthyidae	Sand flounders	13	2	0.3	1.588	0.040	0.3
Ostraciidae	Boxfishes, cowfishes, trunkfishes	21	1	0.1	0.435	0.016	0.1
Chilomycterus schoepfi	Burrfishes	45	5	0.6	4.295	0.096	0.8
Tetraodontidae	Puffers	4	1	0.1	0.139	0.006	0.1
Testudines	Terrapins, tortoises, and turtles	190	—	—	24.973	0.273	2.4
Kinosternon subrubrum	Eastern mud turtle	2	1	0.1	0.514	0.020	0.2
Emydidae	Pond turtles and terrapins	4	—	—	0.507	0.020	0.2
Pseudemys spp.	Cooters	3	1	0.1	2.296	0.055	0.5
Terrapene carolina	Eastern box turtle	3	1	0.1	22.345	0.253	2.2
Colubridae	Non-venomous snakes	2	1	0.1	0.047	0.001	<0.1
Phalacrocorax auritus	Double-crested cormorant	1	1	0.1	0.642	0.014	0.1
Passeriformes	Perching birds	1	1	0.1	0.011	0.0003	<0.1
Mammalia	Indeterminate mammals	37	—	—	9.760	0.204	1.8
Rodentia	Indeterminate rodents	1	—	—	0.048	0.002	<0.1
Sigmodon hispidus	Hispid cotton rat	2	1	0.1	0.088	0.003	<0.1
Odocoileus virginianus	White-tailed deer	5	1	0.1	28.959	0.544	4.7
Vertebrata	Indeterminate vertebrates	—	—	—	40.992	—	—
Total		**9032**	**792**		**26130.422**	**11.54474**	

Table 4.18. Hare Hammock Late Summary Table.

	MNI		Biomass	
	#	%	kg	%
Aquatic gastropods	492	62.1	4.66224	63.5
Bivalves	159	20.1	0.0832	1.1
Decapods	1	0.1	0.001	<0.1
Fishes	95	12.0	1.702	23.2
Turtles	3	0.4	0.328	4.5
Wild birds	2	0.3	0.0143	0.2
Deer	1	0.1	0.544	7.4
Other wild mammals	—	—	—	—
Invertebrate commensals	37	4.7	0.0006	<0.1
Vertebrate commensals	2	0.3	0.004	0.1
Total	**792**		**7.33934**	

Note: Anurans and barnacles are included in the MNI estimate, but are not included in the biomass estimate because allometric values are not currently available.

Table 4.19. Hare Hammock Late Deer Element Distribution.

Portion	**NISP**
Head	1
Vertebra/Rib	0
Forequarter	0
Hindquarter	1
Forefoot	1
Hindfoot	1
Foot	1
Total	5

Table 4.20. Hare Hammock Late Modifications.

Taxa	**Hacked**	**Cut**	**Worked**	**Burned**	**Calcined**
Fishes				394	74
Birds					
Reptiles				25	1
Deer	2	2			
Other wild mammals				14	2
Indeterminate vertebrates				56	26
Total	2	2		489	103

Table 4.21. Hare Hammock Aggregated (3.18-mm) Species List.

			MNI			Biomass	
Taxa	**Common Name**	**NISP**	**#**	**%**	**Weight, g**	**kg**	**%**
Anthozoa	Indeterminate corals	3	—	—	0.569	—	—
Mollusca	Indeterminate molluscs	—	—	—	2522.052	—	—
Gastropoda	Indeterminate snails	—	—	—	6373.048	2.188	7.9
Stylommatophora	Air-breathing terrestrial snails	7	7	0.4	0.025	0.00002	<0.1
Anguispira strongyloides	Southeastern disc	63	63	3.5	4.708	0.003	<0.1
Polygyridae	Flatcoils	5	5	0.3	0.067	0.0001	<0.1
Polygyra cereolus	Southern flatcoil	34	34	1.9	1.061	0.001	<0.1
Euglandina rosea	Rosey wolfsnail	6	6	0.3	10.657	0.006	<0.1
Glyphyalina indentata	Carved glyph snail	9	9	0.5	0.061	0.0001	<0.1
Triodopsis tridentata	Northern threetooth	2	2	0.1	0.014	0.00001	<0.1
Ventridens spp.	Dome snails	40	40	2.2	0.605	0.0004	<0.1
Zonitoides spp.	Gloss snails	2	2	0.1	0.020	0.00002	<0.1
Oligyra orbiculata	Globular drop snail	5	5	0.3	0.103	0.0001	<0.1
Strombus alatus	Florida fighting conch	552	552	30.6	19233.094	1.231	4.5
Crepidula spp.	Slippersnails	55	55	3.1	5.292	0.003	<0.1
Crepidula aculeata	Spiny slippersnail	1	1	0.1	0.046	0.00004	<0.1
Crepidula fornicata	Atlantic slippersnail	126	126	7.0	3.688	0.002	<0.1
Turbo castanea	Chestnut turban	3	2	0.1	0.581	0.0004	<0.1
Naticidae	Moonsnails	19	19	1.1	167.410	0.040	0.1
Urosalpinx perrugata	Gulf oyster drill	8	8	0.4	2.460	0.002	<0.1
Muricidae	Rock snails and murexes	1	1	0.1	0.049	0.00004	<0.1
Chicoreus spp.	Murexes	14	13	0.7	46.214	0.024	0.1
Anachis spp.	Dove shell	2	2	0.1	0.082	0.0001	<0.1
Busycotypus spiratus	Pear whelk	14	14	0.8	84.275	0.041	0.1
Busycon sinistrum	Lightning whelk	138	120	6.7	9094.765	5.800	21.0
Melongena corona	Crown conch	4	4	0.2	41.422	0.010	<0.1
Fasciolariidae	Spindles, tulips, and latiruses	3	3	0.2	34.448	0.018	0.1
Fasciolaria spp.	Tulips	9	6	0.3	24.192	0.013	<0.1
Fasciolaria lilium	Banded tulip	11	11	0.6	90.915	0.061	0.2
Fasciolaria tulipa	True tulip	12	12	0.7	198.560	0.256	0.9
Pleuroploca gigantea	Horse conch	7	6	0.3	1141.278	0.640	2.3
Marginella apicina	Atlantic marginella	5	5	0.3	0.481	0.0004	<0.1
Bivalvia	Indeterminate bivalves	—	—	—	2808.847	0.231	0.8
Geukensia demissa	Ribbed mussel	1	1	0.1	0.230	0.0002	<0.1
Anadara sp.	Arks	1	1	0.1	1.018	0.0001	<0.1
Argopecten spp.	Bay and callico scallops	1072	293	16.3	826.479	0.100	0.4
Crassostrea virginica	Eastern oyster	43	27	1.5	656.940	0.092	0.3
Chamidae	Jewelboxes	2	2	0.1	2.025	0.002	<0.1
Cardiidae	Cockles and pricklycockles	1	1	0.1	0.288	0.0004	<0.1
Dinocardium robustum	Atlantic giant cockle	3	2	0.1	3.570	0.002	<0.1
Trachycardium egmontianum	Florida pricklycockle	1	1	0.1	4.322	0.003	<0.1
Rangia cuneata	Atlantic rangia	13	8	0.4	25.001	0.009	<0.1
Chione cancellata	Cross-barred venus	1	1	0.1	0.015	0.0001	<0.1
Dosinia discus	Disk dosinia	1	1	0.1	0.127	0.0003	<0.1
Macrocallista nimbosa	Sunray venus	75	47	2.6	154.243	0.032	0.1

Table 4.21. Hare Hammock Aggregated (3.18-mm) Species List. (cont.)

			MNI			**Biomass**	
Taxa	**Common Name**	**NISP**	**#**	**%**	**Weight, g**	**kg**	**%**
Mercenaria sp.	Quahog	1	1	0.1	9.115	0.003	<0.1
Decapoda	Crabs	9	1	0.1	1.628	0.015	0.1
Balanus spp.	Barnacles	11	2	0.1	0.292	—	—
Chondrichthyes	Indeterminate cartilaginous fishes	11	—	—	0.285	0.043	0.2
Myliobatidae	Rays	1	1	0.1	0.116	0.020	0.1
Rhinoptera bonasus	Cownose ray	4	1	0.1	0.728	0.096	0.3
Actinopterygii	Indeterminate ray-finned fishes	27409	—	—	629.158	5.457	19.8
Acipenser oxyrhynchus	Atlantic sturgeon	2	1	0.1	1.637	0.045	0.2
Lepisosteus spp.	Gars	10	1	0.1	1.768	0.054	0.2
Amia calva	Bowfin	2	1	0.1	0.292	0.002	<0.1
Elops saurus	Ladyfish	63	2	0.1	2.623	0.065	0.2
Clupeidae	Herring, menhadens, and shads	142	4	0.2	3.569	0.083	0.3
Brevoortia smithii	Yellowfin menhaden	3	(3)	—	0.109	0.005	<0.1
Siluriformes	Catfishes	1269	—	—	49.752	0.817	3.0
Ariidae	Sea catfishes	388	—	—	35.262	0.589	2.1
Ariopsis felis	Hardhead catfish	2574	68	3.8	236.889	3.596	13.0
Bagre marinus	Gafftopsail catfish	4	1	0.1	1.041	0.021	0.1
Opsanus spp.	Toadfishes	274	17	0.9	15.974	0.270	1.0
Mugil spp.	Mullets	1481	71	3.9	98.358	1.133	4.1
Cyprinodontidae	Killifishes and pupfishes	41	4	0.2	0.448	0.016	0.1
Pomatomus saltatrix	Bluefish	9	1	0.1	0.968	0.027	0.1
Carangidae	Jacks, permits, and pompanos	58	—	—	6.238	0.195	0.7
Caranx spp.	Jacks	19	—	—	3.125	0.106	0.4
Caranx hippos	Crevalle jack	3	1	0.1	2.706	0.093	0.3
Trachinotus spp.	Pompanos	12	2	0.1	1.423	0.053	0.2
Lutjanus spp.	Snappers	1	1	0.1	0.051	0.002	<0.1
Orthopristis chrysoptera	Pigfish	22	6	0.3	0.461	0.013	<0.1
Sparidae	Porgies	5	—	—	0.444	0.008	<0.1
Archosargus probatocephalus	Sheepshead	2	1	0.1	3.278	0.047	0.2
Lagodon rhomboides	Pinfish	116	12	0.7	1.871	0.028	0.1
Sciaenidae	Drums	3	—	—	0.045	0.004	<0.1
Bairdiella chrysoura	Silver perch	2	1	0.1	0.043	0.004	<0.1
Cynoscion spp.	Seatrouts and corvinas	43	5	0.3	6.883	0.162	0.6
Cynoscion nebulosus	Spotted seatrout	13	(3)	—	4.441	0.117	0.4
Leiostomus xanthurus	Spot	116	36	2.0	2.562	0.078	0.3
Micropogonias undulatus	Atlantic croaker	17	3	0.2	1.144	0.043	0.2
Pogonias cromis	Black drum	45	9	0.5	21.277	0.374	1.4
Sciaenops ocellatus	Red drum	4	1	0.1	1.055	0.040	0.1
Paralichthyidae	Sand flounders	74	4	0.2	12.223	0.244	0.9
Ostraciidae	Boxfishes, cowfishes, trunkfishes	56	1	0.1	1.107	0.033	0.1
Chilomycterus schoepfi	Burrfishes	187	8	0.4	16.763	0.280	1.0
Tetraodontidae	Puffers	4	1	0.1	0.139	0.006	<0.1
Anaxyrus americanus	American toad	1	1	0.1	0.029	—	—
Testudines	Terrapins, tortoises, and turtles	346	—	—	56.877	0.474	1.7
Chelydra serpentina	Snapping turtle	3	1	0.1	2.101	0.052	0.2

Table 4.21. Hare Hammock Aggregated (3.18-mm) Species List. (cont.)

			MNI			**Biomass**	
Taxa	**Common Name**	**NISP**	**#**	**%**	**Weight, g**	**kg**	**%**
Kinosternidae	Mud and musk turtles	4	—	—	0.650	0.024	0.1
Kinosternon subrubrum	Eastern mud turtle	5	1	0.1	1.600	0.043	0.2
Emydidae	Pond turtles and terrapins	7	—	—	0.704	0.025	0.1
Pseudemys spp.	Cooters	3	1	0.1	2.296	0.052	0.2
Terrapene carolina	Eastern box turtle	13	3	0.2	31.244	0.052	0.2
Lacertilia	Indeterminate lizards	1	—	—	0.012	—	—
Anolis carolinensis	Green anole	2	1	0.1	0.018	—	—
Colubridae	Non-venomous snakes	6	1	0.1	0.168	0.002	<0.1
Aves	Indeterminate birds	1	—	—	0.036	0.001	<0.1
Phalacrocorax auritus	Double-crested cormorant	1	1	0.1	0.642	0.014	<0.1
Anatidae	Ducks, geese, and swans	1	1	0.1	0.104	0.003	<0.1
Passeriformes	Perching birds	1	1	0.1	0.011	0.0003	<0.1
Mammalia	Indeterminate mammals	98	—	—	26.458	0.502	1.8
Rodentia	Indeterminate rodents	4	—	—	0.122	0.004	<0.1
Sciurus carolinensis	Gray squirrel	10	1	0.1	0.812	0.022	0.1
Sigmodon hispidus	Hispid cotton rat	3	1	0.1	0.116	0.004	<0.1
Odocoileus virginianus	White-tailed deer	25	1	0.1	65.118	1.128	4.3
Vertebrata	Indeterminate vertebrates	—	—	—	98.132	—	—
Total		**37419**	**1802**		**45029.888**	**27.50213**	

Note: Aggregated species list includes Hare Hammock Early, Hare Hammock House Mound, and Hare Hammock Late. See Appendix A for list of proveniences and FS#s included.

Table 4.22. Hare Hammock Aggregated (3.18-mm) Summary Table.

	MNI		**Biomass**	
	#	**%**	**kg**	**%**
Aquatic gastropods	960	53.3	8.14198	48.5
Bivalves	386	21.4	0.2441	1.5
Decapods	1	0.1	0.015	0.1
Fishes	265	14.7	6.928	41.3
Turtles	6	0.3	0.199	1.2
Wild birds	3	0.2	0.017	0.1
Deer	1	0.1	1.197	7.1
Other wild mammals	1	0.1	0.022	0.1
Invertebrate commensals	175	9.7	0.01075	0.1
Vertebrate commensals	4	0.2	0.006	<0.1
Total	**1802**		**16.78083**	

Note: Anurans and barnacles are included in the MNI calculation, but are not included in the biomass calculation because allometric values are not currently available.

Table 4.23. Hare Hammock Aggregated (6.35-mm) Species List.

			MNI			**Biomass**	
Taxa	**Common name**	**NISP**	**#**	**%**	**Weight, g**	**kg**	**%**
Anthozoa	Indeterminate corals	2	—	—	0.505	—	—
Mollusca	Indeterminate molluscs	—	—	—	1311.455	—	—
Gastropoda	Indeterminate snails	—	—	—	7344.681	2.493	10.3
Anguispira strongyloides	Southeastern disc	40	40	2.2	4.197	0.003	<0.1
Polygyridae	Flatcoils	17	17	0.9	2.027	0.001	<0.1
Polygyra cereolus	Southern flatcoil	30	30	1.6	0.945	0.001	<0.1
Euglandina rosea	Rosey wolfsnail	6	6	0.3	10.657	0.006	<0.1
Ventridens spp.	Dome snails	15	15	0.8	0.338	0.0003	<0.1
Strombus alatus	Florida fighting conch	633	619	33.8	20791.241	1.318	5.4
Crepidula spp.	Slippersnails	40	40	2.2	6.813	0.004	<0.1
Crepidula aculeata	Spiny slippersnail	1	1	0.1	0.277	0.0002	<0.1
Crepidula fornicata	Atlantic slippersnail	13	13	0.7	1.676	0.001	<0.1
Turbo castanea	Chestnut turban	2	1	0.1	0.522	0.0004	<0.1
Naticidae	Moonsnails	25	25	1.4	203.932	0.045	0.2
Urosalpinx perrugata	Gulf oyster drill	6	6	0.3	2.571	0.002	<0.1
Muricidae	Rock snails and murexes	1	1	0.1	0.713	0.001	<0.1
Eupleura sulcidentata	Sharp-ribbed drill	1	1	0.1	0.141	0.0001	<0.1
Chicoreus spp.	Murexes	17	15	0.8	55.635	0.028	0.1
Busycotypus spiratus	Pear whelk	17	16	0.9	89.423	0.043	0.2
Busycon sinistrum	Lightning whelk	167	140	7.7	10589.269	6.899	28.4
Melongena corona	Crown conch	6	5	0.3	45.819	0.023	0.1
Fasciolariidae	Spindles, tulips, and latiruses	9	3	0.2	39.404	0.020	0.1
Fasciolaria spp.	Tulips	11	8	0.4	26.400	0.014	0.1
Fasciolaria lilium	Banded tulip	11	11	0.6	90.915	0.061	0.3
Fasciolaria tulipa	True tulip	12	12	0.7	198.560	0.256	1.1
Pleuroploca gigantea	Horse conch	9	9	0.5	1289.750	0.736	3.0
Marginella apicina	Atlantic marginella	3	3	0.2	0.603	0.0004	<0.1
Bivalvia	Indeterminate bivalves	—	—	—	6007.240	0.387	1.6
Geukensia demissa	Ribbed mussel	1	1	0.1	0.230	0.0002	<0.1
Anadara sp.	Arks	1	1	0.1	1.018	0.001	<0.1
Argopecten spp.	Bay and callico scallops	1919	511	27.9	1383.090	0.142	0.6
Crassostrea virginica	Eastern oyster	51	31	1.7	688.597	0.096	0.4
Chamidae	Jewelboxes	2	1	0.1	2.025	0.002	<0.1
Dinocardium robustum	Atlantic giant cockle	6	2	0.1	11.899	0.006	<0.1
Trachycardium egmontianum	Florida pricklycockle	4	3	0.2	6.775	0.004	<0.1
Rangia cuneata	Atlantic rangia	16	10	0.5	27.963	0.010	<0.1
Chione cancellata	Cross-barred venus	2	2	0.1	0.929	0.001	<0.1
Dosinia discus	Disk dosinia	1	1	0.1	0.127	0.0003	<0.1
Macrocallista nimbosa	Sunray venus	198	98	5.4	343.057	0.055	0.2
Mercenaria sp.	Quahog	1	1	0.1	9.115	0.003	<0.1
Decapoda	Crabs	8	1	0.1	2.496	0.021	0.1
Menippe mercenaria	Stone crab	1	1	0.1	1.118	0.011	<0.1
Balanus spp.	Barnacles	3	1	0.1	0.156	—	—
Rhinoptera bonasus	Cownose ray	1	1	0.1	0.347	0.051	0.2
Actinopterygii	Indeterminate ray-finned fishes	2430	—	—	188.928	2.060	8.5

Table 4.23. Hare Hammock Aggregated (6.35-mm) Species List. (cont.)

			MNI			**Biomass**	
Taxa	**Common name**	**NISP**	**#**	**%**	**Weight, g**	**kg**	**%**
Acipenser oxyrhynchus	Atlantic sturgeon	2	1	0.1	1.637	0.045	0.2
Lepisosteus spp.	Gars	3	1	0.1	1.434	0.045	0.2
Amia calva	Bowfin	1	1	0.1	0.258	0.001	<0.1
Elops saurus	Ladyfish	17	1	0.1	1.038	0.031	0.1
Siluriformes	Catfishes	99	—	—	7.913	0.142	0.6
Ariidae	Sea catfishes	46	—	—	10.168	0.181	0.7
Ariopsis felis	Hardhead catfish	1003	44	2.4	179.509	2.763	11.4
Bagre marinus	Gafftopsail catfish	4	1	0.1	1.045	0.021	0.1
Opsanus spp.	Toadfishes	56	6	0.3	7.473	0.148	0.6
Mugil spp.	Mullets	646	28	1.5	71.621	0.882	3.6
Perciformes cf. *Morone* spp.	Perch-like fishes	1	—	—	0.132	0.005	<0.1
Centrarchidae	Sunfishes	1	1	0.1	0.026	0.001	<0.1
Pomatomus saltatrix	Bluefish	8	1	0.1	0.960	0.027	0.1
Carangidae	Jacks, permits, and pompanos	51	—	—	7.121	0.219	0.9
Caranx spp.	Jacks	6	—	—	2.602	0.090	0.4
Caranx hippos	Crevalle jack	3	1	0.1	2.706	0.093	0.4
Trachinotus spp.	Pompanos	7	2	0.1	1.701	0.062	0.3
Lutjanus spp.	Snappers	2	1	0.1	0.328	0.011	<0.1
Sparidae	Porgies	2	1	0.1	0.202	0.004	<0.1
Archosargus probatocephalus	Sheepshead	6	1	0.1	5.105	0.071	0.3
Sciaenidae	Drums	2	—	—	0.680	0.029	0.1
Cynoscion spp.	Seatrouts and corvinas	40	3	0.2	7.753	0.177	0.7
Cynoscion nebulosus	Spotted seatrout	2	(1)	—	0.704	0.030	0.1
Leiostomus xanthurus	Spot	3	2	0.1	0.111	0.008	<0.1
Micropogonias undulatus	Atlantic croaker	1	1	0.1	0.448	0.021	0.1
Pogonias cromis	Black drum	23	2	0.1	29.311	0.474	2.0
Sciaenops ocellatus	Red rum	3	1	0.1	1.008	0.039	0.2
Paralichthyidae	Sand flounders	60	2	0.1	12.740	0.253	1.0
Ostraciidae	Boxfishes, cowfishes, trunkfishe	1	1	0.1	0.028	0.002	<0.1
Chilomycterus schoepfi	Burrfishes	61	8	0.4	14.351	0.248	1.0
Testudines	Terrapins, tortoises, and turtles	216	—	—	75.530	0.573	2.4
Chelydra serpentina	Snapping turtle	1	1	0.1	1.990	0.050	0.2
Kinosternidae	Mud and musk turtles	4	—	—	0.650	0.024	0.1
Kinosternon subrubrum	Eastern mud turtle	10	1	0.1	3.624	0.075	0.3
Emydidae	Pond turtles and terrapins	5	—	—	2.961	0.065	0.3
Malaclemys terrapin	Diamondback terrapin	2	1	0.1	1.660	0.044	0.2
Pseudemys spp.	Cooters	3	1	0.1	2.296	0.055	0.2
Terrapene carolina	Eastern box turtle	20	2	0.1	43.724	0.397	1.6
Cheloniidae	Sea turtles	1	1	0.1	0.742	0.026	0.1
Aves	Indeterminate birds	3	—	—	0.913	0.019	0.1
Phalacrocorax auritus	Double-crested cormorant	1	1	0.1	0.642	0.014	0.1
Anatidae	Ducks, geese, and swans	2	1	0.1	0.561	0.012	<0.1
Passeriformes	Perching birds	1	1	0.1	0.032	0.001	<0.1
Mammalia	Indeterminate mammals	61	—	—	33.430	0.619	2.6
Didelphis virginiana	Virginia opossum	1	1	0.1	0.671	0.018	0.1

Table 4.23. Hare Hammock Aggregated (6.35-mm) Species List. (cont.)

			MNI			**Biomass**	
Taxa	**Common name**	**NISP**	**#**	**%**	**Weight, g**	**kg**	**%**
Sciurus carolinensis	Gray squirrel	4	1	0.1	0.448	0.013	0.1
Sciurus niger	Fox squirrel	1	1	0.1	0.104	0.003	<0.1
Sigmodon hispidus	Hispid cotton rat	1	1	0.1	0.172	0.005	<0.1
Odocoileus virginianus	White-tailed deer	27	1	0.1	77.320	1.317	5.4
Vertebrata	Indeterminate vertebrates	—	—	—	67.412	—	—
Total		**8263**	**1829**		**51468.574**	**24.2602**	

Note: Aggregated species list includes Hare Hammock Early, Hare Hammock House Mound, Hare Hammock Late, and additional proveniences not reported elsewhere. See Appendix A for list of proveniences and FS#s included.

Table 4.24. Hare Hammock Aggregated (6.35-mm) Summary Table.

	MNI		**Biomass**	
	#	**%**	**kg**	**%**
Aquatic gastropods	929	50.8	9.4524	54.6
Bivalves	662	36.2	0.3205	1.9
Decapods	2	0.1	0.032	0.2
Fishes	112	6.1	5.478	31.6
Turtles	7	0.4	0.647	3.7
Wild birds	3	0.2	0.027	0.2
Deer	1	0.1	1.317	7.6
Other wild mammals	3	0.2	0.034	0.2
Invertebrate commensals	109	6.0	0.0113	0.1
Vertebrate commensals	1	0.1	0.005	<0.1
Total	**1829**		**17.3242**	

Note: Anurans and barnacles are included in the MNI estimate, but are not included in the biomass estimate because allometric values are not currently available.

Table 4.25. Northern Gulf Coast Region Species List.

		Mitchell River 1 8WL1278		Meig's Pasture 8OK102		Hawkshaw 8ES1287		Flash Island 1BA134		Shell Mound 8LV42		Harrison Ring 8BY1359		Mack Bayou 8WL101		Hare Hammock 8BY1347		Bayou St. John 1BA21		Strange's Ring 8BY1355		Bayview 8BY137		Bottle Creek 1BA2	
Taxon	**UI**	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg
Animalia	0.25					72.01	—											0.941	—					1.68	—
Invertebrata	0.50							4211.007	—	4409.00	—	18.500	—	1332.84	—			10066.366	—			1417.5	—		
Bryozoa	0.08																							0.004	—
Anthozoa	0.08															0.569	—								
Mollusca	0.75	10822.33	—	2940.730		23.75	—					1312.671	—	3.76	—	2522.052	—	3365.515	—	260.712	—			1.85	—
Gastropoda	0.92	0.54	0.0004	0.04	0.00004	4.60	0.003	20.197	0.011	9.30	0.005	1880.287	0.712			6373.048	2.188	395.493	0.170	114.599	0.054	17.7	0.010	0.20	0.0002
Pleuroceridae	0.08																							0.24	0.0002
Pleurocera canaliculata	0.08																							2.37	0.002
Elimia hydei	0.08																							1.07	0.001
Terrestrial snail	0.25											1.202	0.001			0.025	0.00002							0.05	0.00004
Anguispira strongyloides	0.17											0.134	0.0001			4.708	0.003								
Subulinidae	0.08							0.006	0.00001																
Polygyridea	0.08									0.10	0.0001														
Polygyridae	0.50							12.269	0.007	0.10	0.0001					0.067	0.0001	0.336	0.0003	0.111	0.0001	4.22	0.003		
Polygyra spp.	0.25			0.13	0.0001			0.132	0.0001									0.123	0.0001						
Polygyra cereolus	0.17											0.459	0.0003			1.061	0.001								
Euglandina rosea	0.42							30.012	0.016							10.657	0.006	3.100	0.002	0.095	0.0001	0.5	0.0004		
Glyphyalina indentata	0.08															0.061	0.0001								
Hawaiia miniscula	0.08									<0.1	0.000001														
Triodopsis hopetonensis	0.08											0.094	0.0001												
Triodopsis tridentata	0.08															0.014	0.00001								
Ventridens spp.	0.17											0.061	0.0001			0.605	0.0004								
Zonitidae	0.08							0.149	0.0001																
Zonitoides spp.	0.17											0.051	0.00004			0.020	0.00002								
Oligyra orbiculata	0.08															0.103	0.0001								
Turbo castanea	0.08															0.581	0.0004								
Neritidae	0.08	0.53	0.0004																						
Neritina reclivata	0.08	3724.94	1.335																						
Neritina spp.	0.33			3.90	0.002			2.487	0.002					20.04	0.011			4.420	0.003						
Littorina irrorata	0.33			368.90	0.118	0.37	0.0002			0.30	0.0001											0.6	0.0003		
Littorina spp.	0.25							2487.576	0.711									7.098	0.003			0.2	0.0001		
Vermetidae	0.08									<0.1	—														
Modulus cf. *modulus*	0.08																					0.2	0.0002		
Modulus modulus	0.17			0.47	0.0003																	0.2	0.0002		
Cerithium atratum	0.08			6.50	0.004																				
Cerithium eburneum	0.08									0.70	0.0005														
Cerithium sp.	0.08									<0.1	0.000001														
Seila adamsi	0.08									<0.1	0.000001														
Crepidula aculeata	0.17											2.321	0.002			0.046	0.00004								
Crepidula fornicata	0.17											12.862	0.007			3.688	0.002								
Crepidula spp.	0.50			0.60	0.0004			0.624	0.0004	16.50	0.009	0.182	0.0001			5.292	0.003					0.91	0.001		
Strombus alatus	0.42			1610.90	0.139							749.487	0.071			19233.094	1.231	151.978	0.017	52.391	0.007				
Naticidae/*Neverita*/*Polinices*	0.83			53.80	0.021	1495.17	0.135	65.487	0.024	16.60	0.011	63.680	0.032	316.76	0.057	167.410	0.040	694.075	0.088	29.777	0.016	7.7	0.007		
Muricidae	0.17															0.049	0.00004	29.685	0.016						
Chicoreus cf. *pomum*	0.08																					71.8	0.035		
Chicoreus spp.	0.25											14.138	0.008			46.214	0.024					0.3	0.0002		
Thais haemastoma floridana	0.08			16.80	0.009																				
Urosalpinx cinerea	0.08																	5.987	0.004						
Urosalpinx perrugata	0.42			2.30	0.001					1.50	0.001	5.910	0.004			2.460	0.002					0.6	0.0004		
Urosalpinx tampaensis	0.08																					0.5	0.0004		
Eupleura sulcidentata	0.08			0.50	0.0004																				
Anachis floridana	0.08									<0.1	0.000001														
Anachis spp.	0.17									<0.1	0.000001					0.082	0.0001								
Melongena corona	0.83			9.50	0.003	34.72	0.008	1.078	0.0004	673.70	0.115	38.883	0.009	35.45	0.009	41.422	0.010	496.804	0.088	37.188	0.009	37.39	0.009		
Busycon sinistrum	0.58					18.78	0.005			19.50	0.005	2778.414	1.501			9094.765	5.800	16.856	0.004	89.054	0.030	77.23	0.025		
Busycotypus canaliculatus	0.08																	13.147	0.007						
Busycotypus spiratus	0.33			18.50	0.010							170.300	0.078			84.275	0.041			1.471	0.001				
Busycotypus spp.	0.08																			0.389	0.0003				
Nassarius vibex	0.08					0.28	0.0002																		
Fasciolariidae	0.25											15.962	0.009			34.448	0.018					9.2	0.005		
Fasciolaria lilium	0.17											40.609	0.020			90.915	0.061								
Fasciolaria spp.	0.25									27.10	0.014	73.391	0.036			24.192	0.013								
Fasciolaria tulipa	0.25											224.377	0.289			198.560	0.256					40.4	0.052		
Pleuroploca gigantea	0.25											1169.296	0.658			1141.278	0.640			29.008	0.009				
Olividae	0.08																	5.264	0.003						
Marginella apicina	0.17											0.970	0.001			0.481	0.0004								
Marginella spp.	0.08			0.04	0.00004																				
Boonea impressa	0.17									<0.1	0.000003											0.1	0.0001		
Melampus bidentatus	0.08							0.265	0.0002																
Bivalvia	0.75	890.85	0.106			25.02	0.009	76.720	0.020			1851.752	0.174	2.24	0.002	2808.847	0.231	17.968	0.007	2302.685	0.201			74.91	0.020
Anadara ovalis	0.17					12.26	0.006											4.471	0.001						
Anadara spp.	0.17															1.018	0.0001	1.093	0.0001						
Noetia ponderosa	0.08			70.80	0.019																				
Mytilidae	0.42	57.51	0.015					0.379	0.001	5.60	0.003			0.35	0.001									59.79	0.017
Brachidontes exustus	0.08			0.90	0.001																				
Geukensia demissa	0.25							124.205	0.029							0.230	0.0002	40.686	0.012						
Chlamys spp.	0.08					0.07	0.0002																		
Argopecten irradians	0.42			506.20	0.072	133.10	0.029							7.81	0.004					0.206	0.0004	1128.3	0.124		
Argopecten spp.	0.42									11.10	0.005	424.629	0.064			826.479	0.100	246.944	0.044	0.256	0.0004				
Ostrea equestris	0.17									144.50	0.031											2.0	0.002		
Ostreidae	0.08							51.423	0.015																

Table 4.25. Northern Gulf Coast Region Species List. (cont.)

		Mitchell River 1 8WL1278		Meig's Pasture 8OK102		Hawkshaw 8ES1287		Flash Island 1BA134		Shell Mound 8LV42		Harrison Ring 8BY1359		Mack Bayou 8WL101		Hare Hammock 8BY1347		Bayou St. John 1BA21		Strange's Ring 8BY1355		Bayview 8BY137		Bottle Creek 1BA2	
Taxon	**UI**	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg
Crassostrea virginica	1.00	18312.40	2.319	12892.40	1.650	103677.12	12.464	44390.457	5.474	32339.20	4.026	49.040	0.007	1840.22	0.25	656.940	0.092	24151.378	3.033	879.096	0.105	8460.3	1.097	259.88	0.037
Lopha frons	0.08																					0.81	0.001		
Chamidae	0.17											0.156	0.0003			2.025	0.002								
Fusconaia ebena	0.08																							435.14	0.065
Quadrula apiculata	0.08																							109.82	0.025
Quadrula spp.	0.08																							14.34	0.006
Unionidae	0.17					9.40	0.005																	356.52	0.057
Cardiidae	0.25															0.288	0.0004	1.426	0.001	0.158	0.0003				
Dinocardium robustum	0.25									5.60	0.003	2.542	0.002			3.570	0.002								
Trachycardium egmontianum	0.25											13.933	0.006			4.322	0.003					2.3	0.002		
Trachycardium muricatum	0.08											0.440	0.001												
Trachycardium spp.	0.08											1.628	0.001												
Mactra fragilis	0.08																	8.070	0.004						
Spisula solidissima	0.08																					1.1	0.001		
Rangia cuneata	0.67	840.14	0.101	2057.86	0.187	40.59	0.013	3226.034	0.253					22719.103	0.955	25.001	0.009	1881.816	0.176					8228.45	0.479
Tellina spp.	0.08					48.14	0.015																		
Donax variabilis	0.17							13.091	0.006									4290.337	0.308						
Polymesoda carolina	0.33	179.32	0.076	105.20	0.049	19.71	0.012																	9.03	0.006
Chione cancellata	0.42			60.80	0.017			0.277	0.0004							0.015	0.0001	1.926	0.002			36.71	0.012		
Mercenaria spp.	0.75	160.54	0.037	6965.90	1.294	585.93	0.126	423.870	0.093	95.70	0.023					9.115	0.003	6538.344	1.220	272.349	0.061			5.62	0.002
Macrocallista nimbosa	0.33											53.895	0.016			154.243	0.032			0.783	0.001	7.4	0.004		
Dosinia discus	0.17											0.289	0.0004			0.127	0.0003								
Cyrtopleura costata	0.17							17.781	0.007	2.60	0.002														
Pholadidae	0.08					0.75	0.001																		
Decapoda/Brachyura	0.92	0.11	0.002			3.12	0.025	12.710	0.079	1.70	0.015	1.728	0.015	0.80	0.008	1.628	0.015	6.226	0.044	0.031	0.001	0.1	0.001	0.24	0.003
Callinectes sapidus	0.25							1.303	0.012									0.338	0.004	0.035	0.001				
Menippe spp.	0.08									0.80	0.008														
Menippe mercenaria	0.08																					1.4	0.013		
Cirripedia/Balanidae/*Balanus*	0.67							57.392		376.20	—	1.696	—			0.292	—	22.635	—	0.136	—	0.9	—	0.111	—
Chondrichthyes	0.50							1.506	0.179	0.50	0.069	0.010	0.002			0.285	0.043	0.117	0.020	0.018	0.004				
Squaliformes	0.08					1.50	0.178																		
Carcharinidae	0.25							0.209	0.033			0.266	0.040					0.026	0.005						
Carcharhinus sp.	0.08					1.30	0.158																		
Sphyrnidae	0.08																	0.091	0.016						
Rajiformes	0.25	0.24	0.037			0.05	0.01											0.053	0.010						
Dasyatidae	0.08																			0.381	0.055				
Myliobatiformes	0.17							0.071	0.013									0.013	0.003						
Myliobatidae	0.17															0.116	0.020	0.061	0.011						
Rhinoptera bonasus	0.33							0.298	0.044							0.728	0.096	0.300	0.045	0.224	0.035				
Actinopterygii	1.00	106.33	1.293	12.98	0.235	1096.40	8.558	725.590	6.126	107.90	1.308	274.465	2.787	1137.47	8.816	629.158	5.457	1989.972	13.869	93.742	1.167	75.3	0.978	78.75	1.014
Acipenseridae	0.08							0.275	0.011																
Acipenser oxyrinchus	0.17	0.10	0.005													1.637	0.045								
Lepisosteidae/*Lepisosteus*	0.83	12.37	0.295			9.16	0.227	29.492	0.629	<0.1	0.0001			4.97	0.134	1.768	0.054	46.539	0.935	1.163	0.038	0.1	0.004	5.53	0.147
Amia calva	0.33	0.15	0.001									0.515	0.003			0.292	0.002							0.04	0.0002
Anguilla rostrata	0.25	0.08	0.004					0.065	0.003									0.128	0.006						
Elops saurus	0.92	0.41	0.015	0.06	0.003	0.60	0.02	1.958	0.051	0.20	0.008	0.171	0.007	4.54	0.1	2.623	0.065	30.979	0.455			0.3	0.012	0.09	0.005
Clupeidae	0.83	2.82	0.068	0.10	0.005	17.07	0.284	23.928	0.371			0.214	0.009	3.16	0.075	3.569	0.083	0.514	0.018			0.1	0.005	3.72	0.085
Alosa spp.	0.08			0.06	0.003																				
Alosa mediocris	0.08																					1.3	0.037		
Brevoortia spp.	0.33	0.241	0.010			0.91	0.028									0.109	0.005							0.10	0.005
Opisthonema oglinum	0.08							0.009	0.001																
Engraulidae	0.08			0.06	0.003																				
Notemigonus spp.	0.08																							<0.01	0.0001
Siluriformes	0.83	7.32	0.132			0.11	0.002	21.204	0.363			0.907	0.018	16.84	0.292	49.752	0.817	74.003	1.191	4.471	0.083	0.2	0.004	1.01	0.020
Ictaluridae	0.17											0.093	0.002											1.37	0.027
Ariidae	0.92	3.14	0.059	0.61	0.012	4.18	0.078	31.400	0.527	0.50	0.01	0.251	0.005	5.86	0.107	35.262	0.589	297.266	4.461	5.939	0.108	2.5	0.048		
Ariopsis felis	0.92	6.69	0.121			14.87	0.259	25.158	0.427	3.10	0.058	6.309	0.115	54.45	0.89	236.889	3.596	244.077	3.699	17.029	0.295	1.0	0.020	0.24	0.005
Bagre marinus	0.58	0.61	0.012	0.04	0.001	11.44	0.202	22.871	0.39					0.29	0.006	1.041	0.021	33.404	0.559						
Opsanus spp.	0.67					3.88	0.088	0.273	0.011	0.10	0.005	9.224	0.165			15.974	0.270	5.439	0.115	5.547	0.117	1.6	0.044		
Mugil spp.	0.92	3.91	0.089			19.95	0.321	38.056	0.535	1.80	0.048	15.717	0.273	32.75	0.475	98.358	1.133	464.994	3.866	10.357	0.191	32.8	0.476	14.09	0.244
Mugil cephalus	0.08									1.40	0.039														
Belonidae	0.17	0.02	0.001					0.116	0.006																
Strongylura spp.	0.08					0.04	0.002																		
Cyprinodontidae	0.50	0.03	0.002			0.21	0.009	0.031	0.002			0.159	0.003	0.14	0.006	0.448	0.016								
Fundulus spp.	0.33	0.02	0.001			0.82	0.026			<0.1	0.0003									0.047	0.003				
Fundulus grandis	0.08					0.29	0.011																		
Triglidae	0.08																	0.018	0.001						
Prionotus spp.	0.08											0.107	0.004												
Perciformes	0.08																	0.400	0.013						
Centrarchidae	0.25	0.02	0.001					0.017	0.001															2.16	0.033
cff. *Ambloplites* spp.	0.08																							0.05	0.001
Lepomis spp.	0.25	0.06	0.002									0.023	0.001											0.24	0.005
Lepomis auritus	0.08	0.11	0.003																						
Lepomis aff. *macrochirus*	0.08																							0.04	0.001
Lepomis macrochirus	0.08																							0.13	0.003
Lepomis microlophus	0.17	1.08	0.019																					0.54	0.010
Micropterus spp.	0.17	0.57	0.011																					2.07	0.032
Micropterus salmoides	0.33	0.02	0.001			0.09	0.002											0.294	0.006			2.5	0.038		
Pomoxis nigromaculatus	0.08																							0.09	0.002
Pomatomus saltatrix	0.33					0.01	0.0004							0.45	0.014	0.968	0.027	0.441	0.014						
Coryphaena spp.	0.08											0.038	0.002												

Table 4.25. Northern Gulf Coast Region Species List. (cont.)

		Mitchell River 1 8WL1278		Meig's Pasture 8OK102		Hawkshaw 8ES1287		Flash Island 1BA134		Shell Mound 8LV42		Harrison Ring 8BY1359		Mack Bayou 8WL101		Hare Hammock 8BY1347		Bayou St. John 1BA21		Strange's Ring 8BY1355		Bayview 8BY137		Bottle Creek 1BA2	
Taxon	**UI**	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg
Carangidae	0.83	0.20	0.009	0.72	0.029	0.06	0.003	0.243	0.011	1.40	0.052	1.514	0.056	40.87	1.019	6.238	0.195	65.979	1.553	0.557	0.023				
Caranx spp.	0.42	0.02	0.001									0.564	0.024			3.125	0.106	10.334	0.304			8.5	0.256		
Caranx crysos	0.33					0.61	0.025			0.60	0.025	0.631	0.026					3.566	0.119						
Caranx hippos	0.50			2.07	0.074	275.88	5.468			11.30	0.329			13.23	0.378	2.706	0.093	19.031	0.520						
Caranx latus	0.17							0.017	0.001			0.200	0.009												
Chloroscombrus chrysurus	0.17					0.42	0.018											0.025	0.002						
Selene vomer	0.08																	0.055	0.003						
Trachinotus spp.	0.17											0.618	0.025			1.423	0.053								
Lutjanus spp.	0.17															0.051	0.002	0.101	0.004						
Haemulidae	0.08																					0.6	0.016		
Orthopristis chrysoptera	0.58	0.01	0.001					0.019	0.001	<0.1	0.0001	0.520	0.014			0.461	0.013	0.048	0.002	0.061	0.002				
Sparidae or Sciaenidae	0.08	0.06	0.003																						
Sparidae	0.58	0.07	0.001	0.03	0.001			0.509	0.009					23.61	0.291	0.444	0.008	3.127	0.045	0.095	0.002				
Archosargus probatocephalus	0.83	0.03	0.001			79.01	0.883	64.378	0.731			0.355	0.006	383.88	3.78	3.278	0.047	279.919	2.827	0.804	0.013	0.5	0.008	1.38	0.021
Calamus spp.	0.08					0.02	0.0004																		
Lagodon rhomboides	0.75	0.07	0.001	0.13	0.002			0.205	0.004	0.20	0.004	0.949	0.015	2.90	0.042	1.871	0.028	1.111	0.017	0.156	0.003				
Sciaenidae	0.75	0.15	0.010			0.49	0.023	13.678	0.27			0.721	0.031	114.10	1.295	0.045	0.004	37.985	0.574	0.138	0.009			0.59	0.026
Aplodinotus grunniens	0.08																							1.05	0.040
Bairdiella chrysoura	0.58	0.06	0.005			0.25	0.014	0.209	0.012	0.20	0.012	0.092	0.007			0.043	0.004	0.640	0.028						
Cynoscion spp.	0.92	0.10	0.007			13.21	0.263	40.978	0.607	0.90	0.036	3.459	0.097	3.94	0.107	6.883	0.162	40.014	0.597	1.768	0.059	0.6	0.027	0.41	0.020
Cynoscion arenarius	0.08							5.450	0.136																
Cynoscion nebulosus	0.50							17.533	0.324	1.00	0.039	2.936	0.086			4.441	0.117	2.075	0.067			2.7	0.081		
Cynoscion nothus	0.08																	0.122	0.008						
Larimus fasciatus	0.08							4.598	0.12																
Leiostomus xanthurus	0.75	0.08	0.006	0.59	0.026			0.620	0.027	<0.1	0.0002	0.532	0.024	0.83	0.034	2.562	0.078	0.970	0.038	0.106	0.007				
Menticirrhus spp.	0.17							0.337	0.017									0.865	0.035						
Menticirrhus littoralis	0.08																					1.3	0.047		
Micropogonias undulatus	0.92	2.55	0.078	0.09	0.007	16.52	0.31	86.441	1.055			2.559	0.078	1.41	0.05	1.144	0.043	13.774	0.271	0.146	0.009	1.2	0.045	0.70	0.030
Pogonias cromis	0.67					0.31	0.016	0.796	0.033	7.90	0.18	8.713	0.193	1.99	0.065	21.277	0.374	61.038	0.815			6.6	0.157		
Sciaenops ocellatus	0.75					6.23	0.151	16.281	0.307	0.30	0.016	0.991	0.039	15.63	0.298	1.055	0.040	115.568	1.308	0.719	0.030			4.14	0.111
Stellifer lanceolatus	0.17							0.016	0.002									0.047	0.004						
Trichiuridae	0.08							0.008	0.001																
cf. *Scomberomorus* spp.	0.08																					0.1	0.004		
Peprilus spp.	0.25					0.10	0.005	0.886	0.027									0.055	0.002						
Paralichthyidae	0.50							8.425	0.175	<0.1	0.0001	2.174	0.053			12.223	0.244	31.450	0.566	6.414	0.138				
Paralichthys spp.	0.58					1.53	0.038	1.028	0.027					9.81	0.201			13.178	0.261	0.151	0.005	1.9	0.047	1.72	0.043
cf. Mullidae	0.08																					0.1	0.004		
Ostraciidae	0.25									<0.1	0.0001	0.300	0.006			1.107	0.033								
Diodontidae	0.00																								
Chilomycterus schoepfi	0.25											3.965	0.074			16.763	0.280			1.650	0.045				
Diodon spp.	0.08					0.98	0.03																		
Tetraodontidae	0.17											0.036	0.00001			0.139	0.006								
Sphoeroides spp.	0.08																			0.129	0.006				
Caudata	0.25					0.01	—	0.024	—									0.003	—						
Amphiuma means	0.08	0.01	—																						
Anura	0.50	<0.01	—			0.09	—	0.106	—			0.017	—					0.102	—					0.04	—
Anaxyrus spp.	0.17															0.029	—	0.056	—						
Scaphiopus holbrookii	0.17							0.215	—									0.053	—						
Ranidae	0.08																			0.033	—				
Reptilia	0.08	1.23	—																						
Alligator mississippiensis	0.08	1.27	0.018																						
Testudines	0.92	5.90	0.104			4.43	0.086	6.522	0.111	1.90	0.049	57.735	0.479	20.56	0.24	56.877	0.474	5.960	0.105	30.485	0.312	2.1	0.052	3.07	0.067
Chelydra serpentina	0.08															2.101	0.052								
Kinosternidae	0.75	0.49	0.020			0.34	0.015	5.356	0.097	0.20	0.011			0.33	0.015	0.650	0.024	0.416	0.018	0.755	0.026	2.4	0.057		
cf. Kinosternidae	0.08									2.70	0.062														
Kinosternon spp.	0.25					2.55	0.059	1.679	0.045											0.815	0.028				
Kinosternon subrubrum	0.25							0.286	0.014			3.455	0.073			1.600	0.043								
Sternotherus spp.	0.08							0.454	0.019																
Emydidae	0.50	0.51	0.020					4.899	0.092			1.333	0.038			0.704	0.025	0.408	0.017	3.327	0.071				
Deirochelys reticularia	0.08							0.657	0.024																
Malaclemys terrapin	0.25					4.11	0.082	0.185	0.01			0.614	0.023												
Pseudemys spp.	0.17													39.84	0.373	2.296	0.052								
Terrapene carolina	0.67	4.41	0.085			5.41	0.098	20.810	0.242			3.316	0.071	10.54	0.153	31.244	0.052			0.928	0.030	2.9	0.065		
cf. *Terrapene carolina*	0.08																							0.36	0.016
Gopherus polyphemus	0.08					8.50	0.133																		
Cheloniidae	0.08																	2.377	0.056						
Squamata	0.17					0.01	—																	<0.01	—
Lacertilia	0.17							0.017	—							0.012	—								
Iguanidae	0.25	0.02	—			0.04	—																	<0.01	—
Anolis carolinensis	0.17	0.01	—													0.018	—								
Serpentes	0.42							0.047	0.001	0.20	0.003			0.40	0.005			0.167	0.002					0.01	0.0001
Colubridae	0.58	0.35	0.005			0.08	0.001	0.128	0.002			0.174	0.002			0.168	0.002	0.074	0.001	0.049	0.001				
Aves	0.92	1.01	0.021			2.46	0.046	0.610	0.013	0.90	0.019	0.544	0.012	7.58	0.129	0.036	0.001	1.651	0.032	0.277	0.006	0.1	0.003	0.30	0.007
Aves, large	0.17					1.31	0.026																	2.90	0.054
Aves, medium	0.17					4.42	0.079																	4.73	0.084
Aves, small	0.17					0.14	0.003																	0.03	0.001
Podiceps auritus	0.08					0.27	0.006																		
Phalacrocorax auritus	0.08															0.642	0.014								
Anatidae	0.42							0.122	0.003			0.368	0.008			0.104	0.003	0.701	0.015					2.60	0.049
Aix sponsa	0.08							0.787	0.016																
Anas platyrhynchos	0.08																							1.27	0.025

Table 4.25. Northern Gulf Coast Region Species List. (cont.)

		Mitchell River 1 8WL1278		Meig's Pasture 8OK102		Hawkshaw 8ES1287		Flash Island 1BA134		Shell Mound 8LV42		Harrison Ring 8BY1359		Mack Bayou 8WL101		Hare Hammock 8BY1347		Bayou St. John 1BA21		Strange's Ring 8BY1355		Bayview 8BY137		Bottle Creek 1BA2	
Taxon	**UI**	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg	Wt., g	Bm., kg
Meleagris gallopavo	0.17					15.74	0.251							16.98	0.269										
Buteo spp.	0.08																							1.70	0.033
Fulica americana	0.08																							1.31	0.026
Passeriformes	0.17							0.011	0.0003							0.011	0.0003								
Mammalia	0.83	7.28	0.157			0.16	0.005	89.237	1.498	0.60	0.017	72.260	1.239	2.04	0.05	26.458	0.502	106.334	1.754	31.782	0.592			4.69	0.106
Mammalia, large	0.25			6.85	0.149	107.46	1.771																	10.07	0.210
Mammalia, small	0.08																							0.08	0.003
Didelphis virginiana	0.50					3.63	0.084	4.537	0.103			1.535	0.039	0.10	0.003			3.733	0.086	0.276	0.008				
Blarina brevicauda	0.08							0.012	0.0005																
Blarina carolinensis	0.08							0.015	0.001																
Vespertilionidae	0.08							0.040	0.001																
Sylvilagus spp.	0.33			0.02	0.001			1.603	0.04			0.091	0.003							0.478	0.014				
Rodentia	0.67	0.10	0.003			0.02	0.001	0.108	0.004			0.101	0.003	0.02	0.001	0.122	0.004					0.1	0.003	0.01	0.0004
Glaucomys volans	0.08							0.017	0.001																
Sciurus spp.	0.17	0.09	0.003															0.396	0.011						
Sciurus carolinensis	0.33			0.09	0.003							0.194	0.006			0.812	0.022	0.674	0.018						
Sciurus niger	0.08					2.64	0.063																		
Sigmodontinae	0.17							0.081	0.003									0.135	0.004						
Oryzomys palustris	0.08							0.032	0.001																
Peromyscus spp.	0.08							0.088	0.003																
Neotoma floridana	0.08																	0.181	0.006						
Sigmodon hispidus	0.50					0.08	0.003	0.268	0.008			0.031	0.001			0.116	0.004	0.235	0.007	0.019	0.001				
cf. *Sigmodon hispidus*	0.08																					0.1	0.003		
Carnivora	0.08																	0.612	0.017						
Canis sp.	0.08																	0.072	0.002						
Mustela vison	0.08																							0.19	0.006
Lontra canadensis	0.08	8.32	0.177																						
Procyon lotor	0.33	0.09	0.003					0.275	0.008			0.093	0.003							0.128	0.004				
Ursus americanus	0.08							8.525	0.181																
Artiodactyla	0.08					6.72	0.146																		
Odocoileus virginianus	0.92	31.39	0.585	23.71	0.454	128.80	2.084	176.337	2.765			32.287	0.600	52.67	0.932	65.118	1.128	70.558	1.213	9.804	0.205	10.6	0.220	27.33	0.516
Delphinidae	0.08													3.98	0.091										
Vertebrata	1.00	63.07	—	15.92	—	141.38	—	53.798	—	4.90	—	125.730	—	479.39	—	98.132	—	238.455	—	57.666	—	146.9	—	12.61	—
Total		35264.503	7.4978	**27757.80**	**4.60528**	108224.19	35.6094	**56790.001**	**25.68841**	38308.10	6.67671	**11616.145**	**10.02445**	28786.923	22.033	**45029.888**	**27.50213**	56794.405	47.91350	**4359.164**	**4.243**	11635.570	4.1673	**9,754.865**	**3.85424**

Table 4.26. Comparison of Vertebrate and Invertebrate Species Richness, Diversity, Equitability, Mean TL, VI, and Abundance Indices in the Northern Gulf Coast Region.

	Mitchell River 1 8WL1278	Meig's Pasture 8Ok102	Hawk-shaw 8ES1287	Plash Island 1BA134	Shell Mound 8LV42	Harrison Ring 8BY1359	Mack Bayou 8WL101	Hare Hammock 8BY1347	Bayou St. John 1BA21	Strange's Ring 8BY1355	Bayview 8BY137	Bottle Creek 1BA2
Mean age ± 1σ, cal B.P.	5124 ± 1414	3800 ± 433	1724 ± 102	1331 ± 230	1336 ± 46	1327 ± 60	1305 ± 132	1102 ± 143	1135 ± 138	1082 ± 159	1107 ± 324	649 ± 118
Median age, cal B.P.	4633	3801	1709	1361	1334	1324	1308	1120	1118	1108	1104	628
Sources of biomass, %												
Fishes	12.9	2.9	35.7	33.1	15.3	26.1	68.0	41.4	71.3	63.5	42.8	37.2
Invertebrates	70.3	86.2	52.6	44.0	82.8	57.0	13.2	50.3	22.3	16.3	45.7	31.8
Other	16.6	11.0	11.7	22.9	2.0	16.9	18.8	8.3	6.4	20.2	11.5	31.0
Species richness												
Total	42	32	56	67	41	62	34	70	67	40	42	39
Fishes	23	8	27	31	18	28	17	29	34	18	17	19
Invertebrates	7	21	16	14	19	22	8	28	20	12	20	10
Other	12	3	13	22	4	12	9	13	13	10	5	10
Diversity (H')												
Total taxa	1.62	1.71	1.75	2.34	1.07	2.63	2.31	2.31	2.62	2.75	2.36	2.39
Fishes	1.91	1.18	1.58	2.40	1.78	2.54	1.61	1.85	2.18	2.14	2.04	2.08
Invertebrates	0.92	1.39	0.19	0.65	0.31	1.44	0.81	1.11	1.21	1.59	0.89	0.95
Other	1.14	0.06	1.09	0.85	1.39	1.05	1.37	0.80	0.71	1.12	0.98	0.72
Evenness (V')												
Total	0.43	0.49	0.43	0.57	0.29	0.64	0.65	0.54	0.62	0.75	0.63	0.65
Fishes	0.61	0.57	0.48	0.70	0.61	0.76	0.57	0.55	0.62	0.74	0.72	0.71
Invertebrates	0.47	0.46	0.07	0.25	0.10	0.47	0.39	0.33	0.40	0.64	0.30	0.41
Other	0.46	0.05	0.43	0.28	0.73	0.42	0.63	0.31	0.28	0.49	0.61	0.31
Trophic level (TL)												
Fishes	3.64	3.55	3.59	3.63	3.58	3.44	3.43	3.23	3.29	3.28	3.41	3.34
Fishes and invertebr	2.34	2.15	2.71	2.76	2.34	2.78	3.22	2.79	3.01	3.07	2.76	2.77
Vulnerability index (VI)												
Fishes	58.52	44.21	49.34	45.78	53.10	46.74	40.40	44.86	46.85	46.87	51.32	51.73
Abundance indices (AI)												
Sea catfish	0.20	0.02	0.06	0.20	0.11	0.09	0.33	0.59	0.54	0.46	0.06	0.01
Mullet	0.09	0.00	0.04	0.08	0.15	0.21	0.16	0.16	0.24	0.22	0.40	0.30
Deer	0.60	0.82	0.23	0.41	0.00	0.45	0.31	0.17	0.08	0.24	0.19	0.63
Abundance indices (AI)												
Sea catfish	0.34	0.03	0.10	0.34	0.19	0.15	0.56	1.00	0.92	0.78	0.10	0.01
Mullet	0.23	0.00	0.09	0.20	0.38	0.53	0.40	0.40	0.60	0.55	1.00	0.74
Deer	0.60	0.82	0.23	0.41	0.00	0.45	0.31	0.17	0.08	0.24	0.19	0.63

Table 4.27. Statistical Results of Mann-Kendall Trend Tests for Diversity, Evenness, TL, and VI Over Time in Northern Gulf Coast Region.

Diversity (H')	τ	p	**Significance level**
Total	0.534	0.02	*
Fishes	0.273	0.24	
Invertebrates	0.242	0.30	
Other	-0.182	0.45	
Evenness (V')			
Total	0.554	0.02	*
Fishes	0.308	0.19	
Invertebrates	0.107	0.68	
Other	0.062	0.84	
Trophic level (TL)			
Fishes	-0.636	< 0.01	**
Fishes and invertertebr	0.492	0.03	*
Vulnerability index (VI)			
Fishes	0.121	0.63	

Note: * indicates statistically significant result at $\alpha = .05$; ** indicates statistically significant result at $\alpha = .01$. "Other" includes all mammals, birds, and reptiles.

Table 4.28. Variables included in cluster and ordination analyses.

		Percent of total assemblage biomass																	
		Cluster 1								Cluster 2				Cluster 3					Cluster 4
MDS taxon	**Taxon**	**Mitchell River 1**	**Meigs Pasture**	**Hawk-shaw**	**Plash Island**	**Shell Mound**	**Bay-view**	**Avg**	**95% CI**	**Harrison Ring**	**Hare Hamm.**	**Avg**	**95% CI**	**Mack Bayou**	**Strange's Ring**	**Bayou St John**	**Avg**	**95% CI**	**Bottle Creek**
Nerite*	Neritidae*	17.8	0.0	0.0	0.0	0.0	0.0	3.0	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Perwinkle*	*Littorina* spp. *	0.0	2.6	0.0	2.8	0.0	0.0	0.9	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fighting conch	*Strombus alatus*	0.0	3.0	0.0	0.0	0.0	0.0	0.5	1.0	0.7	4.5	2.6	3.7	0.0	0.2	0.0	0.1	0.1	0.0
Lighting whelk	*Busycon sinistrum*	0.0	0.0	0.0	0.0	0.1	0.6	0.1	0.2	14.1	21.1	17.6	6.9	0.0	0.7	0.0	0.2	0.4	0.0
Tulip*	*Fasciolaria* spp. *	0.0	0.0	0.0	0.0	0.2	1.2	0.2	0.4	3.2	1.2	2.2	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Horse conch	*Plueroploca gigantea*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2	2.3	4.3	3.8	0.0	0.2	0.0	0.1	0.1	0.0
Scallop*	*Argopecten* spp. *	0.0	1.6	0.1	0.0	0.1	3.0	0.8	1.0	0.6	0.4	0.5	0.2	0.0	0.0	0.1	0.0	0.1	0.0
Oyster	*Crassostrea virginica*	30.9	35.8	35.0	21.3	60.3	26.3	34.9	10.9	0.1	0.3	0.2	0.2	1.1	2.5	6.3	3.3	2.6	1.0
Rangia	*Rangia cuneata*	1.3	4.1	0.0	1.0	0.0	0.0	1.1	1.3	0.0	0.0	0.0	0.0	4.3	0.0	0.4	1.6	2.3	12.4
Quahog	*Mercenaria* spp.	0.5	28.1	0.4	0.4	0.3	0.0	5.0	9.1	0.0	0.0	0.0	0.0	0.0	1.4	2.5	1.3	1.2	0.1
Gar	Lepisosteidae	3.9	0.0	0.6	2.4	0.0	0.1	1.2	1.3	0.0	0.2	0.1	0.2	0.6	0.9	2.0	1.2	0.7	3.8
Hardhead catfish	*Ariopsis felis*	1.6	0.0	0.7	1.7	0.9	0.5	0.9	0.5	1.1	13.1	7.1	11.8	4.0	7.0	7.7	6.2	1.9	0.1
Toadfish	*Opsanus* spp.	0.0	0.0	0.2	0.0	0.1	1.1	0.2	0.3	1.6	1.0	1.3	0.6	0.0	2.8	0.2	1.0	1.5	0.0
Mullet*	*Mugil* spp. *	1.2	0.0	0.9	2.1	1.3	11.4	2.8	3.4	2.6	4.1	3.4	1.5	2.2	4.5	8.1	4.9	2.9	6.3
Jack*	Carangidae *	0.0	1.6	15.4	0.0	5.3	6.1	4.7	4.7	0.6	0.7	0.7	0.1	1.7	0.0	2.0	1.2	1.1	0.0
Sheepshead	*Archosargus probatocephal*	0.0	0.0	2.5	2.8	0.0	0.2	0.9	1.1	0.1	0.2	0.2	0.1	17.2	0.3	5.9	7.8	8.4	0.5
Seatrout*	*Cynoscion* spp. *	0.1	0.0	0.7	4.2	1.1	2.6	1.5	1.3	1.7	1.0	1.4	0.7	0.5	1.4	1.4	1.1	0.5	0.5
Croaker	*Micropogonias undulatus*	1.0	0.2	0.9	4.1	0.0	1.1	1.2	1.2	0.7	0.2	0.5	0.5	0.2	0.2	0.6	0.3	0.2	0.8
Black drum	*Pogonias cromis*	0.0	0.0	0.0	0.1	2.7	3.8	1.1	1.4	1.8	1.4	1.6	0.4	0.3	0.0	1.7	0.7	0.9	0.0
Red drum	*Sciaenops ocellatus*	0.0	0.0	0.4	1.2	0.2	0.0	0.3	0.4	0.4	0.1	0.3	0.3	1.4	0.7	2.7	1.6	1.0	2.9
Flounder*	Paralichthyidae *	0.0	0.0	0.1	0.8	0.0	1.1	0.3	0.4	0.5	0.9	0.7	0.4	0.9	3.4	1.7	2.0	1.3	1.1
River otter	*Lontra canadensis*	2.4	0.0	0.0	0.0	0.0	0.0	0.4	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deer	*Odocoileus virginanus*	7.8	9.9	5.9	10.8	0.0	5.3	6.6	3.1	5.6	4.1	4.9	1.5	4.2	4.8	2.5	3.8	1.2	13.4

* Lower-level taxonomic identifications were aggregated to the taxonomic level indicated .

Table 4.29. Deer Stable Isotope Data.

Sample #	Site	Element	$\delta^{13}C$	$\delta^{15}N$	C/N ratio	$^{87}Sr/^{86}Sr$ ratio	Reference
Delta							
UGAMS13933, 10142	Corps site	metacarpal, rt, distal, fused	-23.2	5.5	2.9	0.7096	Reitz et al. 2013
UGAMS10143	Corps site	metacarpal shaft, lt	-21.8	5.1	2.8	—	Reitz et al. 2013
UGAMS13934, 10144	Corps site	metacarpal, rt, distal,unfused diaphysis	-21.8	6.4	2.9	0.7092	Reitz et al. 2013
UGAMS10145	Corps site	metacarpal, rt, proximal	-22.1	6.7	2.8	—	Reitz et al. 2013
Average ± SD			*-22.2 ± 0.7*	*5.9 ± 0.8*		*0.7094 ± 0.0003*	
Panhandle							
UGAMS13921	Plash Island	humerus, lt	-21.6	5.9	2.9	0.7100	Reitz et al. 2013
UGAMS13922	Plash Island	humerus, lt	-21.9	5.7	2.9	0.7097	Reitz et al. 2013
UGAMS13923	Plash Island	tibia, rt	-22.0	4.7	2.9	0.7098	Reitz et al. 2013
UGAMS13931, 10139	Plash Island	astragalus, rt	-22.4	6.5	3.1	0.7095	Reitz et al. 2013
UGAMS8557	Bayou St. John	calcaneus, lt, proximal	-21.2	6.4	3.0	—	Reitz et al. 2013
UGAMS10140	Bayou St. John	metapodial condyle, burned, indet fusion	-21.6	8.0	2.9	—	Reitz et al. 2013
UGAMS13924	Bayou St. John	cubonavicular, rt	-21.5	4.5	2.9	0.7095	Reitz et al. 2013
UGAMS13925	Bayou St. John	scapula, lt	-21.3	7.5	2.9	0.7108	Reitz et al. 2013
UGAMS13926	Bayou St. John	antler	-19.7	5.2	—	0.7093	Reitz et al. 2013
UGAMS13928*	Bayou St. John	metapodial, indet side, worked, Tool 463a	-21.4	7.0	3.1	0.7099	Reitz et al. 2013
UGAMS13929*	Bayou St. John	metararsal, rt, worked, Tool 716d	-21.6	6.7	2.9	0.7103	Reitz et al. 2013
UGAMS13930*	Bayou St. John	metatarsal, rt, worked, Tool 221b	-21.2	4.8	3.0	0.7100	Reitz et al. 2013
UGAMS13932, 10141	Bayou St. John	vertebra centrum, unfused	-21.2	7.7	2.9	0.7097	Reitz et al. 2013
UGAMS17806	Harrison Ring	proximal metatarsal, lt, fused	-21.2	5.4	3.1	—	This study
UGAMS17807	Hare Hammock	metacarpal shaft, indet side, indet fusion	-21.5	5.9	3.2	—	This study
UGAMS17808	Hare Hammock	astragalus, rt	(-23.8)	(9.0)	11.8	—	This study
BETA360014	Hare Hammock	distal metapodial, indet side, fused	-21.5	5.9	—	—	This study
UGAMS17809	Strange's Ring	metapodial shaft, indet side, indet fusion	(-21.7)	(6.9)	4.6	—	This study
Average ± SD			*-21.4 ± 0.6*	*6.1 ± 1.1*		*0.7099 ± 0.0004*	
Big Bend							
BETA393322	Bird Hammock	misc. frag	-22.1	5.0	—	—	This study
BETA393323	Bird Hammock	long bone shaft frag	-21.9	4.4	—	—	This study
BETA393325	Bird Hammock	vertebra centrum, fused	-20.3	4.5	—	—	This study
BETA394494	Bird Hammock	metapodial shaft frag	-21.6	4.2	—	—	This study
BETA393321	Mound Field	long bone shaft frag	-22.2	4.8	—	—	This study
BETA394868	Mound Field	astragalus/calcaneus, side not recorded	-22.1	4.5	—	—	This study
Average ± SD			*-21.7 ± 0.7*	*4.6 ± 0.3*			
Georgia inland							
UGAMS17372	Singer Moye	distal tibia, lt, fusing	-21.0	8.5	3.3	—	This study
UGAMS17373	Singer Moye	distal tibia, rt, fused	-20.8	6.0	3.5	—	This study
UGAMS17374	Singer Moye	distal tibia, rt, fused	-21.3	7.6	3.3	—	This study
Average ± SD			*-21.0 ± 0.3*	*7.4 ± 1.3*			
Georgia coast							
O_01	St. Cath. (9LI21)	not recorded	-20.9	3.2	3.5	—	Bergh 2012
O_02	St. Cath. (9LI21)	not recorded	-20.6	5.6	3.5	—	Bergh 2012
O_03	St. Cath. (9LI21)	not recorded	-21.5	6.2	3.5	—	Bergh 2012
O_04	St. Cath. (9LI230)	not recorded	-21.3	5.3	3.4	—	Bergh 2012
O_05	St. Cath. (9LI21)	not recorded	-20.1	5.8	3.3	—	Bergh 2012
O_06	St. Cath. (9LI21)	not recorded	-21.3	5.7	3.5	—	Bergh 2012
O_07	St. Cath. (9LI229)	not recorded	-21.2	3.6	3.5	—	Bergh 2012
O_08	St. Cath. (9LI229)	not recorded	-22.6	5.2	3.4	—	Bergh 2012
O_09	St. Cath. (9LI637)	not recorded	-21.4	4.7	3.3	—	Bergh 2012
O_10	St. Cath. (9LI229)	not recorded	-21.3	3.7	3.3	—	Bergh 2012
O_11	St. Cath. (9LI637)	not recorded	(-22.1)	(-4.9)	3.7	—	Bergh 2012
O_13	St. Cath. (9LI207)	not recorded	-21.3	3.7	3.3	—	Bergh 2012
O_14	St. Cath. (9LI207)	not recorded	-21.7	3.6	3.3	—	Bergh 2012

Table 4.29. Deer Stable Isotope Data. (cont.)

Sample #	**Site**	**Element**	**δ^{13}C**	**δ^{15}N**	**C/N ratio**	**^{87}Sr/^{86}Sr ratio**	**Reference**
***Georgia coast* (cont.)**							
O_15	St. Cath. (9LI207)	not recorded	-21.4	4.3	3.4	—	Bergh 2012
O_16	St. Cath. (9LI207)	not recorded	-21.6	4.9	3.4	—	Bergh 2012
O_17	St. Cath. (9LI207)	not recorded	-21.7	4.6	3.3	—	Bergh 2012
O_18	St. Cath. (9LI207)	not recorded	-21.5	2.6	3.3	—	Bergh 2012
O_19	St. Cath. (9LI207)	not recorded	-21.9	3.8	3.4	—	Bergh 2012
O_21	St. Cath. (9LI8)	not recorded	-21.8	3.2	3.6	—	Bergh 2012
O_22	St. Cath. (AMNH680)	not recorded	-21.1	4.9	3.3	—	Bergh 2012
O_23	St. Cath. (AMNH680)	not recorded	-21.2	7.2	3.4	—	Bergh 2012
O_24	St. Cath. (9LI231)	not recorded	-22.5	5.2	3.3	—	Bergh 2012
O_25	St. Cath. (9LI231)	not recorded	-22.5	4.7	3.4	—	Bergh 2012
O_26	St. Cath. (9LI231)	not recorded	-22.5	4.9	3.5	—	Bergh 2012
O_27	St. Cath. (9LI231)	not recorded	-22.6	4	3.4	—	Bergh 2012
O_28	St. Cath. (9LI207)	not recorded	-21.7	6.9	3.4	—	Bergh 2012
Average ± SD			*-21.6 ± 0.6*	*4.7 ± 1.2*			
Texas inland							
AU37-0144F	Leonard K.	not recorded	-20.6	4.5	3.2	—	Hard and Katzenberg 2011
AU37-0146F	Leonard K.	not recorded	-20.9	3.6	3.2	—	Hard and Katzenberg 2011
AU37-0143F	Leonard K.	not recorded	-20.9	5.0	3.2	—	Hard and Katzenberg 2011
BX1-0008F	Olmos Dam	not recorded	-20.1	6.3	3.3	—	Hard and Katzenberg 2011
BX1-0009F	Olmos Dam	not recorded	-20.3	6.2	3.2	—	Hard and Katzenberg 2011
BX1-0007F	Olmos Dam	not recorded	-19.8	6.2	3.2	—	Hard and Katzenberg 2011
Average ± SD			*-20.4 ± 0.4*	*5.3 ± 1.1*			
Texas coast							
RF1-0021F	Mission Refugio	not recorded	-21.3	5.2	3.2	—	Hard and Katzenberg 2011
RF1-0028F	Mission Refugio	not recorded	-19.8	6.9	3.2	—	Hard and Katzenberg 2011
RF1-0023F	Mission Refugio	not recorded	-19.4	7.3	3.4	—	Hard and Katzenberg 2011
Average ± SD			*-20.2 ± 1.0*	*6.5 ± 1.1*			

Notes: Values in parentheses are not included in summary statistics because they have C/N ratios outside of the acceptable range. Asterisks denote deer bone tools. See Figure 3.4 for site location. Sample size refers to the number of deer specimens analyzed for stable isotopes from each site. See Table 3.6 for information on laboratories utilized.

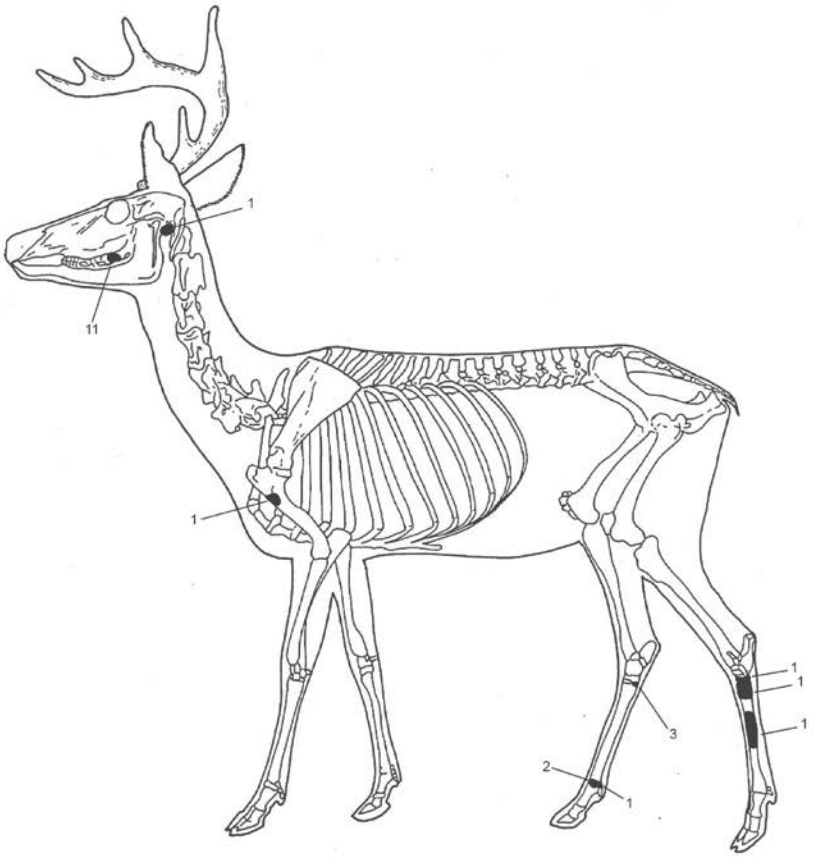

Figure 4.1. Deer elements recovered from the Harrison Ring Midden (NISP = 22).

Figure 4.2. Deer elements recovered from the Hare Hammock Early assemblage (NISP = 6).

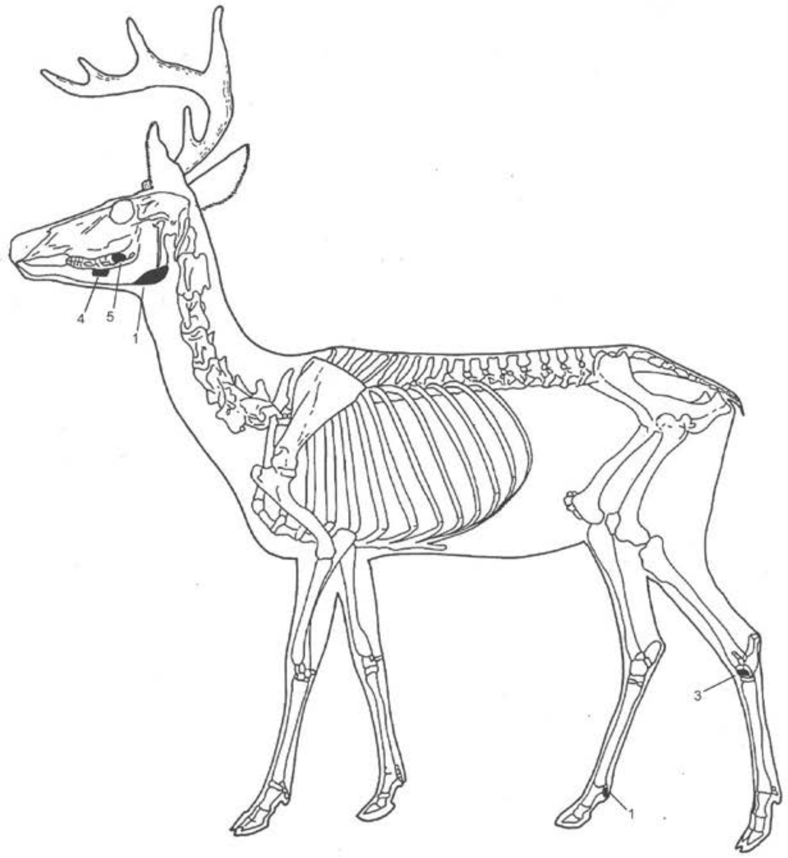

Figure 4.3. Deer elements recovered from the Hare Hammock House Mound assemblage (NISP = 14).

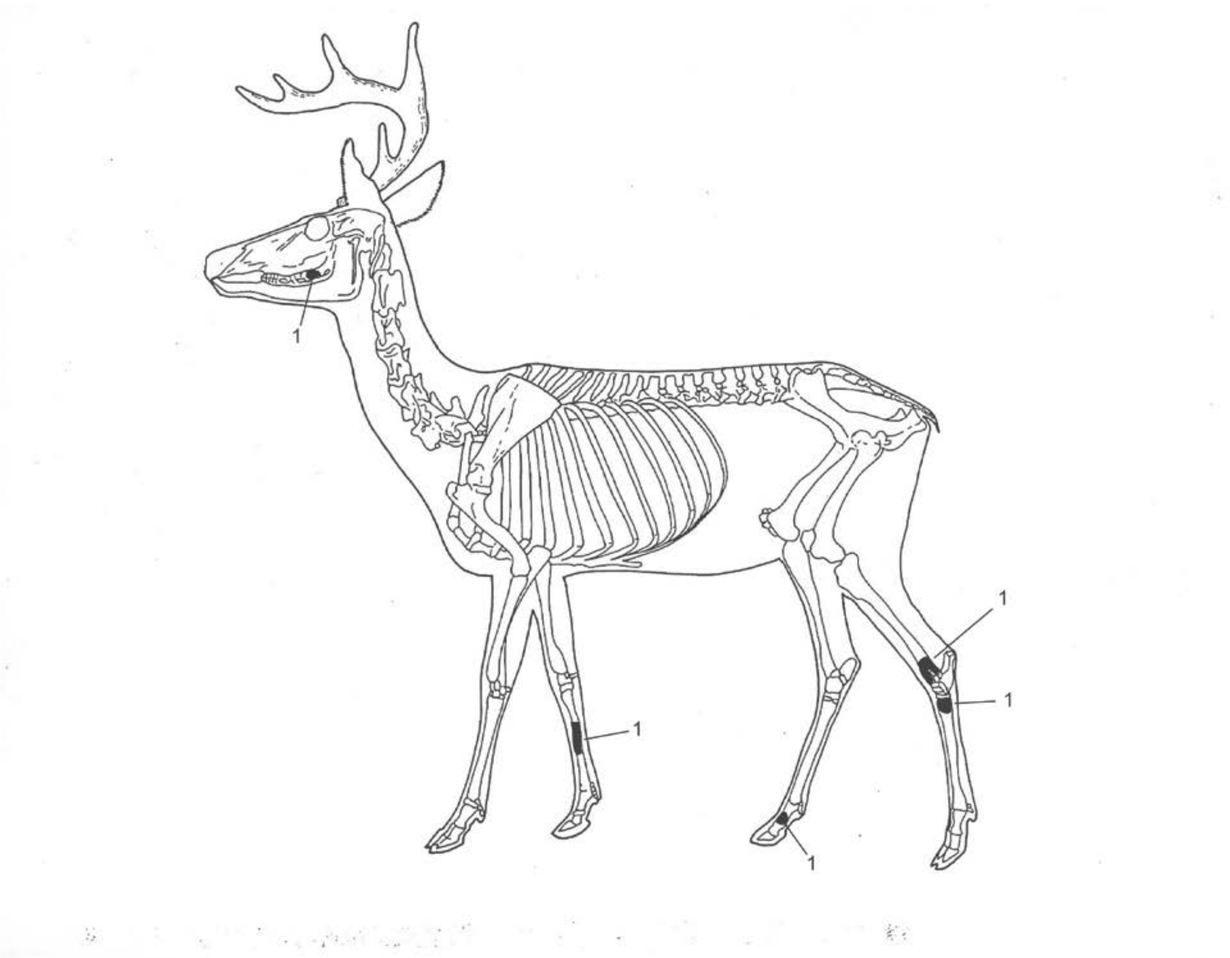

Figure 4.4. Deer specimens recovered from the Hare Hammock Late assemblage (NISP = 5).

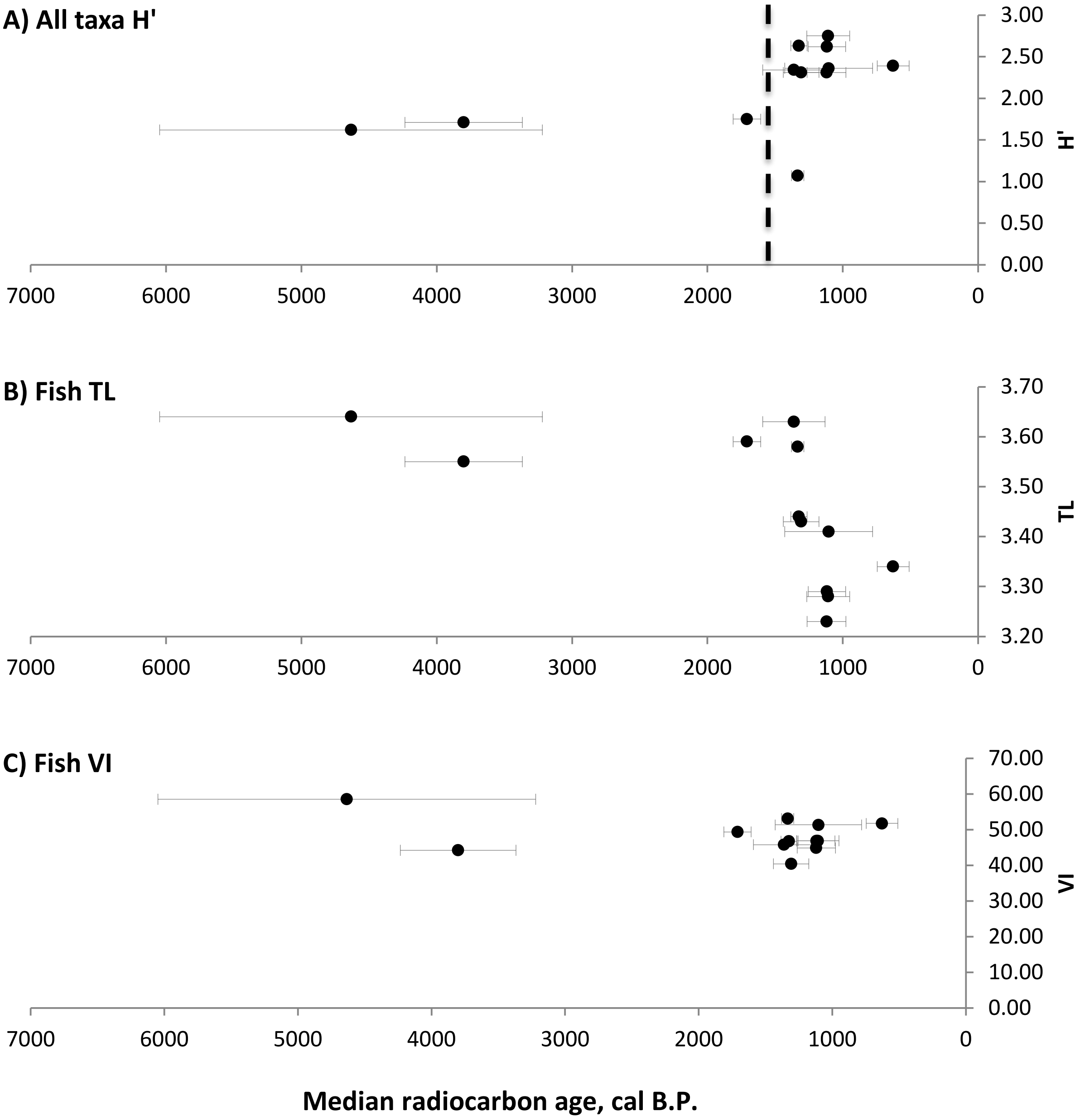

Figure 4.5. Temporal trends in (A) taxonomic diversity; (B) fish Trophic Level (TL); and (C) fish Vulnerability Index (VI) with sites listed in chronological order showing median and 2-σ range of radiocarbon ages for each site. Vertical line in 4.5(A) indicates 1300 cal BP. See Table 3.5 for site information and Figure 3.3 for site locations.

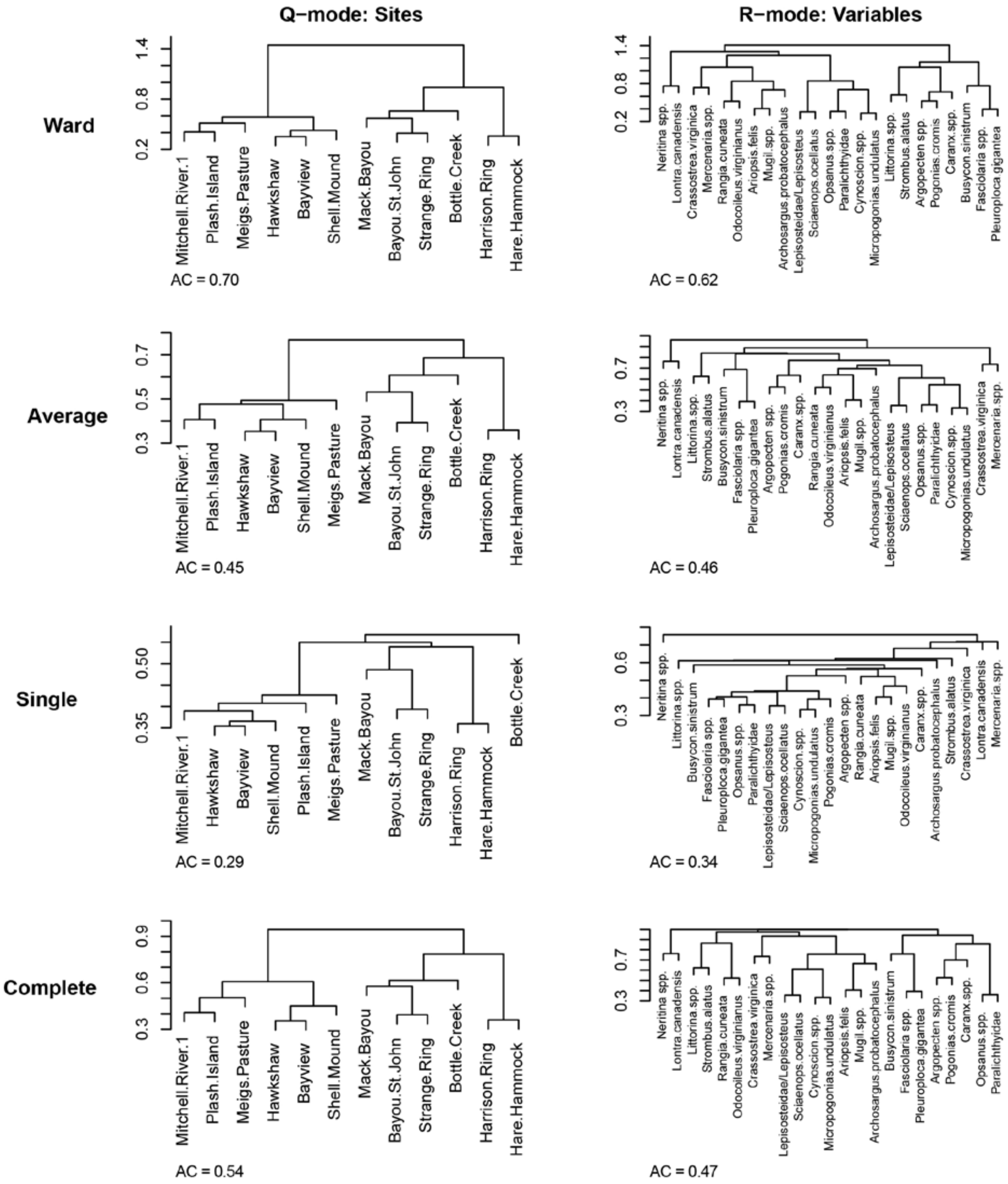

Figure 4.6. Cluster analysis of sites and variables based on constellations of major and minor resources. See Table 3.5 for site information and Figure 3.3 for site locations.

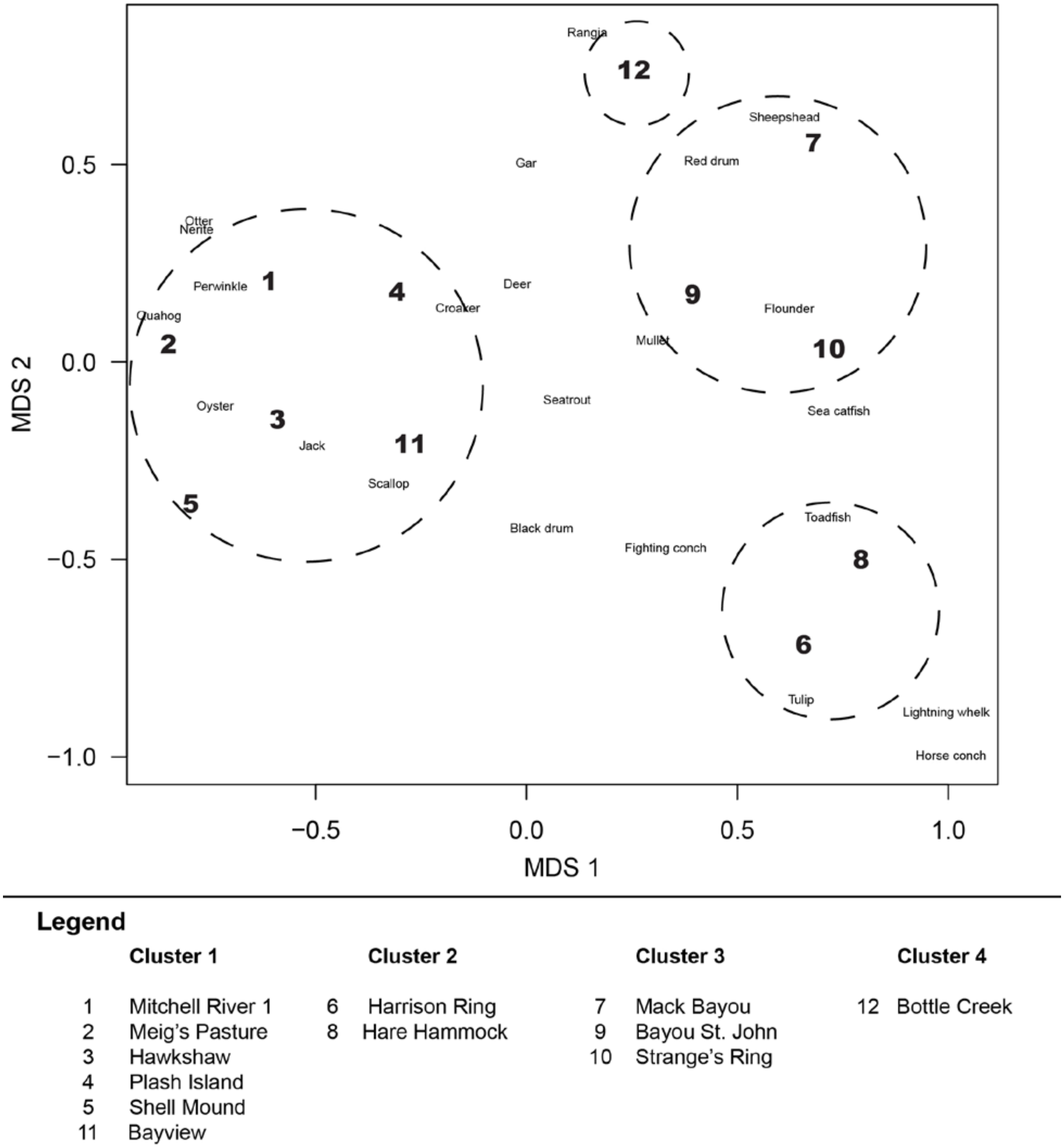

Figure 4.7. Non-metric multidimensional scaling (MDS) of sites and variables in the regional dataset. See Table 3.5 for site information and Figure 3.3 for site locations.

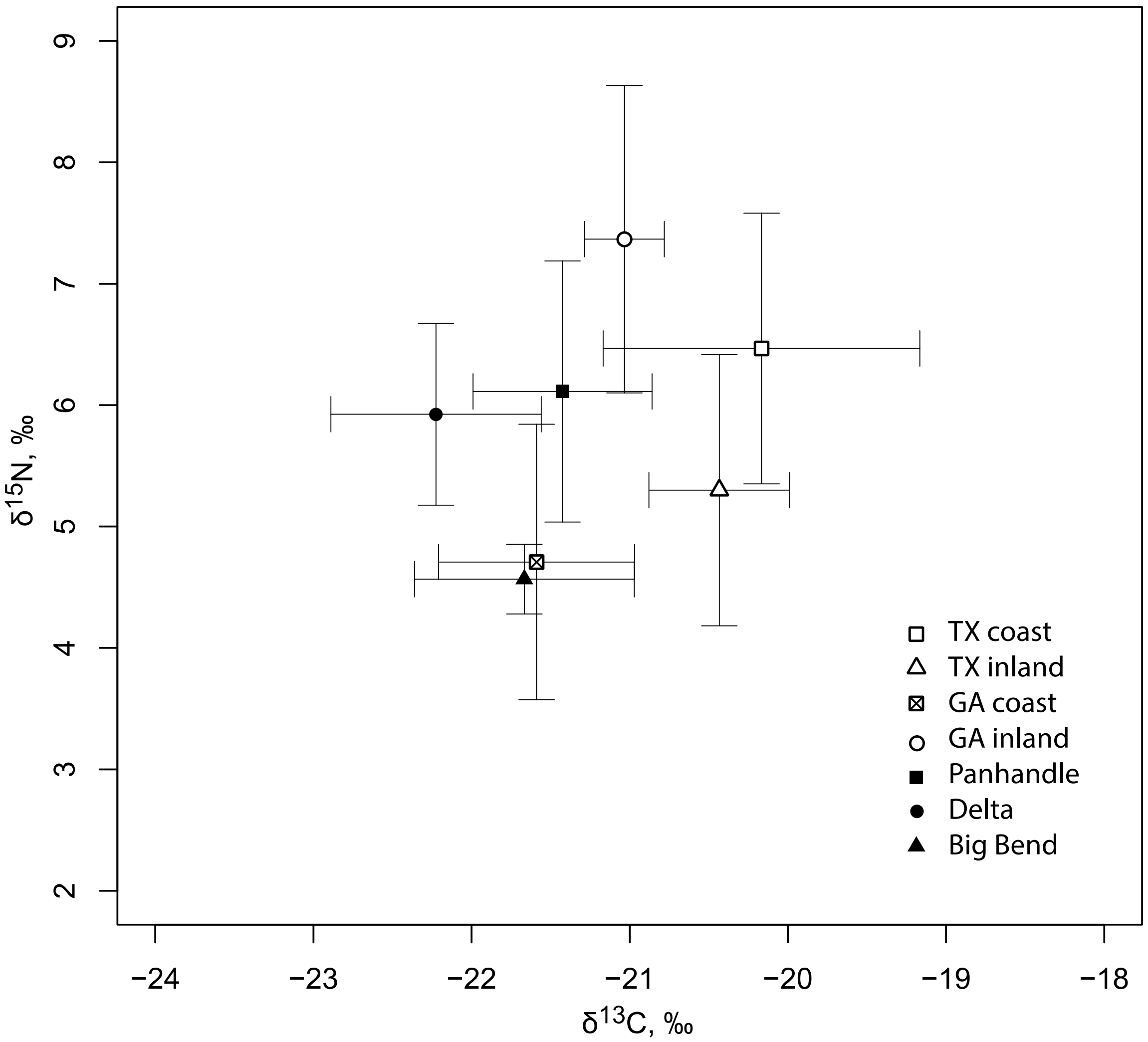

Figure 4.8. Mean and standard deviation of deer stable carbon and nitrogen values by region. Data reported with respect to VPDB standard. See Table 4.28 for specimen descriptions and sources of data.

CHAPTER 5:

SUBSISTENCE AND SEASONALITY AT EAST PENINSULA

This chapter presents a case study of two sites on the Gulf Coast of East Peninsula, the Harrison Ring Midden, and the Hare Hammock Ring Midden. This chapter addresses the basic research questions from a local spatial scale of analysis:

(1) Was the coastal zone occupied on a seasonal rather than continuous basis?

(2) What was the basis of coastal subsistence during the Woodland period?

(3) Is instability of coastal ecosystems a modern phenomenon?

These questions contribute to the broader anthropological discussion about the relationships among coastal sedentism, subsistence strategies, and resource abundance, landscape, and identity. In Chapter 6, these questions are revisited from a regional perspective.

This chapter consists of three sections. The first section evaluates evidence for season(s) of occupation of the Harrison and Hare Hammock Ring Middens. The second section describes the subsistence activities evidenced by the zooarchaeological remains, focusing on terrestrial versus aquatic procurement, evidence for technologies, and the social, economic, political, and ritual contexts of resource acquisition and distribution. The third section examines evidence for temporal trends in resource use related to sustainability, intensification, and resource depression.

Seasons of Occupation and Seasons of Use

Population mobility is a “defining feature of social life and cultural identity” (Pauketat 2003:41). Who, how far, and how often people move about on the landscape reflects the need to negotiate a number of social and economic activities in time and space (Binford 1980; Jochim

1976). Seasonality of resource use and residential patterns are fundamental to many other human behaviors including rituals, harvest cycles, population demographics, and political and economic organization.

The florescence of zooarchaeological techniques for evaluating seasons of resource use revolutionized the way we think about seasonal aspects of population mobility in the coastal Southeast (e.g., Keene 2004; Quitmyer et al. 1997; Russo 1994, 2004). For example, we now recognize that year-round habitation of the coast is an ancient tradition in the Georgia Bight and southwestern Florida (Colaninno 2010; Marquardt 1996; Russo 1991, 1998). Although we are only just beginning to understand how coastal forms of mobility differed from inland forms in those areas, we know very little about human mobility in other areas of the coastal Southeast, including the northern Gulf Coast.

Ethnohistorical accounts of coastal communities around the world indicate that shellfishing efforts and/or yields tended to follow seasonal cycles (Meehan 1982; Waselkov 1987). Seasonal subsistence models for the Southeast typically assume that the use of marine resources, particularly shellfish, peaked during the winter months, when presumably preferred terrestrial foods were scarce (e.g., Curren 1976). Curren’s (1976) model for subsistence and settlement of the Woodland Gulf Coast was based on accounts of the Choctaw of coastal Mississippi (Lincecum 1904), which he modified based on the hydrologic cycles of the Mobile Bay and Delta. Curren’s (1976) model involved a yearly cycle, with populations coalescing on the fertile soils of the delta when river levels were low, from late spring through early fall, to prepare fields, plant, and harvest crops. People dispersed along the coast to hunt, gather, and collect wild foods during the rest of the year, from late fall through early spring.

Percy and Brose (1974:22) argued that there was no evidence that coastal sites in the Florida Panhandle region were seasonal stations of inland farming communities during either the Woodland or Mississippi periods. Ethnohistorical accounts support the existence of separate coastal and inland communities in that region, as well. Cabeza de Vaca encountered both coastal and inland groups during his ill-fated visit to the Apalachee province of Florida Panhandle in the summer of 1527. Relatively prosperous farmers lived in inland villages (Cabeza de Vaca 1905:26–32), and on the coast they encountered "…indians who fished and were poor and wretched people" (Cabeza de Vaca 1905:42).

Few archaeological data are available for evaluating seasonal aspects of coastal life in this region. These are limited to a few zooarchaeological studies (Ellison 2009; Lawson 2005; Nanfro 2004) and gray literature reports (e.g., Russo et al. 2006). Whether settlements of the Woodland Gulf Coast represent seasonal or year-round occupations remains an important area for archaeological research. The following section focuses on new zooarchaeological data from the Harrison and Hare Hammock sites to test the hypothesis that the sites were used on a highly seasonal basis. These data are reviewed on a species-by-species basis.

Evidence for seasonality at the Harrison Ring Midden

Scallops (*Argopecten* spp.) of the Gulf of Mexico typically live for only one year, and because spawning events are synchronized, there is a strong correlation between scallop valve height and the season of collection (Geiger et al. 2006; Russo 1991). Modern populations of bay scallops in St. Joseph Bay, 15 km east of the Harrison Ring, average 45.7 mm in height in June, 54.5 mm in August, and 57.7 mm in September (Geiger et al. 2006). Similarly, modern scallops from Anclote Key, southeast of the study area, measured between 15–20 mm from January to March, reaching 50 mm in height by June, and 60 mm in September (Russo 1991).

The abundance of scallops demonstrates shellfishing activities occurred at Harrison Ring at least during the summer months. At least 202 individual scallops are represented in the Harrison collection (Table 4.2). Most are highly fragmented, and few could be measured. The scallop valves that could be measured range between 34 mm and 66 mm in Valve Height (Table 4.4) and average 44–53 mm (*n* = 14; 95 percent CI). The majority of measureable valves (64 percent) measure between 40–50 mm in height (Figure 5.1a). Based on modern monthly size class data, the range of values observed in the Harrison Ring sample is consistent with a spring through fall collection season, with the modal size class suggesting a collection peak in early summer.

Large marine gastropods also have seasonal habitats. Lightning whelks, horse conchs, and true tulips exhibit seasonal patterns of abundance in northwestern Florida (Paine 1963), possibly related to horizontal movement between inter-tidal and sub-tidal habitats or vertical movement (burrowing) (Walker et al. 2008). Today, lightning whelks in the Big Bend region outnumber horse conchs at least 10:1 in intertidal habitats during the winter, but they are observed at approximately 1:1 ratios during the summer (Harke et al. 2015). Year-round collection of both taxa is expected to yield a ratio of approximately 6:1 in shell midden contexts (Harke et al. 2015). Lightning whelks outnumber tulip shells approximately 12:1 during the winter, but tulips are more common in the summer with a ratio of approximately one lightning whelk for every three tulips (Paine 1963). At Harrison Ring, the ratio of lightning whelks to horse conchs is 9:1, similar to the expected ratio for a winter collection season. However, other explanations can account for the observed ratio including varying intensity of collection across multiple seasons, field processing, and exchange of marine shells with inland groups.

Red drums spawn during September and October along the western coast of Florida (Yokel 1966). Juvenile red drums grow at a rate of about 30 mm in standard length (SL) per month, reaching a size of about 300–340 mm SL in the first year of life (Lawson 2005; Reagan 1985). Only two red drums are present in the Harrison assemblage (Table 4.4). Skeletal allometry based on otolith length suggests that the two red drum specimens were both from small individuals. One was a juvenile, approximately 208 mm in SL, and the other was approximately 334 mm SL and was probably about a year old (Table 4.4). Based on these parameters the juvenile may have been caught in spring. However, it is difficult to make interpretations about season-of-collection of red drums from just two specimens. Size class analyses that include multiple specimens are preferred because individual organisms may deviate substantially from population parameters, such as growth rate or the timing of spawning.

Another line of evidence for site seasonality at Harrison Ring is the size distribution of hardhead catfish. Sea catfishes spawn in shallow bays and estuaries along the northern Gulf Coast between May and August, and reach maturity at between 150–250 mm SL (Muncy and Wingo 1983:4). Juvenile catfishes (<150 mm SL) are abundant in shallow nearshore environments in the summer and early fall, while adults are available throughout the year, albeit in variable numbers. Skeletal allometry is used to estimate SL of archaeological specimens of hardhead catfish from pectoral spine pad widths (Table 4.4). Sea catfish SLs range from 88 mm to 259 mm and average SL of 93–195 mm based on left pectoral spines (*n* = 7; 95 percent CI), and from 94 mm to 204 mm and an average SL of 100–164 mm (Figure 5.1b) based on right pectoral spines (*n* = 7; 95 percent CI) (Appendix B). A wide size range of individuals is represented, including both juveniles and adults. However, most of the pectoral spines that could be measured are from juveniles under 150 mm SL (53 percent). The predominance of juvenile sea catfishes indicates that fishing occurred at least during the summer and early fall, when juveniles are abundant. The adults could have been collected during any time of the year.

Evidence for seasonality at the Hare Hammock Ring Midden

Compared with Harrison Ring, highly seasonal or migratory taxa are considerably more abundant at the Hare Hammock Ring Midden. Nine bluefish (*Pomatomus saltatrix*) specimens were recovered from the Hare Hammock Ring (Table 4.21). These are generally northern, cool-water fishes, and appear inshore in the northern Gulf of Mexico only during the cool months of the year (Hoese and Moore 1998:213). Sturgeons (*Acipenser oxyrhynchus*) are anadromous fish that winter in the Gulf of Mexico. Two sturgeon specimens further demonstrate that fishing occurred at this site during the winter months.

Sea turtles (Cheloniidae) are another sensitive seasonal indicator identified in the Hare Hammock assemblage. Carcasses from stranded sea turtles may be scavenged from beaches during any time of the year, but live adults and eggs were most likely taken during the spring and summer nesting season. At least one sea turtle is present in the Hare Hammock Aggregated assemblage (P80 FS#223; Table 4.23), providing a weak line of evidence for warm-season occupation of the site.

Cownose rays (*Rhinoptera bonasus*) are generally migratory, short-term residents of inshore waters in the Gulf of Mexico, though longer residence times are reported in subtropical southern Florida (Collins et al. 2007). Cownose rays may be encountered any month of the year along the temperate northern Gulf coast, but are most common during the warmer months, and they generally move offshore when water temperatures drop below 15° C or exceed 28° C (Neer and Thompson 2005). In the summer months, they form large schools in inshore waters and saltier bays (Hoese and Moore 1998:140). Four specimens of cownose ray are identified in the Hare Hammock collection (Table 4.21).

Scallops are abundant in the Hare Hammock assemblage, including remains of at least 511 individuals (Table 4.23). Twenty-nine scallop valves are measureable (Table 4.4 and Figure 5.1a), and range in size from 41 mm to 61 mm VH, averaging 50–54 mm (*n* = 29; 95 percent CI). The majority (76 percent) are between 50–60 mm VH. Based on the monthly size classes of modern specimens (Geiger et al. 2006), both the mean and mode suggest that scallop season peaked during the late summer.

Horse conchs are rare in the Hare Hammock assemblage, outnumbered 20:1 by lightning whelks. Recalling that the expected ratio for winter-collected gastropods is a considerably more modest 10:1, factors other than season-of-year may be responsible for the disparity as mentioned previously.

At least 68 hardhead catfish are represented in the Hare Hammock assemblage (Table 4.21). Sea catfishes range from 78 mm to 306 mm SL (Table 4.4), and average 211–238 mm based on left pectoral spines (*n* = 53; 95 percent CI), and range from 102 mm to 333 mm SL, averaging 227–252 mm SL, based on right pectoral spines (*n* = 40; 95 percent CI) (Figure 5.1b). Considering SL from both left and right elements, a wide size range of individuals is represented, including juveniles and adults. Whereas the majority of Harrison Ring sea catfishes were juveniles, both the mean and modal size classes indicate that most of the Hare Hammock sea catfishes were adults and could have been collected during any time of the year. Few pectoral spines (*n* = 3, or 3 percent) were from juveniles under 150 mm SL. Although an abundance of juveniles can be taken as evidence for summer/fall collection, the opposite does not necessarily hold true. The paucity of juveniles is not necessarily evidence that sea catfishes were collected during months when juveniles are absent (winter/spring). A change in technology, such as an increased gauge size of nets, could also be responsible for the lack of juvenile catfishes. Owing to the problem of equifinality, where different processes could produce the same results, it is not possible to make a determination for the season-of-collection of sea catfishes at this site.

A single red drum otolith was measured to estimate the SL. The individual is estimated to be 292 mm SL, and probably a little less than a year old when it was caught. Based on spawning cycles and growth rate of red drum, this fish may have been caught in late summer.

Seasonality and settlement patterns

These data demonstrate qualitatively that this locale was used across multiple seasons, rather than during a single season, such as winter. Unfortunately, the temporal resolution and quantitative seasonality data are lacking to evaluate how these sites functioned in local and regional mobility and settlement systems. Site structure can also elucidate site function, duration, and intensity of use (e.g., Meehan 1982; Kelly et al. 2005). A variety of site types may be associated with coastal societies including foraging camps, processing sites, seasonal base camps, and villages. The archaeological attributes of these site types are described below.

Dinnertime camps and processing sites are structurally simple site types, located adjacent to shellfish beds or fish traps, which are used intermittently, but sometimes repeatedly, to field-process goods (e.g., shellfish) for transport back to the home base, or to prepare meals for the task-group (Meehan 1982:112–118). These are special-use sites with few features and a low diversity of activities (Kelly et al. 2005). At short-term occupation sites such as these trash is simply discarded underfoot or in hearths; it is deposited farther away from the hearth as length of occupation increases (Kelly et al. 2005). Repeated re-use of dinnertime camps increases the structural complexity of the site as sitting areas, hearths, and middens are not always consigned to the same spot (Meehan 1982:114). Field processing decisions reflect the cost of field processing (time), the benefits of field processing (reducing weight), and transport distance (Bird and Bliege Bird 1997). The resources present at various site types should reflect those field-processing decisions. Processing sites are distinguished from dinnertime camps by low species diversity and ubiquity, usually containing the remains of one or two species of shellfishes (Meehan 1982:117).

Longer-term occupations evidence a wider variety of tasks and activities than do processing sites or dinnertime camps. They generally conform to a site plan with distinct activity areas (Meehan 1982:114), with greater investments in architectural site features (Kelly et al. 2005). Ring-shaped villages are a basic settlement form that was once widespread throughout eastern North America (e.g., Drooker 1997:48; Means 2007; Russo et al. 2006; Ward and Davis 1993) and other areas of the world, including Amazonia (Wüst and Barreto 1999), southern Africa (Yellen 1977), and New Guinea (Fraser 1968). Different activity areas are found in concentric zones in ring-shaped settlements (Means 2007; Russo 2014). The central plaza was an open public space, surrounded by a domestic zone of houses and household activities. Behind the ring of houses is where private activities, refuse disposal, and defecation took place. The plaza was not simply a negative space that existed only in contrast to the domestic zone. Rather, it was a central design feature that was actively constructed and maintained (Kidder 2004). Plazas served multiple functions including social interaction, a forum for public oration, and a locus for both sacred and secular rituals, performances, and exchanges (Kidder 2004; Russo et al. 2006:101; Russo 2014).

On the basis of the characteristics described above, the Harrison and Hare Hammock ring middens are most consistent with long-term occupational sites such as villages. The Harrison and

Hare Hammock sites each consist of a low, annular or ring-shaped midden of mixed soil and shell, defining domestic zones that surround relatively clean central plazas. The bits of shell, bone, pottery, charcoal, stone, and minerals that make up the ring middens suggest that both domestic and ritual activities were carried out in these places (Russo et al. 2006). The burial mounds at these sites also represent an investment in terms of labor as well as a “permanent confirmation of lineage membership” (Milanich 1994:41).

The faunal remains themselves also indicate that a diversity of activities were carried out at and around these sites. To live and work within coastal environments requires a specific local knowledge of the tides and currents, the locations of resource patches, and the habits of fishes and shellfishes (O’Sullivan 2003:465). People at these sites were not targeting a single resource intensively and then moving on. They had expert knowledge of their landscape, making use of over 66 non-commensal taxa (Table 4.1) from a variety of nearshore, terrestrial, and freshwater habitats. The reliance on mass-capture fishing facilities such as weirs, fences, and nets also suggests that the site occupants invested a great deal of time in building and maintaining these facilities. The time investment, and the logistical problems with transporting them, suggests that their use was only practical among sedentary or semi-sedentary communities (Larson 1980:123–124). Highly mobile groups probably would not expend the effort to construct such a facility only to be forced to abandon it after a short time.

Based on site structure, evidence for investments in permanent facilities, and the meager evidence for seasonality of resource use, the Harrison and Hare Hammock ring middens most likely represent ring-shaped villages that were occupied for multiple seasons of the year, if not year-round. Currently, there is limited evidence for occupation during all seasons at the Harrison Ring, while Hare Hammock was used at least in the winter and summer. However, these assessments make broad generalizations about site seasonality from just a handful of specimens (Waselkov 2012). Temporal resolution is lacking for determining whether these sites were occupied during successive seasons or years, whether they experienced periods of vacancy for months or years at a time, or whether the functions of these sites changed over time.

It remains to be seen whether these sites were year-round villages for part or all of their use history. It should not be surprising if at least a portion of the population were extended-season or year-round village residents. Russo (1991, 1998) found zooarchaeological evidence for year-round occupation at Horr's Island, a pre-ceramic shell ring in southwestern Florida. Late Archaic shell ring sites on the Georgia coast also were used during all seasons of the year (Colaninno 2010; Thompson and Andrus 2011). It is possible, or even probable, that the populations of coastal villages fluctuated on an annual or seasonal basis, as individuals or groups of individuals dispersed or coalesced for a variety of social, political, and economic purposes. Population fluxes could potentially involve movement between the coast and the interior, along the coast, or both.

Future research on resource scheduling and site seasonality should focus on refining interpretations using a combination of seasonal indicators. This should include stable oxygen isotope analyses of fishes and molluscs that are potentially available year-round, rather than single-season or migratory animals (Andrus 2012). Over 30 years of zooarchaeological research in the coastal Southeast, including research at the Harrison and Hare Hammock rings, has shown that animals with broad tolerances and that were available year-round were emphasized over seasonally available animals or those with narrow tolerances (Reitz 2014; Reitz et al. 2013).

Stable oxygen isotope analyses of fishes and molluscs would greatly improve the current understanding of seasonal aspects of occupation and subsistence at the Harrison and Hare

Hammock rings. This method has been applied to several aquatic species in southeastern archaeology, including sea catfishes, drums, oysters, quahogs, marsh clams, and coquinas (Andrus 2012; Andrus and Crowe 2000, 2002, 2008; Andrus and Rich 2008; Colaninno 2010; Keene 2004; Quitmyer et al. 1997; Reitz et al. 2013; Thompson and Andrus 2011). Stable isotope analyses combined with presence/absence data and size class analyses would refine our interpretations about seasonal patterns of resource use and occupation at these sites. In particular, a more extensive study at these sites should focus on quantitative comparisons of seasons of use of the Harrison and Hare Hammock ring middens. Higher resolution data on this aspect of settlement may contribute to an understanding of why people who used Swift Creek pottery at the Harrison Ring abandoned the site, and why people who used Weeden Island pottery established a settlement less than 100 m away. Determining whether the seasons or duration of site use changed at this locale would require a more quantitative approach than is presented here.

The mollusc taxa featured in seasonality studies using stable isotopes unfortunately are rare or absent at Harrison and Hare Hammock. The dominant shellfishes at these sites are scallops, which are warm-season indicators, and large marine gastropods (Chapter 4). Recent work by Harke and colleagues (2015) demonstrated that lightning whelk shells record fluctuations in $\delta^{18}O$ that reflect environmental parameters, such a temperature, evaporation, and precipitation. Refinements in techniques for determining season-of-collection of lightning whelks and other marine gastropods are necessary before archaeologists can apply these methods to archaeological specimens.

Subsistence Strategies

The term “subsistence strategies” refers to the most basic component of livelihoods: the tasks people perform in order to make a living. Subsistence strategies include procurement decisions, technologies, and the contexts of resource acquisition and distribution. These are important areas of research because acquiring raw materials is one of the most direct ways in which humans interact with their environments. Different ways of making a living, such as fishing, farming, or herding, which Steward (1955) referred to as the "cultural core," also engender different practices and worldviews that are inextricably tied to tradition, identity, and place (Ingold 2000; Thompson and Turck 2009; Zedeño 2013). The goal of this section is to explore the complex relationships among environment, subsistence, and identity in this region by characterizing coastal subsistence strategies as represented by the faunal assemblages from these sites.

Habitats exploited

Terrestrial fauna contribute little to total MNI and biomass in both the Harrison and aggregated Hare Hammock assemblages. The most important terrestrial animal at both sites is deer (*Odocoileus virginianus*), which contributes 12 and 7 percent of the assemblage biomass, respectively. Deer are found in a variety of habits including forests, swamps, and even disturbed or densely populated areas. Other terrestrial fauna identified at the archaeological sites include box turtles (*Terrapene carolina*), opossums (*Didelphis virginianus*), rabbits (*Sylvilagus* spp.), squirrels (*Sciurus* spp.), cotton rats (*Sigmodon hispidus*), and perching birds (Passeriformes). The terrestrial fauna at Harrison and Hare Hammock have an affinity for woodlands with open and grassy patches (Burt and Grossenheider 1980:218).

Based on modern plant communities and associated animal communities, the local terrestrial habitat probably consisted of woody vegetation, dominated by oaks (*Quercus* spp.) and pines (*Pinus* spp.), with open sandy areas and an understory of saw palmettos (*Serenoa repens*), hollies (*Ilex* spp.), and low-growing oaks (Table 2.1). A limited analysis of microbotanicals preserved in pot residues from the Hare Hammock site documented both cool-season C_3 grasses (Pooideae) and warm-season C_4 grasses (Chloridoideae and Panicoideae), various sedges and trees including cypresses (Cyperaceae), pines (*Pinus* spp.), and magnolias (*Magnolia* spp.) (Yost and Cummings 2012).

Aquatic fauna, including fishes, molluscs, and crabs, contribute most of the MNI and biomass at both sites (Tables 4.3 and 4.22). These include at least 50 species of fishes and non-commensal shellfishes in the Harrison assemblage and 57 species in the aggregated Hare Hammock assemblage (Table 4.1). The dominance of fishes and molluscs suggests the subsistence strategy was centered on aquatic environments, rather than terrestrial ones. Nearshore habitats (Table 2.1) are interconnected both physically and ecologically. An important characteristic of coastal subsistence strategies was an emphasis on so-called “catholic” or widely distributed resources, organisms with broad environmental tolerances (Reitz 2014). Many of the organisms that are identified archaeologically could have been collected from a variety of estuarine or marine habitats. Few taxa are confined to a single, discrete habitat.

Those few taxa with strict habitat requirements indicate that nearshore marine habitats were used, rather than estuarine or freshwater environments. Lightning whelks (*Busycon sinistrum*) and other large marine gastropods are more abundant in coastal middens associated with saline or hyper-saline environments, and they are indicators of marine habitat use (White 2014). Seagrass beds are mostly found in areas of low wave energy, often occurring next to and interacting with intertidal communities. Scallops (*Argopecten* spp.) are an excellent indicator taxon for use of seagrass habitats because they are dependent on seagrasses throughout their life cycle (Greenawalt-Boswell et al. 2007). Scallops account for 25 and 16 percent of MNI in the Harrison and Hare Hammock assemblages, respectively (Table 5.1), suggesting extensive use of seagrass habitats, at least for shellfishing. Florida seagrass beds are vital to coastal ecology as they are an important source of primary production, and provide a complex habitat that is used by over 170 invertebrates and 100 species of fishes (Dawes et al. 2004). Direct access to seagrass beds probably was a major draw to this location. Today, the small volume of freshwater input and low sediment loads in the St. Andrews Bay system results in low turbidity and very clear waters, conditions conducive to flourishing seagrass beds (FLDEP 2012). Today seagrass beds are less abundant and more patchily distributed in St. Andrews Sound (Figure 2.2) than in St. Andrews Bay proper (Yarbro and Carlson 2013).

Many other shellfish taxa are associated with seagrass beds, but are not restricted to this habitat. These include lightning whelks, tulips (Fasciolariidae), fighting conchs (*Strombus alatus*), and moon snails (Naticidae). Seagrass habitats probably were the primary habitat used for shellfishing, but it is likely that other resources were taken from this habitat as well. Pinfish (*Lagodon rhomboides*), mullets (*Mugil* spp.), spotted seatrouts (*Cynoscion nebulosus*), silver perches (*Bairdiella chrysoura*), and juvenile red drums (*Sciaenops ocellatus*) are common fishes in warm-temperate seagrass beds of the Gulf of Mexico (Gilmore 1987). Sea turtles (Cheloniidae) also are seasonally abundant in seagrass habitats.

Tidal flats are non-vegetated intertidal habitats (Table 2.1). Many organisms found in seagrass beds and salt marshes also can be found in intertidal flats, but the soft-bottomed habitat is particularly suitable for infaunal and burrowing organisms such as giant cockles (*Dinocardium robustum*), moonsnails, and tulips. Together, these taxa account for 1 percent of individuals in both the Harrison and Hare Hammock collections (Tables 4.2 and 4.21). The people who used Harrison Ring and Hare Hammock probably collected shellfish from tidal flats, but evidently used this habitat less frequently than seagrass beds.

Salt marshes are vegetated intertidal habitats that form in sheltered coastal areas and support biologically diverse communities. Many organisms found in seagrass beds are associated with salt marshes also. Marsh periwinkles (*Littorina irrorata*) are strong indicators of salt marsh habitats because they are dependent on marsh grasses, especially *Spartina* spp. (Silliman and Newell 2003). Ribbed mussels (*Geukensia demissa*) and oysters are common salt marsh organisms as well (McClary 2004; Montague and Wiegert 1990:481). All three of these mollusc species are rare or absent in the Harrison and Hare Hammock assemblages, although they are abundant in other coastal assemblages in the region (Table 4.25).

Notable for their absence are oysters, the keystone species of oyster reef communities. Oysters account for only 1 and 2 percent of MNI of the Harrison and Hare Hammock assemblages, respectively, although they dominate other coastal shell midden sites in this region (Table 4.25). Also rare are marsh clams (*Rangia cuneata*), which are indicators of low-salinity environments and are generally found in the upper reaches of estuaries (LaSalle and de la Cruz 1985). These and other low-salinity and freshwater animals, including gars (*Lepisosteus* spp.), bowfins (*Amia calva*), freshwater catfishes (Ictaluridae), sunfishes (*Lepomis* sp.), mud turtles (*Kinosternon subrubrum*), pond turtles (*Pseudemys* spp.), and snapping turtles (*Chelydra serpentina*), contribute less than 1 percent of the individuals in the Harrison (Table 4.2) and Hare Hammock (Table 4.21) assemblages.

Negative evidence is always difficult to evaluate in zooarchaeology because the absence of an organism in the archaeological record does not necessarily mean that it was absent from the environment or that people did not use the animal (e.g., Lyman 1995). It could be that oyster reefs, salt marshes, upper estuaries, and freshwater environments were used extensively in the local subsistence strategy, but that the particular indicator taxa considered here, oysters, periwinkles, mussels, marsh clams, etc., simply were not high priority targets on the local menu. The possibility that the use of marine gastropods and scallops over oysters reflects localized differences in cultural standards or personal preferences cannot be discounted. However, that seems unlikely considering that Woodland settlements often were situated near marshes and estuaries in other areas of the Gulf and Atlantic coasts, and oysters, periwinkles, mussels, etc., are common midden constituents at such sites throughout the region (Table 4.25).

Milanich (1973) suggested that the locations of estuaries and marshes, and the resources they provided, was an important factor in settlement location. The immediate catchment area of the Harrison and Hare Hammock sites may not have included salt marsh, oyster reef, and estuarine habitats. Oysters have wide salinity tolerances, but thrive in brackish environments with salinities from 10–20 ppt, and they do not do well on pure sand bottoms (Cake 1983). Today, St. Andrew Sound is shallow with marine salinities of 32–35 ppt, with fine quartz sand substrate (Garman and Harris 1997:84). If it is assumed that the midden assemblages reflect the habitat types that were present in the immediate vicinity of the sites, specifically St. Andrews Sound, the fauna strongly indicate a marine environment that supported seagrass beds. The Sound probably was highly saline in the past as well, too sandy for oysters, and too salty for either marsh clams or oysters, as demonstrated by the predominance of scallops and marine gastropods such as lightning whelks.

Although animals from salt marshes, oyster reefs, and low-salinity environments are generally rare in the Harrison and Hare Hammock ring middens, the sites' occupants possibly used those habitats and resources at other times, in other places, or in different contexts. Shell middens only contain the remains of animals that were processed and discarded at the site, and do not faithfully reflect the full range of resources or habitats used within the broader subsistence system (Waselkov 1987:109). The near-absence of oyster shells in the Harrison and Hare Hammock middens, for example, should not be taken as evidence that people did not use oysters; only that oysters were not processed at these sites. Ethnographic accounts of southeastern groups (the Powhatan, North Carolina Algonquians, Acolapissas, and Pascagoulas) describe oysters and clams being smoked on small grills for storage and for trade (Waselkov 1987:Table 3.2). It is possible that oysters were brought to these sites without the shell, and collected, field-processed, or consumed elsewhere in the St. Andrews Bay system or beyond.

Resource constellations

Wing (1977) used major and minor resource “constellations” to characterize four distinct subsistence systems of the greater Southeast. Wing’s subsistence systems were defined based on the vertebrate animals identified in zooarchaeological assemblages. Shellfishes and other invertebrate animals were not included in her classification scheme. One of the goals of this chapter is to characterize the constellations of resources used at the Harrison and Hare Hammock rings, taking into account both vertebrate and invertebrate components of the coastal subsistence strategy.

Both the Harrison and Hare Hammock assemblages are broadly similar to Wing’s (1977) specialized coastal and fishing subsistence strategy: fishes, particularly mullets and sea catfishes (Ariidae), as well as deer and turtles, were routine components of the coastal economies (Table 5.1). Shellfish taxa dominate the suite of major and minor resources that constitute the resource constellations at Harrison and Hare Hammock (Table 5.1), dominating the total faunal assemblages in terms of MNI and biomass (Tables 4.3 and 4.22).

The resource constellations represented by the Harrison and Hare Hammock assemblages are similar but not identical. Based on biomass alone, the only major resource at the Harrison

Ring is lightning whelks, with minor resources including deer, mullets, tulip snails, and horse conchs (*Pleuroploca gigantea*). On the basis of MNI, five additional shellfish taxa, including scallops, are added to the Harrison resource constellation (Table 5.1). At Hare Hammock, two species qualify as major resources in terms of biomass: lightning whelks and hardhead catfish (*Ariopsis felis*). Minor resources include deer, mullets, and horse conchs. Expanding the resource constellation to account for MNI increases the number of major resources from two to five, all of which are shellfishes (Table 5.1).

At Harrison and Hare Hammock, people focused on shallow marine seagrass beds, which provided abundant access to scallops, gastropods, and fishes, rather than marshes and oyster beds that are more typical of coastal sites in the Southeast (e.g., Curren 1976; Reitz et al. 2013; Reitz and Quitmyer 1988; Walker 1992). Variability in the relative abundances of fish and shellfish taxa in Gulf Coast shell middens (Table 4.25) generally is attributed to variability in local habitats (e.g., Mikell 2012; Nanfro 2004; Orr 2007; White 2014). According to these perspectives, individual taxa were more-or-less interchangeable components within a relatively uniform subsistence pattern (e.g., Lawson 2005:128; Nanfro 2004:58). As I argue in Chapter 6, the regional dataset demonstrates patterned variability, rather than uniformity. Differences in access to resources, such as lightning whelks versus oysters, have important social and economic implications for coastal dwellers, a point to which I will return.

The apparent emphasis on molluscs over fishes has multiple possible explanations and implications. One possibility is that a broad regional trend has gone unrecognized due to a paucity of zooarchaeological studies that include large samples of both vertebrate and invertebrate fauna. A second possibility is that the Harrison and Hare Hammock assemblages represent a localized adaptation to locally available gastropod-dominated marine habitats, in contrast to bivalve-dominated marine habitats, such as oyster beds, which are more common elsewhere. These possibilities will be explored further Chapter 6.

A third possibility is that methodological biases are at least partly responsible for the apparent dominance of molluscs at these sites. As with most methods for quantifying archaeofauna, aggregation methods may introduce biases that influence the results and our interpretations of them. The traditional zooarchaeological method for comparing relative abundances of taxonomic groups (e.g., classes) is to exclude taxa for which MNI is not estimated (Chapter 3). Typically, higher taxonomic levels are excluded. For example, the species lists indicate that the indeterminate ray-finned fishes category (Actinopterygii) accounts for 26 percent of the Harrison Ring collection biomass based on Table 4.2; but this category is excluded from the summary Table 4.3 because MNI cannot be estimated for Actinopterygii. In comparison, indeterminate gastropods (Gastropoda) account for 7 percent of biomass in Table 4.2, but is excluded from the summary Table 4.3. The exclusion of these and other higher-level taxa disproportionately affects fishes, because fish elements such as ray spines and vertebrae are numerous but difficult to identify to lower taxonomic levels. The summary tables are skewed towards shellfishes within these collections.

To evaluate the magnitude and effects of this bias, the biomass summaries for all fishes, compared to all non-commensal shellfishes, are recalculated using all taxonomic categories for which biomass can be estimated from Tables 4.2 and 4.21, regardless of whether MNI can be estimated. This permits the inclusion of biomass estimates from higher taxonomic levels, such as Actinopterygii, Bivalvia, and Gastropoda. For both sites, recalculating the relative abundances using as much of the data as possible results in a reversal of the rank order of resources: fishes, not shellfishes, contribute most of the biomass in these shell midden assemblages. At Harrison

Ring, fishes accounted for 40 percent of the total biomass, compared to 35 percent for non-commensal molluscs (Table 4.2). At Hare Hammock Ring, fishes contribute 52 percent of the total biomass, compared to 39 percent for non-commensal molluscs (Table 4.21).

Despite this analytical bias, this case study demonstrates that shellfishes, and particularly gastropods, were central to the overall subsistence strategy at Harrison and Hare Hammock. Both fishes and shellfishes were probably consumed and/or collected on a daily basis. Many archaeologists have cautioned that the numerical or volumetric abundance of shellfishes in shell midden sites may exaggerate their economic importance due to differential preservation of shell compared to bone, low caloric or meat yield per unit, and methodological difficulties with dietary reconstruction (e.g., Claassen 1991, 1998:194–195; Moss 1993:637; Parmalee and Klippel 1974; Thompson and Worth 2011). Although this is an important point, it also should not be assumed *a priori* that shellfishes were a minor or supplementary component of coastal economies.

Shellfishing strategies

The shellfishing strategy practiced at Harrison and Hare Hammock was highly specialized, as demonstrated by the low diversity of the invertebrate assemblages (Table 4.1). People focused on a few large-bodied taxa, such as whelks and conchs, which contributed most of the individuals and biomass. Several other taxa are represented in smaller numbers, possibly collected by accident, to increase variety in the diet, or for some other purpose. Shellfish remains discarded in the Harrison and Hare Hammock shell middens were not necessarily consumed by the site occupants, or consumed at all. Shells are a durable, workable raw material for manufacturing tools and other objects (Eyles 2004; Marquardt 1992b), although formal shell tools are exceedingly rare at these sites (Russo et al. 2009). Shellfishes also could be used as bait, either to chum the water to attract prey, or used in conjunction with hooks, in nets, or in fish baskets (Larson 1980). Debris left behind from emptying fish pots of their spent bait can potentially create large middens of shell and fish bones (Claassen 1991). Although this possibility cannot be discounted, the major and minor shellfish resources at Harrison and Hare Hammock are, for the most part, relatively large prey items and therefore should be ranked relatively high as food resources (Broughton 1994a, 1994b, 1995). Many of the molluscs discarded in the Harrison and Hare Hammock assemblages probably represent food waste.

The most abundant large marine gastropods at these sites, lightning whelks, tulips, and fighting conchs, probably were collected individually, on purpose, by hand (or foot). They are not attracted to baited traps (Walker et al. 2008). Live specimens are frequently encountered partially or completely buried, and can be located either by sight or by touch (Stephenson et al. 2013). Other large gastropods such as crown conchs (*Melongena corona*), channel whelks (*Busycotypus canaliculatus*), and pearwhelks (*B. spiratum*) are attracted to traps, whether or not they are the species targeted by the trap (Walker et al. 2008), but only small numbers of these taxa were present in these collections.

Lightning whelks were potentially available year-round, although their availability or use may have a seasonal pattern. On the Georgia coast, modern populations of lightning whelks are common on intertidal flats and near oyster reefs during the daytime in fall and spring, but are generally absent during daytime in summer and winter. Whether they bury themselves or move off the flats into subtidal areas is unknown (Walker et al. 2008). Lightning whelks in the Florida Gulf Coast may have different patterns of seasonal mobility. In the Big Bend region of Florida, lightning whelks are thought to be most abundant in the winter but are present year-round (Paine 1963). I collected large numbers of lightning whelks in seagrass beds of the Florida Panhandle on multiple trips to the coast during the winter, spring, and summer months. I cannot personally speak to their presence in the fall. Tulips are especially abundant in the Florida Panhandle compared to the rest the Florida coast (Stephenson et al. 2013), and their seasonal pattern is thought to be opposite of lightning whelks. Tulips peak in the summer months, and are less common in the winter (Paine 1963), although they are present in nearshore environments year-round also.

Little is known about the behavior of Florida fighting conchs compared to other strombid conchs, such as queen conchs (*Strombus gigas*) and the closely related fighting conchs (*S. pugilis*). Colonies of Florida fighting conchs generally remain buried in sand bars, and could have been dug out using sticks or other digging implements, potentially year-round. Mass stranding events of live fighting conchs are observed under certain conditions on the western coast of Florida today (Hewitt 2013). Minus tides are extreme low tides that occur periodically but predictably over the course of the year. Some sand bars are exposed only during minus tides, forcing the resident conch colonies to dig themselves out (Hewitt 2013). This provides an opportunity for easy mass harvest. Individuals with expert knowledge of the local tides and benthic topography could predict when and where mass strandings would occur.

Fighting conchs in the archaeological assemblage are extremely uniform in size, and consist of mature specimens almost exclusively (Figure 5.1a and Table 4.4). During the stranding event observed by Hewitt (2013), she saw no juveniles, only adults. She hypothesized that juvenile fighting conchs either live in the sandbar but remain buried during minus tides, or live in a different habitat entirely. Isotopic analyses support the hypothesis that fighting conchs change habitats through ontogeny, possibly living in deep or offshore environments during the juvenile life stage (Hadden and Cherkinsky 2015).

Scallops can be gathered by hand, or using rakes, in shallow (1 to 3 m) seagrass beds during the summer months. Today, recreational scalloping is permitted in Florida from July through September. Scalloping is fun and “blessedly simple” (Abercrombie 2014). Today, popular scalloping locations may attract hundreds of harvesters each day during the open season (FWC 2006), and many of the modern harvesters are nuclear families with children, enjoying a recreational food-getting activity in which the whole family can participate. This mental image of the practice of shellfishing is a far cry from the “low form of existence” Uhle (1907:31) imagined while he pondered the Emeryville shell mounds in California.

In general, shellfishing requires few tools or equipment: your hands, perhaps a stick for digging or prying, and a mesh bag to hold your catch. Shellfishes are easily collected by hand and require no particular skills other than the knowledge of where to find them. All members of the community, including the young, infirm, and unskilled, can contribute to subsistence efforts through shellfishing (Bird and Bliege Bird 2000; Meehan 1982). Shellfishing in the intertidal zone poses few risks to the collector, except where oysters are abundant. The edges of oyster shells are sharp and can cut flesh easily, and wounds from oyster shells are prone to infection.

Processing shellfishes is more difficult than collecting them because the animals are able to enclose their soft bodies entirely within their protective shells. There are a few standard methods for extracting shellfish meat, which may be used alone or in combination. The application of heat causes bivalves to open, so they can be opened and cooked in a single operation by roasting, baking, steaming, or boiling. Alternatively, bivalves can be opening by cracking or perforating the shell, or by using a shucking tool (Waselkov 1987:100). Today, scallops are usually shucked, either on the water or on land. The possibility that scallops were field-processed in the past means that scallops could be underrepresented in shell midden assemblages.

Gastropods are more of a challenge to open than are bivalves because they retreat into spiral shells, sealing themselves off with a calcareous or chitinous operculum. One method for extracting the meat from large gastropods is by perforating the spire or removing the apex to break the vacuum within the shell and force the animal to release its hold (Reitz and Wing 2008:126; Waselkov 1987:103). Modern queen conch harvesters throughout the Caribbean employ this method frequently. None of the large marine gastropods observed in either archaeological collection had the distinctive “kill hole” that is left by this method. An alternative strategy for processing large gastropods, and the one probably used at these sites, is to apply heat, which causes the animal to release its hold and permits extraction using a pointed tool (Waselkov 1987:103), or by using the operculum as a handhold to pull out the meat.

Shellfishes were probably also smoked or dried to preserve the meat from spoilage, either for trade or for later use (Waselkov 1987:108). Preserved shellfish meat could be traded with inland groups; transported inland from the coast during a seasonal migration; or prepared during brief logistical forays on the coast (Waselkov 1987:105–109). The relative importance of preserved molluscs reflects the culture’s access to coastal resources and mobility strategies.

Shrimps, lobsters, and crabs were probably available to coastal dwellers as well, although they are more difficult to identify archaeologically. Crustaceans possess few hard tissues that survive archaeologically, and they may have been more important economically than their presence in archaeological sites suggests (Reitz and Wing 2008:45). The most likely tissues to survive are the claws (chelipeds) and mandibles because they are more heavily calcified than other parts of the exoskeleton (Reitz and Wing 2008:49). Today, three penaeid shrimp species, brown shrimp (*Farfantepenaeus aztecus*), white shrimp (*Litopenaeus setiferus*), and pink shrimp (*Farfantepenaeus duorarum*), comprise the majority of 80 million kg of shrimp landed in the Gulf of Mexico annually (Scott-Denton et al. 2012). Shrimps are seasonally abundant in shallow vegetated marine and estuarine habitats during the warmer months of the year in the Gulf of Mexico. They can be taken using nets or traps and are especially active at night and while the tide recedes (Larson 1980:78). Despite their small size, shrimps constitute a large proportion of faunal biomass in modern coastal ecosystems. By weight, shrimps of various species accounted for 34 percent of trawl landings in a survey of Louisiana, Mississippi, and Alabama (Scott-Denton et al. 2014), and an average of 20 percent of commercial fishery landings in Florida (FWC 2014). The underrepresentation of shrimps in the zooarchaeological record has potentially serious implications for trophic level analyses, if shrimps were in fact used in traditional fisheries.

Fishing strategies

Along with shellfishing, fishing was a central subsistence activity at the Harrison and Hare Hammock ring middens. Nearly 30 fish taxa are identified zooarchaeologically, and mullets, hardhead catfish, toadfishes (*Opsanus* spp.), and black drums (*Pogonias cromis*) were abundant in both assemblages. Fishing was less specialized than was shellfishing, and fish taxa are represented more evenly than are molluscs (Table 4.1). Fishing techniques are selective of fishes of different species, sizes, and habits. The greater diversity of fish taxa probably reflects a greater diversity of techniques used.

A variety of fishing technologies is known ethnographically and archaeologically (Chapman 1987; Cushing 1896; Gilliland 1975:213; Larson 1980:116; Oswalt 1976:91–101; Rostlund 1952; Thomas 2008a:122–131; Wheeler and Jones 1989:167–176). Fishing technologies are specific to a targeted species or suite of species, and also differ in terms of when and where they can be used effectively, the number of people involved in the activity, and the level of skill required (Chapman 1987; Jones and Quinn 2009; Wheeler and Jones 1989:168). Unfortunately, we did not identify any direct evidence for fishing technologies used at the Harrison and Hare Hammock sites, such as fishhooks, net weights, or net impressions. It is difficult to determine the specific fishing devices employed at a given locale, although some generalizations are possible.

Fishing technologies can generally be categorized as either mass-capture or individual-capture technologies. Mass-capture technologies are designed to impound or corral fishes to collect multiple individuals, and often multiple species, at once. Mass-capture strategies include impounding facilities such as fish weirs, reed fences, traps, and gill and seine nets; and handheld dip and basketry scoops. Individual-capture technologies are designed to capture or hunt fishes one at a time, using spears, leisters, harpoons, trot lines, and hook-and-line (Larson 1980; Rostlund 1952; Thomas 2008a:122–131). Individual- and mass-capture techniques also can be used together.

The habits of the most abundant fish taxa present in these collections—mullets, hardhead catfish, toadfishes, and drums—suggest that both individual- and mass-capture techniques were used. Mullets are almost impossible to catch by hook-and-line because of their small, fragile mouths (Larson 1980:103). They aggregate into large schools, “swarm[ing] in all suitable places” along the Gulf Coast (Jordan and Evermann 1902:253), and probably were captured en masse using nets or scoops. Hardhead catfish are easily caught on baited hooks, although they are rarely eaten today and are considered a nuisance fish by modern anglers (Froese and Pauly 2014; Larson 1980:105). Sea catfishes also can be caught at night in great numbers, as they are attracted to light such as headlamps or torches (McLane 1955:103). Both toadfishes and black drums will readily accept a baited hook (Larson 1980:106–107), but could also be caught using mass-capture techniques such as trotlines, heavy fishing lines with baited hooks attached at intervals. Trotlines are an effective means of catching large quantities of drums and hardhead catfish in the Gulf of Mexico (McEachron et al. 1985).

Hardhead catfish and mullets are categorized as small- and large-bodied, respectively, based on osteometric data from the archaeological specimens (Table 4.4). Most of the mullets recovered from the Harrison and Hare Hammock assemblages are estimated to have been between 200 and 300 mm in Standard Length (Figure 5.1b). The average Standard Length for mullets exceeds the 250-mm threshold, and mullets are thus classified as large-bodied fish, but the assemblage includes both large- and small-bodied individuals ranging from 178 mm to 414 mm in Standard Length (Table 4.4). The catfishes in these assemblages are quite small, typically under 200 mm in Standard Length in the Harrison Ring assemblage, and between 200 and 250 mm in the Hare Hammock assemblages (Figure 5.1). Catfishes ranged in size from 77 to 308 mm in Standard Length (Table 4.4).

Overall, the ichthyofaunal assemblages demonstrate an emphasis on small-bodied fishes (Tables 4.4 and 4.5). Small individuals could be collected using fine-gauge nets or handheld scoops or dip nets, while the largest individuals may have been caught in seine nets, or even using individual capture methods such as spearing. There is a clear emphasis on the use of mass-capture techniques in the Hare Hammock assemblage, less so at Harrison Ring (Table 4.6). The sociopolitical implications of individual- versus mass-capture techniques are discussed in a later section. People probably made extensive use of fish weirs, fences, nets, and traps. Weirs and fences operate by blocking off an area of moving water, taking advantage of the natural movement of fishes through certain locations such as tidal creeks or channels to coral them as they pass through (Larson 1980:120; Rostlund 1952:101). These techniques are relatively unselective in terms of the species and sizes of fishes captured (Colaninno 2011; Tveskov and Erlandson 2003).

In contrast to weirs and fences, nets are relatively size-selective. They come in an array of sizes and shapes to take advantage of fishes of different sizes, and with different habits (Wheeler and Jones 1989:169). Southeastern fishers used a variety of nets, including gill, seine, surround, and dip nets (Thomas 2008a:126–127). Gill nets are stationary facilities anchored with weights or staked in the water in natural travelways, generally entangling medium-size fishes as they attempt to swim through the mesh (Colaninno 2011; Larson 1980:118). Fishes much smaller than the net mesh size can easily pass through, and those that are much too large can back away from the net unharmed (Balme 1983; Greenspan 1998). Seine nets consist of long sections of nets held vertically and pulled through the water to entrap fishes, by people in canoes or wading in the water (Larson 1980:119). Unlike gill nets, seine nets capture large-bodied fishes if they cannot flee the active movement of the net. Dip nets and basketry scoops typically capture small-bodied, schooling fishes. Gill nets, seines, dip nets, and scoops are most efficient at exploiting schooling, shoaling, or otherwise aggregating fishes, particularly mullets, herrings and shads (Clupeidae), and other small-bodied and herbivorous fishes that are difficult to take by hook-and-line or spear. Mass-capture technologies can be used alone, or in combination with other strategies. Spears, leisters, and harpoons are used most effectively in shallow, clear waters where fishes are seen easily (Plug et al. 2010). Fishes corralled within weirs or fences in shallow water are easier to hunt.

Terrestrial subsistence strategies

The terrestrial component of the subsistence strategy is characterized by low species richness, and low MNI and biomass diversity (Table 4.1). Terrestrial hunting and trapping was the most specialized aspect of the coastal subsistence strategy as represented by the zooarchaeological collections, and was focused mostly on deer. Few other terrestrial animals are represented in the assemblages. Other terrestrial animals include box turtles, opossums, rabbits, squirrels, and birds. These animals are represented equally in terms of MNI, typically represented by one individual each, and each contributes but little biomass (Tables 4.3 and 4.22). Box turtles probably were collected by hand during incidental encounters. Box turtles are typically found near fresh water sources, in shallow burrows in plant debris, under logs, or in loose soil (Larson 1980:137). In the Southeast, box turtles generally were more important to the subsistence economies at inland horticultural sites than they were at coastal sites, possibly because they were raked up in large numbers while fields were being cleared for farming (Larson 1980:137). Opossums and rabbits are generally solitary and active at night, and were most likely taken using traps or snares (Larson 1980:177, 179). Squirrels, cotton rats, and perching birds also were identified in small numbers. Seminole Indians consumed opossums often, and sometimes hunted squirrels and rabbits (MacCauley 1887:504). The hunting of small game, including birds, was usually left to children (MacCauley 1887:506, 512).

Deer are the only terrestrial animals that qualified as a minor resource at the Harrison and Hare Hammock sites, meaning that deer account for at least 2 percent of total MNI or biomass. All other terrestrial animals contributed less. While deer provided useful raw materials such as bone, sinew, antler, and hides, they contributed far less meat to the diet than did aquatic resources. Deer and other terrestrial animals possibly provided variety, fat, and flavor to an otherwise aquatic protein base. One method for hunting deer was cooperative prey drives. Deer tend to move alone, or in small family groups consisting of a doe and her fawns. Solitary deer and small family groups can be driven with fire into a restricted spit or point of land where they can be ambushed by hunters. Cooperative prey drives probably were not the primary method of deer hunting at Harrison Ring and Hare Hammock. Deer have small home ranges, usually spending their whole life within a few kilometers of where they were born (Larson 1980:169), and population densities probably did not exceed estimates from the Georgia coast, about 20 deer per km^2 (Larson 1980:170). The local deer population probably would have been depleted too quickly to support frequent deer drives (Larson 1980:172).

Stalking and hunting individual deer probably occurred on a far more regular basis than did prey drives. This method requires extensive knowledge of the habits and body language of deer, as well as stealth, dexterity, and strength. MacCauley (1887:512) described one strategy for stalking deer:

> *The Seminole always hunt their game on foot. They can approach a deer to within sixty yards by their method of rapidly nearing him while he is feeding, and standing perfectly still when he raises his head. They say that they are able to discover by certain movements on the part of the deer when the head is about to be lifted. They stand side to the animal. They believe that they can thus deceive the deer, appearing to them as stumps or trees.*

A variation of this type of hunt was famously depicted in the de Bry engravings (Alexander 1976:Plate XXV), with the following inscription:

> *They put themselves inside the skins of the largest stags they have been able to kill, so that their heads are in those of the animals. As with a mask they see out*

> *through the holes of the eyes. Thus dressed they can approach the deer closely without frightening them. Beforehand they find out the time when the animals come to the river to drink. Bow and arrow to hand, it is easy for them to aim, especially since stags are numerous in this country.*

Deer remains are not abundant at the Harrison and Hare Hammock assemblages, calling into doubt whether hunting was a regular or routine activity in this area. However, deer remains possibly were discarded in a different manner or in a different location within the ring midden sites than the fish and shellfish remains. It is entirely plausible that deer, fishes, and shellfishes were butchered or otherwise processed by different individuals within the community, perhaps in different areas of the site. Because the field methods focused on shell-bearing portions of the site, vertebrate remains deposited elsewhere would not be recovered. Thus, the paucity of deer remains in the zooarchaeological assemblages may in part reflect sampling bias.

Most of the identified specimens are from the foot and head portions of the animal (Figures 4.1 through 4.4). These are low-utility elements in terms meat, marrow, and bone grease (Metcalfe and Jones 1988). Low-utility portions frequently are left at the kill site, with the more desirable portions transported elsewhere for use (Perkins and Daly 1968). Elements of low food utility are not useless; they are valuable raw materials for manufacturing goods and for flavoring stews. Archaeologically, bones from the lower legs and feet were used as raw materials for objects such as awls (Price 2008, 2009), bone points or gorges (Walker 2000), fishhooks (Guilday et al. 1962:78), ornaments (Jeffries 2004), or gaming pieces (Koerper and Whitney-Desautels 1999). Skull fragments may be associated with the extraction of the tongue and brain, both of which are edible. The brain also can be used for tanning leather (Spier 1970:117).

Age and gender roles in coastal subsistence

Foragers and hunters will often make different decisions about how to obtain resources within a single habitat, and different strategies and technologies can be employed at the same time, or in rapid succession (Bird 1999). Diversifying subsistence efforts within a habitat adds variety to the diet and buffers against failure. Owing to the diversity of resources available in the seagrass and intertidal habitats, multiple task groups could have exploited the same habitat for different resources concurrently. Shellfishing task groups consisting of women and children possibly targeted scallops and other shellfishes in seagrass beds (Bird and Bleige Bird 2000; Meehan 1982), which are reliable, low-risk, and seasonally abundant. At the same time, the skilled hunters of the community, often men, could hunt in the intertidal zone (Bliege Bird 2007). As such, the same physical environment could mean different things to different people depending on their age, gender, skill, social standing, etc.

Ethnographic accounts suggest that males tended to focus on riskier, high-yield resources, such as hunting, while women and children tended to focus on reliable resources with low-variance yields, including shellfishes and more reliable fishes such as mullets (Bliege Bird 2007; Meehan 1982). While women are thought to put more time and effort into shellfishing than do men (Meehan 1982; Waselkov 1987), women also fish and hunt (Bliege Bird 2007; Meehan 1982), and men also collect shellfish (Bird and Bleige Bird 1997; Moss 1993). It is not possible to identify from the archaeological record who the primary shellfishers were. All members of the East Peninsula communities—men and women, young and old—probably collected and consumed shellfishes from St. Andrews Sound during the Woodland period, perhaps in different contexts.

When men collect shellfish, they may focus on activities that require greater strength or have higher yields (Waselkov 1987:97). For example, the Yahgan and Alacaluf men of Patagonia used spears and pronged poles to obtain shellfishes and urchins from deeper waters than those used by women (Bird 1946:69; Lothrop 1928:Figure 84a). In the village of Kawakuchi, Japan, both sexes dove for shellfishes, but men dove less frequently, for longer periods of time, and to greater depths compared to women (Irimoto 1977:98–114). Men (and women) also collect shellfish when they are encountered incidentally, while focusing on some other food type. For example, Anbarra men and boys would pick up large gastropods while they were hunting or fishing in the intertidal zone (Meehan 1982:111).

Ethnographically, young children tend to hunt and forage in “play” groups (MacCauley 1887:506), sometimes collecting shellfish for their own consumption (Bird and Bliege Bird 2000; Meehan 1982:125–126). Anbarra boys played at spearfishing in the intertidal zone, and, like older males, would occasionally collect shellfish while engaged in that activity (Meehan 1982:125–126). Older Anbarra girls took foraging more seriously, as a training period for the time when they would have families of their own to support (Meehan 1982:128).

Commensal politics

An important component of a subsistence strategy is the sociopolitical context of resource acquisition and distribution. The term “commensal politics” refers to the relationships among food, power, and politics (Dietler 1996). Forms of social inequality have always existed, and unequal access to food is a common manifestation of inequality (Hayden 1995:20). Environments shape social and political systems as the source of raw materials and the media for social engagement. Control over raw materials and resources is a mechanism by which a superior position over others may be established or maintained (Arnold 1992; Blanton et al. 1996; Dietler 1996; Trubitt 2000, 2003; Wiessner 1996).

Whether success in obtaining food translates into prestige depends on a number of factors, including population size and density; cultural concepts of ownership and rights of redistribution; and beliefs about the nature of humanity, nature, and the cosmos (Clark 2014:99; Wiessner 1996). Within the contexts of the Harrison and Hare Hammock assemblages, there is clear evidence for the use of mass-capture facilities, possibly indicating a mechanism for amassing and controlling surpluses (Byrd 1997).

Patterns described for the McKeithen site, an interior Weeden Island ceremonial center, are used to model contemporary cultures throughout the region. Milanich et al. (1997) suggested that political organization within Weeden Island communities lacked centralized leadership. Instead, Weeden Island society was organized into villages made up of lineages, each with a religious leader of elevated social status (Milanich et al. 1997:188). Lineages or villages with greater or more direct access to resources possibly had a production advantage over other villages, conferring higher status to those villages and their leaders (Milanich et al. 1997:189). Knowledge of the supernatural, religion, and ritual possibly provided alternate or complementary sources of power in political economies (Blanton et al. 1996).

Grøn's (1991) social space theory suggests that when small communities form circular settlement patterns, such as the Harrison and Hare Hammock rings, kin groups or positions of rank may be associated with specific positions within the circle. Whether power came from material wealth or commodities (objective sources of power) or in the form of supernatural, religious, or ritual knowledge (symbolic sources of power) (Blanton et al. 1996), social distinctions may be reflected in the spatial distribution of archaeological materials also.

The House Mound, at the extreme northern end of the Hare Hammock ring, is a unique feature of the site in terms of location, topography, and possibly status or function. Previous research at the Hare Hammock Ring demonstrated differences in the ceramic assemblages between the northern and southern sides of the ring, suggesting differentiation among the social groups who occupied those positions (Russo et al. 2009). If a person or group of people of elevated social status used the House Mound area, social distinctions might appear in the representation of animal resources as well. Zooarchaeological correlates for elite status that are commonly used in eastern North America include rare or uncommon animals, better cuts or meatier portions, or greater diversity of animals (deFrance 2009:Table 1). Ritual use of animals might be indicated by anything “unusual”: animals from higher or lower trophic levels than is typical; rare or exotic animals, or those with unusual behavior or that are dangerous to acquire; or unusual depositional contexts, such as complete skeletons (Reitz and Wing 2008:Table 8.1).

There are clear differences between the House Mound area and contemporaneous deposits from elsewhere in the ring. Oysters contribute 8 percent of individuals in the House Mound assemblage, compared to less than 1 percent of individuals in the contemporaneous Hare Hammock Early assemblage (Table 4.9). Though still not abundant compared with other sites in the region (see Chapter 6), the House Mound assemblage is the only analytical unit from either Harrison Ring or Hare Hammock in which oysters contribute greater than 2 percent of biomass (Table 4.13). The relative abundance in this unusual setting may suggest that the individuals who used this area of the site had access to resources from more distant estuarine habitats. Such might be the case if the occupant of the House Mound area was provisioned by people from the village or received gifts from outside of the village.

Gastropods, though still abundant in the House Mound assemblage (Table 4.14), are less abundant than in other assemblages from Hare Hammock, while fishes and deer are more common. Overall, molluscs contribute far fewer MNI and less biomass compared with the contemporaneous Hare Hammock Early assemblage, but the shellfish assemblage is both more diverse and more equitable than the latter (Table 4.1), suggesting a more varied use of resources. The fishing strategy represented by the House Mound assemblage emphasizes higher trophic levels and more vulnerable taxa, with a higher proportion of individually captured fishes (Tables 4.1 and 4.6). Higher trophic-level fishes are less abundant in nature and may be more difficult or dangerous to capture.

A possible explanation is that the northern and southern sides of the ring served fundamentally different functions. The terrace-edge middens are assumed to be associated with a former shoreline, and consist of multiple, overlapping, ring-shaped deposits of domestic household waste. These may represent the accumulation of processing and discard activities resulting from forays in the seagrass and intertidal habitats the immediate vicinity of the site, by all members of the community, while the House Mound may be a specifically domestic or domiciliary area.

An alternative explanation is that both sides of the ring served similar functions, as domestic areas, but the people who occupied opposite sides of the ring differed in status, access to resources, or both. Among many societies of traditional subsistence fishers individuals or groups have privileged access to certain fishing technologies, techniques, or areas (Carrier 1981). Mass-capture technologies such as weirs, fences, gill and seine nets, and other impounding facilities require substantial investments in their construction and maintenance. Globally, a common aspect of sea tenure is that permanent weirs and mass-capture facilities belong to those who construct them (Carrier 1981; Harris 2001:133; Pitt-Rivers 1925:437). Through ownership of food-procuring locations, tools, and facilities, individuals or groups may be able to leverage control over access to resources. The ability to restrict or control access to resources can lead to either cooperative (e.g., Campbell and Butler 2010) or competitive (Dietler 1996) strategies for managing resources, leading to common-pool resource management on the one hand, or incipient forms of social power, on the other. The extent to which marine resources were held privately or in common has important implications for social, political, and economic relationships.

Traditional sea tenure systems tend to promote sharing within the community. Throughout the Philippines and Oceania, the construction of massive stone fish weirs, which sometimes take years to complete, is an ancient tradition that continues into the twenty-first century (Zayas 2011). Prior to the feudal age of Japan, weirs were the property of the village, and everyone in the community had equal access to the weir, as well as the sea fronting the village (Nishimura 1975). In Central Philippines, the weirs are constructed and managed by communities, and the weir-building communities' social formation traditionally centered around its maintenance and the distribution of its catch (Zayas 2011). Other collecting areas are public, exempt from all forms of property rights, although individuals can own smaller traps and their yields privately (Zayas 2011). Although communities differ in their attitudes towards allowing outsiders to forage within their territories, interloping neighbors are generally tolerated in traditional sea tenure systems (Aswani 2005).

In contrast, private ownership of weirs in feudal Japan and medieval Europe provided income and power for the upper classes (Nishimura 1975; O'Sullivan 2003) as a means of accumulating resources and excluding individuals from their bounty. Political economies involve a mix of strategies for mobilizing resources for political gains. Some strategies emphasize the control of the production of surpluses of commodities; others focus on the provisioning of elites in payment for services they provide to the society; still others focus on the control of resources moving through exchange networks (Hirth 1996). At small scales, management of resource patches at the household level could limit harvesting pressure and promote sustainable harvesting (Wessen 2005), or allowed individuals or groups to sponsor feasts, create or repay social obligations through sharing of surpluses, and gain prestige through generous giving (Clark 2014:99; Dietler 1996).

The redundancy in the types of activities that occurred throughout the Hare Hammock Ring Midden does not support the interpretation that the House Mound faunal assemblage represents fundamentally different subsistence activities than are represented by the other Hare Hammock assemblages. Both areas were used for processing fishes and shellfishes, among other activities. However, resources were used differently in that particular locale compared with other areas within the ring midden. The House Mound assemblage is characterize by a higher diversity of fauna, a greater relative abundance of deer, a greater emphasis on fishes over shellfishes, particularly high-TL fishes, and more oysters compared with other areas of the ring midden. The zooarchaeological record offers no definitive answer on whether individuals controlled particular resource patches or procurement strategies. However, the House Mound assemblage does not differ in terms of abundances of mass-captured fishes, as might be expected if such facilities were owned privately. All areas of the ring midden evidence intensive use of mass-capture facilities (Table 4.6).

The individual or group of individuals who occupied the House Mound area had access to a larger catchment area as indicated by the increased abundance of oysters. The catchment area could be expanded through mobility, trade, or provisioning. The physical context of the House

Mound area—its elevation and location—combined with the differential distribution of elite ceramics as well as animal remains suggests that the individual or group that occupied this portion of the settlement had elevated social status over the community. Each Weeden Island village is thought to have had a religious practitioner who provided a link to the supernatural, and this priest/chief enjoyed a special social status (Milanich et al. 1997:188). The House Mound may represent the dwelling site of such an individual, who possibly received gifts or compensation from individuals for his or her participation in ceremonial or ritual activities (Hirth 1996:215), or in return for granting access to fish or hunt within his or her territory.

Continuity and Change

The northern Gulf Coast is a dynamic environment. Coastlines change constantly, estuaries fill with sediments, and are flooded by storm surges, rivers, and run-off. Landforms wander, shift, and disappear. In present-day Gulf County, Florida, erosion averages 1–2 m per year, but erosion rates up to 7 m per year and accretion up to 20 m per year are documented (White 2005:314). In addition to the physical instability characteristic of all coastal environments, Middle and Late Woodland populations on the northern Gulf Coast ca. A.D. 400–1200 likely experienced other significant destabilizing events. Evidence of storm surge over-wash recorded in sediment cores suggests that direct hits from category 4 and 5 hurricanes were far more frequent from approximately 1700 B.C. to A.D. 1000, but particularly during the period ca. A.D. 1–1000, than they are today on the northern Gulf Coast (Liu and Fearn 2000a, 2000b). Pollen records suggest that these catastrophic hurricanes contributed to salinized soils, tree mortality, and increased frequency and intensity of wildfires (Liu et al. 2008). Isotopic records from fish otoliths suggest that the rainy season typical of modern Florida summers emerged during this time as well (Surge and Walker 2005). Sea level varied considerably, and was lower than present ca. A.D. 450 (the Buck Key low-sea stand) but higher than present by ca. A.D. 1000 (the La Costa high-sea stand) (Ricklis and Weinstein 2005; Tanner 2000; Walker 1992, 2013).

Despite these environmental disruptions, a core subsistence strategy that focused on lightning whelks, scallops, fighting conchs, mullets, sea catfishes, and deer persisted for at least 800 years, as documented by the shell midden assemblages at the Harrison and Hare Hammock sites. Although fluctuations and perturbations likely occurred over the short-term, the core strategy persisted over the long term. The purpose of this section is to review the characteristics of the coastal economic system that contributed to its persistence through time.

The East Peninsula Sequence forms the basis of this diachronic examination of coastal subsistence in this area. The term "generalized resource stress" refers to a suite of symptoms that suggests resource depression and/or intensification (Murawski 2000), regardless of whether they were caused by anthropogenic or non-anthropogenic events. These symptoms include: reductions in diversity; reductions in aggregate production of exploitable resources; decline in mean trophic level, increased by-catch; greater variability in abundance of species; greater anthropogenic habitat modification (Hall 1999); and, in extreme cases, change to alternative stable species regimes (Steele 1998). The symptoms that can be evaluated from zooarchaeological evidence include reduced diversity, increased by-catch, reduced mean trophic level (Pauly et al. 1998; Reitz 2004), reduced foraging efficiency, or a regime change from marine to terrestrial animals; from fishes to shellfishes; or from large- to small-bodied animals (e.g., Allen 2012; Braje et al. 2007; Broughton 1994a, 1994b, 1995, 1997; Butler 2000, 2001; Butler and Campbell 2004; Reitz 2014).

This approach is meant to assess the stability and resilience of the subsistence system as a whole. In addition to systems-level approach, the health and stability of local single-species populations and fisheries are assessed. In particular, large intertidal whelks and scallops were major resources in the subsistence system, and both are subject to boom-and-bust population cycles. Changes in the size classes may reveal changes in population demography related to generalized stress.

Vulnerability

Vulnerability is the degree to which a system or component is likely to be harmed by a disturbance (Turner et al. 2003). Research demonstrates that the vulnerability of a system is not merely a function of exposure to hazards, perturbations, and stresses, but is related also to the sensitivity and resilience of the system and its components (Turner et al. 2003). In this case, the system is the core subsistence strategy, and components are individual species or groups of species within the system.

The mean Trophic Level (TL) is used as a metric of fisheries vulnerability because fisheries that target high trophic levels are potentially unsustainable and vulnerable to overexploitation (Pauly et al. 1998). Pauly and his colleagues (1998, 2000) argue that significant changes in the structure of the marine food web occurred during the last half of the twentieth century. The mean trophic level for the combined invertebrate and vertebrate fishery peaked at 3.4 in the 1970s, followed by a decline to 2.9 by 1994. The decline was termed “fishing down the food web,” and was considered a warning sign of a troubled fishery. The mean TL of the Woodland fishery system, including invertebrates, is lower still than the modern low of 2.9, with a mean across time periods of 2.4 ± 0.2 as estimated from MNI, and 2.8 ± 0.2 as estimated from biomass (Table 4.1). Over 80 percent of individuals, and over 60 percent of the biomass, are from low-TL (2.1–2.5) organisms (Figure 5.2). This reflects the importance of invertebrates in the Woodland fishery system, as the low-TL category consists of molluscs and mullets exclusively. The list of major and minor resources (Table 5.1) is dominated by low-TL taxa, including mullets, lightning whelks, tulips, fighting conchs, scallops, and horse conchs. Overall, low-TL taxa, not high-TL organisms, were the basis of the Woodland fishery. If shrimps were an important part of the subsistence strategy, the actual mean TL would be lower still.

Erlandson and colleagues (2009) hypothesized that fisheries that targeted low-TL organisms were more sustainable and less vulnerable to overfishing than were high-TL fisheries. From this perspective, and at this temporal scale of this analysis, the fishery system evidenced at Harrison Ring and Hare Hammock was sustainable. However, this may be an oversimplification of how resource abundance and scarcity were actually perceived on a day-to-day and year-to-year basis. Local populations of specific taxa are vulnerable to boom-and-bust population cycles, and the magnitude of inter-annual variability in the abundances and locations of many resources can be considerable. Bay scallops, for example, are extremely variable in number from year to year, and prone to periodic collapse, owing to natural and anthropogenic events such as salinity fluctuations, seagrass habitat loss, and overharvesting (Arnold et al. 2005). Today, larval exchange is sufficient to maintain genetic homogeneity among bay scallops on the western coast of Florida, but is less than is needed to re-establish extirpated populations (Wilbur et al. 2005). Large predatory gastropods such as lightning whelks also are prone to episodes of localized population collapse and can be quickly depleted, even when collected by hand (Shalack et al. 2011). The recovery of the local populations relates to the interconnectivity of local populations (Waples 1998) as well as the resilience of the ecosystem (Campbell and Butler 2010; Reitz 2014). Although the fishery system was apparently stable over the scale of centuries, it is unclear how people responded to short-term fluctuations.

To consider the trophic dynamics and stability of the finfish component of the fishery, invertebrates are excluded and mean TL of the finfishery is estimated. High-TL fishes (TL > 3.5), which include sharks, toadfishes, several drum taxa, several jack species, and pinfish, were a major part of the finfishing strategy, particularly at Harrison Ring and the later occupation of Hare Hammock (Figure 5.2). Moderately high TL fishes (TL 3.1–3.5), which include rays, sea catfishes, pigfish, burrfishes, and puffers, dominate the Hare Hammock Early assemblage. The lowest-TL group consists of a single taxon, mullets. This taxon and TL-group contributes over 20 percent of biomass during all time periods studied. The mean sizes of mullets and drums are stable through this period (Figure 5.1b).

The mean finfish TL is, of course, much higher compared to the total fishery, at 3.3 ± 0.1 in terms of both MNI and biomass (Table 4.1). This is comparable to the mean TLs reported for two Woodland sites on the Georgia coast (Quitmyer and Reitz 2006). Fishing above TL 3.2 appears to have been the norm prior to the introduction of European and industrial fishing strategies to North America (Quitmyer and Reitz 2006:818). Landings data from Bay County, Florida, from A.D. 1986 to 2011, indicate that local commercial fisheries today target much higher trophic levels than did Woodland fisheries, with mean TL 3.9 ± 0.1 over a 25-year record (Appendix D). A large portion of the modern landings consist of large-bodied, open-ocean fishes, rather than nearshore fishes, suggesting a qualitative difference between pre-European and modern commercial fisheries.

Another aspect to fisheries vulnerability and sustainability relates to the intrinsic vulnerabilities of individual fish species to over-exploitation. Cheung et al. (2005) created an index for the intrinsic vulnerability of individual fish species, which is related to population parameters and life history traits. Generally, species with larger body size, higher longevity, higher age at maturity, and lower growth rates have higher vulnerabilities to over-fishing (Jennings et al. 1999a, 1999b; Reynolds et al. 2005). Species with these life history traits may be less able to sustain high fishing mortality, and fisheries comprised of those species are vulnerable to overfishing as well.

Among the Harrison and Hare Hammock assemblages, the bulk of individuals and biomass are from moderately vulnerable fishes (VI 31–60), which include hardhead catfish, toadfishes, and mullets (Figure 5.2). The midden assemblages demonstrate less emphasis on either low-vulnerability (VI ≤ 30) fishes such as killifishes, burrfishes, and sea robins, or high-vulnerability fishes (VI ≥ 61) such as black drums and gars (Figure 5.2). The average VI is 41.9 ± 1.7 in terms of MNI, and is slightly higher at 45.2 ± 1.5 in terms of biomass (Table 4.1). In terms of intrinsic vulnerability to overfishing, the archaeological data are comparable to modern industrial fisheries, with global mean VIs between 45 and 50 (Cheung et al. 2007). The Harrison and Hare Hammock VI values are slightly lower than the average intrinsic vulnerabilities of modern (ca. 2003) coastal and estuarine fisheries, which were presumably at historic low-points following decades of severe fisheries depletion (Cheung et al. 2007). The TL and VI data suggest that the Woodland fishery was potentially vulnerable to overfishing but persisted for several centuries nonetheless.

Stability and resilience

The goal of this section is to evaluate whether marine fisheries were stable over the 800-year period of study. The stability of the system relates to its exposure to perturbations, as well as its resistance and resilience during periods of disturbance (Reitz 2014; Walker et al. 2004). A resistant system is one that typically survives short- and long-term disturbances unaltered but is slow to recover once altered. A resilient system is vulnerable to perturbations, but quickly recovers or rebounds to its former condition. Woodland fisheries certainly were exposed to natural disturbances, such as hurricanes and shoreline modifications, and, possibly, over-exploitation. To investigate the stability of the system, zooarchaeological data were used to assess change through time in: (1) intrinsic vulnerabilities and TLs targeted; (2) measures of subsistence efficiency; and (3) abundance indices of important resources.

Cheung et al. (2007) reported “steep” declines in mean VI of commercial fisheries during their study period (A.D. 1950–2003): from 50 to 46 globally, and from 48 to 45 within estuaries (Cheung et al 2007:Figure 2). They attributed these declines to overfishing, as highly vulnerable taxa were presumably removed from the fisheries and were replaced by less vulnerable species. Similarly, a decline in mean TL from 3.4 to 2.9 over the same time period was interpreted as evidence of a fishery trending toward collapse (Pauly et al. 1998).

The zooarchaeological study operates at a much coarser time scale, with only three time points representing over 800 years of human occupation at a single locale. Three temporal analytical units were described in Chapter 3: the Harrison, Hare Hammock Early, and Hare Hammock Late assemblages. There are minor variations in mean VI among the Woodland samples: a slight increase in intrinsic VI over time in terms of MNI, from 40 to 42, and a very small decline in mean TL, from 2.4 to 2.3 in terms of MNI and from 2.8 to 2.6 in terms of biomass (Table 4.1). Quitmyer and Reitz (2006) documented a similar decline in mean TL, on the order of approximately 0.2 TL, from Swift Creek (A.D. 300 to 700) to Savannah (A.D. 1200 to 1500) occupations at two locations on the Georgia coast. These declines were characterized by an increase of low-TL taxa, including invertebrates, and a decrease in high-TL fishes, which they interpreted as a response to a larger stimulus felt throughout the region, rather than a local, cultural shift in technology because it was observed at two roughly contemporaneous sites

(Quitmyer and Reitz 2006:820). Although the minor declines reported here may reflect similar effects, it is not clear whether these reflect system-wide changes or minor temporal fluctuations.

It is difficult to evaluate whether these differences are ecologically or behaviorally meaningful on either the Gulf of Mexico and the Georgia coast (Quitmyer and Reitz 2006). The nature of zooarchaeological datasets is that each assemblage is a time-averaged representation of subsistence activities, and each is treated as a single analytical unit with indices such as TL and VI estimated for the assemblage as a whole. Effectively, each time period in both studies is represented by a single sample. Multiple samples are needed to estimate uncertainty in population parameters such as TL and VI. A better approach might be to focus on analyzing several small samples, such as features, in order to estimate these parameters as well as our uncertainty in them.

Another possible signal of a stressed resource base is a decline in foraging efficiency caused by over-exploitation or intensification, as lower-ranked resources are added to the optimal strategy to compensate for declines in top-ranked resources. This can present as increase in species richness or diversity, or a shift from large-bodied to small-bodied prey (Allen 2012; Broughton 1994a, 1994b, 1997; Butler 2001; Butler and Campbell 2004; Chatters 1987; Reitz 2014). Faunal diversity (H’) demonstrates a moderate decline from the Harrison Ring to Hare Hammock Early assemblage, with full or nearly full recovery from the Hare Hammock Early to Late assemblages (Table 4.1). As with other parameters discussed in this section, estimation of uncertainty is not possible with these zooarchaeological data.

Lacking estimates of certainty for these parameters, such as confidence intervals, it is not possible to determine whether the small declines observed are real trends or random variations. One conclusion that can be made is that, if the decline from Harrison to Hare Hammock Early was real, it was followed by a recovery to near-previous levels. Resilience, rather than stability, may be the key to the persistence of the subsistence strategy at this locale (see Reitz 2014 for a similar argument for the Georgia coast). One characteristic that contributes to the resilience of the fishery is the resilience of the ecosystem upon which it is based (Campbell and Butler 2010; Reitz 2014). Resilient ecosystems are typically found in areas that are physically unstable and prone to disturbance, such as coastal environments, while resistant ecosystems are favored in stable environments (Odum and Barrett 2005:70). A generalized, rather than specialized, subsistence strategy that involved a broad resource base and a resilient ecosystem may have been well-equipped to recover from disturbances, or not be as affected by them.

Morphometric data also allow for interpretations about the health of individual species fisheries. Hand-harvesting can quickly deplete stocks of intertidal whelks, particularly when harvesting occurs at night (Shalack et al. 2011). The size of lightning whelks decreased over a period of about 20 years in the Big Bend region of Florida (Kent 1983). Lightning whelks observed from AD 1959–1960 had a mean Shell Height of 250 mm (Paine 1963). Twenty years later, a modal size class of 90–99 mm was reported. Kent (1983) suggested that the decline in size of lightning whelks during the twentieth century was due to over-exploitation by humans.

At least 181 individual lightning whelks are represented in the Harrison (*n* = 69) and Hare Hammock (*n* = 112) assemblages. Few are complete specimens, so the minimum SH of nearly complete individuals is used to evaluate changes in the size classes of whelks used. At Harrison Ring, lightning whelk shells averaged 82–100 mm in minimum SH (*n* = 53; 95 percent CI). At Hare Hammock Ring, lightning whelks averaged 121–140 mm (*n* = 81; 95 percent CI). This represents a moderate but statistically significant increase in the size of lightning whelk shells during the Woodland period (Figure 5.1), which may reflect a combination of factors. The increase in size also is accompanied by a decrease in the relative numbers of individuals (Tables 4.2 and 4.21). The increase in size and decrease in number of lightning whelks is perplexing. It could be an indication that harvest pressure declined, allowing whelks to live longer and achieve greater sizes. Alternatively, an increase in growth rate would cause them to achieve larger sizes at younger ages, as is observed in other marine species (e.g., Bologna and Heck 1999; Rijnsdorp, and van Leeuwen 1992). The latter might happen if density-dependent variables (e.g., competition) decline. Overexploitation by human predators, increased habitat availability, or niche partitioning among competitors could reduce the effects of density-dependent factors leading to increased growth rate. This possibility should be more thoroughly explored through growth increment analysis to investigate changes in growth rate, rather than absolute size.

The apparent size increase may also reflect changes in human practices, including the technology used, the timing, intensity, or location of collection, or the life-use or discard of shells and shell objects. This could include exploitation by divers offshore, rather than nearshore, or a change from seagrass beds to oyster habitats. Lightning whelks associated with oyster habitats may grow to larger sizes than do those in grass flats (Kent 1983). However, evidence for oyster reefs are generally lacking at Harrison and Hare Hammock during the Woodland period.

Another possibility is that size changes relate to the pan-regional demand for lightning whelk shells, and in the export of shells from the Gulf Coast region. The Harrison Ring, a Swift Creek-period site, probably participated in an exchange network with inland groups and likely was involved in pan-regional interaction spheres. If lightning whelk shells were exported from the vicinity of the Harrison Ring site, lightning whelks actually may be under-represented in the shell midden. This may be a missing component of coastal subsistence record, if the meat was processed for local or regional consumption and the shells exchanged with inland groups for other goods. A pilot study aimed at sourcing lightning whelk shells recovered from inland sites concluded that the shells came from several areas of the Gulf Coast (Claassen and Sigmann 1993). There is no evidence for local craft specialization involving whelk shells such as the bead workshops reported for Mississippian-period sites on the Atlantic coast (Pearson and Cook 2012) and the interior (Trubitt 2003). The potential export of lightning whelks could influence the sizes of shells in the midden if shells were judged based on size. Perhaps the largest specimens were systematically removed from the coastal context for export, while smaller specimens remained on the coast and are therefore over-represented in the midden. As the Middle Woodland interaction spheres declined, so may have the demand for lightning whelk shell exports.

There is no change in the mean Standard Length of mullets or hardhead catfish over time (Figure 5.1b), suggesting that these were possibly stable metapopulations over the scale of centuries. Sea catfishes exhibited an increase in size from the Harrison to Hare Hammock periods of occupation. While this may reflect changes in population demography to some extent, it more likely reflects a shift in focus from juveniles (<150 mm SL) to adults, possibly reflecting a change in technology, season of collection, or both.

Chapter Summary

Zooarchaeological data from the East Peninsula sequence are used to address subsistence, seasonality, and sustainability of coastal economies at a single locale on the Woodland Gulf Coast over a span of approximately 800 years. The major findings as they relate to the research questions are reviewed below. Chapter 6 approaches the same issues from a larger spatiotemporal scale, reinterpreting the East Peninsula dataset in the context of broad regional patterns over the span of approximately 5,000 years.

Was the coastal zone used on a seasonal basis?

Seasonality data are sparse for the Harrison and Hare Hammock ring middens. Seasonality data from the Harrison Ring include valve measurements of scallops that indicate early summer collection, ratios of lightning whelks to horse conchs that tentatively indicate winter collection, and Standard Length estimates of hardhead catfish indicating collection at least during summer/fall. These demonstrate that Harrison Ring was occupied at least sporadically from spring through fall over its 300-year history of occupation. There is little evidence at this time pointing to subsistence activities during the winter months at Harrison Ring, with the exception of gastropod collection, although this absence of evidence should not be interpreted as evidence of absence.

Seasonality data from Hare Hammock include the presence of bluefish and sturgeon, which are highly seasonal (winter) taxa in the northern Gulf of Mexico, and sea turtle and cownose ray, both of which are more abundant during the spring and summer. Scallop measurements indicated a late summer season of collection. As with the Harrison Ring, the available data broadly suggest that Hare Hammock was used over multiple seasons, and was occupied at least sporadically during both summer and winter. However, these broad generalizations about site seasonality are based on just a handful of specimens (Waselkov 2012).

On the basis of site structure along with the site seasonality data, I suggest that the Harrison and Hare Hammock ring middens were base camps or villages occupied for extended seasons, if not year-round. This study lacks the temporal necessary to determine whether these sites were occupied during successive seasons or years, whether they experienced periods of vacancy for months or years at a time, and how the functions of these sites changed over time.

What was the basis of coastal subsistence?

The core subsistence strategy at the Harrison and Hare Hammock ring middens focused on marine and estuarine fishes and molluscs, chiefly from seagrass beds and intertidal habitats. A combination of strategies likely was used to target different resources in these environments simultaneously, by different task groups. The use of relatively unselective mass-capture fishing techniques yielded a diversity of fish species, with mullets, hardhead catfish, black drums, and toadfishes predominating. Shellfishes were collected by hand individually. Shellfishing efforts were more specialized than finfishing, and were focused on bay scallops and a few species of large marine gastropods, particularly lightning whelks, fighting conchs, and tulips. Terrestrial hunting was highly specialized, and focused on deer, although terrestrial animals were secondary to aquatic ones. Fishes and shellfisheses probably were collected and consumed on a regular basis, while deer and other animals probably were less routine components of the diet.

The distribution of animal remains within the Hare Hammock site suggests that individuals and/or households within the community used resources differently. Specifically, the House Mound on the northern end of the ring demonstrates a greater reliance on deer and fishes, particularly individually captured fishes from higher trophic levels. In comparison, the shoreline midden on the opposite side of the ring demonstrates a greater reliance on shellfishes, particularly gastropods, with a greater reliance on mass-captured fishes from lower trophic levels. This may reflect differences in status, access to resources, activity areas, or a combination of factors.

Is instability of coastal ecosystems a modern phenomenon?

The ecological concepts of vulnerability, resistance, and resilience were used to evaluate the characteristics of a persistent coastal subsistence strategy. The safest strategy would focus on low-TL taxa, and fishes with low intrinsic vulnerabilities; the “riskiest” strategy would focus on high-TL animals and fishes with high intrinsic vulnerabilities. The TL and VI data demonstrated that the Woodland fishery was not invulnerable to overfishing. Pre-European fisheries targeted lower trophic levels than do modern industrial fisheries, but as a whole the Woodland fishery system as represented by these sites exhibited moderate vulnerability to overfishing, with a mix of high- and low-TL organisms with varying intrinsic vulnerabilities.

At this time it is not possible to evaluate definitively whether diversity, TL, and VI were stable through the study period. Qualitatively, it appears that several measures exhibit a period of decline, which typically is interpreted as resource depression, followed by recovery to near-previous levels. Whether the variability is random or related to social or ecological phenomena remains to be seen. Individual taxa or groups of taxa likely varied over shorter time scales, although the core subsistence strategy persisted. The persistence of the fishery system is likely due to a combination of factors, including the exploitation of a broad and resilient resource base.

Table 5.1. Major and Minor Resources at the Harrison and Hare Hammock Ring Midden

Harrison Ring Midden

Major Resources			**Minor Resources**		
Taxon	**%MNI**	**% Biomass**	**Taxon**	**%MNI**	**%Biomass**
Lightning whelk	8.6	14.1	Fighting conch	6.10	0.7
Scallop	25.0	0.6	Pear whelk	3.20	0.7
Slippersnail	10.3	0.1	True tulip	2.00	2.7
			Horse conch	1.00	6.2
			Marginella	2.00	<0.1
			Mullet	2.00	2.6
			Deer	0.10	5.6

Hare Hammock Ring Midden

Major Resources			**Minor Resources**		
Taxon	**%MNI**	**% Biomass**	**Taxon**	**%MNI**	**%Biomass**
Fighting conch	30.6	4.5	Horse conch	0.3	2.3
Lightning whelk	6.7	21.0	Mullet	3.9	4.1
Scallop	16.3	0.4	Spot	2.0	0.3
Hardhead catfish	3.8	13.0	Deer	0.1	4.3
Slippersnail	7.0	<0.1			

Note: Major resources contribute >10% of biomass or MNI; minor resources contribute 2-10% of biomass or MNI.

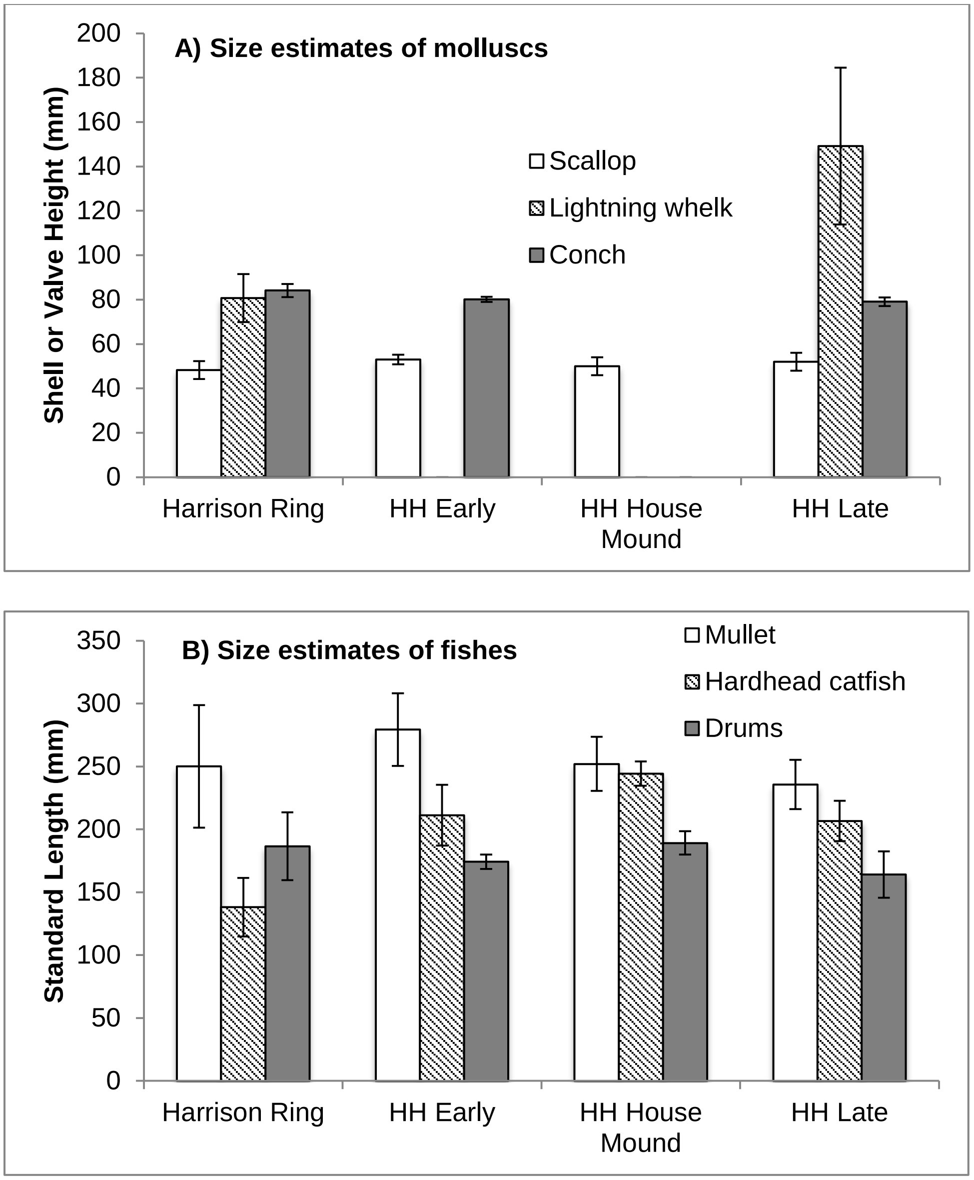

Figure 5.1. Size estimates of (A) molluscs and (B) fishes at Harrison Ring and Hare Hammock (HH) through time showing average and 95 percent confidence limits.

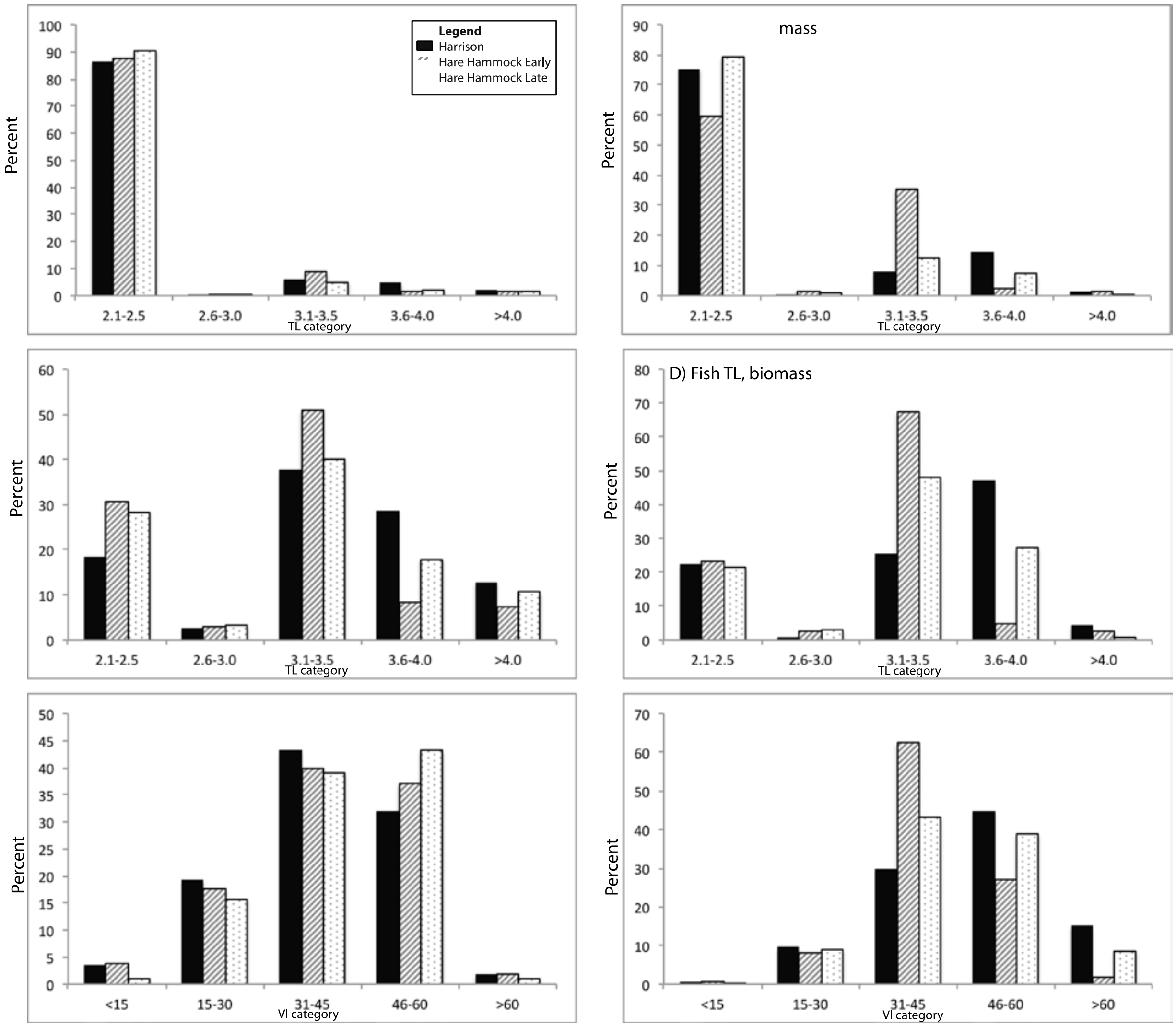

Figure 5.2. Frequency histogram of percent of total fish and shellfish MNI and biomass by TL (A,B); fish MNI and biomass by TL (C,D); and fish MNI and biomass by VI category (E,F).Total TL includes non-commensal invertebrates.

CHAPTER 6:

SUBSISTENCE AND SEASONALITY ON THE GULF COAST

This chapter synthesizes the regional zooarchaeological dataset to expand on the major themes in Chapter 1 from a regional perspective. Specifically, I ask:

(1) Was the coast occupied on a seasonal basis?

(2) Were there one or many coastal subsistence strategies?

(3) Were coastal economies and ecosystems stable over the scale of millennia?

This chapter consists of three sections. The first section summarizes the evidence for seasonality and mobility on the northern Gulf Coast, including a discussion of human-mediated movement of goods between the coast and interior. The second section discusses the variability in subsistence systems across the northern Gulf Coast. The third section discusses broad temporal trends in resource use related to sustainability, intensification, and resource depression.

Seasonality and Mobility

Human mobility takes many forms. Individuals and groups of people probably moved within the coastal zone, and between the coast and the interior, on a fairly regular basis and for a variety of purposes. Individuals and families relocate when opportunities to make a better living arise elsewhere, marry and take up residence with the spouse’s kin group, and make pilgrimages to sacred places. Coastal people also may have congregated in regional ceremonial centers such as McKeithen in northern Florida, Kolomoki in southern Georgia, and Crystal River in central Florida for religious/ceremonial, social, and economic purposes. Large, multi-mound sites such as these possibly served as meeting places for establishing and maintaining intergroup alliances and as gateways for trade within the regional interaction sphere (Knight 2001; Pluckhahn 2003). However, the use-histories of centers such as these are complex and varied. The timing, tempo, and purpose of occupation at these sites changed at multiple temporal scales (e.g., Pluckhahn et al. 2015).

While all of these forms of mobility are important, this section focuses on evidence for year-round occupation of the coast, in contrast to seasonal migrations between the coast and the interior. A standard model for coastal mobility assumes, without the support of archaeological data, that populations aggregated in upland/interior villages during most of the year, and scattered to the coast during the winter (e.g., Crook 1986; Curren 1986). Seasonality data from the northern Gulf Coast region remain sparse, but additional data from sites that were not included in the regional dataset are available to expand upon seasonal aspects of site use in this coastal zone (Table 6.2).

It is not possible to make quantitative comparisons about the peak seasons of use of specific sites, habitats, or resources during the Archaic period with the current dataset. Although seasonality data are spotty, year-round occupation of the coast, if not year-round site-specific sedentism, possibly appeared by the Archaic period in some areas of the northern Gulf Coast (Table 6.2). What is clear, however, is that the coast was occupied in warm weather as well as cold. Meig’s Pasture and Mitchell River both represent specialized shellfishing strategies, and may have functioned as camps that were used throughout the year as part of a broader subsistence system.

More lines of evidence are available for seasons-of-use and seasons-of-occupation during the Early Woodland period (Table 6.2). Bense (1985:161) interpreted three archaeological features at the Hawkshaw site as summer deposits, although other seasons could not be ruled out.

Refuge Tower, in the Big Bend region, also was occupied during the warm months of the year, but is interpreted as a multi-season, if not year-round dwelling site (Lawson 2005). Evidence for fall and winter use of these sites is present, but less abundant (Table 6.2).

The most comprehensive seasonality dataset for the Middle Woodland period is from the Plash Island site (Reitz et al. 2013). Extensive use of stable oxygen isotope analyses of carbonate skeletal structures (fish otoliths and mollusc valves) permits quantitative comparisons for seasons of use at this site. All seasons are represented, with a clearly bimodal distribution of summer- and winter-collected specimens (Hadden et al. 2015; Reitz et al. 2013). Other lines of evidence support these conclusions (Table 6.2). The few seasonality indicators at the Harrison Ring suggest occupation during at least summer, fall, and winter (Chapter 5). The evidence for coastal occupation during the spring during the Middle Woodland period at these two sites is not strong, but whether these sites are representative of the region is uncertain. Both sites represent generalized subsistence strategies with high species diversity, consistent with extended or long-term use. The reliance on mass-capture techniques is also consistent with extended or long-term occupation.

Extended or year-round coastal occupations are documented during the Late Woodland period, though this may reflect a greater sampling effort by archaeologists rather than changes in patterns of residential mobility (Table 6.2). Comparable datasets based on δ^{18}O curves for fishes and molluscs are available for the Bayou St. John (Hadden et al. 2015; Reitz et al. 2013) and the Graveline (Blitz et al. 2014) sites. All seasons are represented at Bayou St. John, but especially abundant are specimens from animals that died during the winter and spring. Summer-collected specimens are common also, and, though present, fall-collected specimens are uncommon. If these data reflect the intensity of occupation at Bayou St. John, use of the site possibly peaked during the winter and spring, with only a few residents during the fall. In contrast, the Graveline Mound site on the Mississippi coast was used most intensively during the spring and summer, with little evidence for use during the fall and winter (Blitz et al. 2014). Other Late Woodland sites document year-round occupation of the coast (Table 6.2), but an interesting feature of the Bayou St. John and Graveline datasets is that they indicate the intensity of site occupation, or at least the collection the of species targeted for isotopic analysis, was bimodal, with little evidence for occupation during the fall. Taken together, the seasonality data from the Late Woodland Gulf Coast region suggest that the coastal zone was a primary locus of settlement and exploitation, and not a winter refuge for an otherwise inland-adapted human population.

Bar-Yosef and Rocek (1998:2) warn that we should not try to reconstruct entire settlement systems, and must be satisfied with modeling portions of the annual or decadal range of human activities from one or a few sites. Data from the northern Gulf Coast demonstrate that single sites are not representative of the overall settlement pattern for the coastal region. One possibility is that coastal dwellers practiced a form of residential mobility that was largely restricted to the coastal region, with portions of the population moving among coastal sites for various social or economic purposes. This would explain the modality in seasonal indicators within sites, and the complementarity of seasons of occupation among sites.

The paucity of data for coastal occupation during the fall warrants further research. A portion of the coastal population possibly travelled inland during the fall to take advantage of the peak season for deer and nut mast. Comparable seasonality data for inland Weeden Island sites are rare, but Milanich (1974), Lolley (2003), and Mickwee (2011) commented on the seasonality of occupation of three such sites: Sycamore, Coahatchee, and Woodland Terrace. The Sycamore house site, a part of the Aspalaga village, was interpreted as a fall and winter occupation based on the abundance of deer and nuts (Milanich 1974:32). Plant and animal remains from the Coahatchee site suggested the Late Woodland occupations were probably most intense during the late summer and fall, based on the abundance of deer, hickory, acorns, and other fruits and seeds (Lolley 2003:74). Woodland Terrace was likely a fall to winter residential base occupied multiple times during the Late Woodland period (Mickwee 2011). Although Milanich (1974) did not explicitly discuss movement between the coast and the interior with reference to the Sycamore site, a worked lightning whelk columella found at Sycamore suggests at least indirect contact, and probably direct contact, with coastal peoples and/or resources.

To investigate the flow of commodities between the interior and the coast, I attempted to identify the human-mediated movement of deer products (venison and bone tools) between coastal and interior locales. White-tailed deer are large-bodied game animals with a widespread distribution across the Americas. Deer are common in archaeofaunal assemblages throughout the hemisphere, but their remains are relatively more abundant in inland assemblages than in coastal ones.

Light stable isotopes of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) vary among plants at the base of the food chain reflecting photosynthetic pathway (e.g., C_3 versus C_4), and the trophic levels of consumers (Hedges and Reynard 2007). In addition, environmental variables such as elevation, aridity, fire frequency, and vegetation cover influence stable isotope ratios as well (e.g., Cook 2001; van de Water et al. 2002). These isotopic differences are manifest in plants, as well as plant consumers. $\delta^{13}C$ and $\delta^{15}N$ analyses are increasingly used to differentiate among sources and management strategies of archaeological artiodactyl specimens (e.g., Hartman et al. 2013), rather then for dietary reconstruction.

The plant communities of the greater Southeast are patterned by the landforms, elevations, and soils that define its physiographic regions. Deer have small home ranges, usually less than 2 km^2 (Harestad and Bunnel 1979). Consequently, the stable isotope geochemistry of deer bones should reflect the isotopic make-up of their plant-based diet, which is geographically well-constrained. Stable isotope data from deer bone collagens should reflect spatial patterning corresponding to physiography, with extreme isotopic outliers within isozones potentially being from non-local sources.

Deer originating on the coast were expected to be enriched in δ^{13}C and δ^{15}N compared to inland deer, because coastal plants should be enriched relative to inland ones owing to the relative abundance of C_4 plants in the coastal southeast; enrichment in plants influenced by salinity (Stevens et al. 2006); and the possibility of coastal deer foraging on marine-influenced plants in the marsh. However, the pilot study of 66 deer specimens representing coastal and inland sites did not yield discrete, non-overlapping stable isotope ranges corresponding to different coastal and inland environments (Figure 4.8). There is some degree of isotopic discrimination among sources (e.g., between the coast and inland Georgia), but there is also much overlap. Based on these data, it is not possible to source deer bone products to a region based on light stable isotopes of carbon and nitrogen at this time.

Because the data and interpretations of this pilot study are tentative, they are discussed here only briefly. One outlier from the coastal Panhandle, specimen # UGAMS13926 from the Bayou St. John site, is more enriched in δ^{13}C compared with the rest of its group (Table 4.29), which may indicate that it was from a non-local source or had a diet unlike other members of the group. It also may be different because the sample is from antler collagen, rather than bone collagen, and trophic shifts are thought to be greater in antler compared to other deer tissues

(Darr and Hewitt 2010). Alternatively, because antlers are grown and shed seasonally, their isotopic values may reflect just a portion of the year and could represent a seasonal change in diet.

Strontium isotope(^{87}Sr/^{86}Sr) analysis of tooth enamel is useful in identifying the movement of people and other animals between coastal and inland locations. Generally, measurements of ^{87}Sr/^{86}Sr vary by rock type, composition, and geological age (Faure and Powell 1972). Limestone substrates on the coast reflect strontium isotope compositions of seawater at the time of formation. Marine limestones and dolomites have ^{87}Sr/^{86}Sr values between 0.707 and 0.710 (Palmer and Elderfield 1985; Wright 2005), and values around 0.709 are expected for plant and animal communities on limestone bedrocks of the Panhandle region of the Gulf Coast (Quinn et al. 2008). Many old igneous and metamorphic rocks from the earth's crust have high strontium values (0.715 and higher), and recent volcanic rocks have low strontium values (typically 0.703–0.707) (Hedman et al. 2009:65).

Strontium isotope outliers in this pilot study were unexpected because the Sr concentration and isotopic composition of archaeological bone (but not tooth enamel) often reflect nearly complete exchange with local groundwater (Nelson et al. 1986). Thus, even bone of non-local origin is expected to adopt a local strontium isotope signature. Nonetheless, a single Sr isotope outlier (specimen # UGAMS13925) was present. The strontium outlier is an unworked left scapula from the Bayou St. John site. High-precision isotope ratio mass spectrometry such as TIMS produces measurements with very small uncertainties (± 0.0004), therefore differences among samples reflect very small analytical errors. The ^{87}Sr/^{86}Sr outlier yielded a value of 0.7108, greater than 2-σ from the group mean (Table 4.2) and outside of the expected range for geologically recent marine sediments. This specimen may have originated in an area with a different geological substrate, perhaps from farther inland.

Although it is currently not possible to discriminate between coastal and inland deer on the basis of $\delta^{13}C$ and $\delta^{15}N$ data alone, these data can be used to help interpret the anomalous $^{87}Sr/^{86}Sr$ data point. This particular bone specimen was recovered in the Panhandle region, but it is more similar to the inland Georgia group than to the Gulf Coast groups in terms of stable carbon and nitrogen isotopes. Though not definitive evidence of the origin of this specimen, it tentatively supports the hypothesis that specimen UGAMS13925 was transported to the coast from the interior. Even if the deer scapula did not originate on the coast, and was imported from an inland locale, it is but a single specimen. Further research is needed to evaluate the connectivity between communities on the coast and in the interior region during the Woodland period.

Patterned Variability in Subsistence Strategies

All 12 sites generally conform to what Wing (1977) described as a “coastal and specialized fisherman” strategy, which, according to her definition, focused on sea catfishes (Ariidae), jacks (Carangidae), and sheepsheads (*Archosargus probatocephalus*), with minor resources including deer (*Odocoileus virginianus*), mullets (*Mugil* spp.), and burrfishes (*Chilomycterus schoepfi*). This classification very broadly describes the vertebrate coastal resources that were important to coastal economies in the greater Southeast, but it glosses over an enormous range of variability in how resources were used. Archaeologists note that local variability exists, probably due to differences in habitat (e.g., Mikell 2012; Nanfro 2004; Orr 2007), but we lack a framework for synthesizing the dimensions of variability. Such a framework is critical for understanding how subsistence systems, landscapes, identities, and political economies interacted.

Based on the cluster analyses and ordination (Figures 4.6 and 4.7), four clusters of sites with similar resource constellations reflect alternative or complementary strategies within the broader coastal subsistence system. These appear to represent variations on Wing's "specialized fisherman strategies." The clusters are defined by the constellations of major and minor resources (Table 4.28), but they differ also in terms of the degree of specialization, the use of estuarine versus marine habitats, the relative abundances of fishes and shellfishes, and the trophic levels targeted (Table 6.1). Presumably, the patterned variability reflects not only local habitat types, but also variability in site function and/or age. Differential access to resources owing to site location also involved aspects of local and regional political economies.

Cluster 1 consists of six sites in the regional dataset: Mitchell River 1, Meig's Pasture, Shell Mound, Hawkshaw, and Bayview, and Plash Island (Figure 4.7). Five of these sites are in the Panhandle region, and one is in the Big Bend region. Shellfishes are the primary source of biomass, and indicate specialized subsistence activities targeting oyster (Table 6.1). Fishing was secondary to shellfishing, and was also highly specialized. Fishing activities at these sites targeted jacks, a high-TL fish, as well as mullets. Jacks are characterized as large-bodied, single-capture fishes, though small ones are readily caught in nets.

The specialized estuarine shellfishing system represents a focal adaptation to a specific habitat type and is characterized by low diversity. The constellations of resources at these sites generally indicate exploitation of oyster-dominated estuaries, salt marshes, and oyster beds. Finfishing functioned in a supplementary role at these and similar sites. There is less emphasis on mass-capture fishes that would involve the use of nets, seines, weirs, and other facilities that would require considerable investments in maintenance and for which frequent relocation is impractical.

There is no clear pattern as to how specialized estuarine shellfishing sites fit within a broader settlement system. The earliest sites in the regional dataset are in this cluster, but later sites are in this cluster also (Table 4.26). This subsistence strategy represents an early, but long-lived, coastal adaptation in this region. Sites in this group include presumably short-term camps used for resource procurement and as well as village sites as discussed in Chapter 3. It is possible that this strategy was used in a variety of contexts. In short-term occupations, it may have been just one aspect of a more generalized coastal strategy that used short-term special-function sites. In presumed village sites (e.g., Hawkshaw and Bayview), a focus on select, high-yielding resources was possibly an important factor in selecting the site location (Struever 1968:305).

Cluster 2 includes the Harrison and Hare Hammock sites (Figure 4.7) and reflects a generalized marine shellfishing and fishing strategy (Table 6.1). This strategy was limited to sites with direct access to seagrass beds and hypersaline bays. It is characterized by relatively high species diversity, suggesting a generalized strategy. Shellfishes are the major source of biomass, but fishes are abundant also. Large marine gastropods, particularly lightning whelks, dominate these assemblages. The overall finfishing strategy was relatively generalized, and targeted a variety of fishes such as mullets, sea catfishes, as well as drums, suggesting a combination of individual- and mass-capture techniques as discussed in Chapter 5.

The generalized marine shellfishing strategy is predicted to dominate in low-energy, hypersaline habitats. The two sites included in this cluster are interpreted as extended-occupation villages (Chapter 5). Middens and scatters unaffiliated with mounds are found on the same peninsula (East Peninsula) as the Harrison and Hare Hammock sites (Russo et al. 2012), and may represent more specialized processing sites. White (2014) documented whelk-dominated middens in the hypersaline St. Joseph Bay, ca. 20 km east of the Harrison and Hare Hammock sites. Complete zooarchaeological analyses of fine-screen archaeofaunal fractions have not been conducted at the sites reported by White (2014). They would possibly exhibit a similar subsistence strategy to the one described here.

Cluster 3 includes the Mack Bayou, Bayou St. John, and Strange's Ring Midden midden sites (Figure 4.7). These assemblages represent a generalized estuarine fishing and shellfishing strategy (Table 6.1). Fishes are the major source of biomass, with shellfishes being secondary resources. This is a generalized strategy, and not characterized by a focus on any one particular resource. The diverse suite of resources includes brackish-water finfishes such as sea catfishes, mullets, sheepsheads, and flounders, suggesting a mix of both individual- and mass-capture techniques. Shellfishing, in contrast, was relatively specialized (Table 6.1), but secondary to fishing. Oysters are the dominant shellfishes, and marine gastropods are rare or absent from the assemblages.

The generalized estuarine fishing and shellfishing strategy used a wide range of resources and technologies, and represents a diverse and broad-based strategy for exploiting estuarine environments. This resource strategy may be associated with long-term or extended occupations or villages, rather than logistical camps, as indicated by the diversity of activities that took place at these sites. Bayou St. John and Mack Bayou, at least, represent multi-season coastal occupations (Hadden et al. 2015; Mikell 2012; Reitz et al. 2013). The abundance of mass-capture fishes may reflect greater investments in persistent facilities such as fish weirs. The use of mass-capture technologies may also be associated with increased individual or group property rights or territoriality (Byrd 1997).

Cluster 4 consists of a single site, Bottle Creek (Figure 4.7). This is not surprising, as it differs from the rest of the sites in the regional dataset in terms of time period, location, and function. As discussed in Chapter 3, Bottle Creek was a major Mississippian-period political and ceremonial center, where an elite class was provisioned by a class of common-folk (Brown 2003). Animal remains from the Bottle Creek site reflect a diverse strategy representing an equal mix of terrestrial, estuarine, and freshwater taxa (Table 6.1), suggesting a broad catchment area. The strategy is similar to the generalized estuarine strategy in terms of the diversity of the fish and shellfish assemblages and the focus on moderate-TL fishes, however, with a greater emphasis on terrestrial and low-salinity aquatic taxa. The interpretation of the faunal assemblage is that people brought animals and domestic plant foods to Bottle Creek from a variety of environments, including Mobile Bay and the Gulf Coast, the intermittently brackish swamps of the Mobile Delta, terrestrial uplands, and upriver freshwater environments (Quitmyer 2003; Scarry 2003).

The clusters described above, and the subsistence strategies they reflect, are treated as discrete groups to facilitate the discussion of broad patterns. Habitats, of course, played a role in the types and relative quantities of resources used, but people did not simply overlay a “uniform pattern” (Nanfro 2004:58) of resource use onto varied habitats. While some people focused on a few high-yield resources, others practiced a more generalized strategy. People at similar sites took different approaches to fishing and shellfishing. The reverse is true also: in some cases people practiced similar subsistence strategies in very different contexts. There was not a single pattern of resource use for the coastal Southeast.

The generalized estuarine fishing and shellfishing strategy described above (Cluster 3) is most similar to Wing’s (1977) definition of a specialized fisherman strategy, and is probably how most archaeologists would characterize economies of the coastal Southeast. In Chapter 5, I questioned whether the dominance of molluscs at the Harrison and Hare Hammock sites represented a localized adaptation to gastropod-dominated marine habitats, or whether a broad regional trend had gone unrecognized. The answer to both is yes: molluscs dominate two of the four coastal subsistence sub-systems (Table 6.1), and eight of the 12 sites included in the regional study (Table 4.26). Habitat also played an important role. The generalized marine strategy (Cluster 2) is in many regards similar to the generalized estuarine strategy (Cluster 3), and may represent a variation on a theme reflecting the different habitats used. One sub-system was a specialized shellfishing strategy focused on oyster habitats, and the other, a generalized strategy that took advantage of gastropod-dominated seagrass beds.

However, shellfish taxa are not interchangeable resources, and the implications of having access to one type over another are nontrivial. Focusing on large marine gastropods instead of oysters had logistical implications. Marine gastropods are mobile, large, and collected individually, whereas oysters are sessile, small, and can be collected en masse. Shellfishing was possibly carried out during different times, by different means, or by different members of the community depending on which species were locally abundant (Chapter 5). Thus shellfish, and the places they were acquired, took on different social meanings for the people who acquired and consumed them. Coastal dwellers were not desperate people, “clinging to life by eating any foods” that were available (Meehan 1982:260). Coastal fishers have high gastronomic standards and clear ideas about what was good to eat and what was valued highly (Meehan 1982). Different types of shellfish meat, like lightning whelks and oysters, differ in terms of size, texture, taste, appearance, cooking properties, and odor, which likely influenced local preparation methods and cuisines. Food is a particularly powerful symbol of personal and group identity (e.g., Bradatan 2003; Fischler 1988; Wilk 1999).

The shells of various taxa had different potentials for use as well. Large gastropods, particularly lightning whelks, were valued for their shells as raw materials for exchange (Anderson 2002:279; Hudson 1976:310,316) or for manufacturing goods. Whelk shells were fashioned into a variety of formal and expedient tools (e.g., Eyles 2004; Marquardt 1992b), ceremonial paraphernalia, and items of personal adornment including beads, pendants, and gorgets (Hudson 2004; Kozuch 1998; Pearson and Cook 2012). Oyster shells were more limited in their possible uses. Oysters could have been used as cultch for expanding oyster beds, as fill for architectural projects (Marquardt 2012), or as cutting tools and net weights (Marquardt 1992b:212–213).

The generalized marine shellfishing strategy has unique political economic implications. Based on the sample of 12 sites, this was relatively uncommon and restricted geographically. Modern populations of lightning whelks exhibit a patchy distribution and extreme inter-annual variability in population abundance (Stephenson et al. 2013). Based on the distribution of lightning whelk shells in the archaeological record, this probably was true in the past as well. The western coast of Florida has been assumed to be the origin of the large *Busycon* shells found in Archaic, Woodland, and Mississippian sites in the Mississippi Valley (Claassen and Sigmann 1998; Kozuch 1998). Artifacts made from marine shell have been found as far west as Oklahoma and as far north as Wisconsin (Milanich 2004:86). Shell cups made from lightning whelks were an important part of black drink ceremonies throughout the region (Milanich 2004:85). Both the drink, a tea made from yaupon holly (*Ilex vomitoria*), and the shell drinking cups had religious and ceremonial significance to southeastern Indians (Hudson 2004).

Not all coastal communities had direct access to this sacred shell. Lightning whelk “hot spots,” such as the Harrison and Hare Hammock locality and other marine gastropod-dominated shell midden sites on the Gulf Coast (e.g., White 2014) were possible sources of the marine shells used in the black drink ceremony by both coastal and inland groups in the Southeast and beyond. Carr (2006:Table 16.2) proposed several possible mechanisms for the pan-regional distribution of lightning whelks, including direct acquisition via pilgrimage, purchase of religious objects, and elite exchange. Coastal communities with access to lightning whelks possibly engaged with these pan-regional exchange networks through control over the export of shells.

Communities in close proximity to one another practiced very different subsistence strategies. At East Peninsula, a spit of land that measures 30 km in length and 4 km in width (Figure 2.2), people at Harrison Ring and Hare Hammock on the gulf-side focused on marine gastropods, particularly lightning whelks, with very little evidence for the use of oysters. Less than 20 km away, on the bay-side, contemporaneous groups at the Strange’s Ring and Bayview village sites made use of oysters, and were more or less generalized or specialized in their use of fishes and shellfishes. People evidently did not transport large quantities of un-shucked oysters from the bay-side to the gulf-side, nor did they transport considerable quantities of lightning whelk or conch shells from the gulf-side to the bay-side. Coastal communities had relatively small catchment areas, suggesting the existence of community fishing and shellfishing territories. However, it is possible that meat without the shell was transported throughout the peninsula.

Different sites may represent different social groups, perhaps kin groups, who had access to different suites of resources by virtue of their physical and social position within a broader social landscape. Sigler-Lavelle posed a “fissioning” model of social organization for Weeden

Island cultures in northern Florida (Milanich et al. 1997:188–189), where villages were interpreted as interacting segments within a larger kinship system. As villages outgrew a comfortable population size, a group would separate and start a new settlement, yet still retain ties to the previous. Mound burial functioned as "permanent confirmation of lineage membership and it would allow the physical centralization of ritual obligations for lineage descendants" (Milanich 1994:169–170). Of the 43 Weeden Island sites known on East Peninsula, four are associated with burial mounds (Russo et al. 2011). Thus, at least four lineages may have occupied the peninsula during Weeden Island times, with the mounds at Hare Hammock, Strange's, Baker's Landing, and possibly Bayview representing distinct lineages.

The human burials from the Harrison, Hare Hammock, and Strange's sites were described by Moore (1902, 1918). These descriptions provide a case study in the role that subsistence practices and landscapes played in social identity. Shells were traditional grave offerings in the Panhandle and Big Bend regions (e.g., Moore 1902, 1918). The specific taxa included in burials generally reflects the dominant taxa in the middens. For example, both burials and middens in the Big Bend region often are associated with masses of oyster shell (Moore 1902, 1918; White 2014). In contrast, burials at the Harrison Mound (Moore's "smaller mound at Hare Hammock") typically included deposits of lightning whelks (*Busycon perversum* [*sinistrum*]) and tulips (*Fasciolaria* spp.) (Moore 1918:550), which also are major resources as represented in the shell midden at that site (Table 5.1). The burial mound excavated by Moore at Hare Hammock (1902:198) included 31 burials, which "in nearly every case lay beneath masses of shells, not oyster-shells, however, such as we have found to be the case in other mounds, but small conchs (*Fulgur pugilis).*" The small conchs were Florida fighting conchs, now known as

Strombus alatus. Other burials were associated with shell drinking cups, probably lightning whelks. These are major resources in the Hare Hammock midden as well (Table 5.1).

Moore excavated the mound at Strange's Landing, associated with Strange's Ring Midden, and encountered only five burials representing at least eight individuals (Moore 1902:196). Two of the individuals were buried without shell, and five of the individuals were buried under oyster shells. Oysters are the dominant shell species in the Strange's Ring Midden (Little 2015). One individual "did not lie under oyster-shells, but was covered with a mass of small conchs" (Moore 1902:196).

A possible explanation for the variability in burial treatments is that only some members of the community were buried with shell, perhaps the primary shellfishers in the community, and that the taxa included in those burials were selected intentionally by virtue of their abundance in nature or their role in the local subsistence strategy. Oyster shell burials would then be expected to be associated with oyster-dominated habitats, and marine gastropod burials with marine gastropod-dominated habitats. Based on Moore's (1902, 1918) descriptions and zooarchaeological midden data, this generally holds true.

The conch burial at Strange's Ring is out of place in terms of the subsistence strategy used and the habitats exploited at that site. Fighting conchs are associated with fully marine environments, rather than the brackish environments indicated by the zooarchaeological data. Fighting conchs account for less than 1 percent of biomass at Strange's Ring midden (Table 4.25), suggesting they were not a major component of the local subsistence strategy. Perhaps shells were not merely symbols of the immediate environment and daily activities that were practiced therein, but were linked more broadly to the identities of groups and individuals. Specific shell taxa were possibly associated with different places, practices, and communities.

Shells may have been symbols of identity, which I have argued are closely tied to a sense of place and perceptions of the landscape. As symbols of a place-based social identity, the oyster burials at Strange's Ring may represent members of the local kin group, where collecting and consuming oysters was a routine component of daily life. The individual buried with conchs was possibly an outsider, perhaps from a place where conchs were central to coastal livelihoods. This individual way represent a link or interaction between gulf- and bay-side communities.

Identifying and classifying different types of zooarchaeological assemblages is useful heuristically because it forces us to recognize and appreciate that there was not a single, typical subsistence system of the northern Gulf Coast. However, the sub-systems described here almost certainly do not represent the full range of diversity in resource strategies. Although I treated them as discrete groups, they are perhaps better conceived as points within a spectrum of possible variation. Some subsistence tasks are probably not represented sufficiently, or at all, in the regional dataset. Wing's (1977) sea turtle harvesting sites were apparently sufficiently numerous and distinct to merit their own category, but none of the sites in the northern Gulf Coast regional dataset suggest intensive sea turtle harvesting. Other specialized strategies probably are not represented in the regional dataset either, or are subsumed in other categories. A larger and more representative regional dataset would probably reveal additional variants. For example, Luer and Almy (1979) described scattered deposits of marine gastropods and scallops on the Florida Gulf Coast that were not associated with villages. White (2014) observed dense, marsh clam-dominated middens, with few oysters, in the Big Bend region of the coast. The dimensions of variability in coastal resource use may not merely be matters of diet and nutrition, but may also shape or reflect social identities and positions of power within local and regional political economies. My attempt to classify subsistence strategies is intended as a point of departure for the discussion of how coastal economies differed and how those differences played out in social and political relationships.

Continuity and Change

The goals of this section are to evaluate whether marine fisheries were stable and sustainable over the scale of several millennia, and to create a baseline against which recent and future ecosystem changes can be evaluated. This study is a first attempt to identify long-term patterns in coastal fisheries and ecosystems of the northern Gulf Coast. The regional dataset spans approximately 5,000 years of human history in this area.

Zooarchaeological data were used to assess change through time in: (1) intrinsic vulnerabilities (VI) and trophic levels (TL) targeted; (2) species diversity (H'); and (3) abundance indices of specific, high-ubiquity resources. In Table 4.26, the sites are arranged in chronological order on the basis of the median of the summed probability of radiocarbon dates for each site (Figure 3.4). This same order of sites is used in the discussion of temporal trends.

As previously discussed, Cheung et al. (2007) observed declines in global average VI from 48 to 45 during their study period of A.D. 1950–2003. This decline of approximately 0.2 units per decade was interpreted as "steep," and having important ecological implications (Cheung et al. 2007:10). They attributed the decline to overfishing, as highly vulnerable taxa were removed from the fisheries and were replaced by less vulnerable species.

Woodland period fisheries were similar to modern fisheries in terms of mean VI. In the archaeological sequence, the VI of the earliest archaeological was 58.6 (Mitchell River 1); higher than was observed in the rest of the archaeological dataset and in modern fisheries data. The lowest VI index of 40.4 (Mack Bayou) is likewise lower than is observed in modern fisheries (Table 4.26 and Figure 4.5). After ca. 1300 cal B.P. (A.D. 650), VI values are relatively stable at approximately 48 ± 2. Exploitation within estuaries and seagrass beds has the potential to impact fisheries at large spatial scales because these habitats function as nurseries for many important Gulf Coast fisheries. Nonetheless, the archaeological dataset suggests the Gulf of Mexico supported fisheries that targeted near-modern VI levels for centuries or millennia. Exploitation of nearshore environments, though intensive, did not result in a downward shift in VI.

Fish TL averages 3.4 ± 0.1 for the northern Gulf Coast regional dataset. These values are comparable to, but slightly higher than, pre-European fisheries of the Georgia Bight region, which were relatively stable at approximately 3.2 (Quitmyer and Reitz 2006:818). In comparison, TL of global commercial fisheries declined from slightly more than 3.3 to under 3.1 from A.D. 1950–1994 (Pauly et al. 1998). Pre-European fisheries of the coastal Southeast region routinely fished at higher trophic levels than do modern industrialized commercial fisheries. Evidently, nearshore fisheries sustained high-TL subsistence fisheries for thousands of years in this region.

Declines in TL are thought to reflect overfishing primarily. A decline in TL of 0.2 units as represented by modern commercial fisheries landings was thought to be a symptom of unsustainable landings (Pauly et al. 1998). In the northern Gulf Coast region, mean TL declined from 3.6 to 3.3 over a period of 5,000 years as represented by the zooarchaeological assemblages (Table 4.27 and Figure 6.1), equating to a decline of approximately 0.1 unit *per millennium*. In comparison, modern fisheries are declining at a rate of approximately 0.1 unit *per decade* (Pauly et al. 1998:863). In the case of the archaeological dataset, the gradual decline would not have been perceived over the scale of a human lifetime.

One criticism of the mean-TL approach to assessing fisheries health, and of interpreting a decline in mean TL as “fishing down the food web,” is that fluctuations in abundances of lower-

TL organisms may occur through both top-down and bottom-up processes (Caddy et al. 1998). Lower-TL organisms may increase in abundance, and therefore contribute relatively more to landings biomass than high-TL animals, independently of the population dynamics of the animals that prey upon them. Shrimps are low-TL animals that are prone to large medium- and short-term population fluctuations. It is unclear whether the absence of evidence for a pre-European shrimp fishery reflects cultural practices or preservation biases. If shrimps were used but the practice left no archaeological record: (1) mean TL may be overestimated in the archaeological assemblages, and (2) fluctuations in the abundances of shrimp may relate to fluctuations in the abundances of higher-TL organisms, reflecting “bottom-up” trophic changes.

Faunal diversity, measured as H’, is an index that can be used to measure generalized resource stress from zooarchaeological data. H’ is influenced by both anthropogenic and non-anthropogenic factors, and is not explicitly tied overexploitation as are VI and TL indices. H’ is a measure of entropy that, in zooarchaeological applications, is interpreted as a measure of diet breadth. In optimal foraging models, changes in diet breadth equate to changes foraging efficiency (Allen 2012; Broughton 1994a, 1994b, 1997; Butler 2001; Butler and Campbell 2004; Chatters 1987; Reitz 2014). Efficient predators should take higher-ranked prey when encountered, and use lower-ranked prey only when the abundance of higher-ranked resources declines. Thus, an expansion of diet breadth (i.e., an increase in H’) is interpreted as a decline in foraging efficiency and evidence for resource stress.

The Gulf Coast regional dataset documents an increase in diet breadth over time (Figure 4.5), from 1.6 in the earliest assemblage to 2.4 in the latest (Table 4.26). On a scale from zero to five, this represents a large increase and represents a shift from specialized to generalized coastal exploitation strategies. The shift, however, was not gradual. Approximately 1300 cal B.P., diet breadth increased sharply from an average H’ of 1.5 ± 0.3 to an average of 2.5 ± 0.1 (Figure 4.5a). All of the early sites in the regional dataset, with lower diversity, clustered together (Cluster 1) in the specialized estuarine shellfishing strategy. Woodland-period sites, however, are represented in several clusters and exhibit higher diversity and greater variability in the habitats and resources used compared with Archaic sites. If these temporal trends are supported by additional data, particularly from Archaic-period sites which are underrepresented compared with Woodland-period sites, this shift may indicate a regime change in Gulf Coast subsistence systems. Regime change refers to changes in the structure and function of a system (Reitz 2014).

The trends of decreasing fish TL and increasing diversity are classic symptoms of generalized resource stress (Murawski 2000; Quitmyer and Reitz 2006; Reitz 2004). Alternatively, the shift in subsistence efficiency may not relate to resource depression *per se,* but rather to a fundamental change in the manner in which humans engaged with coastal landscapes. Changes in human settlement patterns, population demography, technologies, ritual calendars, and cultural beliefs and perceptions, among other factors, possibly caused people to exploit local habitats more intensively. For example, a growing coastal population during the Woodland period, as evidenced by an increase in the number and density of sites, possibly resulted in greater competition for resources and smaller home ranges of coastal dwellers (Milanich 1998:59). The combination of increased competition for resources and naturally circumscribed aquatic resource patches (e.g., bays and estuaries) possibly necessitated novel social institutions, such as ownership and access rights, to promote intra- and intergroup cooperation.

Coastal dwellers would not necessarily have perceived gradual, ecosystem-level changes such as the decline in Trophic Level, and therefore would not have responded to it through a change in behavior. Rather, the perception of scarcity or abundance of resources would have been evaluated based on local populations and resource patches. Individual populations or resource patches are potentially vulnerable to local collapse, without necessarily impacting resource abundance on a regional or metapopulation scale. In particular, lightning whelks and scallops are prone to localized population declines and collapses over short time scales (Arnold et al. 2005; Shalack et al. 2011). Thus, there is a scalar mismatch between how archaeologists perceive resource abundance and variability from the faunal record, and how coastal dwellers experienced it on a day-to-day and year-to-year basis.

Chapter Summary

There is limited evidence of site seasonality and population mobility prior to the Middle Woodland period in this region. What evidence we do have suggests that the coastal zone was not a winter-time refuge, and that people were living within the coastal zone, if not individual sites, during multiple seasons of the year at least by the Late Archaic period. Evidence of site seasonality for the Middle and Late Woodland periods suggests that individual sites were occupied for extended seasons, if not year-round. However, the best-studied sites demonstrate modality in site use, with the peak seasons of use complementing one another. This may suggest that population mobility was more or less fluid along the coast, with the population densities of individual sites fluctuating on a seasonal basis. The general paucity of data for fall occupation of the coast merits further research.

There was not a single, uniform pattern of resource use that underlay coastal subsistence decisions. Rather, coastal subsistence strategies were multiple, varied, and context-dependent. Normative thinking about coastal economies obscures important differences in how coastal dwellers engaged with the environment. At the regional scale, coastal communities were united by the shared experiences of living at the water’s edge. At local scales, communities and individuals had different goals, and engaged in different tasks. Understanding the dimensions of variability can contribute to the understanding of the development of cultural identities and social institutions in coastal settings. The core subsistence strategy of a social group is the primary means by which people interact with the environment, and also contributes to their identity and position in regional economies. Living and working at the interface between land and sea requires a distinctive local knowledge that includes an understanding of tides, currents, weather, channels, and the movement of fishes (O'Sullivan 2003). People worked according to the rhythms of the tides, and the daily, monthly and seasonal cycles of neaps and springs.

Four patterns of resource use are identified in the sample of 12 assemblages. The specialized estuarine shellfishing strategy represents an early but long-lived coastal adaptation in the region. This strategy is characterized by low species diversity, an emphasis shellfish in general, and oysters in particular, as well as on individually captured, high-TL fishes. The generalized estuarine fishing and shellfishing strategy is perhaps the "classical" archaeological model of coastal subsistence in the Southeast as defined by Wing (1977). This strategy emphasizes fishes, especially mullets and other mass-capture fishes (e.g., Colaninno 2011), and represents an increase in diet breadth as compared with the specialized estuarine strategy. The generalized marine shellfishing and fishing may represent a localized adaptation to marine-gastropod dominated habitats, which are comparatively rare. The provisioned economy at Bottle Creek stands apart in terms of the habitats used and the size of the catchment area.

Indices related to fisheries health suggest that pre-European fisheries were vulnerable to overexploitation because they targeted high trophic levels and fishes with moderate intrinsic vulnerabilities to overfishing. In modern commercial fisheries, declining trends in mean fishery trophic level and mean vulnerability indices are interpreted as symptoms of overfishing and warning signs of fishery collapse. Both pre-European and modern commercial fisheries of the Gulf of Mexico experienced declines in trophic level indices over time, but the rate of change in the late-twentieth century was over a hundred times faster than in the archaeological record.

Pre-European fisheries were sustainable at the regional level, although changing human settlement patterns, population demographics, and short-term variability in local resource patches possibly led to increased competition for coastal resources. A shift towards diversified subsistence strategies ca. 1300 B.P. may reflect changing perceptions about resource abundance and proprietorship of resources.

Table 6.1. Subsistence Systems of the Northern Gulf Coast.

	Specialized Estuarine Shellfishing (*n* = 6)	**Generalized Marine Shellfishing and Fishing (*n* = 2)**	**Generalized Estuarine Fishing and Shellfishing (*n* = 3)**	**Provisioned (*n* = 1)**
Total Diversity (H')	Low (1.8 ± .4)	High (2.5 ± .3)	High (2.6 ± .3)	High (2.4)
Focus (% biomass)	Shellfishes (64 ± 15)	Shellfishes (54 ± 7) and fishes (34 ± 15)	Fishes (68 ± 4) and shellfishes (17 ± 5)	Equal mix of fishes, shellfishes, and other animals
Top source of biomass (%)	Oyster (35 ± 11)	Lightning whelk (18 ± 7)	Sea catfish (6 ± 2) and mullet (5 ± 3)	Deer (13) and rangia (12)
Resource constellation	Oyster, quahog, nerite	Lightning whelk, horse conch, tulip	Oyster	Rangia
	Jack, mullet	Sea catfish, mullet	Sea catfish, mullet, sheepshead, flounder	Gar, mullet, red drum
	Deer	Deer	Deer	Deer
Fishing strategy	Specialized (H' = 1.8 ± .3)	Generalized (H' = 2.2 ± 7)	Moderate (H' = 2.0 ± .4)	Moderate (2.1)
	High TL (3.6 ± .1)	Moderate TL (3.3 ±. 2)	Moderate TL (3.3 ± .1)	Moderate TL (3.3)
Shellfishing strategy	Extremely specialized (H' = .7 ± .4)	Specialized (H' = 1.3 ± .3)	Specialized (H' = 1.2 ± .4)	Specialized (1.0)
	Bivalves	Gastropods	Bivalves	Bivalves
Habitat	Estuary (salt marsh)	Marine (seagrass beds)	Estuary	Terrestrial and estuary

Note: TL refers to mean trophic level. Resource constellations based on major and minor resources. Major resources contribute >10% of biomass; minor resources contribute 2-10% of biomass.

Table 6.2. Summary of Available Season-of-collection Data for the Study Area.

Sites	Period	Method	Interpretation	Reference
Mitchell River 1 (8WL1278)	Archaic	sturgeon, presence	winter	Mikell and Saunders 2007:Table 6
		impressed odostomes, age class	year-round	Quitmyer 2002
		Atlantic croaker, age class	year-round	Quitymer 2002
Meig's Pasture (8OK102)	Archaic	scallops, presence	late spring through fall	Curren 1987:Tables 14–23
		marsh clams, growth increments	fall through spring	Curren 1987:37
Shell Mound (8LV42)	Archaic - Woodland	low diversity	seasonal?	Palmiotto 2012:51
		young fishes?	spring/summer?	Palmiotto 2012:65
Hawkshaw (8ES1287)	Early Woodland	species composition	summer	Bense 1985:Table 41
		scallops, presence	summer	Bense 1985:Appendix IV
		bluefish, presence	winter	Bense 1985:Appendix IV
Refuge Tower (8WA14)	Early Woodland	loon, presence	fall/winter	Lawson 2005:Table 8
		porcupinefishes, presence	spring through fall	Lawson 2005:Table 8
		toadfish, presence	spring through fall	Lawson 2005:Table 8
		skates and rays, presence	spring through fall	Lawson 2005:Table 8
		raccoon, epiphyseal fusion	summer/fall	Lawson 2005:Table 8
		deer, epiphyseal fusion	summer/fall	Lawson 2005:Table 8
		oysters, optimal yield	spring through summer	Lawson 2005:Table 8
		scallops, optimal yield	late spring through fall	Lawson 2005:Table 8
		deer, optimal yield	fall/winter	Lawson 2005:Table 8
		red drum, age class	late spring/summer	Lawson 2005: 100
Plash Island (1BA134)	Middle Woodland	cownose ray, presence	spring through fall	Reitz et al. 2013:Table 22
		fishes and molluscs, δ^{18}O curves	peak in summer and winter	Hadden et al. 2015; Reitz et al. 2013:Table 22
	Middle Woodland	juvenile sea catfish, presence	summer/fall	Hadden et al. 2015
		mast (nuts), presence	early fall	Leone 2008
		plant seeds, absence	winter	Leone 2008
Harrison Ring (8BY1359)	Middle Woodland	scallops, size class	early summer	This study
		mollusc species composition	winter	This study

Table 6.2. Summary of Available Season-of-collection Data for the Study Area. (cont.)

Sites	Period	Method	Interpretation	Reference
Harrison Ring (cont.)		juvenile sea catfish, presence	summer/fall	This study
Hare Hammock (8BY1347)	Late Woodland	scallops, size class	late summer	This study
		sea turtle, presence	spring/summer	This study
		cownose ray, presence	spring/summer	This study
		bluefish, presence	winter	This study
		sturgeon, presence	winter	This study
Bayou St. John (1BA21)	Late Woodland	fishes and molluscs, $\delta^{18}O$ curves	spring, summer, and winter	Hadden et al. 2015; Reitz et al. 2013:Table 22
		bluefish, presence	winter	Reitz et al. 2013:Table 22
		sea turtle, presence	spring/summer	Reitz et al. 2013:Table 22
		cownose ray, presence	spring/summer	Reitz et al. 2013:Table 22
		juvenile sea catfish, presence	summer/fall	Hadden et al. 2015
		mast (nuts), presence	early fall	Leone and Mickelson 2009
		unshed deer antler	fall	Reitz et al. 2013
Graveline Mound (22JA503)	Late Woodland	molluscs, $\delta^{18}O$ curves	spring and summer	Blitz et al. 2014: Figure 6
		sea turtle, presence	spring/summer	Blitz et al. 2014:707
		sturgeon, presence	winter	Blitz et al. 2014:707
A.B.'s Midden (8LV65)	Late Woodland	hard clam, sclerochronology	year-round	Quitmyer et al. 1997
Gardner's Point (8LV68)	Late Woodland	hard clam, sclerochronology	year-round	Quitmyer et al. 1997

CHAPTER 7:

CONCLUSIONS AND FUTURE DIRECTIONS

The research presented here focuses on two major themes: diversity among coastal livelihoods and persistence of coastal ecosystems and economies. The project relies on zooarchaeological data because subsistence is the primary means by which people engage with the environment. Within the major themes of the diversity and persistence of coastal livelihoods, this research set out to clarify three points about coastal subsistence/settlement systems in this region: (1) whether these systems were seasonal, rather than year-round occupations on the northern Gulf Coast; (2) whether a single, uniform pattern of resource use prevailed across the region; and (3) whether a baseline for pre-European Gulf Coast fisheries could be developed which could indicate whether said fisheries were stable at the millennial scale.

Was the Coastal Zone Occupied on a Seasonal Basis?

Data on seasonal aspects of site and resource use for the Archaic and Early Woodland periods are limited. Considerably more data are available for the Middle and Late Woodland periods, though still insufficient in detail. The data currently available and summarized in Chapter 6 do not support the hypothesis that the coastal zone was occupied on a highly seasonal (i.e., winter) basis during either the Archaic or Woodland periods. On the contrary, the coastal zone was probably occupied year-round.

The best-studied sites in terms of seasonal periodicity in use or occupation are Plash Island, Bayou St. John, and Graveline. The specific taxa used for those studies were chosen because they are archaeologically abundant and available year-round. Stable oxygen isotope and other faunal data from those sites indicate that all four seasons were represented, but not in equal proportions (Blitz et al. 2014; Reitz et al. 2013). Faunal data predominantly indicate winter and summer seasons of use at Plash Island, winter and spring at Bayou St. John (Reitz et al. 2013), and spring and summer at Graveline (Blitz et al. 2014). The coastal zone was not wholly abandoned during any season of the year, although sites varied throughout the year in terms of population density, intensity of site use, or intensity of fishing and shellfishing efforts.

The implication of these patterns of site and resource use for the region as a whole is that a single pattern cannot be extrapolated from any single site and imposed on all other sites, because site use differed from one site to another. Each site, as well as broad groups of site types, possibly functioned on different calendric cycles. Graveline and other monumental sites were places where people came together for social, political, or religious rituals, following calendars appropriate to those functions. Villages were permanent habitations, possibly occupied by a core group of people throughout the year, with temporary, seasonal fluctuations in population density and/or intensity of resource acquisition.

Notably, there is but little unequivocal evidence in faunal remains for intensive occupation of the coast during the fall, except for the occasional deer antler. Deer were possibly hunted during all seasons, but “most avidly and most successfully in late fall and winter” (Hudson 1976:275). This is the optimal time of year for hunting deer for several reasons. Deer aggregate in oak forests during the fall and winter to take advantage of fallen mast. They also reach maximum weight during this time of year. Finally, it is hard to get within close range of bucks except during the rutting season, which runs from late September through November (Hudson 1976:275). People who remained on the coast during the fall may have temporarily shifted their focus away from the ocean towards maritime forests and terrestrial resources such as deer and mast. Even so, deer remains are rare in coastal assemblages compared to most inland ones.

Quantitative, in-depth analyses of site and resource seasonality such as those undertaken at the Bayou St. John, Plash Island, and Graveline sites have not been carried out for contemporaneous inland sites in this region. Limited site seasonality data from Sycamore, Coahatchee, and Woodland Terrace suggest these inland sites at least were occupied predominantly during the fall (Lolley 2003:74; Mickwee 2011; Milanich 1974:32). A hypothesis that warrants further testing is that a portion of the coastal population traveled inland from the coast during the fall to take advantage of seasonal abundances of deer and mast nuts.

Many inland sites probably were year-round villages. However, year-round sedentism among inland groups has been accepted somewhat uncritically. Kolomoki was interpreted as a year-round settlement on the basis of limited plant and animal remains, which suggested site use from summer through fall (Pluckhahn 2003:163–165, 2013:195). The McKeithen village was inferred, but not demonstrated, to be a year-round occupation (Milanich et al. 1997:76). The record for site and resource seasonality for the northern Gulf Coast region, though still limited, is, in fact, far better than that for the adjacent interior zone. In order to understand connections between coastal and inland communities and sites, future research should question normative thinking about inland sites and assess the seasonal aspects of inland sites with the same rigor that is applied and expected in coast settings.

Materials sourcing provides another perspective on the nature of interactions between coastal and inland communities. Investigations of coastal/inland interactions tend to focus on social functions of prestige goods, rather than on the flow of commodities and the mechanisms of exchange. Marine shell found at inland sites, such as a worked lightning whelk columella at

Sycamore (Milanich 1974), is evidence for the movement of goods, and possibly of people, from the coast to the interior. The deer sourcing study presented in Chapter 6 focused on a very small sample of deer remains, from a limited number of sites, and only three stable isotope systems. The results were inconclusive but promising, suggesting that at least some of the venison consumed on the coast possibly originated in the interior zone. An expansion of that study would refine the regional isotopic signatures and allow for more robust interpretations of isotopic outliers, which possibly represent nonlocal deer. Still, the movement of goods does not equate to the movement of people. Material sourcing combined with site seasonality studies, at inland as well as coastal sites, could potentially reveal pathways of exchange, mobility, and other forms of connectivity among coastal and inland communities.

What was the Basis of Coastal Subsistence?

For many years, anthropologists viewed aquatic foods as secondary to large game, or even as starvation foods (e.g., Bailey 1978; Cohen 1977; Osborn 1977; Parmalee and Klippel 1974). Even more pervasive was a tendency to view shellfishes as marginal resources, although they often are the primary constituents of coastal middens (Claassen 1998; Larson 1980; Parmalee and Klippel 1974). The synthesis of 12 zooarchaeological datasets presented in Chapter 6 clarifies several aspects of coastal subsistence on the northern Gulf of Mexico: (1) aquatic animals, not terrestrial ones, were the major sources of protein; (2) shellfishes rather than fishes provided most of the biomass at many coastal sites; and (3) many distinct coastal subsistence strategies co-occurred in the region, each with different implications for human settlement patterns and economies.

Archaic and Early Woodland-period assemblages in this study indicate a highly specialized pattern of coastal resource use that was focused on oyster-dominated estuarine habitats. Focusing on oysters, though small and energetically expensive to process, provided a predictable and reliable sources of protein during all seasons of the year (Thomas 2008b:979–984). By ca. 1300 B.P., coastal subsistence strategies diversified. Over even small geographic scales, neighboring communities practiced different strategies for exploiting nearshore environments that involved more diverse habitats and different suites of resources, beyond oyster bars. The apparent shift from one pattern to many patterns of resource use by may reflect changes in population demographics, settlement patterns, technologies, and, perhaps, concepts of sea tenure. As the coastal population grew, competition for resources increased, and new villages fissioned from parent villages. People explored alternative strategies for making a living on the coast, and in more diverse settings. Instead of focusing on oyster beds, these new strategies made extensive use of a variety of estuarine as well as nearshore marine environments, including seagrass beds in more saline bays. Multiple and varied local fishing and shellfishing traditions grew out of the repetition and ritualization of the daily practices associated with particular places and tasks.

Normative thinking about coastal subsistence obscures the variability in resource use demonstrated by zooarchaeological data. The tendency to interpret every faunal assemblage as a habitat-specific veneer to an otherwise uniform pattern of resource use has contributed to the marginalization of zooarchaeological data in social archaeology. Rather than practicing a single, uniform pattern of coastal resource use, people who occupied different places on the landscape used different resources and, by extension, were engaged in different “ensembles of tasks” (Ingold 2000:195) that constituted daily life. The shared experiences of engaging with particular places and doing particular things within the environment contributed to a place-based sense of identity and community tied to the landscape (Ingold 2000:148). Appreciating the differences, as well as the similarities, among coastal subsistence strategies shifts the attention from large regional culture areas to localized social identities and provides a richer, more contextualized understanding of coastal societies.

The expansion from one to many coastal subsistence strategies during the Woodland period also brought about changes in the ways people viewed sea tenure and property rights. Cooperation and competition are opposing mechanisms for regulating social relationships (Boone 1992; Kennett and Kennett 2000; Smith and Winterhalder 1992). Management of resources, which presumably relied on cooperation during the Middle Woodland period, possibly became increasingly competitive (Milanich 2002:368). Open access is the absence of any form of property rights. Under a scenario of low population density, an open-access property regime may flourish where competition for resources is minimal and territorial behavior is uneconomical. A common response to perceived scarcity of resources is to increase competitive behaviors (Grossman and Mendoza 2003). Territoriality is a mechanism for reducing competition for resources, and is favored among populations that exploit dense and predictable resource patches (Boone 1992; Cashdan 1992). Territoriality and communal or private ownership of resources, as opposed to open access, may have developed as mechanisms for coping with competition.

Cooperative and competitive mechanisms were “counterposed at different social and spatial scales” (Pluckhahn 2013:189). Under communal or private property regimes, individuals and communities enjoyed privileged access to specific resources, rituals, emblems, etc., as well as the right to grant or deny access to others. Territorial boundaries likely were negotiated and contested, but maintenance of boundaries need not involve violence or aggression (Cashdan 1992). In fact, the intent of boundary maintenance might be to avoid conflict. Sharing, exchange, tolerated theft, and interterritorial visiting would foster cooperation among communities and potentially benefit the group if such generosity increased the status or prestige of the group, or created social obligations that would be reciprocated during times of scarcity. Such obligations possibly created or reaffirmed alliances among communities.

East Peninsula is a natural laboratory for studying the evolution of competition and cooperation among neighboring communities. The diversity of subsistence strategies within such a small geographic area may be due to territorial behavior, with each community fishing within its own territory. Other explanations should be tested. Perhaps the ring midden sites on East Peninsula represent seasonal or sequential habitations of a smaller number of groups, instead of neighboring villages. Future research at East Peninsula might focus on verifying the contemporaneity of these sites, the seasonal aspects of their use, and evidence for competitive or cooperative interactions among the people who used them.

Is Instability of Coastal Ecosystems a Modern Phenomenon?

This study presents an assessment of the trajectory of Gulf Coast fisheries at two scales. Chapter 5 presents a case study spanning 800 years of coastal resource use at a single locale. Chapter 6 presents a macroscale approach involving 12 zooarchaeological assemblages and spanning over 5,000 years. Perhaps not surprisingly, instability in coastal economies and ecosystems is evident at both scales of analysis. It is not a modern phenomenon. However, there are important quantitative as well as qualitative differences between traditional subsistence fisheries and modern commercial fisheries in this region.

At the regional scale (Chapter 6), the archaeological record documents increasing diet breadth and evenness of resource use coupled with declining mean trophic levels. These classic symptoms of generalized resource stress are consistent with the model of larger human populations on the coast and increasing competition for resources. However, the ecosystem-level changes documented in this study are quite small and probably were not noticeable within an individual's lifetime.

At one locale (Chapter 5), an economy focused on specialized marine shellfishing persisted, but was not necessarily stable, over the period of several hundred years. Many nearshore resources, particularly molluscs, are prone to extreme fluctuations in productivity and even collapse at the local scale, without impacting the regional metapopulation. If increasingly territorial behavior was a response to competition for resources, it was likely a reaction to short-term fluctuations in resource patches at the local scale or over-crowding of people, rather than gradual ecosystem-level changes of the resource base at the regional scale. Thus, there is a scalar mismatch between how archaeologists perceive or measure resource abundance and variability from the zooarchaeological record, and how coastal dwellers experienced it on a day-to-day and year-to-year basis.

Data from sustainable traditional subsistence fisheries can offer models for developing such management tools. Selective approaches to fisheries management (e.g., regulations on fish size, species, or sex) result in unintended and undesirable impacts on both fisheries and marine ecosystems. An alternative approach termed balanced exploitation seeks to maintain balance among fisheries and marine ecosystems by spreading fishing pressure across fish sizes, species, and sexes in proportion to their abundance in the ecosystem (Zhou et al. 2010, 2015). Zooarchaeology provides a means of developing baseline data for such alternative management strategies.

Traditional Southeast coastal peoples routinely fished at higher trophic levels than do modern industrialized fisheries, and in many cases targeted smaller individuals than are permitted by modern size regulations. Nonetheless, these fisheries persisted for hundreds if not thousands of years in this region. This suggests that a relatively high mean trophic level does not, in and of itself, indicate an unsustainable fishery, nor are size regulations absolutely necessary for a sustainable fishery. The persistence and sustainability of traditional fisheries, which were presumably less regulated compared to modern fisheries, may be evidence in support of the balanced exploitation approach to resource management.

Although traditional subsistence fisheries may provide models for sustainable systems, their usefulness to modern management efforts is limited because traditional subsistence fisheries differ from modern commercial and recreational fisheries in terms of fishing effort, habitats exploited, and technologies used. It is unclear precisely which attributes, or combinations of attributes, contributed to the sustainability of traditional fisheries, or whether those attributes would continue to promote sustainability in large-scale commercial operations today.

Data from traditional subsistence fisheries are valuable for comparing the rate of change of former and modern marine ecosystems. Both pre-European and modern commercial fisheries of the Gulf of Mexico experienced declines in trophic level indices over time. Mean trophic level of zooarchaeological assemblages declined at a rate of approximately 0.1 units per millennium over the span several thousand years. In comparison, the mean trophic level of modern fisheries is declining at approximately 0.1 unit *per decade*, a rate one hundred times faster than in the preceding millennia. People were potentially impacting Gulf Coast fisheries from the beginning of human history in that area, but the present rate of change is unprecedented.

Concluding Remarks

This research attempted to synthesize our current state of knowledge of the zooarchaeology of the northern Gulf of Mexico from the Late Archaic through Woodland periods (ca. 5000 B.C. to A.D. 1100). A common concern among zooarchaeologists is the "appendicization" of our datasets (Albarella 2001:3; Emery 2004:201), wherein zooarchaeological research and the bulky datasets they generate are too often appended to, rather than integrated with, more traditional archaeological research. Indeed, many of the datasets included in the project presented here were resurrected from the appendices of various monographs. The project was possible only through the combined efforts of multiple independent researchers, and hundreds if not thousands of hours in the laboratory over the span of 30 years.

If "Big Data is the next frontier of archaeological knowledge in North America" (Kelly 2015:17), one thing zooarchaeology has is Big Data. The zooarchaeological record of the coastal Southeast has the potential to address several Big Questions in regional and global archaeology. What were the effects of climatic shifts on marine ecosystems? How did increasing population pressure affect marine ecosystems on local, regional, and global scales? Was sedentism the rule, rather than the exception, among non-farming coastal societies? How did resource abundance relate to the emergence of social complexity in coastal contexts? The future of zooarchaeological research, in the Southeast and elsewhere, is in synthesizing and integrating our data.

The logistics of integrating and synthesizing zooarchaeological datasets are challenging. In the southwestern United States, efforts to synthesize regional-scale zooarchaeological have made it possible for independent researchers to integrate their data with those of others using a shared conceptual framework for analysis (Spielmann and Kintigh 2011), although not without problems and at a considerable cost. Other efforts to standardize and centralize digital zooarcheological data have met with less success.

The research presented here is a first step towards synthesizing zooarchaeological data for the coastal Southeast. It is my hope that it will not be the last. As with most research, the results generated as many questions as it answered, of not more. Multiple and varied patterns of resource use were found, where previous researchers saw uniformity. But if subsistence strategies shaped community identities, distinctions among groups should be evident in other aspects of the archaeological record also. Further evidence for local communities and networks of interaction should be sought in ceramic, botanical, lithic, and bioarchaeological datasets. Coastal ecosystems and economies were sustainable for hundreds, if not thousands of years, but what about changes over the scale of an individual lifetime, or from year-to-year? To what extent were such changes caused by people, compared to other causal agents? One thing that is clear is that we can no longer assume that a single subsistence strategy or pattern of mobility dominated a given site, time period, or region. Understanding the causes and consequences of variability should be the goal of future research.

REFERENCES

Abercrombie, Paul

2014 Shell Game: Off Florida's Coast, Harvesting Scallops is an Underwater Easter Egg Hunt. *Washington Post* 30 October 2014, Washington, D.C.

Acheson, James M.

1981 Anthropology of Fishing. *Annual Review of Anthropology* 10:275–31.

Albarella, Umberto

2001 Exploring the Real Nature of Environmental Archaeology: An Introduction. In *Environmental Archaeology: Meaning and Purpose*, U. Albarella, ed., pp. 3–13. Klewer Academic Publishers, Norwell, Massachusetts.

Alexander, Michael

1976 *Discovering the New World*. Harper & Row, New York.

Allen, Melinda S.

2012 Molluscan Foraging Efficiency and Patterns of Mobility amongst Foraging Agriculturalists: A Case Study from Northern New Zealand. *Journal of Archaeological Science* 39:295–307.

Ambrose, Stanley H.

1990 Preparation and Characterization of Bone and Tooth Collagen for Isotopic Analysis. *Journal of Archaeological Science* 17:431–451.

Ames, Kenneth M.

1985 Hierarchies, Stress, and Logistical Strategies among Hunter–Gatherers in Northwestern

North America. In *Prehistoric Hunter–Gatherers: The Emergence of Cultural Complexity*, T.D. Price and J. Brown, eds., pp. 155–180. Academic Press, San Diego.

2002 Going by Boat: The Forager–Collector Continuum at Sea. In *Beyond Foraging and Collecting: Evolutionary Change in Hunter–Gatherer Settlement Systems.* B. Fitzhugh and J. Habu, eds., pp. 19–52. Plenum, New York.

Anderson, David G.

2002 Swift Creek in a Regional Perspective. In *A World Engraved: Archaeology of the Swift Creek Culture,* M. Williams and D.T. Elliott, eds., pp. 274–300. University of Alabama Press, Tuscaloosa.

Anderson, David G., Michael Russo, and Kenneth E. Sassaman

2007 Mid-Holocene Cultural Dynamics in Southeastern North America. In *Climate Change and Cultural Dynamics: A Global Perspective on Mid-Holocene Transitions*, D.G. Anderson, K.A. Maasch, and D.H. Sandweiss, eds., pp. 457–489. Academic Press, New York.

Anderson, David G., and Kenneth E. Sassaman

2012 *Recent Developments in Southeastern Archaeology: From Colonization to Complexity*. Society for American Archaeology Press, Washington, D.C.

Anderson, John B., Antonio Rodriguez, Kenneth C. Abdulah, Richard H. Fillon, Laura A. Banfield, and Heather A. McKeown

2012 Late Quaternary Stratigraphic Evolution of the Northern Gulf of Mexico Margin: A Synthesis. SEPM Special Publication No. 79, pp. 1–23.

Andrus, C. Fred T.

2012 Molluscs as Oxygen-isotope Season-of-capture Proxies in Southeastern United States

Archaeology. In *Seasonality and Human Mobility along the Georgia Bight*, E.J. Reitz, I.R. Quitmyer, and D.H. Thomas, eds., pp. 123–134. Anthropological Papers No. 97, American Museum of Natural History, New York.

Andrus, C. Fred T., and Douglas E. Crowe

2000 Geochemical Analysis of *Crassostrea virginica* as a Method to Determine Season of Capture. *Journal of Archaeological Science* 27:33–42.

2002 Alteration of Otolith Aragonite: Effects of Prehistoric Cooking Methods on Otolith Chemistry. *Journal of Archaeological Science* 29:291–299.

2008 Isotope Analysis as a Means for Determining Season of Capture for *Mercenaria*. In *Native American Landscapes of St. Catherines Island, Georgia I. The Data,* D.H. Thomas, ed., pp. 498–518. Anthropological Papers No. 88, American Museum of Natural History, New York.

Andrus, C. Fred. T., and Kelly Whatley Rich

2008 A Preliminary Assessment of Oxygen Isotope Fractionation and Growth Increment Periodicity in the Estuarine Clam *Rangia cuneata*. *Geo-marine Letters* 28:301–308.

Arnold, Jeanne E.

1987 *Craft Specialization in the Prehistoric Channel Islands, California*. University of California Press, Berkeley.

1992 Complex Hunter–Gatherer–Fishers of Prehistoric California: Chiefs, Specialists, and Maritime Adaptations of the Channel Islands. *American Antiquity* 57:60–84.

1996 The Archaeology of Complex Hunter–Gatherers. *Journal of Archaeological Method and Theory* 3:77–126.

Arnold, William S., Norman J. Blake, Melissa M. Harrison, Dan C. Marelli, Melanie L. Parker, Sarah C. Peters, and Don E. Sweat

2005 Restoration of Bay Scallop *Argopecten irradians* (Lamarck) Populations in Florida Coastal Waters: Planting Techniques and the Growth, Mortality, and Reproductive Development of Planted Scallops. *Journal of Shellfish Research* 24(4):883–904.

Astuti, Rita

1995 *People of the Sea: Identity and Descent among the Vezo of Madagascar*. Cambridge University Press, Cambridge.

Aswani, Shankar

2005 Customary Sea Tenure in Oceania as a Case of Rights-based Fishery Management: Does it Work? *Review of Fish Biology and Fisheries* 15:285–307.

Austin, Robert J., Lisabeth Carlson, and Richard W. Estabrook

2009 Archaic Period Faunal Use in the West-Central Florida Interior. *Southeastern Archaeology* 28(2):148–164.

Avise, John C., Carol. A. Reeb, and Nancy C. Saunders

1987 Geographic Population Structure and Species Differences in Mitochondrial DNA of Mouthbrooding Marine Catfishes (Ariidae) and Demersal Spawning Toadfishes (Batrachoididae). *Evolution* 41:991–1002.

Bailey, Geoffrey N.

1978 Shell Middens as Indicators of Postglacial Economies: A Territorial Perspective. In *The Early Postglacial Settlement of Northern Europe*, P.A. Mellars, ed., pp. 37–63. Duckworth, London.

Bailey, Geoffrey N., and Nicky Milner

2002 Coastal Hunter–Gatherers and Social Evolution: Marginal or Central? *Before Farming* 3-4:1–15.

Baisre, Julio A.

2010 Setting a Baseline for Caribbean Fisheries. *Journal of Island and Coastal Archaeology* 5:120–147.

Baleé William

1998 Historical Ecology: Premises and Postulates. In *Advances in Historical Ecology*, W. Baleé, ed., pp. 13–30, Columbia University Press, New York.

Balée, William, and Clark L. Erickson

2006 Time and Complexity in Historical Ecology. In *Time and Complexity in Historical Ecology: Studies in the Neotropical Lowlands*, W.L. Balée and C.L. Erickson, eds., pp. 1–20, Columbia University Press, New York.

Balme, Jane

1983 Prehistoric Fishing in the Lower Darling, Western New South Wales. *Animals and Archaeology* 2:19–32.

Bannerman, Nigel, and Cecil Jones

1999 Fish-Trap Types: A Component of the Maritime Cultural Landscape. *International Journal of Nautical Archaeology* 28(1):70–84.

Bar-Yosef, Ofer, and Thomas R. Rocek

1998 Introduction. In *Seasonality and Sedentism: Archaeological Perspectives from Old and New World Sites*, T.R. Rocek and O. Bar-Yosef, eds., pp. 1–8. Peabody Museum of Archaeology and Ethnology Bulletin 6.

Begossi, Alpina

1995 Fishing Spots and Sea Tenure: Incipient Forms of Local Management in Atlantic Forest Coastal Communities. *Human Ecology* 23(3):387–406.

Bense, Judith A.

1985 *Hawkshaw: Prehistory and History in an Urban Neighborhood in Pensacola, Florida*. University of West Florida Office of Cultural and Archaeological Research, Pensacola.

1994 *Archaeology of the Southeastern United States: Paleoindian to World War I.* Academic Press, San Diego.

1998 Santa Rosa–Swift Creek in Northwest Florida. In *A World Engraved: Archaeology of the Swift Creek Culture*, M. Williams and D.T. Elliott, eds., pp. 247–273. University of Alabama Press, Tuscaloosa.

Bergh, Sarah Greenhoe

2012 *Subsistence, Settlement, and Land-use Changes during the Mississippian Period on St. Catherines Island, Georgia.* Ph.D. dissertation, University of Georgia, Athens.

Berlocher, Stewart H.

2000 Allozyme Variation in Busycon Whelks (Gastropoda: Melongenidae). *Biochemical Genetics* 38:285–296.

Bettinger, Robert L.

2009 *Hunter-Gatherer Foraging: Five Simple Models*. Percheron Press, Clinton Corners, New York.

Biachi, Thomas S.

2007 *Biogeochemistry of Estuaries*. Oxford University Press, New York.

Bicho, Nuno F., Jonathan A. Haws, and Lorgen G. David (Eds).

2011 *Trekking the Shore: Changing Coastlines and the Antiquity of Coastal Settlement.* Springer, New York.

Binford, Lewis R.

1968 Post-Pleistocene Adaptations. In *New Perspectives in Archaeology*, S.R. Binford and L.R. Binford, eds., pp. 313–341. Aldine Publishing, Chicago.

1980 Willow Smoke and Dogs’ Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45:4–20.

Bird, Douglas, and Rebecca L. Bliege Bird

1997 Contemporary Shellfish Gathering Strategies among the Meriam of the Torres Strait Islands, Australia: Testing Predictions of a Central Place Foraging Model. *Journal of Archaeological Science* 24:39–63.

2000 The Ethnoarchaeology of Juvenile Foragers: Shellfishing Strategies among Meriam Children. *Journal of Anthropological Archaeology* 19:461–476.

Bird, Junius Bouton

1946 The Alacaluf. In *Handbook of South American Indians*, J. H. Steward, ed., Smithsonian Institution Bureau of American Ethnology 143(1):55–80.

Bird, Rebecca

1999 Cooperation and Conflict: The Behavioral Ecology of the Sexual Division of Labor. *Evolutionary Anthropology Issues News and Reviews* 8(2):65–75.

Black, Robert J.

1993 Florida Climate Data. Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, Circular EES-5, University of Florida, Gainesville.

Blanton, Richard E., Gary M. Feinman, Stephen A. Kowalewski, and Peter N. Peregrine

1996 A Dual-Processual Theory for the Evolution of Mesoamerican Civilization. *Current Anthropology* 37:1–14.

Bliege Bird, Rebecca

2007 Fishing and the Sexual Division of Labor among the Meriam. *American Anthropologist* 109(3):442–451.

Blitz, John H., C. Fred T. Andrus, and Lauren E. Downs

2014 Sclerochrnological Measures of Seasonality at a Late Woodland Mound on the Mississippi Gulf Coast. *American Antiquity* 79(4):697–711.

Blitz, John H., and Karl G. Lorenz

2002 The Early Mississippian Frontier in the Lower Chattahoochee-Apalachicola River Valley. *Southeastern Archaeology* 21(2):117–135.

Blitz, John H., and C. Baxter Mann

2000 *Fisherfolk, Farmers, and Frenchmen: Archaeological Explorations on the Mississippi Gulf Coast*. Mississippi Department of Archives and History, Jackson.

Bologna, Paul A.X., and Kenneth L. Heck, Jr.

1999 Differential Predation and Growth Rates of Bay Scallops within a Seagrass Habitat. *Journal of Experimental Marine Biology and Ecology* 239:299–314.

Boone, James L.

1992 Competition, Conflict, and Development of Social Hierarchies. In *Evolutionary Ecology and Human Behavior*. E.A. Smith and B. Winterhalder, eds., pp. 301–338. Aldine de Gruyter, New York.

Bowman, Sheridan

1990 *Radiocarbon Dating.* University of California Press, Berkeley.

Boyer, Timothy P., John I. Antonov, Olga K. Baranova, Hernan E. Garcia, Daphne R. Johnson, Ricardo A. Locarnini, Alexey V. Mishonov, Todd D. O'Brien, Dan Seidov, Igor V. Smolyar, and Melissa M. Zweng

2009 World Ocean Database 2009. S. Levitus, ed., NOAA Atlas NESDIS 66, U.S. Gov. Printing Office, Washington, D.C.

Bradatan, Cristina

2003 Cuisine and Cultural Identity in Balkans. *Anthropology of East Europe Review* 21(1): (2003):43–47.

Braje, Todd J., Douglas J. Kennett, Jon M. Erlandson, and Brendan J. Culleton

2007 Human Impacts on Nearshore Shellfish Taxa: A 7,000 Year Record from Santa Rosa Island, California. *American Antiquity* 72:735–756.

Braun, David P.

1986 Midwestern Hopewellian Exchange and Supralocal Interaction. In *Peer Polity Interaction and Socio-Political Change*, C. Renfrew and J.F. Cherry, eds., pp. 117–126. Cambridge University Press, Cambridge.

Bray, J. Roger, and John T. Curtis

1957 An Ordination of the Upland Forest Communities of Southern Wisconsin. *Ecological Monographs* 27(4):325–349.

Bronk Ramsey, Christopher

2009a Bayesian Analysis of Radiocarbon Dates. *Radiocarbon* 51(1):337–360.

2009b Dealing with Outliers and Offsets in Radiocarbon Dating. *Radiocarbon* 51(3):1023–1045.

Broughton, Jack M.

1994a Declines in Mammalian Foraging Efficiency During the Late Holocene, San Francisco Bay, California. *Journal of Anthropological Archaeology* 13:371–401.

1994b Late Holocene Resource Intensification in the Sacramento Valley, California: The Vertebrate Evidence. *Journal of Archaeological Science* 21:501–514.

1995 *Resource Depression and Intensification during the Late Holocene, San Francisco Bay: Evidence from the Emeryville Shellmound*, Ph.D. dissertation, University of Washington, Seattle.

1997 Widening Diet Breadth, Declining Foraging Efficiency, and Prehistoric Harvest Pressure: Ichthyofaunal Evidence from the Emeryville Shellmound, California. *Antiquity* 71:845–862.

Brown, Ian W.

1982 *The Southeastern Check Stamped Pottery Tradition: A View from Louisiana.* Kent State University Press, Kent.

2003 *Bottle Creek: A Pensacola Culture Site in South Alabama.* The University of Alabama Press, Tuscaloosa.

Brown, Joseph Epes

1982 *The Spiritual Legacy of the American Indian*. Crossroad Publishing, New York.

Brown, Pamela

2009 *Saint Andrew Bay Watershed: A Look into One of Florida's Most Diverse Watersheds.* M.S. thesis, University of Florida, Gainesville.

Brown, Randall B., Earl L. Stone, and Victor W. Carlisle

1990 Soils. In *Ecosystems of Florida*, R.L. Myers and J.J. Ewel, eds., pp. 35–69. University of Central Florida Press, Orlando.

Burt, William H., and Richard P. Grossenheider

1980 *A Field Guide to the Mammals: North America North of Mexico.* Houghton Mifflin Company, New York.

Butler, Virginia L.

2000 Resource Depression on the Northwest Coast of North America. *Antiquity* 74:649–661.

2001 Changing Fish Use on Mangaia, Southern Cook Islands: Resource Depression and the Prey Choice Model. *International Journal of Osteoarchaeology* 11:88–100.

Butler, Virginia L., and Sarah K. Campbell

2004 Resource Intensification and Resource Depression in the Pacific Northwest of North America: A Zooarchaeological Review. *Journal of World Prehistory* 18(4):327–405.

Byrd, John E.

1994 *The Zooarchaeology of Four Gulf Coast Prehistoric Sites*. Ph.D. dissertation, University of Tennessee, Knoxville.

1997 The Analysis of Diversity in Archaeological Faunal Assemblages: Complexity and Subsistence Strategies in the Southeast during the Middle Woodland Period. *Journal of Anthropological Archaeology* 16:49–72.

Cabeza de Vaca, Alvar Nunez

1905 *The Journey of Alvar Nunez Cabeza de Vaca and His Companions from Florida to the Pacific 1528–1536,* A.F. Bandelier, ed., trans. A.S. Barnes & Company, New York.

Caddy, J.F., J. Csirke, S. M. Garcia, and R.J.R. Grainger

1998 How Pervasive is “Fishing Down Marine Food Webs”? *Science* 282:1383a.

Cake, Edwin W.

1983 *Habitat Suitability Index Models: Gulf of Mexico American Oyster*. National Coastal Ecosystems Team, Division of Biological Services, Research and Development, Fish and Wildlife Service, US Department of the Interior.

Caldwell, Joseph R.

1964 Interaction Spheres in Prehistory. In *Hopewellian Studies,* J. Caldwell and R. Hall, eds., pp. 133–143. Illinois State Museum Scientific Papers No. 12, Springfield.

Campbell, Sarah K., and Virginia L. Butler

2010 Archaeological Evidence for Resilience of Pacific Northwest Salmon Populations and the Socioecological System Over the Last ~7,500 Years. *Ecology & Society* 15(1):1–20.

Carr, Christopher

2006 Rethinking Interregional Hopewellian "Interaction." In *Gathering Hopewell: Society, Ritual, and Ritual Interaction,* C. Carr and D.T. Case, eds., pp. 575–623. Springer, New York.

Carré, Matthieu, Laurent Klaric, Danièle Lavallée, Michèle Julien, Ilhem Bentaleb, Michel Fontugne, and Orest Kawka

2009 Insights into Early Holocene Hunter-Gatherer Mobility on the Peruvian Southern Coast from Mollusk Gathering Seasonality. *Journal of Archaeological Science* 36:1173–1178.

Carrier, James G.

1981 Ownership of Productive Resources on Ponam Island, Manus Province. *Journal de la Société des Océanistes*. 37(72–73):205–217.

Carriker, Melbourne R.

1967 Ecology of Estuarine Benthic Invertebrates: A Perspective. In *Estuaries*, G.H. Lauff, ed., pp. 442–487. American Association for the Advancement of Science, Washington, D.C.

Cashdan, Elizabeth

1992 Spatial Organization and Habitat Use. In *Evolutionary Ecology and Human Behavior*. E.A. Smith and B. Winterhalder, eds., pp. 238–266. Aldine de Gruyter, New York.

Chadwick, Michael A., and Jack W. Feminella.

2001 Influence of Salinity and Temperature on the Growth and Production of a Freshwater Mayfly in the Lower Mobile River, Alabama. *Limnology and Oceanography* 46(3):532–542.

Chaplin, Glen Ira

2001 *Effects of Habitat Complexity, Created by Native and Exotic Macrophytes, on Secondary Production and the Transfer of Energy to Higher Order Consumers in the Lower Mobile-Tensaw Delta, Alabama*. Ph.D. dissertation, University of South Alabama, Mobile.

Chapman, Margaret D.

1987 Women’s Fishing in Oceania. *Human Ecology* 15:267–288.

Chatters, James C.

1987 Hunter–Gatherer Adaptations and Assemblage Structure. *Journal of Anthropological Archaeology* 6(4):336–375.

Chen, Ellen, and John F. Gerber

1990 Climate. In *Ecosystems of Florida*, R.L. Myers and J.J. Ewel, eds., pp. 11–34. University of Central Florida Press, Orlando.

Cheung, William L., Tony J. Pitcher, and Daniel Pauly

2005 A Fuzzy Logic Expert System to Estimate Intrinsic Extinction Vulnerabilities of Marine Fishes to Fishing. *Biological Conservation* 124(1):97–111.

Cheung, William W.L., Reg Watson, Telmo Morato, Tony J. Pitcher, and Daniel Pauly

2007 Intrinsic Vulnerability in the Global Fish Catch. *Marine Ecology Progress Series* 333:1–12.

Claassen, Cheryl

1986 Seasons in the Prehistoric Southeastern United States. *American Antiquity* 51(1):21–37.

1991 Normative Thinking and Shell Bearing Sites. In *Archaeological Method and Theory* Vol. 3, M.B. Schiffer, ed., pp. 249–298. University of Arizona Press, Tuscon.

1998 *Shells*. Cambridge University Press, Cambridge.

2010 *Feasting with Shellfish in the Southern Ohio Valley: Archaic Sacred Sites and Rituals.* University of Tennessee Press, Knoxville.

Claassen, Cheryl, and Samuella Sigmann

1993 Sourcing *Busycon* Artifacts of the Eastern United States. *American Antiquity* 58:333–347.

Clark, John E.

2014 Towards a Better Explanation of Hereditary Inequality. In *Agency in Archaeology*, Marcia-Anne Dobres and John Robb, eds., pp. 92:112. Routledge, New York.

Clarke, K. Robert, Paul J. Somerfield, and M. Gee Chapman

2006 On Resemblance Measures for Ecological Studies, Including Taxonomic Dissimilarities and a Zero-adjusted Bray–Curtis Coefficient for Denuded Assemblages. *Journal of Experimental Marine Biology and Ecology* 330(1):55–80.

Clayton, Tonya

2012 *How to Read a Florida Gulf Coast Beach: A Guide to Shadow Dunes, Ghost Forests, and Other Telltale Clues from an Ever-Changing Coast*. University of North Carolina Press, Chapel Hill.

Cohen, Mark Nathan

1977 *The Food Crisis in Prehistory: Overpopulation and the Origins of Agriculture*. Yale University Press, New Haven.

Colaninno, Carol E.

2010 *Zooarchaeological Analysis of Vertebrate Remains from Five Late Archaic Shell Rings on the Georgia Coast, USA*. Ph.D. dissertation, University of Georgia, Athens.

2011 Examining Ichthyofaunal Remains for Evidence of Fishing Technologies Employed in Georgia Estuaries during the Late Archaic Period. *Southeastern Archaeology* 30(2):337–350.

2012 Evaluating Formational Models for Late Archaic Shell Rings of the Southeastern United States Using Vertebrate Fauna from the St. Catherines Shell Ring, St. Catherines Island, Georgia. *The Journal of Island and Coastal Archaeology* 7(3):338–362.

Collins, A.B., M.R. Heupel, and P.J. Motta

2007 Residence and Movement Patterns of Cownose Rays *Rhinoptera bonasus* within a South-West Florida Estuary. *Journal of Fish Biology* 71:1159–1178.

Conmy, Robyn

2010 *St. Andrew Bay*. Presented to the Pensacola public workshop, February 10, 2010, in support of the development of numeric nutrient criteria in Florida estuaries and coastal waters. Available: http://www.dep.state.fl.us/water/wqssp/nutrients/estuarine.htm.

Connaway, John M.

2007 *Fishweirs: A World Perspective with Emphasis on the Fishweirs of Mississippi*, Archaeological Reports No. 33, Mississippi Department of Archives and History, Jackson.

Conner, William H., John W. Day Jr., Robert H. Baumann, and John M. Randall

1989 Influence of Hurricanes on Coastal Ecosystems along the Northern Gulf of Mexcio. *Wetlands Ecology and Management* 1(1):45–56.

Cook, G.D.

2001 Effects of Frequent Fires and Grazing on Stable Nitrogen Isotope Ratios of Vegetation in Northern Australia. *Australian Ecology* 26:630–636.

Cortés-Sánchez, Miguel, Arturo Morales-Muñiz , María D. Simón-Vallejo, María C. Lozano-Francisco, José L. Vera-Peláez, Clive Finlayson, Joaquín Rodríguez-Vidal, Antonio Delgado-Huertas, Francisco J. Jiménez-Espejo, Francisca Martínez-Ruiz, M. Aranzazu Martínez-Aguirre, Arturo J. Pascual-Granged, M. Mercè Bergadà-Zapata, Juan F. Gibaja-Bao, José A. Riquelme-Cantal, J. Antonio López-Sáez, Marta Rodrigo-Gámiz, Saburo Sakai, Saiko Sugisaki, Geraldine Finlayson, Darren A. Fa, Nuno F. Bicho

2011 Earliest Known Use of Marine Resources by Neanderthals. *PloS ONE* 6(9):1–15.

Crook, Morgan R.

1986 *Mississippi Period Archaeology of the Georgia Coastal Zone.* University of Georgia Laboratory of Archaeology Series Report No. 23, Athens.

Crosetti, D., J. C. Avise, F. Placidi, A. R. Rossi and L. Sola

1993 Geographic Variability in the Grey Mullet *Mugil cephalus*: Preliminary Results of mtDNA and Chromosome Analyses. *Aquaculture* 111:95–101.

Crumley, Carole L.

1994 Historical Ecology: A Multidimensional Ecological Orientation. In *Historical Ecology: Cultural Knowledge and Changing Landscapes*, C.L. Crumley, ed., pp. 1–17. School of American Research Press, Santa Fe.

Curray, Joseph R

1960 Sediments and History of Holocene Transgression, Continental Shelf, Northwest Gulf of Mexico. In *Recent Sediments, Northwest Gulf of Mexico*, F.P. Shepard, ed., pp. 221–266. American Association of Petroleum Geologists, Tulsa.

Curren, Cailup B., Jr.

1976 Prehistoric and Early Historic Occupation of the Mobile Bay and Mobile Delta Area of Alabama with an Emphasis on Subsistence. *Journal of Alabama Archaeology* 22:61–84.

1987 *Archaeology at Bluewater Bay: An Archaic Site in Northwest Florida.* University of West Florida, Office of Cultural and Archaeological Research, Reports on Investigation No. 9.

Cushing, Frank Hamilton

1896 Exploration of Ancient Key Dwellers' Remains on the Gulf Coast of Florida. *Proceedings of the American Philosophical Society* 35(153):329–448.

Darr, Ryan L., and David G. Hewitt

2008 Stable Isotope Trophic Shifts in White-Tailed Deer. *Journal of Wildlife Management* 72(7):1525–1531.

Darwin, Charles

1860 *Journal of Researches into the Natural History and Geology of the Countries Visited during the Voyage of the HMS "Beagle" Round the World.* Clowes and Sons, London.

Dawes, Clinton J., Ronald C. Phillips, and Gerold Morrison

2004 *Seagrass Communities of the Gulf Coast of Florida: Status and Ecology*. Florida Fish and Wildlife Conservation Commission Fish and Wildlife Research Institute and the Tampa Bay Estuary Program. St. Petersburg, Florida.

De la Vega, Garcilaso

1961 *The Incas: The Royal Commentaries of the Inca*, by Maria Jolas, trans., A. Gheerbrant, ed. Orion Press, New York.

Dengel, Craig, Rebecca Saunders, and Jules Haigler

2012 Excavations in a Middle Woodland "Plaza:" Hare Hammock (and Environs): Revisited. *Southeastern Archaeological Conference Bulletin* 55:37.

DeNiro, Michael J.

1985 Postmortem Preservation and Alteration of in Vivo Bone Collagen Isotope Ratios in Relation to Palaeodietary Reconstruction. *Nature* 317:806–809.

deFrance, Susan D.

2009 Zooarchaeology in Complex Societies: Political Economy, Status, and Ideology. *Journal of Archaeological Research* 17:105–168.

Dietler, Michael

1996 Feasts and Commensal Politics in the Political Economy: Food, Power, and Status in Prehistoric Europe. In *Food and the Status Quest: An Interdisciplinary Perspective,* P. Wiessner and W. Schiefenhövel, eds., pp. 87–126. Berghahn Books, Providence.

Dillehay, Tom D., C. Ramirez, M. Pino, M.B. Collins, J. Rossen, and J.D. Pino-Navarro

2008 Monte Verde: Seaweed, Food, Medicine, and the Peopling of South America. *Science* 320:784–786.

Driesch, Angela von den

1976 *A Guide to the Measurements of Animal Bones from Archaeological Sites*. Peabody Museum Bulletin No. 1, Harvard University.

Drooker, Penelope Ballard

1997 *The View from Madisonville: Protohistoric Western Fort Ancient Interaction Patterns*. Memoirs of the Museum of Anthropology No. 31. University of Michigan, Ann Arbor.

Duffee, Ernest M., Robert A. Baldwin, Douglas L. Lewis, and William B. Warmack

1984 *Soil Survey of Bay County, Florida*. U. S. Department of Agriculture, Soil Conservation Service, Washington, D.C.

Ellison, Tria M.

2009 *Identifying Social Structure through Spatial Patterning at Bayview, a Weeden Island Coastal Community in Northwest Florida*. M.A. thesis, University of Florida, Gainesville.

Emery, Kitty F.

2004 Maya Zooarchaeology: In Pursuit of Social Variability and Environmental Heterogeneity. In *Continuities and Changes in Maya Archaeology: Perspectives at the Millennium*, C.W. Golden and G. Borgstede, eds., pp. 193–217. Routledge, New York.

Erlandson Jon M.

2001 The Archaeology of Aquatic Adaptations: Paradigms for a New Millennium. *Journal of Archaeological Research* 9(4):287–350.

2002 Anatomically Modern Humans, Maritime Voyaging, and the Pleistocene Colonization of the Americas. *Memoirs of the California Academy of Sciences* 27:59–92.

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(23):2232–2245.

Erlandson, Jon M., and Torben C. Rick

2008 Archaeology, Marine Ecology, and Human Impacts on Marine Ecosystems. In *Human Impacts on Ancient Marine Ecosystems: A Global Perspective*, T.C. Rick and J.M. Erlandson, eds., pp. 1–19. University of California Press, Berkeley.

Erlandson, Jon M., Torben C. Rick, and Todd J. 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.

Eyles, Eric C.

2004 *Prehistoric Shell Artifacts from the Apalachicola River Valley Area, Northwest Florida*. M.A. thesis, University of South Florida, Tampa.

Faught, Michael K.

2002 Submerged Paleoindian and Archaic Sites of the Big Bend, Florida. *Journal of Field Archaeology* 29(3/4):273–290.

Faught, Michael K., and Brinnen Carter

1998 Human Occupation and Environmental Change in Northwestern Florida. *Quaternary International* 49/50:167–176.

Faure, G., and J.L. Powell

1972 *Strontium Isotope Geology*. Springer-Verlag, New York.

Feeny, David, Fikret Berkes, Bonnie J. McCay, and James Acheson

1990 The Tragedy of the Commons: Twenty-two Years Later. *Human Ecology* 18(1):1–19.

Fischler, Claude

1988 Food, Self and Identity. *Social Science Information* 27(2):275–292.

Florida Department of Environmental Protection (FLDEP)

2012 *Site-Specific Information in Support of Establishing Numeric Nutrient Criteria for St. Andrew Bay*. Nutrient Criteria Technical Support Document, October, 2012.

Florida Fish and Wildlife Commission (FWC)

2006 Bay Scallops: Underwater Canaries. *Sea Stats*. Fish and Wildlife Research Institute.

2009 Tidal Flats Florida. *FWC Quick Maps*. http://atoll.floridamarine.org/Quickmaps/, accessed August 6, 2015.

Florida Natural Areas Inventory (FNAI)

2010 Guide to the Natural Communities of Florida. Florida Natural Areas Inventory, Tallahassee.

Fraser, Douglas

1968 *Village Planning in the Primitive World*. Brazilier, New York.

Froese, Rainer, and Daniel Pauly

2014 *FishBase*. World Wide Web electronic publication. www.fishbase.org, version (11/2014), accessed August 6, 2015.

Garman, Gayle, and Lori Harris

1997 *Coastal Hazardous Waste Site Reviews*. Hazardous Materials Response and Assessment Division, National Oceanic and Atmospheric Administration, Seattle.

Geiger, Stephen P., Janessa Cobb, and William S. Arnold

2006 Variations in Growth and Reproduction of Bay Scallops (*Argopecten irradians*) (Lamark, 1819), from Six Subpopulations in the Northeastern Gulf of Mexico. *Journal of Shellfish Research* 25(2):491–501.

Gilbert, B. Miles

1980 *Mammalian Osteology*. Modern Printing Co., Laramie.

Gilliland, Marion S.

1975 *The Material Culture of Key Marco, Florida*. University Press of Florida, Gainesville.

Gilmore, R. Grant

1987 Subtropical-Tropical Seagrass Communities of the Southeastern United States: Fishes and Fish Communities. Florida Dept. of Natural Resources, Bureau of Marine Research Publication No. 42.

Grayson, Donald K.

1973 On the Methodology of Faunal Analysis. *American Antiquity* 38(4):432–9.

1979 On the Quantification of Vertebrate Archaeofaunas. In *Advances in Archaeological Method and Theory* Vol. 2, M. B. Schiffer, ed., pp. 199–237. Academic Press, New York.

1981 The Effects of Sample Size on Some Derived Measures in Vertebrate Faunal Analysis. *Journal of Archaeological Science* 8(1):77–88.

Greenawalt-Boswell, Jaime, Thomas K. Frazer, Charles A. Jacoby, and William S. Arnold

2007 Mortality and Exploitation Rate Estimates for the Recreational Bay Scallop Fishery off the Gulf Coast of Florida, USA. *North American Journal of Fisheries Management* 27(4):1230–1242.

Greenspan, Ruth L.

1998 Gear Selectivity Models, Mortality Profiles and the Interpretation of Archaeological Fish Remains: A Case Study from the Harney Basin, Oregon. *Journal of Archaeological Science* 25(10):973–984.

Grenda, Donn R., and Jeffrey H. Altschul

1994 The Evolution of Coastal Settlements: A View from the Ballona Lagoon. *Proceedings of the Society for California Archaeology* 7:213–226.

Grøn, Ole

1991 A Method for Reconstruction of Social Organization in Prehistoric Societies and Examples of Practical Applications. In *Social Space: Human Spatial Behaviour in Dwellings and Settlements,* O. Grøn, E. Engelstad, and I. Lindblom, eds., pp. 100–117. Odense University Press, Odense.

Grossman, Herschel I., and Juan Mendoza

2003 Scarcity and Appropriative Competition. *European Journal of Political Economy* 19(44):747–758.

Guilday, John E., Paul W. Parmalee, and Donald P. Tanner

1967 Aboriginal Butchering Techniques at the Eschelman Site (36LA12), Lancaster, Pennsylvania. *Pennsylvania Archaeologist* 32(2):59–83.

Gunn, Joel

1995 Osprey Marsh: Archaeological Data Recovery Investigations at Sites 38BU905 and 38BU921 along the Hilton Head Cross Island Expressway, Beaufort County, South Carolina. Report prepared by Garrow and Associates, Inc., for South Carolina Department of Transportation.

Habu, Junko

2008 Growth and Decline in Complex Hunter–Gatherer Societies: A Case Study from the Jomon Period Sannai Maruyama Site, Japan. *Antiquity* 82:571–584.

Habu, Junko, Akira Matsui, Naoto Yamamoto, and Tomonori Kanno

2011 Shell Midden Archaeology in Japan: Aquatic Food Acquisition and Long-term Change in the Jomon Culture. *Quaternary International* 239:19–27.

Hadden, Carla S.

2016 Excavations at Hare Hammock and Strange's Ring Middens. Report prepared for Tyndall AFB.

Hadden, Carla S., and Alexander Cherkinsky

2015 ^{14}C Variations in Pre-Bomb Nearshore Habitats of the Florida Panhandle, USA. *Radiocarbon* 57(3):469–477.

Hadden, Carla S., Maran E. Little, C. Fred T. Andrus, and Gregory A. Waselkov

2015 Stable Oxygen Isotopic Evidence of Mobility and Site Seasonality on the Northern Gulf of Mexico, USA. Paper presented at the 80th Annual Meeting of the Society for American Archaeology, San Francisco, California, April 15–19.

Hale, H. Stephen, Irvy Quitmyer, and Sylvia Scudder

1987 Methods for Estimating Edible Meat Weights for Faunal Remains from Sites in the Southeastern United States. Manuscript on file, Department of Anthropology, Florida Museum of Natural History, Gainesville.

Hall, Stephen J.

1999 *The Effects of Fishing on Marine Ecosystems and Communities*. Blackwell Science, London.

Hancock, Peter J., Randall J. Hunt, and Andrew J. Boulton

2009 Preface: Hydrogeoecology, the Interdisciplinary Study of Groundwater Dependent Ecosystems. *Hydrogeology Journal* 17:1–3.

Hard, Robert J., and M. Anne Katzenberg

2011 Stable Isotope Study of Hunter–Gatherer–Fisher Diet, Mobility, and Intensification on the Texas Gulf Coastal Plain. *American Antiquity* 76(4):709–751.

Hardin, Garrett

1968 The Tragedy of the Commons. *Science* 162:1243–1248.

Harestad, A.S., and F.L. Bunnel

1979 Home Range and Body Weight: A Reevaluation. *Ecology* 60(2):389–402.

Harke, Ryan M., Gregory S. Herbert, Nancy Marie White, and Jennifer Sliko

2015 Sclerochronology of *Busycon sinistrum*: Late Prehistoric Seasonality Determination at St. Joseph Bay, Florida, USA. *Journal of Archaeological Science* 57:98–108.

Harris, Douglas C.

2001 *Fish, Law, and Colonialism: The Legal Capture of Salmon in British Columbia.* University of Toronto Press, Toronto.

Hartman, Gideon, Guy Bar-Oz, Ram Bouchnick, and Ronny Reich

2013 The Pilgrimage Economy of Early Roman Jerusalem (1st Century BCE–70 CE) Reconstructed from the δ^{15}N and δ^{13}C Values of Goat and Sheep Remains. *Journal of Archaeological Science* 40:4369–4376.

Hayden, Brian

1995 Pathways to Power: Principles for Creating Socioeconomic Inequalities. In *Foundations of Social Inequality*, T.D. Price and G.M. Feinman, eds., pp. 15–86. Plenum Press, New York.

1998 Practical and Prestige Technologies: The Evolution of Material Systems. *Journal of Archaeological Method and Theory* 5(1):1–55.

Hedges, Robert E.M., and Linda M. Reynard

2007 Nitrogen Isotopes and the Trophic Level of Humans in Archaeology. *Journal of Archaeological Science* 34(8):1240–1251.

Hedman, Kristin M., B. Brandon Curry, Thomas M. Johnson, Paul D. Fullagar, and Thomas E. Emerson

2009 Variation in Strontium Isotope Ratios of Archaeological Fauna in the Midwestern United States: A Preliminary Study. *Journal of Archaeological Science* 36:64–73.

Hewitt, Susan J.

2013 Some Observations on the Behavior of *Strombus alatus* (Gastropoda, Strombidae) on Sanibel Island, Lee County, Florida. *Festivus* 45(1):6–8.

Higham, Charles, and Rachanie Thosarat

1994 *Khok Phanom Di: Prehistoric Adaptation to the World's Richest Habitat*. Harcourt Brace, New York.

Hirth, Kenneth G.

1996 Political Economy and Archaeology: Perspectives on Exchange and Production. *Journal of Archaeological Research* 4(3):203–239.

Hodder, Ian

2014 The Entanglements of Humans and Things: A Long-Term View. *New Literary History* 45:19–36.

Hoese, H. Dickson, and Richard H. Moore

1998 *Fishes of the Gulf of Mexico: Texas, Louisiana, and Adjacent Waters*, 2nd ed. Texas A&M University Press, College Station.

Hoover, Cindi A., and Partick M. Gaffney

2005 Geographic Variation in Nuclear Genes of the Eastern Oyster, *Crassostrea virginica* Gmelin. *Journal of Shellfish Research* 24(1):103–112.

Hudson, Charles M.

1976 *The Southeastern Indians.* University of Tennessee Press, Knoxville.

2004 *Black Drink: A Native American Tea.* University of Georgia Press, Athens.

Hutchings, Jeffrey A., and John D. Reynolds

2004 Marine Fish Population Collapses: Consequences for Recovery and Extinction Risk. *Bioscience* 54(4):297–309.

Ingold, Tim

2000 *The Perception of the Environment: Essays on Livelihood, Dwelling and Skill.* Routledge, New York.

Irimoto, Takashi

1977 Ecology of the Sea-Food Gatherers on the Rocky Coast of Kawaguchi. In *Human Activity System: Its Spatiotemporal Structure*, H. Watanabe, ed., pp. 91–116. University of Tokyo Press, Tokyo.

Jackson, Jeremy B. C., Michael X. Kirby, Wolfgang H. Berger, Karen A. Bjorndal, Louis W. Botsford, Bruce J. Bourque, Roger H. Bradbury, Richard Cooke, Jon Erlandson, James A. Estes, Terence P. Hughes, Susan Kidwell, Carina B. Lange, Hunter S. Lenihan, John M. Pandolfi, Charles H. Peterson, Robert S. Steneck, Mia J. Tegner, Robert R. Warner

2001 Historical Overfishing and the Recent Collapse of Coastal Ecosystems. *Science* 293:629–638.

Jeffries, Richard W.

2004 Regional-Scale Interaction Networks and the Emergence of Cultural Complexity along the Northern Margins of the Southeast. In *Signs of Power: The Rise of Cultural Complexity in the Southeast,* J.L. Gibson and P.J. Carr, eds., pp. 71–85. University of Alabama Press, Tuscaloosa.

Jennings, Simon, E.M. Grandcourt, and Nicholas V.C. Polunin

1995 The Effects of Fishing on the Diversity, Biomass, and Trophic Structure of Seychelles Reef Fish Communities. *Coral Reefs* 14:225–235.

Jennings, Simon, Simon P.R. Greenstreet, and John D. Reynolds

1999a Structural Change in an Exploited Fish Community: A Consequence of Differential Fishing Effects on Species with Contrasting Life Histories. *Journal of Animal Ecology* 68(3):617–627.

Jennings, Simon, and Nicholas V.C. Polunin

1996 Effects of Fishing Effort and Catch Rate upon the Structure and Biomass of Fijian Reef

Fish Communities. *Journal of Applied Ecology* 33(2):400–412.

Jennings, Simon, John D. Reynolds, and Nicholas V.C. Polunin

1999b Predicting the Vulnerability of Tropical Reef Fishes to Exploitation with Phylogenies and Life Histories. *Conservation Biology* 13(6):1466–1475.

Jochim, Michael A.

1976 *Hunter-Gatherer Subsistence and Settlement: A Predictive Model.* Academic Press, New York.

Johnson, Ann F., and Michael G. Barbour

1990 Dunes and Maritime Forests. In *Ecosystems of Florida*, R.L. Myers and J.J. Ewel, eds., pp. 429–480. University of Central Florida Press, Orlando.

Jones, B. Calvin

1982 Southern Cult Manifestations at the Lake Jackson Site, Leon County, Florida: Salvage Excavation of Mound 3. *Midcontinental Journal of Archaeology* 7(1):3–44.

Jones, Sharyn, and Rhonda L. Quinn

2009 Prehistoric Fijian Diet and Subsistence: Integration of Faunal, Ethnographic, and Stable Isotopic Evidence from the Lau Island Group. *Journal of Archaeological Science* 36(12):2742–2754.

Jordan, David Starr, and Barton Warren Evermann

1902 *American Food and Game Fishes: A Popular Account of All the Species Found in America North of the Equator, with Keys for Ready Identification, Life Histories and Methods of Capture*. Doubleday, Page & Company, New York.

Jørgensen, Christian, Katja Enberg, Erin S. Dunlop, Robert Arlinghaus, David S. Boukal, Keith Brander, Bruno Erande, Anne Gårdmark, Fiona Johnston, Shuichi Matsumura, Heidi Pardoe, Kristina Raab, Alexandra Silva, Anssi Vainikka, Ulf Dieckmann, Mikko Heino, and Adriaan D. Rijnsdorp

2007 Managing Evolving Fish Stocks. *Science* 318:1247–1248.

Kay, Charles E.

2007 Were Native People Keystone Predators? A Continuous-Time Analysis of Wildlife Observations Made by Lewis and Clark in 1804-1806. *Canadian Field-Naturalist* 121(1):1–16.

Kay, Charles E., and Randy T. Simmons

2002 *Wilderness and Political Ecology: Aboriginal Influences and the Original State of Nature*. University of Utah Press, Salt Lake City.

Keene, Deborah. A.

2004 Reevaluating Late Prehistoric Coastal Subsistence and Settlement Strategies: New Data from Grove’s Creek Site, Skidaway Island, Georgia. *American Antiquity* 69:671–689.

Kelly, Robert L.

1992 Mobility/Sedentism: Concepts, Archaeological Measures, and Effects. *Annual Review of Anthropology* 21:43–66.

2015 The Abyss: An Academic Archaeologist Looks at the Future. *The SAA Archaeological Record* 15(4):12–17.

Kelly, Robert L., Lin Poyer, and Bram Tucker

2005 An Ethnoarchaeological Study of Mobility, Architectural Investment, and Food Sharing among Madagascar’s Mikea. *American Anthropologist* 107(3):403–416.

Kennett, Douglas J., and James P. Kennett

2000 Competitive and Cooperative Responses to Climatic Instability in Coastal Southern California. *American Antiquity* 65(2):379–395.

Kennett, Douglas J., and Barbara Voorhies

1996 Oxygen Isotopic Analysis of Archaeological Shells to Detect Seasonal Use of Wetlands on the Southern Pacific Coast of Mexico. *Journal of Archaeological Science* 23:689–704.

Kent, Bretton W.

1983 Natural History Observations on the Busyconine Whelks *Busycon contrarium* (Conrad) and *Busycotypus spiratum* (Lamarck). *Journal of Molluscan Studies* 48:37–42.

Kidder, Tristram R.

2004 Plazas as Architecture: An Example from the Raffman Site, Northeast Louisiana. *American Antiquity* 69(3):514–532.

Kilgo, John C., Ronald F. Labisky and Duane E. Fritzen

1998 Influences of Hunting on the Behavior of White-Tailed Deer: Implications for Conservation of the Florida Panther. *Conservation Biology* 12(6):1359–1364.

Knight, Vernon J., Jr.

2001 Feasting and the Emergence of Platform Mound Ceremonialism in Eastern North America. In *Feasts: Archaeological and Ethnographic Perspectives on Food, Politics, and Power,* B. Hayden, ed., pp. 311–333. Smithsonian Institution Press, Washington.

Koerper, Henry C., and Nancy A. Whitney-Desautels

1999 Astragalus Bones: Artifacts or Ecofacts? *Pacific Coast Archaeological Society Quarterly* 35(2&3):69–80.

Kohler, Timothy A.

1978 *The Social and Chronological Dimensions of Village Occupation at a North Florida Weeden Island Period Site*. Ph.D. dissertation, University of Florida, Gainesville.

Kozuch, Laura

1998 *The Significance of Sinistral Whelks from Mississippian Archaeological Sites*. Ph.D. dissertation, University of Florida, Gainesville.

Kritzer, Jacob P., and Peter F. Sale

2004 Metapopulation Ecology in the Sea: From Levins' Model to Marine Ecology and Fisheries Science. *Fish and Fisheries* 5:131–140.

Lanza Espino, G., and Gómez Rojas

2004 Physical and Chemical Characteristics of the Gulf of Mexico. In *Environmental Analysis of the Gulf of Mexico*. K. Withers and M. Nipper, eds. (English trans.), pp. 41–62. Harte Research Institute for Gulf of Mexico Studies Special Publication Series No. 1, Corpus Christi.

Larson, Lewis H.

1980 *Aboriginal Subsistence Technology of the Southeastern Atlantic Coastal Plain during the Late Prehistoric Period*. University Presses of Florida, Gainesville.

LaSalle, Mark W., and Armando A. de l a Cruz

1985 Common Rangia. Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Gulf of Mexico), Biological Report 82 (11.31), Fish and Wildlife Service, U.S. Department of the Interior, Washington, DC.

Lawson, Ariana Slemmens

2005 *Vertebrate Fauna from the Refuge Fire Tower Site (8Wa14): A Study of Coastal Subsistence in the Early Woodland Period*. M.S. thesis, Florida State University, Tallahassee.

Lemmon, Randy

2006 *Gulf Coast Gardening with Randy Lemmon*. Lulu Press, Raleigh.

Leone, Karen L.

2008 Plant Remains Analysis. In *Phase III Archaeology at Plash Island, Archaeological Site 1BA134, in Baldwin County, Alabama,* S.E. Price, ed., pp. 296–308. Center for Archaeological Studies, University of South Alabama, Mobile.

Leone, Karen L., and Katherine R. Mickelson

2009 Archaeobotanical Analyses. In *Archaeology at Orange Beach: Phase III Data Recovery at 1BA21, the Bayou St. John Site, Orange Beach, Baldwin County, Alabama*, S.E. Price, ed., pp. 170–190. Center for Archaeological Studies, University of South Alabama, Mobile.

Lepofsky, Dana, Nicole F. Smith, Nathan Cardinal, John Harper, Mary Morris, Gitla (Elroy) White, Randy Bouchard, Dorothy I.D. Kennedy, Anne K. Salomon, Michelle Puckett, and Kirsten Rowell

2015 Ancient Shellfish Mariculture on the Northwest Coast of North America. *American Antiquity* 80(2):236–259.

Lincecum, Gideon

1904 Choctaw Traditions about Their Settlements in Mississippi and the Origin of Their Mounds. *Publications of the Mississippi Historical Society* 8:521–542.

Little, Maran E.

2015 *Coastal Weeden Island Subsistence Economy and Occupation: A Zooarchaeological Analysis of Strange's Ring Midden (8BY1355), Bay County, Florida*. M.S. thesis, University of Georgia, Athens.

Liu, Kam-Biu, and Miriam L. Fearn

2000a Holocene History of Catastrophic Hurricane Landfalls along the Gulf of Mexico Coast Reconstructed from Coastal Lake and Marsh Sediments. In *Current Stresses and Potential Vulnerabilities: Implications of Global Change for the Gulf Coast Region of the United States*, Z.H. Ning and K. Abdollahi, eds., pp. 38–47. Franklin Press, Baton Rouge.

2000b Reconstruction of Prehistoric Landfall Frequencies of Catastrophic Hurricanes in NW Florida from Lake Sediment Records. *Quaternary Research* 54:238–245.

Liu, Kam-Biu, Houyuan Lu, and Caiming Shen

2008 A 1200-Year Proxy Record of Hurricanes and Fires from the Gulf of Mexico Coast: Testing the Hypothesis of Hurricane–Fire Interactions. *Quaternary Research* 69:29–41.

Livingston, Robert J.

1982 Trophic Organization of Fishes in a Coastal Seagrass System. *Marine Ecology Progress Series* 7:1–12.

1984 The Ecology of the Apalachicola Bay System: An Estuarine Profile. FWS/OBS 82/05, U.S. Fish and Wildlife Service, Washington, D.C.

1985 Organization of Fishes in Coastal Seagrass System: The Response to Stress. In *Fish Community Ecology in Estuaries and Coastal Lagoons: Towards an Ecosystem Integration*, A. Yáñez-Arancibia, ed., pp. 367–382. UNAM Press, Mexico City.

1990 Inshore Marine Habitats. In *Ecosystems of Florida*, R.L. Myers and J.J. Ewel, eds., pp. 549–573. University of Central Florida Press, Orlando.

Lolley, Terry L.

2003 Weeden Island Occupation in the Borderland: An Example from South Alabama. *Southeastern Archaeology* 22:63–76.

Lothrop, Samuel Kirkland

1928 *The Indians of Tierra del Fuego*. Museum of the American Indian, Heye Foundation, New York.

Lozano-García, María del Socorro, Margarita Caballero, Beatriz Ortega, Alejandro Rodriguez, and Susana Sosa

2007 Tracing the Effects of the Little Ice Age in the Tropical Lowlands of Eastern Mesoamerica. *Proceedings of the National Academy of Sciences* 104(41):16200–16203.

Luer, George, and Marion M. Almy

1979 Three Aboriginal Shell Middens on Longboat Key, Florida: Manasota Period Sites of Barrier Island Exploitation. *Florida Anthropologist* 32(2):34–45.

Luer, George M., and Michele Loger

2014 Florida Fighting Conch Shells and “Old” Radiocarbon Ages. *Florida Anthropologist* 17:57–68.

Lyman, R. Lee

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

1995 Determining When Rare (Zoo-)Archaeological Phenomena are Truly Absent. *Journal of Archaeological Method and Theory* 2(4):369–424.

MacCauley, Clay

1887 *The Seminole Indians of Florida*. Fifth Annual Report of the Bureau of Ethnology to the Secretary of the Smithsonian Institution, 1883–1884, pp. 469–531, United States Government Printing Office, Washington, D.C.

McClary, Marion, Jr.

2004 *Spartina alterniflora* and *Phragmites australis* as Habitat for the Ribbed Mussel, *Geukensia demissa* (Dillwyn), in Saw Mill Creek of New Jersey's Hackensack Meadowlands. *Urban Habitats* 2(1):83–90.

McEachron, L.W., A.W. Green, G.C. Matlock, and G.E. Saul

1985 A Comparison of Trotline Catches on Two Hook Types in the Laguna Madre. Management Data Series No. 86. Texas Parks and Wildlife Department, Austin.

McLane, William McNair

1955 *The Fisheries of the St. Johns River System.* Ph.D. dissertation, University of Florida, Gainesville.

McLeod, A.I.

2011 Kendall: Kendall rank correlation and Mann-Kendall trend test. R package version 2.2.

Maechler, Martin, Peter Rousseeuw, Anja Struyf, Mia Hubert, Kurt Hornik, Matthias Studer, and Pierre Roudier

2015 cluster: Cluster Analysis Basics and Extensions. R package version 2.0.1.

Mann, Michael E., Jonathan D. Woodruff, Jeffrey P. Donnelly, and Zhihua Zhang

2009 Atlantic Hurricanes and Climate over the Past 1,500 Years. *Nature* 460:880–885.

Marean, Curtis W., Miryam Bar-Matthews, Jocelyn Bernatchez, Erich Fisher, Paul Goldberg, Andy I. R. Herries, Zenobia Jacobs, Antonieta Jerardino, Panagiotis Karkanas, Tom Minichillo, Peter J. Nilssen, Erin Thompson, Ian Watts, and Hope M. Williams

2007 Early Human Use of Marine Resources and Pigment in South Africa during the Middle Pleistocene. *Nature* 449(18):905–909.

Marquardt, William H.

1988 Politics and Production among the Calusa of South Florida. In *Hunters and Gatherers 1: History, Evolution and Social Change*, T. Ingold, D. Riches, and J. Woodburn, eds., pp. 161–188. Berg, New York.

1992a *Culture and Environment in the Domain of the Calusa*. University of Florida Institute of Archaeology and Paleoenvironmental Studies Monograph 1, University of Florida, Gainesville.

1992b Shell Artifacts from the Caloosahatchee Area. In *Culture and Environment in the Domain of the Calusa*, W.H. Marquardt, ed., pp. 191–228 University of Florida Institute of Archaeology and Paleoenvironmental Studies Monograph 1, University of Florida, Gainesville.

1996 Four Discoveries: Environmental Archaeology in Southwest Florida. In *Case Studies in Environmental Archaeology*, E.J. Reitz, L.A. Newsom, and S.J. Scudder, eds., pp. 17–34.

2010a Shell Mounds in the Southeast: Middens, Monuments, Temple Mounds, Rings, or Works? *American Antiquity* 75:551–570.

2010b 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. 253–271. Anthropological Papers No. 93, American Museum of Natural History, New York.

2014 Tracking the Calusa: A Retrospective. *Southeastern Archaeology* 33:1–24.

Marquardt, William H., and Karen J. Walker

2013 *The Archaeology of Pineland: A Coastal Southwest Florida Site Complex, A.D. 50–1710*. University of Florida Institute of Archaeology and Paleoenvironmental Studies Monograph 4, University of Florida, Gainesville.

Marrinan, Rochelle A., and Nancy Marie White

2007 Modeling Fort Walton Culture in Northwest Florida. *Southeastern Archaeology* 26(2):292–318.

Mattson, Robert A., Thomas K. Frazer, Jason Hale, Seth Blitch, and Lisa Ahijevych

2006 Florida Big Bend. In *Seagrass Status and Trends in the Northern Gulf of Mexico:1940–2002*, L. Handley, D. Altsman, and R. DeMay, eds., pp. 171–188. U.S. Geological Survey Scientific Investigations Report 2006–5287 5287 and U.S. Environmental Protection Agency 855-R-04-003.

Means, Bernard K.

2007 *Circular Villages of the Monongahela Tradition*. University of Alabama Press, Tuscaloosa.

Meehan, Betty

1982 *Shell Bed to Shell Midden.* Australian Institute of Aboriginal Studies, Canberra.

Metcalfe, Duncan, and Kevin T. Jones

1988 A Reconsideration of Animal Body-part Utility Indices. *American Antiquity* 53(3):486–504.

Michczyński, Adam

2007 Is it Possible to Find a Good Point Estimate of a Calibrated Radiocarbon Date? *Radiocarbon* 49(2):393–401.

Mickwee, Christopher

2011 Wakulla in the Sandhills: Analysis of Late Weeden Island Site in the Northwest Florida Interior Uplands. M.A. thesis, University of West Florida, Pensacola.

Mikell, Gregory A.

2012 Sheepshead Country: Coastal Woodland Subsistence from the Perspective of Mack Bayou and other Northwest Florida Sites. *Southeastern Archaeology* 31:17–32.

Mikell, Gregory A., and Rebecca Saunders

2007 Terminal Middle to Late Archaic Settlement in Coastal Northwest Florida: Early Estuarine Exploitation on the Northern Gulf Coast. *Southeastern Archaeology* 26(2):169–195.

Mikell, Gregory A., and Brian O. Shoemaker

2005a Cultural Resources Assessment Survey of the Mack Bayou Homes Tract, Walton County, Florida. Panamerican Consultants, Inc. Submitted to C.D. Jones and Company, Destin.

2005b Phase II and Extended Phase II Testing and Evaluation of Site 8WL101 within the Mack Bayou Homes Tract, Walton County, Florida. Panamerican Consultants, Inc. Submitted to C.D. Jones and Company, Destin.

Milanich, Jerald T.

1973 The Southeastern Deptford Culture: A Preliminary Definition. Bureau of Historic Sites and Properties Bulletin No. 3:51–63. Tallahassee.

1974 *Life in a 9th Century Indian Household: A Weeden Island Fall-Winter Site on the Upper Apalachicola River, Florida*. Division of Archives, History and Records Management, Florida Department of State, Tallahassee.

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

1995 *Florida Indians and the Invasion from Europe.* University Press of Florida, Gainesville.

1998 *Florida's Indians from Ancient Times to Present*. University Press of Florida, Gainesville.

2002 Weeden Island Cultures. In *The Woodland Southeast*, D.G. Anderson and R.C. Mainfort Jr., eds., pp. 352–372. University of Alabama Press, Tuscaloosa.

2004 Origins and Prehistoric Distribution of Black Drink and the Ceremonial Shell Drinking Cup. In *Black Drink: A Native American Tea*, C.M. Hudson, ed., pp. 83–119. University of Georgia Press, Athens.

Milanich, Jerald T., Ann S. Cordell, Vernon J. Knight, Jr., Timothy A. Kohler, and Brenda J. Sigler-Lavelle

1997 *Archaeology of Northern Florida AD 200-900: The McKeithen Weeden Island Culture*. University Press of Florida, Gainesville.

Milner, Nicky

2013 Human Impacts on Oyster Resources at the Mesolithic–Neolithic Transition in Denmark. In *The Archaeology and Historical Ecology of Small Scale Economies*, V.D. Thompson and J.C. Waggoner, Jr., eds., pp. 17–40. University Press of Florida, Gainesville.

Mitchener, Lori Jean, and Albert J. Parker

2005 Climate, Lightning, and Wildfire in the National Forests of the Southeastern United States:1989–1998. *Physical Geography* 26(2):147–162.

Mobile Bay National Estuary Program (MBNEP)

2008 *State of Mobile Bay: A Status Report on Alabama's Coastline from the Delta to Our Coastal Waters*. Indicator Report 23, Mobile Bay National Estuary Program, Mobile.

Monreal-Gomez, M.A., D. A. Salas-de-Leon, and H. Velasco-Mendoza

2004 The Hydrodynamics of the Gulf of Mexico. In *Environmental Analysis of the Gulf of Mexico*. K. Withers and M. Nipper, eds. (English trans.), pp. 2–16. Harte Research Institute for Gulf of Mexico Studies Special Publication Series No. 1, Corpus Christi.

Montague, Clay L., and Richard G. Wiegert

1990 Salt Marshes. In *Ecosystems of Florida,* R.L. Myers and J.J. Ewel, eds., pp. 481–516. University of Central Florida Press, Orlando.

Moore, Christopher R., and Victor D. Thompson

2012 Animism and Green River Persistent Places: A Dwelling Perspective of the Shell Mound Archaic. *Journal of Social Archaeology* 12(2):264–284.

Moore, Clarence B.

1902 Certain Aboriginal Remains of the Northwest Florida Coast, Part II. *Journal of the Academy of Natural Sciences of Philadelphia* 12:127–358.

1918 The Northwest Florida Coast Revisited. *Journal of the Academy of Natural Sciences of Philadelphia* 16:513–581.

Morgan, David W.

2003 *Mississippian Heritage: Late Woodland Subsistence and Settlement Patterns in the Mobile-Tensaw Delta, Alabama.* Ph.D. dissertation, Tulane University, New Orleans.

Morita, Kentaro, and Masa-aki Fukuwaka

2007 Why Age and Size at Maturity Have Changed in Pacific Salmon. *Marine Ecology Progress Series* 335:289–294.

Moseley, Michael E.

1975 *The Maritime Foundations of Andean Civilization*. Cummings Publishing Company, Menlo Park, California.

Moss, Madonna L.

1993 Shellfish, Gender, and Status on the Northwest Coast: Reconciling Archeological, Ethnographic, and Ethnohistorical Records of the Tlingit. *American Anthropologist* 95(3):631–652.

Muller, Jon

1997 An Introduction to Political Economy and Mississippian Political Economy. In *Mississippian Political Economy*, pp. 1–54. Plenum, New York.

Muncy, Robert J., and William Wingo

1983 Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Gulf of Mexico): Sea Catfish and Gafftopsail Catfish. U.S. Fish and Wildlife Service Biological Report No. 82(11.5). Performed for the U.S. Army Corps of Engineers, TR EL-82-4.

Murawski, Steven A.

2000 Definitions of Overfishing from an Ecosystem Perspective. *ICES Journal of Marine Science* 57:649–658.

Myers, Richard K., and David H. van Lear

1998 Hurricane–Fire Interactions in Coastal Forests of the South: A Review and Hypothesis. *Forest Ecology and Management* 103:265–276.

Myers, Ronald L.

1990 Scrub and High Pine. In *Ecosystems of Florida*, R.L. Myers and J.J. Ewel, eds., pp. 150–193. University of Central Florida Press, Orlando.

Myers, Ronald L. and John J. Ewel (Eds.)

1990 *Ecosystems of Florida*. University of Central Florida Press, Orlando.

Myers, Ransom A., and Boris Worm

2003 Rapid Worldwide Depletion of Predatory Fish Communities. *Nature* 423:280–283.

Nanfro, Claire Elizabeth

2004 *An Analysis of Faunal Remains from the Bird Hammock Site (8WA30).* M.S. thesis, Florida State University, Tallahassee.

Neer, Julie A., and Bruce A. Thompson

2005 Life History of the Cownose Ray, *Rhinoptera bonasus*, in the Northern Gulf of Mexico, with Comments on Geographic Variability in Life History Traits. *Environmental Biology of Fishes* 73:321–331.

Nelson, Bruce K., Michael J. DeNiro, Margaret J. Schoeninger, and Donald J. DePaolo

1986 Effects of Diagenesis on Strontium, Carbon, Nitrogen, and Oxygen Concentration and Isotopic Composition of Bone. *Geochimica et Cosmochimica Acta* 50:1941–1949.

Newsom, Lee A.

2002 The Paleoethnobotany of the Archaic Mortuary Pond. In *Windover*, G.H. Doran, ed., pp. 190–210. University Press of Florida, Gainesville.

Nishimura, Asahitaro

1975 Cultural and Social Change in the Modes of Ownership of Stone Tidal Weirs. In *Maritime Adaptations of the Pacific*, R.W. Casteel and G.I. Quimby, eds., pp. 77–88. Mounton Publishers, the Hague.

Nordlie, Frank G.

1990 Rivers and Springs. In *Ecosystems of Florida*, R.L. Myers and J.J. Ewel, eds., pp. 392–428. University of Central Florida Press, Orlando.

Odum, William E.

1988 Comparative Ecology of Tidal Freshwater and Salt Marshes. *Annual Review of Ecology and Systematics* 19:147–176.

Odum, Eugene P., and Gary W. Barrett

2005 *Fundamentals of Ecology*. Thomson Brooks, Belmont, California.

Oksanen, Jari, F. Guillaume Blanchet, Roeland Kindt, Pierre Legendre, Peter R. Minchin, R. B. O'Hara, Gavin L. Simpson, Peter Solymos, M. Henry H. Stevens, and Helene Wagner

2015 Community Ecology Package. For R. Version 2.3-0.

Orchard, Trevor J., and Terence Clark

2005 Multidimensional Scaling of Northwest Coast Faunal Assemblages: A Case Study from Southern Haida Gwaii, British Columbia. *Canadian Journal of Archaeology* 29(1):88–112.

Orr , Kelly L.

2007 *Coastal Weeden Island Subsistence Adaptations: Zooarchaeological Evidence from Bayou St. John (1BA21), Alabama*. Ph.D. dissertation, University of Georgia, Athens.

Osborn, Alan J.

1977 Strandloopers, Mermaids, and Other Fairy Tales: Ecological Determinants of Marine Resource Utilization: The Peruvian Case. In *For Theory Building in Archaeology*, L.R. Binford, ed., pp. 157–250. Academic Press, New York.

O’Sullivan, Aidan

2003 Place, Memory, and Identity among Estuarine Fishing Communities: Interpreting the Archaeology of Early Medieval Fish Weirs. *World Archaeology* 35(3):449–468.

Oswalt, Wendell H.

1973 *Habitat and Technology: The Evolution of Hunting.* Holt, Reinhart, and Wilson, New York.

1976 *An Anthropological Analysis of Food-Getting Technology*. John Wiley and Sons/Interscience, New York.

Paine, Robert T.

1963 Trophic Relationships of Eight Sympatric Gastropods. *Ecology* 44(1):63–73.

Palmer, M.R., and H. Elderfield

1985 Sr Isotope Composition of Sea Water over the Past 75 Myr. *Nature* 314:526–528.

Palmiotto, Andrea

2012 Vertebrate and Invertebrate Fauna. In *Archaeological Investigations at Shell Mound (8LV42), Levy County, Florida:2012 Testing*, pp. 51–66. Technical Report 16, University of Florida Laboratory of Southeastern Archaeology, Gainesville.

Parmalee, Paul W., and Walter E. Klippel

1974 Freshwater Mussels as a Prehistoric Food Resource. *American Antiquity* 39(3):421–434.

Paterson, D. M., R. J. Aspden and K. S. Black

2009 Intertidal Flats: Ecosystem Functioning of Soft Sediment Systems. In: *Coastal Wetlands: An Integrated Approach*. G.M Perillo, E. Wolanski, D. R. Cahoon and M. M. Brinson, eds., pp. 317–343. Elsevier, Amsterdam.

Patrick, Ruth

1994 *Rivers of the United States Vol. I: Estuaries.* John Wiley and Sons, New York.

Pauketat, Timothy R.

2003 Resettled Farmers and the Making of a Mississippian Polity. *American Antiquity* 68(1):39–66.

Pauly, Daniel

1995 Anecdotes and the Shifting Baseline Syndrome of Fisheries. *Trends in Ecology and Evolution* 10(10):430.

Pauly, Daniel, Villy Christensen, Johanne Dalsgaard, Rainer Froese, and Francisco Torres, Jr.

1998 Fishing Down Marine Food Webs. *Science* 279:860–863.

Pauly, Daniel, Villy Christensen, and Carl Walters

2000 Ecopath, Ecosim, and Ecospace as Tools for Evaluating Ecosystem Impact of Fisheries. *ICES Journal of Marine Science* 57:697–706.

Pearson, Charles E., and Fred C. Cook

2012 Excavations at the "Bead Maker's Midden," Ossabaw Island, Georgia: An Examination of Mississippi Period Craft Specialization on the Georgia Coast. *Southeastern Archaeology* 31:87–102.

Percy, George W., and David S. Brose

1974 Weeden Island Ecology, Subsistence, and Village Life in Northwest Florida. Paper presented in the Weeden Island Symposium, 39th Annual Meeting of the Society for American Archaeology, Washington.

Perillo, Gerardo M.E.

1995 Definitions and Geomorphologic Classifications of Estuaries. *Developments in Sedimentology* 53:17–47.

Perkins, Dexter, Jr., and Patricia Daly

1968 A Hunter’s Village in Neolithic Turkey. *Scientific American* 219(5):96–106.

Perlman, Stephen M.

1980 An Optimum Diet Model, Coastal Variability, and Hunter–Gatherer Behavior. In *Advances in Archaeological Method and Theory*, Vol. 3. M.B. Schiffer, ed., pp. 257–310. Academic Press, Orlando.

Pinnegar, John K., and Georg H. Engelhard

2008 The “Shifting Baseline” Phenomenon: A Global Perspective. *Reviews in Fish Biology and Fisheries* 18:1–16.

Pitt-Rivers, George Lane

1925 Aua Island: Ethnographical and Sociological Features of a South Sea Pagan Society. *Journal of the Royal Anthropological Institute of Great Britain and Ireland* 55:425–438.

Pluckhahn, Thomas J.

2003 *Kolomoki: Settlement, Ceremony, and Status in the Deep South, A.D. 350 to 750*. University of Alabama Press, Tuscaloosa.

2013 Cooperation and Competition among Late Woodland Households at Kolomoki, Georgia. In *Cooperation and Collective Action: Archaeological Perspectives.* D.M. Carballo, ed., pp. 175–196. University Press of Colorado, Boulder.

Pluckhahn, Thomas J., Victor D. Thompson, and Alexander Cherkinsky

2015 The Temporality of Shell-bearing Landscapes at Crystal River, Florida. *Journal of Archaeological Science* 37:29–36.

Pluckhahn, Thomas J., Victor D. Thompson, and Brent R. Weisman

2010 Toward a New View of History and Process at Crystal River (8CI1). *Southeastern Archaeology* (2010):164–181.

Plug, Ina, Peter Mitchell, and Geoff Bailey

2010 Late Holocene Fishing Strategies in Southern Africa as Seen from Likoaeng, Highland Lesotho. *Journal of Archaeological Science* 37:3111–3123.

Pohlert, Thorsten

2014 The Pairwise Multiple Comparison of Mean Ranks Package (PMCMR) version 1.1. For R.

Poore, R.Z., H.J. Dowsett, S. Verardo, and T.M. Quinn

2003 Millennial- to Century-Scale Variability in Gulf of Mexico Holocene Climate Records. *Paleoceanography* 18(2):1048.

Price, Sarah E. (Ed.)

2008 *Phase III Archaeology at Plash Island, Archaeological Site 1BA134, in Baldwin County, Alabama.* University of South Alabama Center for Archaeological Studies, Mobile.

2009 *Archaeology at Orange Beach: Phase III Data Recovery at 1BA21, the Bayou St. John Site, Orange Beach, Baldwin County, Alabama*. University of South Alabama Center for Archaeological Studies, Mobile.

Pritchard, Donald W.

1967 What is an Estuary: Physical Viewpoint. In *Estuaries*, G.H. Lauff, ed., pp. 3–5. American Association for the Advancement of Science, Washington, D.C..

Prufer, Olaf H.

1964 The Hopewll Cult. *Scientific American* 211(6):90–102.

Purdue, James R.

1983 Epiphyseal Closure in White-Tailed Deer. *Journal of Wildlife Management* 47(4):1207–1213.

Quinn, Rhonda L., Bryan D. Tucker, and John Krigbaum

2008 Diet and Mobility in Middle Archaic Florida: Stable Isotopic and Faunal Evidencefrom the Harris Creek Archaeological Site (8Vo24), Tick Island. *Journal of Archaeological Science* 35:2346–2356.

Quitmyer, Irvy R.

1985 Zooarchaeological Methods for the Analysis of Shell Middens at Kings Bay. In *Aboriginal Subsistence and Settlement Archaeology of the Kings Bay Locality*, Vol. 2: *Zooarchaeology,* W.H. Adams, ed., pp. 33–48. Department of Anthropology, Reports of Investigations No. 2, University of Florida, Gainesville.

2002 The Zooarchaeology of a Middle-Holocene Archaeological Site along the Mitchell River (8WL1278): Subsistence, Seasonality, and Paleoenvironment in the Late Archaic (ca. 5000 BP). Environmental Archaeology Laboratory, Florida Museum of Natural History, Gainesville.

2003 Zooarchaeological Remains from Bottle Creek. In *Bottle Creek: A Pensacola Culture Site in South Alabama,* I.W. Brown, ed., pp. 130–155. University of Alabama Press, Tuscaloosa.

Quitmyer, Irvy R., Douglas S. Jones, and William S. Arnold.

1997 The Sclerochronology of Hard Clams, *Mercenaria* spp., from the South-Eastern USA: A Method of Elucidating the Zooarchaeological Records of Seasonal Resource

Procurement and Seasonality in Prehistoric Shell Middens. *Journal of Archaeological Science* 24:825–840.

Quitmyer, Irvy R., and Elizabeth J. Reitz

2006 Marine Trophic Levels Targeted between A.D. 300 and 1500 on the Georgia Coast, USA. *Journal of Archaeological Science* 33:806–822.

R Core Team

2014 *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org/ accessed August 5, 2105.

Reagan, Roland

1985 *Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Gulf of Mexico): Red Drum.* U.S. Fish and Wildlife Service Biological Report 82(11.36). Performed for the U.S. Army Corps of Engineers, TR EL-82-4.

Reimer P.J., E. Bard, A. Bayliss, W.J. Beck, P.G. Blackwell, C. Bronk Ramsey, C.E. Buck, H. Cheng, R.L. Edwards, M. Friedrich, P.M. Grootes, T.P. Guilderson, H. Haflidason, I. Hajdas, C. Hatté, T.J. Heaton, D.L. Hoffman, A.G. Hogg, K.A. Hughen, K.F. Kaiser, B. Kromer, S.W. Manning, M. Niu, R.W. Reimer, D.A. Richards, E.M. Scott, J.R. Southon, R.A. Staff, C.S.M. Turney, and J. van der Plicht

2013 IntCal13 and Marine13 Radiocarbon Age Calibration Curves 0–50,000 Years Cal BP. *Radiocarbon* 55(4):1869–87.

Reitsema, Laurie J., Tad E. Brown, Carla S. Hadden, Russell B. Cutts, Maran E. Little, and Brandon T. Ritchison

2015 Provisioning an Urban Economy: Isotopic Perspectives on Landscape Use and Animal Sourcing on the Atlantic Coastal Plain. *Southeastern Archaeology* 34(3):in press.

Reitz, Elizabeth J.

1988a Evidence for Coastal Adaptations in Georgia and South Carolina. *Archaeology of Eastern North America* 16:137–158.

1988b Faunal Remains from Paloma, An Archaic Site in Peru. *American Anthropologist* 90:310–322.

2004 "Fishing down the Food Web": A Case Study from St. Augustine, Florida, USA. *American Antiquity* 69:63–83.

2014 Continuity and Resilience in the Central Georgia Bight (USA) Fishery between 2760 BC and AD 1580. *Journal of Archaeological Science* 41:716–731.

Reitz, Elizabeth J., Susan D. deFrance, Daniel H. Sandweiss, and Heather E. McInnis

2015 Flexibility in Southern Peru Coastal Economies: A Vertebrate Perspective on the Terminal Pleistocene/Holocene Transition. *Journal of Island and Coastal Archaeology* 10(2):155–183.

Reitz, Elizabeth J., Carla S. Hadden, Maran E. Little, Gregory A. Waselkov, and C. Fred T. Andrus

2013 *Woodland Seasonality on the Northern Coast of the Gulf of Mexico*. Technical report prepared for the National Science Foundation project title "Collaborative Research Project: Woodland Subsistence Seasonality on the Northern Gulf Coast" (Award #BCS 1026166–8).

Reitz, Elizabeth J., and Irvy R. Quitmyer

1988 Faunal Remains from Two Coastal Georgia Swift Creek Sites. *Southeastern Archaeology* 7(2):95–108.

Reitz, Elizabeth J., Irvy R. Quitmyer, Stephen H. Hale, Sylvia J. Scudder, and Elizabeth S. Wing

1987 Application of Allometry to Zooarchaeology. *American Antiquity* 52(2):304–17.

Reitz, Elizabeth J., and Elizabeth S. Wing

2008 *Zooarchaeology*. Cambridge University Press, Cambridge.

Renfrew, Colin, and Paul Bahn

2015 *Archaeology Essentials*: *Theory, Methods, Practice.* Thames & Hudson, New York.

Reynolds, John D., Nicholas K. Dulvy, Nicholas B. Goodwin, and Jeffrey A. Hutchings

2005 Biology of Extinction Risk in Marine Fishes. *Proceedings of the Royal Society B: Biological Sciences* 272(1579):2337–2344.

Riccio, Joseph F., J. D. Hardin, George Marion Lamb, L. Scarborough, and K. P. Hanby

1973 Development of a Hydrologic Concept for the Greater Mobile Metropolitan-Urban Environment. Geological Survey of Alabama, Bulletin 106, Tuscaloosa.

Rich, Fredrick J., Lee Newsom, Brian Meyer, and R. Kelly Vance

2014 Radiocarbon Dates and the Genesis of Phytogenic Near-shore Sediments on St. Catherines Island, Georgia, USA. *Environmental Earth Sciences* 72(8):2985–2997.

Rick, Torben C., and Jon M. Erlandson (Eds.)

2008 *Human Impacts on Ancient Marine Ecosystems: A Global Perspective*. University of California Press, Berkeley.

Ricklis, Robert A.

1996 *The Karankawa Indians of the Texas Coast: An Ecological Study of Cultural Tradition and Change*. University of Texas Press, Austin.

2004 Prehistoric Occupation of the Central and Lower Texas Coast. In *The Prehistory of Texas,* T.K. Pertulla, ed., pp 155–180. Texas A&M University Press, College Station.

Ricklis, Robert A., and Richard A. Weinstein

2005 Sea-Level Rise and Fluctuation on the Central Texas Coast: Exploring Cultural and Ecological Correlates. In *Gulf Coast Archaeology: The Southeastern United States and Mexico,* N.M. White, ed., pp. 108–154. University Press of Florida, Gainesville.

Rijnsdorp, A. D., and P. I. van Leeuwen

1992 Density-Dependent and Independent Changes in Somatic Growth of Female North Sea Plaice *Pleuronectes platessa* between 1930 and 1985 as Revealed by Back-Calculation of Otoliths. *Marine Ecology Progress* Series 88:19–32.

Roberts, Harry H.

1997 Dynamic Changes of the Holocene Mississippi River Delta Plain: The Delta Cycle. *Journal of Coastal Research* 13(3):605–627.

Romain, William F.

2009 *Shamans of the Lost World: A Cognitive Approach to the Prehistoric Religion of the Ohio Hopewell.* AltaMira, Plymouth, U.K.

Rostlund, Erhard

1952 *Freshwater Fish and Fishing in Native North America*. University of California Publications in Geography 9, Berkeley.

Russo, Michael

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

1994 Why We Don't Believe in Archaic Ceremonial Mounds and Why We Should: The Case from Florida. *Southeastern Archaeology* 13(2):93–109.

1998 Measuring Sedentism with Fauna: Archaic Cultures along the Southwest Florida Coast. In *Seasonality and Sedentism: Archaeological Perspectives from Old and New World*

Sites, T.R. Rocek and O. Bar-Yosef, eds., pp. 143–164. Peabody Museum of Archaeology and Ethnology Bulletin 6.

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., pp. 26–70. University of Alabama Press, Tuscaloosa.

2014 Ringed Shell Features of the Southeastern United States: Architecture and Midden. In *The Cultural Dynamics of Shell-Matrix Sites,* M. Roksandic, S. Mendonça de Souza, S. Eggers, M. Burchell, and D. Klokler, eds., pp. 21–39. University of New Mexico Press, Albuquerque.

Russo, Michael, Craig Dengel, Jeffrey Shanks, and Thadra Stanton

2011 *Baker's and Strange's Mounds and Middens: Woodland Occupations on Tyndall Air Force Base.* Submitted by the National Park Service Southeast Archaeological Center, Tallahassee, to Tyndall Air Force Base, Panama City, Florida.

Russo, Michael, Carla S. Hadden, and Craig Dengel

2009 *Archeological Investigations of Mounds and Ring Middens at Hare Hammock, Tyndall Air Force Base*. Submitted by the National Park Service Southeast Archaeological Center, Tallahassee, to Tyndall Air Force Base, Panama City, Florida.

Russo, Michael, Margo Schwadron, and Emily M. Yates

2006 *Archaeological Investigation of the Bayview Site: A Weeden Island Ring Midden.* Submitted by the National Park Service Southeast Archaeological Center, Tallahassee, Florida, to Tyndall Air Force Base, Panama City, Florida

Ryder, M. L.

1963 Remains of Fishes and Other Aquatic Animals. In *Science in Archaeology*, D.R. Brothwell and E. Higgs, eds., pp. 294–312, Thames and Hudson, New York.

Salsman, G.G., W.H. Tolbert, and R.G. Villars

1966 Sand-Ridge Migration in St. Andrew Bay, Florida. *Marine Geology* 4:11–19.

Sandweiss, Daniel H., Heather McInnis, Richard L. Burger, Asuncion Cano, Bernardino Ojeda, Rolando Paredes, Maria del Carmen Sandweiss, and Michael D. Glascock

1998 Quebrada Jaguay: Early South American Maritime Adaptations. *Science* 281:1830–1832.

Sanford, Malcom T.

2008 Florida's Climate and Its Beekeeping. Florida Cooperative Extension Service Document ENY-134, Institute of Food and Agricultural Sciences, University of Florida, Gainesville.

Sanger, Matthew C., and David Hurst Thomas

2010 The Two Rings of St. Catherines Island: Some Preliminary Results from the St. Catherines and McQueen Shell Rings. In *Trend, Tradition, and Turmoil: What Happened to the Southeastern Archaic?*, D.H. Thomas and M.C. Sanger eds., pp. 45–69. Anthropological Papers No. 93, American Museum of Natural History, New York.

Sanoja, Mario, and Iraida Vargas Arenas

1999 Early Modes of Life of the Indigenous Population of Northeastern Venezuela. In *Archaeology in Latin America*, B. Alberti and G.G. Politis, eds., pp. 146–166. Routledge, New York.

Sassaman, Kenneth E., Andrea Palmiotto, Ginessa Mahar, Micah P. Mones, and Paulette S. McFadden

2012 *Archaeological Investigations at Shell Mound (8LV42), Levy County, Florida:2012 Testing.* Technical Report 16, University of Florida Laboratory of Southeastern Archaeology, Gainesville.

Saunders, Rebecca

2004 The Stratigraphic Sequence at the Rollins Shell Ring: Implications for Ring Function. *Florida Anthropologist* 57:249–268.

Saunders, Rebecca, and James B. Stoltman

1999 A Multidimensional Consideration of Complicated Stamped Pottery Production in Southern Louisiana. *Southeastern Archaeology* 18(1):1–23.

Scarry, C. Margaret

2003 Food Plant Remains from Excavations in Mound A, B, C, D, and L at Bottle Creek. In *Bottle Creek: A Pensacola Culture Site in South Alabama*, I.W. Brown, ed., pp. 103–113. University of Alabama Press, Tuscaloosa.

Schmid, Elisabeth

1972 *Atlas of Animal Bones for Prehistorians, Archaeologists, and Quaternary Geologists*. Elsevier, Amsterdam.

Schroeder, William W.

1978 Riverine Influences on Estuaries: A Case Study. In *Estuarine Interactions*, M.L. Wiley, ed., pp. 347–364. Academic Press, New York.

Schroeder, William W., and William J. Wiseman, Jr.

1999 Geology and Hydrodynamics of Gulf of Mexico Estuaries. In *Biogeochemistry of Gulf of Mexico Estuaries*, T.S. Bianchi, J.R. Pennock, and R.R. Twilley, eds., pp. 3–30. John Wiley & Sons, New York.

Scott-Denton, Elizabeth, Pat F. Cryer, Matt R.Duffy, Judith Gocke, Mike R. Harrelson, Donna L. Kinsella, James M. Nance, Jeff R. Pulver, Rebecca C. Smith, and Jo A. Williams

2012 Characterization of the U.S. Gulf of Mexico and South Atlantic Penaeid and Rock Shrimp Fisheries Based on Observer Data. *Marine Fisheries Review* 74(4):1–26.

Scott-Denton, Elizabeth, Jo A. Williams, and Jeffrey R. Pulver, J.R.

2014 Observer Coverage of the 2014 Gulf of Mexico Skimmer Trawl Fishery. NOAA Technical Memorandum NMFS-SEFSC- 666.

Scudder, Sylvia J.

1993 *Human Influence on Pedogenesis: Midden Soils on a Southwest Florida Pleistocene Dune Island.* M.S. thesis, University of Florida, Gainesville.

Seeman, Mark F.

1995 When Words are Not Enough: Hopewell Interegionalism and the Use of Material Symbols at the GE Mound. In *Native American Interactions: Multiscalar Analyses and Interpretation in the Eastern Woodlands*, M.S. Nassaney and K.E. Sassaman, eds., pp. 122–143. University of Tennessee Press, Knoxville.

Shaklee, James B., and Paul Bentzen

1998 Genetic Identification of Stocks of Marine Fish and Shellfish. *Bulletin of Marine Science* (62)2:589–621.

Shalack, Jacob, Alan Power, and Randal L. Walker

2011 *Whelk Pot Trapping and its Implications for Inshore Fisheries Development in Coastal Georgia.* Occasional Papers of the University of Georgia Marine Extension Service Vol. 10. Marine Extension Service, University of Georgia, Shellfish Research Laboratory, Savannah.

Shannon, Claude E.

1948 A Mathematical Theory of Communication. *Bell System Technical Journal* 27:379–432, 623–656.

Shannon, Claude E., and Warren Weaver

1949 *The Mathematical Theory of Communication*. University of Illinois Press, Urbana.

Sheldon, Andrew L.

1969 Equitability Indices: Dependence on the Species Count. *Ecology* 50:466–7.

Shepard, Francis Parker, and Harold Rollin Wanless

1971 *Our Changing Coastlines.* McGraw-Hill, New York.

Sheppard, Charles

1995 The Shifting Baseline Syndrome. *Marine Pollution Bulletin* 30(12):766–767.

Shipman, Pat, and Jennie Rose

1983 Early Hominid Hunting, Butchering, and Carcass-Processing Behaviors: Approaches to the Fossil Record. *Journal of Anthropological Archaeology* 2:57–98.

Shotwell, J. Arnold

1955 An Approach to the Paleoecology of Mammals. *Ecology* 36(2):327–37.

Silliman, Brian R., and Steven Y. Newell

2003 Fungal Farming in a Snail. *Proceedings of the National Academy of Sciences* 100(26):15643–15648.

Simpson, George Gaylord, Anne Roe, and Richard C. Lewontin

1960 *Quantitative Zoology*. Harcourt, Brace, and Co., New York.

Simpson, Robert H., and Herbert Riehl

1981 *The Hurricane and Its Impact*. Louisiana State University Press, Baton Rouge.

Slater, Philip A., Kristin M. Hedman, and Thomas E. Emerson

2014 Immigrants at the Mississippian Polity of Cahokia: Strontium Isotope Evidence for Population Movement. *Journal of Archaeological Science* 44:117–127.

Smith, Betty A.

1979 The Hopewell Connection in Southwest Georgia. In *Hopewell Archaeology: The Chillicothe Conference,* D.S. Brose and N. Greber, eds., pp. 181–187. Kent State University Press, Kent.

Smith, Bruce D.

2006 Eastern North America as an Independent Center of Plant Domestication. *Proceedings of the National Academy of Sciences* 103(33):12223–12228.

Smith, Eric Alden, and Bruce Winterhalder

1992 Natural Selection and Decision Making: Some Fundamental Principles. In *Evolutionary Ecology and Human Behavior,* E.A. Smith and B. Winterhalder, eds., pp. 25–60. Aldine de Gruyter, New York.

Smith, Karen Y.

2014 Woodland Period Chronology in the Apalachicola and the Lower Chattahoochee River Valleys. *Southeastern Archaeological Conference Bulletin* 57:91.

Smith, W. Everett

1988 *Geomorphology of the Mobile Delta*. Geological Survey of Alabama Bulletin No. 132.

Southeast Archeological Center (SEAC)

2015 Lab Files: Radiocarbon Master File 2015. Electronic document. Southeast Archeological Center, Tallahassee.

Spielmann, Katherine, and Keith Kintigh

2011 The Digital Archaeological Record: The Potentials of Archaeozoological Data Integration through tDAR. *The SAA Archaeological Record* 11(1):22–25.

Spier, Robert F.G.

1970 *From the Hand of Man: Primitive and Preindustrial Technologies*. Houghton Mifflin, Boston.

Steele, John H.

1998 Regime Shifts in Marine Ecosystems. *Ecological Applications* 8(1) Supplement: S33–S36.

Stephenson, Keith, Judith A. Bense, and Frankie Snow

2002 Aspects of Deptford and Swift Creek of the South Atlantic and Gulf Coastal Plains. In *The Woodland Southeast,* D.G. Anderson and R.C. Mainfort Jr., eds, pp. 318–351. University of Alabama Press, Tuscaloosa.

Stephenson, Sarah P., Nancy E. Sheridan, Stephen P. Geiger, and William S. Arnold

2013 Abundance and Distribution of Large Marine Gastropods in Nearshore Seagrass Beds Along the Gulf Coast of Florida. *Journal of Shellfish Research* 32(2):305–313.

Stevens, Rhiannon E., Adrian M. Lister and Robert E. M. Hedges

2006 Predicting Diet, Trophic Level and Palaeoecology from Bone Stable Isotope Analysis: A Comparative Study of Five Red Deer Populations. *Oecologia* 149(1):12–21.

Steward, Julian Haynes

1955 *Theory of Culture Change: The Methodology of Multilinear Evolution*. University of Illinois Press, Chicago.

Stewart, Richard A., and Donn S. Gorsline

1962 Recent Sedimentary History of St. Joseph Bay, Florida. *Sedimentology* 1:256–286.

Struever, Stuart

1964 The Hopewell Interaction Sphere in Riverine–Western Great Lakes Culture History. In *Hopewellian Studies*, J. Caldwell and R.L. Hall, eds., pp. 86–106. Illinois State Museum Scientific Papers No. 12, Springfield.

1968 Woodland Subsistence-Settlement Systems in the Lower Illinois Valley. In *New Perspectives in Archaeology*, S.R Binford and L.R. Binford, eds., pp. 285–312. Aldine Publishing, Chicago.

Surge, Donna, K.C. Lohmann, and David L. Dettman

2001 Controls on Isotopic Chemistry of the American Oyster, *Crassostrea virginica*: Implications for Growth Patterns. *Palaeogeography, Palaeoclimatology, Palaeoecology* 172:283–296.

Surge, Donna, and Karen Jo Walker

2005 Oxygen Isotope Composition of Modern and Archaeological Otoliths from the Estuarine Hardhead Catfish (*Ariopsis felis*) and their Potential to Record Low-Latitude Climate Change. *Palaeogeography, Palaeoclimatology, Palaeoecology* 228:179–191.

Svendsen, Ib A.

2006 *Introduction to Nearshore Hydrodynamics.* World Scientific Printers, Singapore.

Swanton, John R.

1911 *Indian Tribes of the Lower Mississippi Valley and Adjacent Coast of the Gulf of Mexico.* Bureau of American Ethnology, Bulletin 43. U.S. Government Printing Office, Washington, D.C.

Szabó, Katherine, and Judith R. Amesbury

2011 Molluscs in a World of Islands: The Use of Shellfish as a Food Resource in the Tropical Island Asia-Pacific region. *Quaternary International* 239(1):8–18.

Tanner, William F.

2000 Beach Ridge History, Sea Level Change, and the A.D. 536 Event. In *The Years Without Summer: Tracing A.D. 536 and Its Aftermath*, J.D. Gunn, ed., pp. 89–97. Archaeopress, Oxford.

Tesar, Louis Daniel

1980 *The Leon County Bicentennial Survey Report: An Archaeological Survey of Selected Portions of Leon County, Florida.* No. 49. Bureau of Historic Sites and Properties, Division of Archives, History and Records Management, Florida Department of State, Tallahassee.

Thomas, David Hurst

1971 On Distinguishing Natural from Cultural Bone in Archaeological Sites. *American Antiquity* 36(3):366–371.

2008a *Native American Landscapes of St. Catherines Island, Georgia I. The Theoretical Framework.* Anthropological Papers No. 88, American Museum of Natural History, New York.

2008b *Native American Landscapes of St. Catherines Island, Georgia III. Synthesis and Implications.* Anthropological Papers No. 88, American Museum of Natural History, New York.

2014 The Shellfishers of St. Catherines Island: Hardscrabble Foragers or Farming Beachcombers? *Journal of Island and Coastal Archaeology* 9(2):169–182.

Thomas, Prentice, M., and Janice L. Campbell

1993 *Eglin Air Force Base Historic Preservation Plan.* New World Research, Inc. Report of Investigations No. 192. Prepared for National Park Service, Southeast Region (CX5000-2-0497). Submitted to Eglin Air Force Base by New World Research, Fort Walton, Florida.

Thompson, Victor D.

2007 Articulating Activity Areas and Formation Processes at the Sapelo Island Shell Ring Complex. *Southeastern Archaeology* 26:91–107.

2013 Whispers on the Landscape. In *The Archaeology and Historical Ecology of Small Scale Economies*, V.D. Thompson and J.C. Waggoner, Jr., eds., pp. 1–16. University Press of Florida, Gainesville.

Thompson, Victor D., and C. Fred T. Andrus

2011 Evaluating Mobility, Monumentality, and Feasting at the Sapelo Island Shell Ring Complex. *American Antiquity* 76:315–343.

Thompson, Victor D., and John A. Turck

2009 Adaptive Cycles of Coastal Hunter-Gatherers. *American Antiquity* 74(2):255–278.

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.

Trinkley, Michael

1985 The Form and Function of South Carolina’s Early Woodland Shell Rings. In *Structure and Process in Southeastern Archaeology*, R.S. Dickens, Jr., and T. Ward, eds, pp. 102–118. University of Alabama Press, Tuscaloosa.

Trubitt, Mary Beth D.

2000 Mound Building and Prestige Goods Exchange: Changing Strategies in the Cahokia Chiefdom. *American Antiquity* 65:669–690.

2003 The Production and Exchange of Marine Shell Prestige Goods. *Journal of Archaeological Research* 11:243–277.

Turner, B.L. II, Roger E. Kasperson, Pamela A. Matson, James J. McCarthy, Robert W. Corell, Lindsey Christensen, Noelle Eckley, Jeanne X. Kasperson, Amy Luers, Marybeth L. Martello, Colin Polsky, Alexander Pulsipher, and Andrew Schiller

2003 A Framework for Vulnerability Analysis in Sustainability Science. *Proceedings of the National Academy of Science* 100(14):8074–8079.

Tuross, Noreen, Marilyn L. Fogel, Lee Newsom, and Glen H. Doran

1994 Subsistence in the Florida Archaic: The Stable Isotope and Archaeobotanical Evidence from the Windover Site. *American Antiquity* 59(2):288–303.

Tveskov, Mark A., and Jon M. Erlandson

2003 The Haynes Inlet Weirs: Estuarine Fishing and Archaeological Site Visibility on the Southern Cascadia Coast. *Journal of Archaeological Science* 30:1023–1035.

Uhle, M.

1907 The Emeryville Shellmound. *University of California Publications in American Archaeology and Ethnology* 7:1–106.

United States Geological Survey (USGS)

1998 National Water Quality Assessment Program: Mobile River Basin. USGS Fact Sheet FS–100–98.

2005 Preliminary Integrated Geologic Map Databases for the United States: Alabama, Florida, Georgia, Mississippi, North Carolina, and South Carolina. USGS Open-File Report 2005-1323.

van de Water, Peter K., Steven W. Leavitt, and Julio L. Betancourt

2002 Leaf δ^{13}C Variability with Elevation, Slope Aspect, and Precipitation in the Southwest United States. *Oecologia* 132:332–343.

Vince, Susan W., Stephen R. Humphrey, and Robert W. Simons

1989 The Ecology of Hydric Hammocks: A Community Profile. Simons. Biological Report 85(7.26). U.S. Fish and Wildlife Service, Washington, D.C.

Walker, Brian, C.S. Holling, Stephen R. Carpenter, and Ann Kinzig

2004 Resilience, Adaptability and Transformability in Social–Ecological Systems. *Ecology and Society* 9(2):5.

Walker, Karen Jo

1992 The Zooarchaeology of Charlotte Harbor's Prehistoric Maritime Adaptation: Spatial and Temporal Perspectives. In *Culture and Environment in the Domain of the Calusa*, W.H. Marquardt, ed., pp. 265–366. University of Florida Institute of Archaeology and Paleoenvironmental Studies Monograph 1, University of Florida, Gainesville.

2000 The Material Culture of Precolumbian Fishing: Artifacts and Fish Remains from Coastal Southwest Florida. *Southeastern Archaeology* 19(1):24–45.

2013 The Pineland Site Complex: Environmental Contexts. In *The Archaeology of Pineland: A Coastal Southwest Florida Site Complex, A.D. 50–1710*, W.H.Marquardt and K.J. Walker, eds., pp. 23–52. University of Florida Institute of Archaeology and Paleoenvironmental Studies Monograph 4, University of Florida, Gainesville.

Walker, Randal L., Alan J. Power, Mary Sweeney-Reeves, Ellie Covington, Marcy Mitchell and Todd Recicar

2008 *Growth, Migration, Population Structure, and Sex Ratio of Four Whelk Species (Family Melongenidae) within Wassaw Sound, Georgia.* Occasional Papers of the University of Georgia Marine Extension Service Vol. 1. Marine Extension Service, University of Georgia, Shellfish Research Laboratory, Savannah.

Wallis, Neill J.

2011 *The Swift Creek Gift: Vessel Exchange on the Atlantic Coast.* University of Alabama Press, Tuscaloosa.

Walthall, John A.

1980 *Prehistoric Indians of the Southeast.* University of Alabama Press, Tuscaloosa.

Waples, R.S.

1998 Separating the Wheat from the Chaff: Patterns of Genetic Differentiation in High Gene Flow Species. *Journal of Heredity* 89:438–450.

Ward, H. Trawick, and R.P. Stephen Davis, Jr.

1993 *Indian Communities on the North Carolina Piedmont, A.D. 1000 to 1700*. Research Laboratories of Anthropology, University of North Carolina, Chapel Hill.

Waring, Antonio J., and Lewis H. Larson

1968 The Shell Ring on Sapelo Island. In *The Waring Papers: The Collected Works of Antonio J. Waring Jr.,* S.B. Williams, ed., pp. pp. 263–278. Papers of the Peabody Museum of Archaeology and Ethnology, No. 58, Harvard University, Cambridge, Massachusetts.

Waselkov, Gregory A.

1987 Shellfish Gathering and Shell Midden Archaeology. In *Advances in Archaeological Method and Theory* Vol. 10, M.B. Schiffer, ed., pp. 93–210. Academic Press, New York.

2012 Making a Case for Coastal Subsistence Seasonality. In *Seasonality and Subsistence along the Georgia Bight*, E.J. Reitz, I.R. Quitmyer, and D.H. Thomas, eds., pp. 199–206. Anthropological Papers No. 97, American Museum of Natural History, New York.

Wessen, Gary C.

2005 Subsistence Patterns as Reflected by Invertebrate Remains Recovered at the Ozette Site. In *Ozette Archaeological Project Research Reports, Volume II, Fauna*. Report of Investigations 66. R. Stephan, ed., pp. 93–196. Department of Anthropology, Washington State University, Pullman.

Wheeler, Alwyne, and Andrew K.G. Jones

1989 *Fishes*. Cambridge University Press, Cambridge.

Whitaker, Adrian

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.

Whitaker, J. David, John W. McCord, Blaik Pulley, and Elizabeth H. Mullins

2009 Best Management Practices for Wildlife in Maritime Forest Developments. South Carolina Department of Natural Resources, Columbia.

White, Christine D., and Henry P. Schwarcz

1989 Ancient Maya Diet: As Inferred from Isotopic and Chemical Analysis of Human Bone. *Journal of Archaeological Science* 16:451–474.

White, Nancy M.

1994 Archaeological Investigations at Six Sites in the Apalachicola River Valley, Northwest Florida. National Oceanic and Atmospheric Administration Technical Memorandum, NOSSRD 26. U.S. Department of the Interior, Washington, D.C.

2004 Late Archaic Fisher-Foragers in the Apalachicola–Lower Chattahoochee Valley, Northwest Florida–South Georgia/Alabama. In *Signs of Power: The Rise of Cultural Complexity in the Southeast,* J.L. Gibson and P.J. Carr, eds, pp. 10–25. University of Alabama Press, Tuscaloosa.

2005 Discontinuities, Common Foundations, Short-Distance Interactions, and Sporadic Long-Distance Connections around the Gulf of Mexico. In *Gulf Coast Archaeology: The Southeastern United States and Mexico,* N.M. White, ed., pp. 304–319. University Press of Florida, Gainesville.

2014 Apalachicola Valley Riverine, Estuarine, Bayshore, and Saltwater Shell Middens. *Florida Anthropologist* 67:77–104.

White, Theodore E.

1953 Observations on the Butchering Techniques of Some Aboriginal Peoples No. 2. *American Antiquity* 19(2):160–4.

Widmer, Randolph J.

1988 *The Evolution of the Calusa: A Nonagricultural Chiefdom on the Southwest Florida Coast*. University of Alabama Press, Tuscaloosa.

2004 Sociopolitical Complexity in Foraging Adaptations of the Southeast. In *Signs of Power: The Rise of Cultural Complexity in the Southeast*, J.L. Gibson and P.J. Carr, eds., pp. 234–253. University of Alabama Press, Tuscaloosa.

2005 A New Look on the Gulf Coast Formative. In *Gulf Coast Archaeology: The Southeastern United States and Mexico,* N.M. White, ed., pp. 68–86. University Press of Florida, Gainesville.

Wiegert, Richard G., and Byron J. Freeman

1990 Tidal Salt Marshes if the Southeast Atlantic Coast: A Community Profile. Biological Report 85(7.29). U.S. Fish and Wildlife Service, Washington, D.C.

Wiessner, Polly

1996 Leveling the Hunter: Constraints on the Status Quest in Foraging Societies. In *Food and the Status Quest: An Interdisciplinary Perspective,* P. Wiessner and W. Schiefenhövel, ed., pp. 171–192. Berghahn Books, Providence.

Wilbur, A.E., S. Seyou, T.M. Bert, and W.S. Arnold

2005 A Genetic Assessment of Bay Scallop (*Argopecten irradians*) Restoration Efforts in Florida's Gulf of Mexico Coastal Waters (USA). *Conservation Genetics* 6:111–122.

Wilk, Richard

1999 "Real Belizean Food:" Building Local Identity in the Transnational Caribbean. *American Anthropologist* 101(2):244–255.

Willey, Gordon R.

1949 *Archeology of the Florida Gulf Coast*. Smithsonian Miscellaneous Collections Vol. 113. Washington, D.C.

1971 *Introduction to American Archaeology 1: North and Middle America.* Prentice-Hall, Englewood Cliffs, New Jersey.

Wing, Elizabeth S.

1977 Subsistence Systems in the Southeast. *Florida Anthropologist* 30:81–87.

Wing, Elizabeth S., and Antoinette B. Brown

1979 *Paleonutrition: Method and Theory in Prehistoric Foodway*s. Academic Press, New York.

Wing, Elizabeth S., and Stephen R. Wing

2001 Prehistoric Fisheries in the Caribbean. *Coral Reefs* 20:1–8.

Winterhalder, Bruce, and Eric Alden Smith

2000 Analyzing Adaptive Strategies: Human Behavioral Ecology at Twenty-Five. *Evolutionary Anthropology Issues News and Reviews* 9(2):51–72.

Wright, Lori E.

2005 Identifying Immigrants to Tikal, Guatemala: Defining Local Variability in Strontium Isotope Ratios of Human Tooth Enamel. *Journal of Archaeological Science* 32:555–566.

Wüst, Irmhild, and Cristiana Barreto

1999 The Ring Villages of Central Brazil: A Challenge for Amazonian Archaeology. *Latin American Antiquity* 10(1):3–23.

Yarbro, Laura A., and Paul R. Carlson, Jr.

2013 *Seagrass Integrated Mapping and Monitoring for the State of Florida Mapping and Monitoring* Report No. 1. Fish and Wildlife Research Institute Technical Report TR-17.

Yellen, John E.

1977 *Archaeological Approaches to the Present: Models for Reconstructing the Past*. Vol. 1. Academic Press, New York.

Yesner, David R.

1980 Maritime Hunter–Gatherers: Ecology and Prehistory. *Current Anthropology* 21:727–750.

Yokel, Bernard James

1966 *A Contribution to the Biology and Distribution of the Red Drum,* Sciaenops ocellata. Ph.D. dissertation, University of Miami.

Yost, Chad, and Linda Scott Cummings

2012 Ceramic Residue Analysis and Radiocarbon Dating of Ceramic Residue from Site 8BY1347, Florida. PaleoResearch Institute Technical Report 12-110, Prepared for Southeast Archaeological Center Tallahassee.

Zayas, Cynthia

2011 Describing Stewardship of the Common Sea among *Atob* Fishers of the Pacific Rim Islands–Cases from the Philippines, Taiwan, and Japan. *South Pacific Studies* 31(2):71–80.

Zedeño, Maria Nieves

2013 To Become a Mountain Hunter: Flexible Core Values and Subsistence Hunting among Reservation-Era Blackfeet. In *The Archaeology and Historical Ecology of Small Scale Economies*, V.D. Thompson and J.C. Waggoner, Jr., eds., pp. 141–166. University Press of Florida, Gainesville.

Zhou, Shijie, Anthony D.M. Smith, Andre E. Punt, Anthony J. Richardson, Mark Gibbs, Elizabeth A. Fulton, Sean Pascoe, Catherine Bulman, Peter Bayliss, and Keith Sainsbury

2010 Ecosystem-based Fisheries Management Requires a Change to the Selective Fishing Philosophy. *Proceedings of the National Academy of Sciences* 107(21):9485–9489.

Zhou, Shijie, Anthony D.M. Smith, and E. Eric Knudsen

2015 Ending Overfishing while Catching More Fish. *Fish and Fisheries* 16:716–722.

Appendix A. Faunal Samples Studied.

Site	P#	FS#	Unit	Level	Zone	Screen size	Harrison Table 4.2	HH Early Table 4.9	HH House Table 4.13	HH Late Table 4.17	HH Aggregated (3.18 mm) Table 4.21	HH Aggregated (6.35 mm) Table 4.23
8BY1359	—	195	EU 34	1	—	1/4"& 1/8"	x					
8BY1359	—	196	EU 34	3	B	1/4"& 1/8"	x					
8BY1359	—	344	EU 34	3	C	1/4"& 1/8"	x					
8BY1359	—	238	EU 34	5	C	1/4"& 1/8"	x					
8BY1347	19	62	EU 4	5	—	1/4"		x			x	x
8BY1347	19	63	EU 4	5	—	1/8"		x			x	
8BY1347	37	93	EU 5	4	3	1/4"			x		x	x
8BY1347	37	94	EU 5	4	3	1/8"			x		x	
8BY1347	44	112	EU 5	5	3	1/4"			x		x	x
8BY1347	44	113	EU 5	5	3	1/8"			x		x	
8BY1347	63	167	EU 6	3	—	1/4"				x	x	x
8BY1347	63	168	EU 6	3	—	1/8"				x	x	
8BY1347	16	53	EU 4	2	—	1/4"				x	x	x
8BY1347	16	54	EU 4	2	—	1/8"				x	x	
8BY1347	80	223	EU 8	4		1/4"						x
8BY1347	82	229	EU 8	6		1/4"						x
8BY1347	83	231	EU 9	1		1/4"						x
8BY1347	87	243	EU 9	5		1/4"						x
8BY1347	91	255	EU 10	4		1/4"						x
8BY1347	66	176	EU 6	4		1/4"						x
8BY1347	93	261	EU 10	6		1/4"						x
8BY1347	94	264	EU 10	7		1/4"						x
8BY1347	102	280	EU 12	4		1/4"						x
8BY1347	103	283	EU 12	5		1/4"						x
8BY1347	105	289	EU 12	7		1/4"						x
8BY1347	101	277	EU 12	3		1/4"						x

Notes: HH = Hare Hammock; EU = Excavation Unit.

Appendix B. 8By1359 Harrison Ring Midden: Measurements.

Taxon	**GMNH#**	**Element**	**Dimension**	**mm**	**Dimension**	**mm**
Strombus alatus	2660106	Complete	SH	75.15	LT	—
Strombus alatus	2660106	Complete	SH	90.55	LT	2.97
Strombus alatus	2660106	Complete	SH	81.15	LT	4.43
Strombus alatus	2660106	Complete	SH	79.45	LT	4.37
Strombus alatus	2660106	Complete	SH	88.24	LT	4.88
Strombus alatus	2660106	Complete	SH	84.50	LT	4.24
Strombus alatus	2660106	Complete	SH	85.67	LT	—
Strombus alatus	2660106	Complete	SH	80.01	LT	6.15
Strombus alatus	2660106	Complete	SH	93.53	LT	4.87
Strombus alatus	2660106	Complete	SH	—	LT	5.02
Strombus alatus	2660106	Complete	SH	86.08	LT	2.97
Strombus alatus	2660106	Complete	SH	—	LT	3.99
Strombus alatus	2660106	Complete	SH	85.78	LT	—
Strombus alatus	2660106	Complete	SH	79.31	LT	—
Busycotypus spiratus	2660101	Complete	SH	54.62		
Busycotypus spiratus	2660101	Complete	SH	68.93		
Busycotypus spiratus	2660101	Complete	SH	80.17		
Busycotypus spiratus	2660101	Complete	SH	68.97		
Busycotypus spiratus	2660101	Complete	SH	70.27		
Busycotypus spiratus	2660101	Complete	SH	104.99		
Busycotypus spiratus	2660101	Complete	SH	76.91		
Busycotypus spiratus	2660101	Complete	SH	86.52		
Busycotypus spiratus	2660101	Complete	SH	72.24		
Busycon sinistrum	2660156	Nearly complete	Min SH	136.31		
Busycon sinistrum	2660131	Nearly complete	Min SH	73.54		
Busycon sinistrum	2660131	Complete	SH	68.70		
Busycon sinistrum	2660131	Nearly complete	Min SH	65.22		
Busycon sinistrum	2660131	Nearly complete	Min SH	98.51		
Busycon sinistrum	2660131	Nearly complete	Min SH	104.55		
Busycon sinistrum	2660107	Nearly complete	Min SH	80.70		
Busycon sinistrum	2660131	Nearly complete	Min SH	87.75		
Busycon sinistrum	2660052	Nearly complete	Min SH	225.00		
Busycon sinistrum	2660052	Nearly complete	Min SH	138.73		
Busycon sinistrum	2660052	Nearly complete	Min SH	65.03		
Busycon sinistrum	2660052	Nearly complete	Min SH	54.45		
Busycon sinistrum	2660052	Nearly complete	Min SH	85.99		
Busycon sinistrum	2660052	Nearly complete	Min SH	122.65		
Busycon sinistrum	2660107	Nearly complete	Min SH	95.15		
Busycon sinistrum	2660107	Nearly complete	Min SH	70.45		
Busycon sinistrum	2660052	Nearly complete	Min SH	127.73		
Busycon sinistrum	2660107	Complete	SH	66.68		
Busycon sinistrum	2660107	Nearly complete	Min SH	139.63		
Busycon sinistrum	2660107	Nearly complete	Min SH	139.82		
Busycon sinistrum	2660107	Nearly complete	Min SH	161.00		
Busycon sinistrum	2660107	Nearly complete	Min SH	126.73		
Busycon sinistrum	2660107	Nearly complete	Min SH	85.11		
Busycon sinistrum	2660107	Complete	SH	111.09		
Busycon sinistrum	2660107	Nearly complete	Min SH	100.41		
Busycon sinistrum	2660107	Complete	SH	77.24		

Appendix B. 8By1359 Harrison Ring Midden: Measurements. (cont.)

Taxon	**GMNH#**	**Element**	**Dimension**	**mm**	**Dimension**	**mm**
Busycon sinistrum	2660107	Nearly complete	Min SH	96.06		
Busycon sinistrum	2660107	Nearly complete	Min SH	65.01		
Busycon sinistrum	2660107	Complete	SH	78.42		
Busycon sinistrum	2660107	Complete	SH	80.04		
Busycon sinistrum	2660107	Nearly complete	Min SH	92.55		
Busycon sinistrum	2660107	Complete	SH	96.53		
Busycon sinistrum	2660107	Nearly complete	Min SH	76.20		
Busycon sinistrum	2660107	Nearly complete	Min SH	88.53		
Busycon sinistrum	2660107	Nearly complete	Min SH	80.70		
Busycon sinistrum	2660107	Nearly complete	Min SH	86.58		
Busycon sinistrum	2660107	Nearly complete	Min SH	74.11		
Busycon sinistrum	2660107	Nearly complete	Min SH	116.90		
Busycon sinistrum	2660107	Nearly complete	Min SH	67.39		
Busycon sinistrum	2660107	Nearly complete	Min SH	75.33		
Busycon sinistrum	2660107	Nearly complete	Min SH	90.82		
Busycon sinistrum	2660107	Nearly complete	Min SH	84.19		
Busycon sinistrum	2660107	Nearly complete	Min SH	60.79		
Busycon sinistrum	2660107	Nearly complete	Min SH	56.42		
Busycon sinistrum	2660107	Nearly complete	Min SH	85.39		
Busycon sinistrum	2660107	Nearly complete	Min SH	82.94		
Busycon sinistrum	2660107	Nearly complete	Min SH	111.59		
Busycon sinistrum	2660107	Complete	SH	66.91		
Busycon sinistrum	2660107	Nearly complete	Min SH	77.57		
Busycon sinistrum	2660107	Nearly complete	Min SH	114.80		
Busycon sinistrum	2660107	Nearly complete	Min SH	56.56		
Busycon sinistrum	2660107	Nearly complete	Min SH	44.34		
Busycon sinistrum	2660107	Nearly complete	Min SH	53.16		
Busycon sinistrum	2660107	Nearly complete	Min SH	51.21		
Melongena corona	2660099	Complete	SH	74.20		
Fasciolaria lilium	2660102	Complete	SH	57.44		
Fasciolaria tulipa	2660103	Complete	SH	70.97		
Fasciolaria tulipa	2660103	Complete	SH	69.68		
Fasciolaria tulipa	2660103	Complete	SH	61.45		
Fasciolaria tulipa	2660103	Complete	SH	62.13		
Pleuroploca gigantea	2660100	Complete	SH	129.50		
Argopecten spp.	2660084	Valve, lt	VH	50.57		
Argopecten spp.	2660084	Valve, lt	VH	54.83		
Argopecten spp.	2660084	Valve, lt	VH	65.83		
Argopecten spp.	2660084	Valve, lt	VH	49.46		
Argopecten spp.	2660084	Valve, lt	VH	44.74		
Argopecten spp.	2660084	Valve, lt	VH	48.47		
Argopecten spp.	2660084	Valve, lt	VH	43.37		
Argopecten spp.	2660084	Valve, rt	VH	47.96		
Argopecten spp.	2660084	Valve, rt	VH	57.54		
Argopecten spp.	2660084	Valve, rt	VH	42.88		
Argopecten spp.	2660084	Valve, rt	VH	—		
Argopecten spp.	2660084	Valve, rt	VH	33.79		
Argopecten spp.	2660084	Valve, rt	VH	42.58		
Argopecten spp.	2660084	Valve, rt	VH	43.37		

Appendix B. 8By1359 Harrison Ring Midden: Measurements. (cont.)

Taxon	GMNH#	Element	Dimension	mm	Dimension	mm
Argopecten spp.	2660084	Valve, rt	VH	49.82		
Ariopsis felis	2660203	Pectoral spine, lt	Wdh	3.23		
Ariopsis felis	2660203	Pectoral spine, lt	Wdh	4.24		
Ariopsis felis	2660203	Pectoral spine, lt	Wdh	3.38		
Ariopsis felis	2660203	Pectoral spine, lt	Wdh	3.66		
Ariopsis felis	2660203	Pectoral spine, lt	Wdh	2.41		
Ariopsis felis	2660203	Pectoral spine, lt	Wdh	6.77		
Ariopsis felis	2660203	Pectoral spine, rt	Wdh	3.25		
Ariopsis felis	2660203	Pectoral spine, rt	Wdh	3.18		
Ariopsis felis	2660203	Pectoral spine, rt	Wdh	3.39		
Ariopsis felis	2660203	Pectoral spine, rt	Wdh	2.56		
Ariopsis felis	2660186	Pectoral spine, lt	Wdh	3.29		
Ariopsis felis	2660203	Pectoral spine, rt	Wdh	3.82		
Ariopsis felis	2660186	Pectoral spine, rt	Wdh	5.39		
Ariopsis felis	2660186	Pectoral spine, rt	Wdh	3.31		
Opsanus spp.	2660021	Atlas	Wdh	3.13		
Opsanus spp.	2660205	Atlas	Wdh	4.35		
Opsanus spp.	2660205	Atlas	Wdh	4.04		
Opsanus spp.	2660205	Atlas	Wdh	3.07		
Opsanus spp.	2660205	Atlas	Wdh	2.96		
Opsanus spp.	2660205	Atlas	Wdh	3.46		
Opsanus spp.	2660205	Atlas	Wdh	1.80		
Opsanus spp.	2660205	Atlas	Wdh	2.42		
Opsanus spp.	2660205	Atlas	Wdh	2.53		
Opsanus spp.	2660137	Atlas	Wdh	3.09		
Opsanus spp.	2660167	Atlas	Wdh	5.39		
Mugil spp.	2660202	Atlas	Wdh	5.77		
Mugil spp.	2660202	Atlas	Wdh	3.37		
Mugil spp.	2660080	Atlas	Wdh	5.83		
Mugil spp.	2660080	Atlas	Wdh	5.07		
Cyprinodontidae	2660037	Atlas	Wdh	2.49		
Cyprinodontidae	2660206	Atlas	Wdh	2.32		
Cyprinodontidae	2660206	Atlas	Wdh	2.11		
Coryphaena spp.	2660042	Atlas	Wdh	3.96		
Caranx crysos	2660078	Atlas	Wdh	4.26		
Orthopristis chrysoptera	2660211	Atlas	Wdh	4.11		
Orthopristis chrysoptera	2660211	Atlas	Wdh	3.06		
Orthopristis chrysoptera	2660211	Atlas	Wdh	2.88		
Orthopristis chrysoptera	2660211	Atlas	Wdh	2.97		
Orthopristis chrysoptera	2660211	Atlas	Wdh	2.76		
Orthopristis chrysoptera	2660211	Atlas	Wdh	3.63		
Orthopristis chrysoptera	2660211	Atlas	Wdh	2.15		
Orthopristis chrysoptera	2660211	Atlas	Wdh	1.95		
Orthopristis chrysoptera	2660211	Otolith, lt	Len	7.48	Wdh	4.83
Orthopristis chrysoptera	2660211	Otolith, lt	Len	6.99	Wdh	4.09
Orthopristis chrysoptera	2660211	Otolith, rt	Len	7.71	Wdh	4.32
Lagodon rhomboides	2660210	Atlas	Wdh	2.26		
Lagodon rhomboides	2660210	Atlas	Wdh	2.08		
Orthopristis chrysoptera	2660211	Otolith, lt	Len	6.61	Wdh	4.1

Appendix B. 8By1359 Harrison Ring Midden: Measurements. (cont.)

Taxon	GMNH#	Element	Dimension	mm	Dimension	mm
Lagodon rhomboides	2660210	Atlas	Wdh	1.65		
Lagodon rhomboides	2660210	Atlas	Wdh	1.67		
Lagodon rhomboides	2660210	Atlas	Wdh	1.90		
Lagodon rhomboides	2660210	Atlas	Wdh	2.11		
Lagodon rhomboides	2660210	Atlas	Wdh	1.95		
Lagodon rhomboides	2660210	Atlas	Wdh	2.13		
Lagodon rhomboides	2660173	Atlas	Wdh	2.38		
Lagodon rhomboides	2660173	Atlas	Wdh	2.13		
Bairdiella chrysoura	2660212	Otolith, lt, sagitta	Len	6.31	Wdh	4.98
Cynoscion spp.	2660140	Otolith, lt	Len	13.57	Wdh	—
Cynoscion spp.	2660215	Otolith, lt	Len	15.53	Wdh	6.28
Cynoscion spp.	2660215	Otolith, rt	Len	14.64	Wdh	6.51
Cynoscion spp.	2660033	Otolith, lt	Len	—	Wdh	5.86
Cynoscion nebulosus	2660068	Atlas	Wdh	7.89		
Cynoscion nebulosus	2660068	Atlas	Wdh	5.64		
Cynoscion nebulosus	2660068	Otolith, rt	Len	21.46	Wdh	7.82
Cynoscion nebulosus	2660068	Otolith, rt	Len	16.29	Wdh	7.1
Cynoscion nebulosus	2660068	Otolith, rt	Len	—	Wdh	6.57
Cynoscion nebulosus	2660214	Atlas	Wdh	2.62		
Leiostomus xanthurus	2660172	Atlas	Wdh	3.14		
Leiostomus xanthurus	2660213	Atlas	Wdh	2.92		
Leiostomus xanthurus	2660213	Atlas	Wdh	2.83		
Leiostomus xanthurus	2660213	Atlas	Wdh	3.24		
Leiostomus xanthurus	2660213	Atlas	Wdh	3.51		
Leiostomus xanthurus	2660213	Atlas	Wdh	1.72		
Leiostomus xanthurus	2660213	Otolith, lt	Len	6.90	Wdh	3.53
Leiostomus xanthurus	2660213	Otolith, rt	Len	7.45	Wdh	3.76
Leiostomus xanthurus	2660036	Atlas	Wdh	3.08		
Micropogonias undulatus	2660190	Otolith, rt	Len	12.67	Wdh	10.42
Micropogonias undulatus	2660216	Atlas	Wdh	3.43		
Micropogonias undulatus	2660216	Otolith, lt	Len	10.90	Wdh	8.03
Micropogonias undulatus	2660216	Otolith, lt	Len	8.14	Wdh	6.15
Micropogonias undulatus	2660216	Otolith, rt	Len	9.21	Wdh	6.89
Micropogonias undulatus	2660216	Otolith, rt	Len	8.01	Wdh	6.33
Micropogonias undulatus	2660216	Otolith, rt	Len	8.47	Wdh	5.93
Micropogonias undulatus	2660216	Otolith, rt	Len	8.18	Wdh	6.38
Micropogonias undulatus	2660023	Otolith, lt	Len	7.58	Wdh	6.12
Pogonias cromis	2660072	Otolith, rt	Len	14.58	Wdh	10.96
Pogonias cromis	2660004	Atlas	Wdh	4.73		
Sciaenops ocellatus	2660071	Otolith, lt	Len	10.53	Wdh	6.23
Sciaenops ocellatus	2660071	Otolith, lt	Len	18.74	Wdh	—

Notes: "Nearly complete" shells are incomplete but at least 75% of the columella length is intact. SH = shell height; Min SH= minimum shell height; LT = lip thickness; VH = valve height; Wdh = width; Len = length. See Figure 3.2 for morphometric landmarks. GMNH# refers to Georgia Museum of Natural History specimen number.

Appendix C. 8By1347 Hare Hammock Measurements.

Taxon	GMNH#	Element	Dimension	mm	Dimension	mm	Dimension	mm	Dimension	mm
Hare Hammock Early										
Strombus alatus	2670287	Complete	SH	83.23						
Strombus alatus	2670287	Complete	SH	82.07						
Strombus alatus	2670287	Complete	SH	92.04						
Strombus alatus	2670287	Complete	SH	83.65						
Strombus alatus	2670287	Complete	SH	71.70						
Strombus alatus	2670287	Complete	SH	80.38						
Strombus alatus	2670287	Complete	SH	83.28						
Strombus alatus	2670287	Complete	SH	81.91						
Strombus alatus	2670287	Complete	SH	80.36						
Strombus alatus	2670287	Complete	SH	80.81						
Strombus alatus	2670287	Complete	SH	74.59						
Strombus alatus	2670287	Complete	SH	79.75						
Strombus alatus	2670287	Complete	SH	73.50	LT	2.25				
Strombus alatus	2670287	Complete	SH	80.04	LT	4.84				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.31				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.53				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.11				
Strombus alatus	2670287	Complete	SH	73.83	LT	—				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.85				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.64				
Strombus alatus	2670287	Complete	SH	78.48	LT	4.7				
Strombus alatus	2670287	Complete	SH	77.86	LT	4.13				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.09				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.72				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.58				
Strombus alatus	2670287	Complete	SH	86.20	LT	—				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	5.42				
Strombus alatus	2670287	Complete	SH	84.87	LT	4.23				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.08				
Strombus alatus	2670287	Complete	SH	80.21	LT	4.45				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.22				
Strombus alatus	2670287	Complete	SH	84.88	LT	—				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	5.31				
Strombus alatus	2670287	Complete	SH	72.11	LT	3.55				
Strombus alatus	2670287	Complete	SH	75.33	LT	—				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.41				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.2				
Strombus alatus	2670287	Complete	SH	76.46	LT	3.46				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.99				
Strombus alatus	2670287	Complete	SH	82.14	LT	4.26				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.68				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.47				
Strombus alatus	2670287	Complete	SH	87.73	LT	4.83				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	2.32				

Appendix C. 8By1347 Hare Hammock Measurements. (cont.)

Taxon	GMNH#	Element	Dimension	mm	Dimension	mm	Dimension	mm	Dimension	mm
Hare Hammock Early (cont.)										
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.5				
Strombus alatus	2670287	Complete	SH	84.86	LT	—				
Strombus alatus	2670287	Complete	SH	87.87	LT	4.7				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.66				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.94				
Strombus alatus	2670287	Complete	SH	71.36	LT	3.46				
Strombus alatus	2670287	Complete	SH	86.20	LT	3.47				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	5.45				
Strombus alatus	2670287	Complete	SH	83.99	LT	6.22				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	5.41				
Strombus alatus	2670287	Complete	SH	79.75	LT	4.32				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.08				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.44				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.06				
Strombus alatus	2670287	Complete	SH	73.87	LT	3.51				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.36				
Strombus alatus	2670287	Complete	SH	75.30	LT	—				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.36				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.67				
Strombus alatus	2670287	Complete	SH	73.47	LT	—				
Strombus alatus	2670287	Complete	SH	73.25	LT	5.2				
Strombus alatus	2670287	Complete	SH	82.35	LT	—				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	5.53				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.1				
Strombus alatus	2670287	Complete	SH	84.25	LT	3.28				
Strombus alatus	2670287	Complete	SH	87.27	LT	—				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.26				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	5.27				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.23				
Strombus alatus	2670287	Complete	SH	74.30	LT	5.83				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.7				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	5.12				
Strombus alatus	2670287	Complete	SH	74.24	LT	4.3				
Strombus alatus	2670287	Complete	SH	82.88	LT	4.24				
Strombus alatus	2670287	Complete	SH	76.91	LT	—				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	5.47				
Strombus alatus	2670287	Complete	SH	79.15	LT	2.57				
Strombus alatus	2670287	Complete	SH	82.23	LT	—				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.85				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.25				
Strombus alatus	2670287	Complete	SH	80.30	LT	3.71				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.27				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.55				
Strombus alatus	2670287	Complete	SH	82.66	LT	3.24				

Appendix C. 8By1347 Hare Hammock Measurements. (cont.)

Taxon	GMNH#	Element	Dimension	mm	Dimension	mm	Dimension	mm	Dimension	mm
Hare Hammock Early (cont.)										
Strombus alatus	2670287	Complete	SH	85.22	LT	4.93				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.36				
Strombus alatus	2670287	Complete	SH	83.18	LT	4.9				
Strombus alatus	2670287	Complete	SH	81.15	LT	4.45				
Strombus alatus	2670287	Complete	SH	78.68	LT	3.86				
Strombus alatus	2670287	Complete	SH	79.64	LT	4.42				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.24				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.97				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.25				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.03				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.17				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.05				
Strombus alatus	2670287	Complete	SH	75.55	LT	2.53				
Strombus alatus	2670287	Complete	SH	77.22	LT	—				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.64				
Strombus alatus	2670287	Complete	SH	80.28	LT	—				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.79				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.4				
Strombus alatus	2670287	Complete	SH	78.42	LT	3.87				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.86				
Strombus alatus	2670287	Complete	SH	85.57	LT	—				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.9				
Strombus alatus	2670287	Complete	SH	76.46	LT	4.49				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.73				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.2				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	2.02				
Strombus alatus	2670287	Complete	SH	79.20	LT	—				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.54				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.09				
Strombus alatus	2670287	Complete	SH	72.90	LT	3.95				
Strombus alatus	2670287	Complete	SH	79.81	LT	—				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	5.1				
Busycotypus spiratus	2670323	Complete	SH	80.70						
Busycon sinistrum	2670318	Nearly complete	Min SH	78.10						
Busycon sinistrum	2670318	Nearly complete	Min SH	110.00						
Busycon sinistrum	2670318	Nearly complete	Min SH	124.80						
Busycon sinistrum	2670318	Nearly complete	Min SH	121.10						
Busycon sinistrum	2670318	Nearly complete	Min SH	113.60						
Busycon sinistrum	2670318	Nearly complete	Min SH	82.20						
Busycon sinistrum	2670318	Nearly complete	Min SH	71.90						
Busycon sinistrum	2670318	Nearly complete	Min SH	86.70						
Busycon sinistrum	2670318	Nearly complete	Min SH	97.10						
Busycon sinistrum	2670318	Nearly complete	Min SH	113.20						
Busycon sinistrum	2670318	Nearly complete	Min SH	101.20						

Appendix C. 8By1347 Hare Hammock Measurements. (cont.)

Taxon	GMNH#	Element	Dimension	mm	Dimension	mm	Dimension	mm	Dimension	mm
Hare Hammock Early (cont.)										
Busycon sinistrum	2670318	Nearly complete	Min SH	89.70						
Busycon sinistrum	2670318	Nearly complete	Min SH	113.70						
Busycon sinistrum	2670318	Nearly complete	Min SH	79.00						
Busycon sinistrum	2670318	Nearly complete	Min SH	140.70						
Busycon sinistrum	2670318	Nearly complete	Min SH	135.50						
Busycon sinistrum	2670318	Nearly complete	Min SH	83.80						
Busycon sinistrum	2670318	Nearly complete	Min SH	150.00						
Busycon sinistrum	2670318	Nearly complete	Min SH	161.00						
Busycon sinistrum	2670318	Nearly complete	Min SH	165.00						
Busycon sinistrum	2670318	Nearly complete	Min SH	153.00						
Busycon sinistrum	2670318	Nearly complete	Min SH	176.00						
Busycon sinistrum	2670318	Nearly complete	Min SH	206.00						
Busycon sinistrum	2670318	Nearly complete	Min SH	185.00						
Busycon sinistrum	2670318	Nearly complete	Min SH	198.00						
Argopecten sp.	2670314	Valve, lt	VH	57.30						
Argopecten sp.	2670314	Valve, lt	VH	51.34						
Argopecten sp.	2670314	Valve, lt	VH	56.29						
Argopecten sp.	2670314	Valve, lt	VH	46.93						
Argopecten sp.	2670314	Valve, lt	VH	51.34						
Argopecten sp.	2670314	Valve, lt	VH	46.42						
Argopecten sp.	2670314	Valve, lt	VH	61.05						
Argopecten sp.	2670314	Valve, lt	VH	58.52						
Argopecten sp.	2670314	Valve, lt	VH	52.17						
Argopecten sp.	2670314	Valve, lt	VH	52.61						
Argopecten sp.	2670314	Valve, lt	VH	51.72						
Argopecten sp.	2670314	Valve, lt	VH	55.82						
Argopecten sp.	2670314	Valve, rt	VH	52.12						
Argopecten sp.	2670314	Valve, rt	VH	56.96						
Argopecten sp.	2670314	Valve, rt	VH	44.66						
Argopecten sp.	2670314	Valve, rt	VH	53.30						
Ariidae	2670292	Otolith, lt	Len	9.17	Wdh	7.81	Th	3.82	Bth	8.4
Ariidae	2670292	Otolith, lt	Len	11.61	Wdh	10.14	Th	4.75	Bth	10.19
Ariidae	2670292	Otolith, lt	Len	9.16	Wdh	8.27	Th	4.2	Bth	8.22
Ariidae	2670292	Otolith, lt	Len	10.05	Wdh	8.54	Th	4.38	Bth	9.03
Ariidae	2670292	Otolith, lt	Len	10.34	Wdh	9.06	Th	4.44	Bth	9.85
Ariidae	2670292	Otolith, lt	Len	8.53	Wdh	8.09	Th	4.02	Bth	7.82
Ariidae	2670292	Otolith, lt	Len	10.71	Wdh	9.53	Th	4.38	Bth	9.63
Ariidae	2670292	Otolith, lt	Len	12.16	Wdh	10.15	Th	5.09	Bth	10.82
Ariidae	2670292	Otolith, lt	Len	8.50	Wdh	8.05	Th	4	Bth	7.97
Ariidae	2670292	Otolith, rt	Len	10.03	Wdh	8.79	Th	4.47	Bth	9.18
Ariidae	2670292	Otolith, rt	Len	8.23	Wdh	7.53	Th	4.3	Bth	7.82
Ariidae	2670292	Otolith, rt	Len	10.38	Wdh	9.64	Th	4.95	Bth	10.02
Ariidae	2670292	Otolith, rt	Len	11.23	Wdh	10.24	Th	4.9	Bth	10.17
Ariidae	2670292	Otolith, rt	Len	11.37	Wdh	10.25	Th	4.52	Bth	10.44

Appendix C. 8By1347 Hare Hammock Measurements.

Taxon	**GMNH#**	**Element**	**Dimension**	**mm**	**Dimension**	**mm**	**Dimension**	**mm**	**Dimension**	**mm**
Hare Hammock Early										
Strombus alatus	2670287	Complete	SH	83.23						
Strombus alatus	2670287	Complete	SH	82.07						
Strombus alatus	2670287	Complete	SH	92.04						
Strombus alatus	2670287	Complete	SH	83.65						
Strombus alatus	2670287	Complete	SH	71.70						
Strombus alatus	2670287	Complete	SH	80.38						
Strombus alatus	2670287	Complete	SH	83.28						
Strombus alatus	2670287	Complete	SH	81.91						
Strombus alatus	2670287	Complete	SH	80.36						
Strombus alatus	2670287	Complete	SH	80.81						
Strombus alatus	2670287	Complete	SH	74.59						
Strombus alatus	2670287	Complete	SH	79.75						
Strombus alatus	2670287	Complete	SH	73.50	LT	2.25				
Strombus alatus	2670287	Complete	SH	80.04	LT	4.84				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.31				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.53				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.11				
Strombus alatus	2670287	Complete	SH	73.83	LT	—				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.85				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.64				
Strombus alatus	2670287	Complete	SH	78.48	LT	4.7				
Strombus alatus	2670287	Complete	SH	77.86	LT	4.13				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.09				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.72				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.58				
Strombus alatus	2670287	Complete	SH	86.20	LT	—				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	5.42				
Strombus alatus	2670287	Complete	SH	84.87	LT	4.23				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.08				
Strombus alatus	2670287	Complete	SH	80.21	LT	4.45				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.22				
Strombus alatus	2670287	Complete	SH	84.88	LT	—				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	5.31				
Strombus alatus	2670287	Complete	SH	72.11	LT	3.55				
Strombus alatus	2670287	Complete	SH	75.33	LT	—				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.41				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.2				
Strombus alatus	2670287	Complete	SH	76.46	LT	3.46				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.99				
Strombus alatus	2670287	Complete	SH	82.14	LT	4.26				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.68				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.47				
Strombus alatus	2670287	Complete	SH	87.73	LT	4.83				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	2.32				

Appendix C. 8By1347 Hare Hammock Measurements. (cont.)

Taxon	**GMNH#**	**Element**	**Dimension**	**mm**	**Dimension**	**mm**	**Dimension**	**mm**	**Dimension**	**mm**
Hare Hammock Early (cont.)										
Mugil sp.	2670289	Atlas	Wdh	5.46						
Mugil sp.	2670289	Atlas	Wdh	6.41						
Cyprinodontidae	2670525	Atlas	Wdh	1.64						
Orthopristis chrysoptera	2670534	Atlas	Wdh	3.05						
Lagodon rhomboides	2670531	Atlas	Wdh	2.12						
Lagodon rhomboides	2670531	Atlas	Wdh	2.06						
Lagodon rhomboides	2670531	Atlas	Wdh	2.15						
Lagodon rhomboides	2670531	Atlas	Wdh	2.07						
Leiostomus xanthurus	2670305	Atlas	Wdh	3.50						
Leiostomus xanthurus	2670535	Atlas	Wdh	3.00						
Leiostomus xanthurus	2670535	Atlas	Wdh	2.91						
Leiostomus xanthurus	2670535	Atlas	Wdh	2.71						
Leiostomus xanthurus	2670535	Atlas	Wdh	3.53						
Leiostomus xanthurus	2670535	Atlas	Wdh	3.40						
Leiostomus xanthurus	2670535	Atlas	Wdh	3.60						
Leiostomus xanthurus	2670535	Atlas	Wdh	3.45						
Leiostomus xanthurus	2670535	Atlas	Wdh	3.02						
Leiostomus xanthurus	2670535	Atlas	Wdh	3.17						
Leiostomus xanthurus	2670535	Atlas	Wdh	3.37						
Micropogonias undulatus	2670539	Otolith, rt	Len	—	Wdh	7.1	Th	4.28		
Micropogonias undulatus	2670304	Otolith, rt	Len	11.42	Wdh	8.83	Th	5.14		
Hare Hammock Late										
Strombus alatus	2670580	Complete	SH	88.39	LT	—				
Strombus alatus	2670580	Complete	SH	—	LT	3.49				
Strombus alatus	2670580	Complete	SH	79.51	LT	—				
Strombus alatus	2670580	Complete	SH	74.31	LT	3.11				
Strombus alatus	2670580	Complete	SH	79.62	LT	—				
Strombus alatus	2670580	Complete	SH	95.49	LT	—				
Strombus alatus	2670580	Complete	SH	83.85	LT	—				
Strombus alatus	2670580	Complete	SH	85.87	LT	4.37				
Strombus alatus	2670580	Complete	SH	67.61	LT	—				
Strombus alatus	2670580	Complete	SH	—	LT	3.87				
Strombus alatus	2670580	Complete	SH	73.72	LT	2.95				
Strombus alatus	2670580	Complete	SH	73.92	LT	—				
Strombus alatus	2670580	Complete	SH	82.75	LT	—				
Strombus alatus	2670580	Complete	SH	91.20	LT	—				
Strombus alatus	2670580	Complete	SH	—	LT	4.03				
Strombus alatus	2670580	Complete	SH	82.38	LT	—				
Strombus alatus	2670580	Complete	SH	82.57	LT	—				
Strombus alatus	2670580	Complete	SH	88.83	LT	3.7				
Strombus alatus	2670580	Complete	SH	78.28	LT	2.34				
Strombus alatus	2670580	Complete	SH	—	LT	5.1				
Strombus alatus	2670580	Complete	SH	72.47	LT	2.75				
Strombus alatus	2670580	Complete	SH	77.01	LT	2.6				

Appendix C. 8By1347 Hare Hammock Measurements. (cont.)

Taxon	**GMNH#**	**Element**	**Dimension**	**mm**	**Dimension**	**mm**	**Dimension**	**mm**	**Dimension**	**mm**
Hare Hammock Late (cont.)										
Strombus alatus	2670580	Complete	SH	78.76	LT	—				
Strombus alatus	2670580	Complete	SH	73.95	LT	—				
Strombus alatus	2670580	Complete	SH	—	LT	3.8				
Strombus alatus	2670580	Complete	SH	—	LT	2.63				
Strombus alatus	2670580	Complete	SH	71.16	LT	—				
Strombus alatus	2670580	Complete	SH	80.12	LT	—				
Strombus alatus	2670580	Complete	SH	68.39	LT	2.9				
Strombus alatus	2670580	Complete	SH	77.72	LT	—				
Strombus alatus	2670580	Complete	SH	87.72	LT	4.19				
Strombus alatus	2670580	Complete	SH	—	LT	4.13				
Strombus alatus	2670580	Complete	SH	61.72	LT	—				
Strombus alatus	2670580	Complete	SH	72.81	LT	—				
Strombus alatus	2670580	Complete	SH	—	LT	3.51				
Strombus alatus	2670580	Complete	SH	75.06	LT	—				
Strombus alatus	2670580	Complete	SH	78.06	LT	—				
Strombus alatus	2670580	Complete	SH	71.17	LT	—				
Strombus alatus	2670580	Complete	SH	83.11	LT	—				
Strombus alatus	2670580	Complete	SH	80.23	LT	3.42				
Strombus alatus	2670580	Complete	SH	74.31	LT	—				
Strombus alatus	2670580	Complete	SH	81.25	LT	3.04				
Strombus alatus	2670580	Complete	SH	84.83	LT	—				
Strombus alatus	2670580	Complete	SH	—	LT	2.44				
Strombus alatus	2670580	Complete	SH	81.68	LT	5.74				
Strombus alatus	2670580	Complete	SH	80.86	LT	5.31				
Strombus alatus	2670580	Complete	SH	89.03	LT	—				
Strombus alatus	2670580	Complete	SH	75.91	LT	—				
Strombus alatus	2670580	Complete	SH	85.47	LT	5.68				
Strombus alatus	2670580	Complete	SH	71.40	LT	4.1				
Strombus alatus	2670580	Complete	SH	69.50	LT	—				
Strombus alatus	2670580	Complete	SH	—	LT	3.38				
Strombus alatus	2670580	Complete	SH	84.39	LT	—				
Strombus alatus	2670580	Complete	SH	89.68	LT	—				
Strombus alatus	2670580	Complete	SH	—	LT	3.95				
Strombus alatus	2670580	Complete	SH	81.82	LT	—				
Strombus alatus	2670580	Complete	SH	74.60	LT	—				
Strombus alatus	2670580	Complete	SH	—	LT	5.3				
Strombus alatus	2670580	Complete	SH	74.12	LT	3.32				
Strombus alatus	2670580	Complete	SH	—	LT	2.74				
Strombus alatus	2670580	Complete	SH	79.10	LT	3.01				
Strombus alatus	2670580	Complete	SH	—	LT	4.44				
Busycon sinistrum	2670570	Nearly complete	Min SH	181.50						
Busycon sinistrum	2670570	Nearly complete	Min SH	197.50						
Busycon sinistrum	2670570	Complete	SH	180.00						
Busycon sinistrum	2670570	Nearly complete	Min SH	154.90						

Appendix C. 8By1347 Hare Hammock Measurements.

Taxon	GMNH#	Element	Dimension	mm	Dimension	mm	Dimension	mm	Dimension	mm
Hare Hammock Early										
Strombus alatus	2670287	Complete	SH	83.23						
Strombus alatus	2670287	Complete	SH	82.07						
Strombus alatus	2670287	Complete	SH	92.04						
Strombus alatus	2670287	Complete	SH	83.65						
Strombus alatus	2670287	Complete	SH	71.70						
Strombus alatus	2670287	Complete	SH	80.38						
Strombus alatus	2670287	Complete	SH	83.28						
Strombus alatus	2670287	Complete	SH	81.91						
Strombus alatus	2670287	Complete	SH	80.36						
Strombus alatus	2670287	Complete	SH	80.81						
Strombus alatus	2670287	Complete	SH	74.59						
Strombus alatus	2670287	Complete	SH	79.75						
Strombus alatus	2670287	Complete	SH	73.50	LT	2.25				
Strombus alatus	2670287	Complete	SH	80.04	LT	4.84				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.31				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.53				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.11				
Strombus alatus	2670287	Complete	SH	73.83	LT	—				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.85				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.64				
Strombus alatus	2670287	Complete	SH	78.48	LT	4.7				
Strombus alatus	2670287	Complete	SH	77.86	LT	4.13				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.09				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.72				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.58				
Strombus alatus	2670287	Complete	SH	86.20	LT	—				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	5.42				
Strombus alatus	2670287	Complete	SH	84.87	LT	4.23				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.08				
Strombus alatus	2670287	Complete	SH	80.21	LT	4.45				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.22				
Strombus alatus	2670287	Complete	SH	84.88	LT	—				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	5.31				
Strombus alatus	2670287	Complete	SH	72.11	LT	3.55				
Strombus alatus	2670287	Complete	SH	75.33	LT	—				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.41				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	4.2				
Strombus alatus	2670287	Complete	SH	76.46	LT	3.46				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.99				
Strombus alatus	2670287	Complete	SH	82.14	LT	4.26				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.68				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	3.47				
Strombus alatus	2670287	Complete	SH	87.73	LT	4.83				
Strombus alatus	2670287	Nearly complete	Min SH	—	LT	2.32				

Appendix C. 8By1347 Hare Hammock Measurements. (cont.)

Taxon	GMNH#	Element	Dimension	mm	Dimension	mm	Dimension	mm	Dimension	mm
Hare Hammock Late (cont.)										
Busycon sinistrum	2670165	Nearly complete	Min SH	125.00						
Busycon sinistrum	2670165	Nearly complete	Min SH	143.00						
Busycon sinistrum	2670165	Nearly complete	Min SH	132.00						
Busycon sinistrum	2670165	Nearly complete	Min SH	125.00						
Busycon sinistrum	2670165	Nearly complete	Min SH	63.00						
Busycon sinistrum	2670165	Nearly complete	Min SH	70.00						
Argopecten sp.	2670568	Valve, lt	VH	50.45						
Argopecten sp.	2670568	Valve, lt	VH	52.55						
Argopecten sp.	2670568	Valve, lt	VH	57.34						
Argopecten sp.	2670568	Valve, lt	VH	51.54						
Argopecten sp.	2670568	Valve, lt	VH	41.01						
Argopecten sp.	2670568	Valve, rt	VH	54.19						
Argopecten sp.	2670568	Valve, rt	VH	56.60						
Ariidae	2670628	Otolith, lt	Len	8.46	Wdh	7.4	Th	3.32	Bth	7.53
Ariidae	2670628	Otolith, rt	Len	7.22	Wdh	5.12	Th	2.99	Bth	5.3
Ariidae	2670494	Otolith, lt	Len	6.83	Wdh	6.61	Th	3.32	Bth	6.97
Ariidae	2670494	Otolith, rt	Len	7.01	Wdh	7.17	Th	3.22	Bth	7.22
Ariopsis felis	2670042	Otolith, lt	Len	8.40	Wdh	8.81	Th	3.98	Bth	8.26
Ariopsis felis	2670042	Otolith, rt	Len	11.98	Wdh	11.28	Th	5.75	Bth	11.77
Ariopsis felis	2670595	Pectoral spine, lt	Wdh	5.10						
Ariopsis felis	2670595	Pectoral spine, lt	Wdh	6.58						
Ariopsis felis	2670595	Pectoral spine, lt	Wdh	6.22						
Ariopsis felis	2670595	Pectoral spine, lt	Wdh	4.51						
Ariopsis felis	2670595	Pectoral spine, rt	Wdh	5.64						
Ariopsis felis	2670629	Pectoral spine, lt	Wdh	4.96						
Ariopsis felis	2670629	Pectoral spine, lt	Wdh	4.74						
Ariopsis felis	2670629	Pectoral spine, lt	Wdh	5.09						
Ariopsis felis	2670629	Pectoral spine, rt	Wdh	6.09						
Ariopsis felis	2670042	Pectoral spine, lt	Wdh	7.14						
Ariopsis felis	2670487	Pectoral spine, rt	Wdh	5.40						
Ariopsis felis	2670487	Pectoral spine, rt	Wdh	5.09						
Ariopsis felis	2670487	Pectoral spine, rt	Wdh	4.95						
Ariopsis felis	2670487	Pectoral spine, rt	Wdh	4.88						
Mugil sp.	2670045	Atlas	Wdh	5.78						
Mugil sp.	2670486	Atlas	Wdh	4.47						
Mugil sp.	2670486	Atlas	Wdh	5.04						
Mugil sp.	2670631	Atlas	Wdh	4.16						
Mugil sp.	2670631	Atlas	Wdh	3.51						
Mugil sp.	2670631	Atlas	Wdh	4.19						
Mugil sp.	2670631	Atlas	Wdh	4.77						
Mugil sp.	2670631	Atlas	Wdh	4.08						
Mugil sp.	2670597	Atlas	Wdh	5.78						
Mugil sp.	2670597	Atlas	Wdh	4.88						
Orthopristis chrysoptera	2670499	Atlas	Wdh	3.47						

Appendix C. 8By1347 Hare Hammock Measurements. (cont.)

Taxon	GMNH#	Element	Dimension	mm	Dimension	mm	Dimension	mm	Dimension	mm
Hare Hammock Late (cont.)										
Orthopristis chrysoptera	2670635	Atlas	Wdh	2.44						
Orthopristis chrysoptera	2670635	Atlas	Wdh	2.81						
Lagodon rhomboides	2670495	Atlas	Wdh	2.35						
Lagodon rhomboides	2670495	Atlas	Wdh	2.07						
Lagodon rhomboides	2670636	Atlas	Wdh	2.35						
Lagodon rhomboides	2670636	Atlas	Wdh	1.74						
Lagodon rhomboides	2670636	Atlas	Wdh	2.25						
Cynoscion sp.	2670044	Otolith, rt	Len	—	Wdh	6.6	Th	4.38		
Cynoscion sp.	2670044	Otolith, lt	Len	19.89	Wdh	8.08	Th	4.38		
Cynoscion sp.	2670637	Otolith, lt	Len	12.65	Wdh	6.1	Th	3.5		
Leiostomus xanthurus	2670500	Atlas	Wdh	3.48						
Leiostomus xanthurus	2670500	Atlas	Wdh	2.24						
Leiostomus xanthurus	2670638	Atlas	Wdh	3.24						
Leiostomus xanthurus	2670638	Atlas	Wdh	2.84						
Sciaenops ocellatus	2670602	Otolith, rt	Len	15.92	Wdh	9.36	Th	4.45		
Odocoileus virginianus	2670653	Tibia, lt	Bd	32.50						
Odocoileus virginianus	2670653	Metatarsal, lt	Bp	21.78						
Hare Hammock House Mound										
Busycon sinistrum	2670344	Nearly complete	Min SH	113.46						
Busycon sinistrum	2670344	Nearly complete	Min SH	91.57						
Argopecten sp.	2670384	Valve, lt	VH	43.54						
Argopecten sp.	2670384	Valve, lt	VH	49.00						
Argopecten sp.	2670384	Valve, rt	VH	51.78						
Argopecten sp.	2670384	Valve, rt	VH	52.30						
Argopecten sp.	2670384	Valve, rt	VH	45.84						
Argopecten sp.	2670384	Valve, rt	VH	57.58						
Ariidae	2670319	Otolith, rt	Len	10.95	Wdh	9.16	Th	4.67	Bth	9.02
Ariopsis felis	2670430	Pectoral spine, lt	Wdh	4.91						
Ariopsis felis	2670430	Pectoral spine, lt	Wdh	6.53						
Ariopsis felis	2670430	Pectoral spine, lt	Wdh	6.62						
Ariopsis felis	2670430	Pectoral spine, lt	Wdh	4.64						
Ariopsis felis	2670430	Pectoral spine, rt	Wdh	6.00						
Ariopsis felis	2670430	Pectoral spine, rt	Wdh	7.11						
Ariopsis felis	2670463	Pectoral spine, lt	Wdh	6.45						
Ariopsis felis	2670463	Pectoral spine, lt	Wdh	6.79						
Ariopsis felis	2670463	Pectoral spine, lt	Wdh	6.21						
Ariopsis felis	2670463	Pectoral spine, lt	Wdh	6.65						
Ariopsis felis	2670463	Pectoral spine, rt	Wdh	6.72						
Ariopsis felis	2670463	Pectoral spine, rt	Wdh	6.53						
Ariopsis felis	2670463	Pectoral spine, rt	Wdh	7.36						
Ariopsis felis	2670463	Pectoral spine, rt	Wdh	6.65						
Ariopsis felis	2670463	Pectoral spine, rt	Wdh	6.99						
Ariopsis felis	2670463	Pectoral spine, rt	Wdh	6.68						
Ariopsis felis	2670463	Pectoral spine, rt	Wdh	6.81						

Appendix C. 8By1347 Hare Hammock Measurements. (cont.)

Taxon	**GMNH#**	**Element**	**Dimension**	**mm**	**Dimension**	**mm**	**Dimension**	**mm**	**Dimension**	**mm**
Hare Hammock House Mound (cont.)										
Ariopsis felis	2670463	Pectoral spine, rt	Wdh	6.33						
Ariopsis felis	2670353	Pectoral spine, lt	Wdh	7.59						
Ariopsis felis	2670353	Pectoral spine, lt	Wdh	7.16						
Ariopsis felis	2670353	Pectoral spine, lt	Wdh	7.15						
Ariopsis felis	2670353	Pectoral spine, lt	Wdh	7.06						
Ariopsis felis	2670353	Pectoral spine, lt	Wdh	6.64						
Ariopsis felis	2670353	Pectoral spine, lt	Wdh	7.40						
Ariopsis felis	2670353	Pectoral spine, lt	Wdh	7.96						
Ariopsis felis	2670353	Pectoral spine, lt	Wdh	7.06						
Ariopsis felis	2670353	Pectoral spine, lt	Wdh	6.58						
Ariopsis felis	2670353	Pectoral spine, lt	Wdh	7.18						
Ariopsis felis	2670353	Pectoral spine, lt	Wdh	7.33						
Ariopsis felis	2670353	Pectoral spine, lt	Wdh	5.71						
Ariopsis felis	2670353	Pectoral spine, lt	Wdh	7.29						
Ariopsis felis	2670353	Pectoral spine, lt	Wdh	5.76						
Ariopsis felis	2670353	Pectoral spine, lt	Wdh	6.22						
Ariopsis felis	2670353	Pectoral spine, rt	Wdh	5.29						
Ariopsis felis	2670353	Pectoral spine, rt	Wdh	6.73						
Ariopsis felis	2670353	Pectoral spine, rt	Wdh	6.43						
Ariopsis felis	2670353	Pectoral spine, rt	Wdh	7.22						
Ariopsis felis	2670353	Pectoral spine, rt	Wdh	6.89						
Ariopsis felis	2670353	Pectoral spine, rt	Wdh	7.11						
Ariopsis felis	2670353	Pectoral spine, rt	Wdh	6.86						
Ariopsis felis	2670353	Pectoral spine, rt	Wdh	6.09						
Ariopsis felis	2670353	Pectoral spine, rt	Wdh	6.20						
Ariopsis felis	2670353	Pectoral spine, rt	Wdh	6.20						
Ariopsis felis	2670353	Pectoral spine, rt	Wdh	6.92						
Ariopsis felis	2670353	Pectoral spine, rt	Wdh	7.31						
Ariopsis felis	2670353	Pectoral spine, rt	Wdh	7.11						
Ariopsis felis	2670372	Pectoral spine, lt	Wdh	6.81						
Ariopsis felis	2670372	Pectoral spine, lt	Wdh	5.89						
Ariopsis felis	2670372	Pectoral spine, lt	Wdh	5.31						
Ariopsis felis	2670372	Pectoral spine, lt	Wdh	7.65						
Ariopsis felis	2670372	Pectoral spine, lt	Wdh	2.14						
Ariopsis felis	2670372	Pectoral spine, rt	Wdh	5.98						
Ariopsis felis	2670372	Pectoral spine, lt	Wdh	5.73						
Ariopsis felis	2670372	Pectoral spine, lt	Wdh	5.98						
Ariopsis felis	2670372	Pectoral spine, lt	Wdh	4.83						
Ariopsis felis	2670372	Pectoral spine, lt	Wdh	5.06						
Ariopsis felis	2670372	Pectoral spine, lt	Wdh	4.97						
Ariopsis felis	2670372	Pectoral spine, lt	Wdh	5.20						
Ariopsis felis	2670372	Pectoral spine, lt	Wdh	5.96						
Mugil sp.	2670432	Atlas	Wdh	4.94						
Mugil sp.	2670356	Atlas	Wdh	5.68						

Appendix C. 8By1347 Hare Hammock Measurements. (cont.)

Taxon	GMNH#	Element	Dimension	mm	Dimension	mm	Dimension	mm	Dimension	mm
Hare Hammock House Mound (cont.)										
Mugil sp.	2670464	Atlas	Wdh	5.60						
Mugil sp.	2670464	Atlas	Wdh	4.55						
Mugil sp.	2670464	Atlas	Wdh	4.45						
Pomatomus saltatrix	2670475	Atlas	Wdh	6.57						
Orthopristis chrysoptera	2670453	Atlas	Wdh	3.60						
Orthopristis chrysoptera	2670453	Atlas	Wdh	3.45						
Bairdiella chrysoura	2670375	Atlas	Wdh	3.14						
Cynoscion nebulosus	2670471	Atlas	Wdh	5.04						
Cynoscion nebulosus	2670471	Otolith, lt	Len	23.14	Wdh	8.71	Th	5.52		
Leiostomus xanthurus	2670374	Atlas	Wdh	3.29						
Leiostomus xanthurus	2670374	Atlas	Wdh	3.67						
Leiostomus xanthurus	2670374	Atlas	Wdh	3.44						
Leiostomus xanthurus	2670374	Atlas	Wdh	3.13						
Leiostomus xanthurus	2670374	Atlas	Wdh	3.22						
Leiostomus xanthurus	2670374	Atlas	Wdh	3.48						
Leiostomus xanthurus	2670374	Atlas	Wdh	3.24						
Micropogonias undulatus	2670377	Atlas	Wdh	4.50						
Micropogonias undulatus	2670410	Otolith, lt	Len	9.16	Wdh	7.45	Th	4.34		
Micropogonias undulatus	2670410	Atlas	Wdh	2.75						
Pogonias cromis	2670376	Atlas	Wdh	4.36						
Pogonias cromis	2670376	Atlas	Wdh	3.90						
Pogonias cromis	2670376	Atlas	Wdh	4.36						
Pogonias cromis	2670417	Atlas	Wdh	3.41						
Pogonias cromis	2670417	Atlas	Wdh	3.80						
Pogonias cromis	2670417	Atlas	Wdh	4.54						
Pogonias cromis	2670417	Atlas	Wdh	3.19						

Notes: "Nearly complete" shells are incomplete but at least 75% of the columella length is intact. lt = left; rt = right; SH = shell height; Min SH= minimum shell height; LT = lip thickness; VH = valve height; Wdh = width; Len = length; Th = thickness; Bth = breadth. See Figure 3.2 for morphometric landmarks. GMNH# refers to Georgia Museum of Natural History specimen number.

Appendix D: FFWCC 2011 Annual Landings Summary: Bay County.

Species	Taxonomic ID	TL	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999
Amberjack	*Seriola* spp.	4.5	69660	40755	78962	59138	61268	90758	72299	49649	7907	71210	75473	66546	69617
Bait fish		3.5	385	2215	11418	7434	11658	6292	1444	5066	10396	10582	12506	6951	6195
Ballyhoo	Hemiramphidae	2.2									9				5
Blue runner	*Caranx crysos*	4.1	110	9	424	35	10	15	156	965	4939	174	1649	8	13901
Bluefish	*Pomatomus saltatrix*	4.5	181	749	454	554	1414	344	263	163	492	3907	322	143	4272
Bumper, atlantic	*Chloroscombrus chrysuru*	3.2													
Catfish	Ariidae	3.4			95				337	340	45	354	295	193	35
Cobia	*Rachycentron canadum*	4.0	4299	8503	3787	4119	6349	3221	5808	7353	6822	5593	5046	7014	11576
Croaker	*Micropogonias undulatus*	4.0	323	190	261	199	162	28		47		241	17		
Dolphin	*Coryphaena* spp.	4.4	48473	8603	207070	137962	58553	23384	3211	18852	5543	6698	2330	9938	7676
Drum, black	*Pogonias cromis*	3.9	461	263	680	654	219	268	51	126	81	9	570	917	1421
Drum, red	*Sciaenops ocellatus*	3.7													
Eels		3.5									33				
Flounders	*Paralichthys* spp.	3.5	15151	12974	20149	16799	20148	12888	15525	17843	22930	18894	20041	20313	19983
Goatfishes	Mullidae	3.4													
Grouper, black	*Mycteroperca bonaci*	4.5													
Grouper, Gag	*Mycteroperca microlepis*	3.7	71028	87370	183439	431648	322426	255553	583253	676756	526452	676650	764118	421060	375598
Grouper, nassau	*Epinephelus striatus*	4.1													
Grouper, Red	*Epinephelus morio*	3.5	381841	88315	201435	484238	252201	575528	905103	541134	490661	555723	708622	454905	351828
Grouper, Scamp	*Mycteroperca phenax*	4.5	19063	19468	57814	63067	50644	35162	54523	52521	64289	46315	63812	34464	50838
Grouper, snowy	*Hyporthodus niveatus*	4.0	9939	15913	29698	32081	23396	32872	22077	27293	40445	23920	25548	42821	7296
Grouper, warsaw	*Hyporthodus nigritus*	4.0	4805	2777	8462	5823	6357	6858	6252	8189	12987	6489	3396	6975	37817
Grouper, yellowedge	*Hyporthodus flavolimbatu*	3.8	63069	119149	181863	236261	143289	140465	113535	121570	347898	236912	216636	359455	379691
Grouper, yellowfin	*Mycteroperca venenosa*	4.5					7			2571				546	
Grouper, Goliath	*Epinephelus itajara*	4.1													
Grouper, other	Serranidae	4.1	566	464	2096		1672	1003	1058	3372	1932	1460	1375	349	1055
Grunts	*Orthopristis chrysoptera*	3.4	13493	474	341	1819	274	882	227	397	305	228	126	18	279
Herring, thread	*Opisthonema oglinum*	4.5											33777	34644	124527
Hogfish	*Lachnolaimus maximus*	4.2													
Jack, crevalle	*Caranx hippos*	3.6		5		1		1		304		68		43	472
Jack, other	*Caranx* spp.	4.2	10206	9075	18632	14946	6527	7962	7034	4464	5632	3989	3634	2968	3002
Kingfish	*Menticirrhus saxatilis*	3.6	154	200	1455	1976	345	2186	531	301	164	556	229	512	2738
Ladyfish	*Elops saurus*	3.5	4177	242	747	702	162	286	1495	3021	81368	55100	4308	1063	1455641
Mackerel, king	*Scomberomorus cavalla*	4.4	32452	56802	137265	39948	83826	34152	11133	16737	27867	50738	63226	43252	140587
Mackerel, spanish	*Scomberomorus maculatu*	4.5	1932	2698	1530	886	4838	5058	10322	12748	7604	11587	10499	1489	6207
Marlin, white	*Kajikia albida*	4.5													
Menhaden	*Brevoortia* spp.	3.2		111	11	7						3819	80		
Mojarra	Gerriedae	3.0		8											339
Marlin, blue	*Makaira nigricans*	4.5													
Mullet, black,	*Mugil cephalus*	2.5	71002	86242	47408	54313	9629	47921	40691	55078	60373	49826	96322	100911	126436
Mullet, silver	*Mugil curema*	2.0	1059	425	1947	1412	1844	915	6284	1005	201	2431	7068	6767	746
Permit	*Trachinotus falcatus*	4.0			5									3	
Pompano	*Trachinotus* spp.	3.5	321	185	449	549	2774	1679	1294	538	1236	1480	1627	3667	987
Porgies	Sparidae	4.0	325187	190472	292312	212785	173449	120304	109913	78864	111334	66480	33302	31475	55722
Pinfish	*Lagodon rhomboides*	4.4				13		44	357			38	4	12	
Rays & Skates		3.2													
Sand perch	*Diplectrum formosum*	4.5										8			
Sardines, scaled	*Harengula pensacolae*	3.4												211	
Sardines, spanish	*Sardinella aurita*	3.4										1688	21079	64722	
Scad, bigeye	*Selar crumenophthalmus*	4.1	152	63	78							1	202		
Scad, round cigarfish	*Decapterus punctatus*	4.3	5982	734	3517	8365		9754	5613	4370	12060	28411	28611	81128	44039
Sea bass, mixed	*Centropristis* spp.	3.9	25238	79	5	37	27		9	1	5	5	35	4	22
Seatrout	*Cynoscion* spp.	4.0	87	300	1141	5957	26	646	143		6	6	208	67	28
Seatrout, spotted	*Cynoscion nebulosus*	4.0	166	147	454	302	73	51	1172	957	1503	637	2494	2719	2022
Shad	*Alosa* spp.	3.1													

Appendix D: FFWCC 2011 Annual Landings SummAppendix D: FFWCC 2011 Annual Landings Summary: Bay County. (cont.)

Species	Taxonomic ID	TL	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987	1986
Amberjack	*Seriola* spp.	4.5	46748	87444	88735	123701	133029	126900	126613	73119	105154	343741	179697	143894	128668
Bait fish		3.5	7255	670	7643	107240	13850	3502	37625	40116	164955	88252	71775	221837	135496
Ballyhoo	Hemiramphidae	2.2			9						14356	825	75	118	
Blue runner	*Caranx crysos*	4.1	98012	71174	6339	554382	649037	585215	580499	510102	494180	97335	761379	367856	187329
Bluefish	*Pomatomus saltatrix*	4.5	71	162	8814	35560	36413	56379	35592	82797	128756	146692	213960	117535	81662
Bumper, atlantic	*Chloroscombrus chrysuru*	3.2													
Catfish	Ariidae	3.4	15	605	1046	99	3644	1150	1055	2500	8156	3550	466	80	16424
Cobia	*Rachycentron canadum*	4.0	13815	9427	8860	4593	5765	7867	4505	4520	5166	7529	3615	2285	2820
Croaker	*Micropogonias undulatus*	4.0		27	201	337	6124	3165	2373	372	451	715	484	540	40712
Dolphin	*Coryphaena* spp.	4.4	5580	38251	28360	33944	32566	35238	76982	108684	109933	13660	24745	23129	60648
Drum, black	*Pogonias cromis*	3.9	79	9	136	3964	7384	10270	6049	7958	9708	4527	4576	6228	1477
Drum, red	*Sciaenops ocellatus*	3.7												9027	15522
Eels		3.5								80			3333	745	3678
Flounders	*Paralichthys* spp.	3.5	21474	28463	12563	13049	20581	20716	15278	20462	24487	25245	25702	23344	8928
Goatfishes	Mullidae	3.4	270	1640											
Grouper, black	*Mycteroperca bonaci*	4.5								91848	91390	167704	136505	122805	105173
Grouper, Gag	*Mycteroperca microlepis*	3.7	532312	350392	387868	457112	328093	342217	233537	79727	48759	26008	20576	12076	84680
Grouper, nassau	*Epinephelus striatus*	4.1	57					92	1895		173				638
Grouper, Red	*Epinephelus morio*	3.5	346098	591283	485648	282322	191578	203515	40415	107262	113474	101388	95951	93639	95729
Grouper, Scamp	*Mycteroperca phenax*	4.5	36842	70820	66917	64988	46998	54269	55573	42178	25857	34509	30057	24376	36932
Grouper, snowy	*Hyporthodus niveatus*	4.0	10356	6170	6246	10205	4583	1147	11408	24666	26434	10758	5977	268	137
Grouper, warsaw	*Hyporthodus nigritus*	4.0	7675	5082	1547	5715	909	3350	8730	13739	29545	18940	10759	5624	18160
Grouper, yellowedge	*Hyporthodus flavolimbatu*	3.8	158547	108128	79724	76304	45101	32632	181892	132256	236853	212506	211406	55301	62728
Grouper, yellowfin	*Mycteroperca venenosa*	4.5		373	4820	1900	166		267	670	611	26	1171	6313	68831
Grouper, Goliath	*Epinephelus itajara*	4.1									0	5074	83		
Grouper, other	Serranidae	4.1	805	336	628	730	569	6236	21463	3491	1971	2773	1889	11878	25833
Grunts	*Orthopristis chrysoptera*	3.4	86	19	33	39	22	244		431	8	134	55		
Herring, thread	*Opisthonema oglinum*	4.5	42550	3592	7200	115150	101489	118194	244428	63169	55749	93466	37725	14043	8790
Hogfish	*Lachnolaimus maximus*	4.2								167					
Jack, crevalle	*Caranx hippos*	3.6		119	10537		284086	244911	207198	115865	595422	240911	64523	224618	171588
Jack, other	*Caranx* spp.	4.2	338	6	234		1494	1586	6672	197	183024	24541	725	71423	207203
Kingfish	*Menticirrhus saxatilis*	3.6	1103	1458	1128	152	1332	891	811	1157	2286	979	1426	903	1617
Ladyfish	*Elops saurus*	3.5	527876	480165	688188	632122	1317318	1622210	1949535	2290083	2508411	1850046	1566112	2447146	1882295
Mackerel, king	*Scomberomorus cavalla*	4.4	55503	194658	151807	46703	231797	43770	23830	28510	5893	5307	3580	3057	1404
Mackerel, spanish	*Scomberomorus maculatu*	4.5	3204	2580	4451	183680	180697	215796	174441	185318	252331	98911	196668	200885	259762
Marlin, white	*Kajikia albida*	4.5											383	5821	36093
Menhaden	*Brevoortia* spp.	3.2	45			79150	242164	501036	1119834	268655	561456	750230	611951	452883	313440
Mojarra	Gerriedae	3.0					11							35	
Marlin, blue	*Makaira nigricans*	4.5											816	3164	8821
Mullet, black,	*Mugil cephalus*	2.5	101353	78737	105929	75174	231875	365095	322805	281299	367564	371009	530308	453590	409949
Mullet, silver	*Mugil curema*	2.0	2193	661	4638	4546	6660	9798	1168	11977	12718	3272	8675	40042	5315
Permit	*Trachinotus falcatus*	4.0					8	3	5	47					4
Pompano	*Trachinotus* spp.	3.5	787	1871	183	2690	9226	10461	9293	7103	7938	4411	4474	5298	4450
Porgies	Sparidae	4.0	49555	67369	69104	67208	91253	129069	71514	67800	46674	128315	14590	33181	28406
Pinfish	*Lagodon rhomboides*	4.4		370	63	155		38							
Rays & Skates		3.2	339		45										
Sand perch	*Diplectrum formosum*	4.5											7		
Sardines, scaled	*Harengula pensacolae*	3.4					14425	84594		122792	16600				
Sardines, spanish	*Sardinella aurita*	3.4	104155	277676	109324	122500	1030085	373715	812107	583040	588896	541311	724939	590354	641506
Scad, bigeye	*Selar crumenophthalmus*	4.1						190			35	3572			1
Scad, round cigarfish	*Decapterus punctatus*	4.3	225794	179391	25209	451599	739576	1296585	1232737	949188	470506	1351031	1038822	378799	189272
Sea bass, mixed	*Centropristis* spp.	3.9	44	24	17	53	1	39	78		224	90	48	9	
Seatrout	*Cynoscion* spp.	4.0	33	454	849	945	2490	784	1224	1161	2758	3329	1625	615	2719
Seatrout, spotted	*Cynoscion nebulosus*	4.0	3547	2493	1419	12674	27410	48999	38952	62613	43286	57670	93663	83854	61143
Shad	*Alosa* spp.	3.1								4	0	21250		25200	

Species	**Taxonomic ID**	**TL**	**2011**	**2010**	**2009**	**2008**	**2007**	**2006**	**2005**	**2004**	**2003**	**2002**	**2001**	**2000**	**1999**
Appendix D: FFWCC 2011 Annual Landings Summary: Bay County. (cont.)															
Shark	Charcharinidae	4.0	6678	2256	7895	3703	12953	21388	2455	1974	1587	1295	13740	20589	9127
Sheepshead	*Archosargus probatoceph*	3.5	1897	2083	2355	2282	1498	1279	1189	2481	1326	1867	4759	2375	3513
Snapper, grey	*Lutjanus griseus*	4.3	14200	11221	16918	15780	11496	12022	12843	15352	13391	14405	16308	17063	12340
Snapper, lane	*Lutjanus synagris*	3.8	2232	1289	3169	1530	609	271	188	304	428	933	498	194	85
Snapper, mutton	*Lutjanus analis*	3.9	58	73	52	102	855	1234	695	3505	376	127	319	210	354
Snapper, red	*Lutjanus campechanus*	4.0	391953	398430	263195	288304	323591	168098	143405	261354	213271	121713	117662	177633	126069
Snapper, silk	*Lutjanus vivanus*	3.1	1179	33	371	256	1412	17	30	225	178	4	327	88	179
Snapper, vermilion	*Rhomboplites aurorubens*	4.3	941984	535971	929362	530835	367206	286785	164344	118292	81565	62748	54690	22364	32272
Snapper, yellowtail	*Ocyurus chrysurus*	4.0	20		9	3		27		2	6	7	23	34	11
Snapper, other		3.9	304	63	223	64	607	624	279	74	417	757	214	36	2252
Spot	*Leiostomus xanthurus*	3.2	4	58	166	25	30	26	96		21			55	314
Swordfish	*Xiphias gladius*	4.5	146116	60244	113156	39053	31631	12950	26002	16977	9753	4833	1334	6606	6645
Tilapia (nile perch	*Lates niloticus*	4.5													330
Tilefish (golden)	*Lopholatilus chamaeleont*	3.9	43922	60476	181162	118460	45920	85359	51443	55884	132563	175203	118474	159786	80204
Tilefish, blueline	*Caulolatilus microps*	3.8	217	963	642	1117	318	4449	1234	673	1329	672	1491	698	416
Triggerfish	*Balistes capriscus*	4.1	50652	22178	36629	28105	28737	23796	38804	41912	43352	24923	17453	13349	25952
Tuna, albacore	*Thunnus alalunga*	4.3	1478	303	399	1834	521	249	159						
Tuna, blackfin,	*Thunnus atlanticus*	4.1	594	708	1314	319	1021	464	178	1600	1111	923	2236	1706	5238
Tuna, bluefin	*Thunnus thynnus*	4.4	2894	8181	2469	3073	4915	3219	4963	8645	2150			609	2473
Tuna, skipjack	*Katsuwonus pelamis*	3.8	231		49	78			230	288	66				
Tuna, bigeye	*Thunnus obesus*	4.5		384	440		1444	128	2123	73		781	386	178	676
Tuna, yellowfin	*Thunnus albacares*	4.4	497939	192549	466375	342646	556725	351830	303724	366818	309835	215124	20854	90175	219780
Tuna, mixed		4.3					229	331							
Tunny, little	*Euthynnus alletteratus*	4.5	5149	2076	9109	3323	940	386	435	481	557	16046	6786	1190	3972
Wahoo	*Acanthocybium solandri*	4.4	16668	5821	14891	24116	18496	14293	13249	10892	4619	5816	1923	4893	4738
Total landings			**3306946**	**2059124**	**3534336**	**3221604**	**2643063**	**2399413**	**2747737**	**2615335**	**2661024**	**2579822**	**2575558**	**2321153**	**3833343**
Mean TL, per year			**4.09**	**4.05**	**4.14**	**3.99**	**4.09**	**3.95**	**3.83**	**3.89**	**3.86**	**3.84**	**3.76**	**3.80**	**3.75**

Species	Taxonomic ID	TL	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987	1986
Appendix D: FFWCC 2011 Annual Landings SummaAppendix D: FFWCC 2011 Annual Landings Summary: Bay County. (cont.)															
Shark	Charcharinidae	4.0	10440	39744	28188	23836	65626	15553	109522	93779	250556	77982	65629	29968	40607
Sheepshead	*Archosargus probatoceph*	3.5	808	351	352	7917	3637	5019	4167	5985	5729	4004	2110	3676	2106
Snapper, grey	*Lutjanus griseus*	4.3	15308	16539	11616	20455	31487	20333	11546	9251	5526	8137	6035	2823	2888
Snapper, lane	*Lutjanus synagris*	3.8	30	521	167	280	436	1083	1462	3600	58	350	935	389	496
Snapper, mutton	*Lutjanus analis*	3.9	276	137	235	342	496	143	620	2803	8534	1530	546	2309	627
Snapper, red	*Lutjanus campechanus*	4.0	19350	15494	46778	30122	107343	66391	152617	155605	259545	201210	168007	111165	286654
Snapper, silk	*Lutjanus vivanus*	3.1	39		31	139	326	51	244	6318	1332	7777	2793	875	1951
Snapper, vermilion	*Rhomboplites aurorubens*	4.3	12333	37346	52729	56739	101720	84255	57100	36861	60027	77472	24252	46633	129277
Snapper, yellowtail	*Ocyurus chrysurus*	4.0		101	435	415	74	12	259		14		13	38	
Snapper, other		3.9	1230	3016	295	387	1303	893	1040	3287	14072	42789	14901	6473	13892
Spot	*Leiostomus xanthurus*	3.2	10348	1500	38	44	3442	1122	226	1283	787	949	1288	1802	2067
Swordfish	*Xiphias gladius*	4.5	10875	13152	22172	24408	49576	53878	42954	45615	143756	239945	192685	68681	138365
Tilapia (nile perch	*Lates niloticus*	4.5						1				17		15	
Tilefish (golden)	*Lopholatilus chamaeleont*	3.9	185394	61824	23047	17711	4913	4530	21569	10880	49888	25369	20517	13665	3811
Tilefish, blueline	*Caulolatilus microps*	3.8	6961	628	1443	4061	532	726	851	1343	5431	6080	2787	2722	223
Triggerfish	*Balistes capriscus*	4.1	16395	20976	24192	33681	47180	56682	33566	39896	31777	26405	9864	9391	11497
Tuna, albacore	*Thunnus alalunga*	4.3		430	333										
Tuna, blackfin,	*Thunnus atlanticus*	4.1	2463	4210	2323	3248	6469	13925	9049	8446	7305	6945	3426	1524	2735
Tuna, bluefin	*Thunnus thynnus*	4.4	541	441	408	509	1763	2105	5034	1451	5431	1814	7138	13513	30008
Tuna, skipjack	*Katsuwonus pelamis*	3.8	70						264		1111	55			
Tuna, bigeye	*Thunnus obesus*	4.5	411	240	123	460	1244	14783	6799	2203	8874	18943	1790	1149	1951
Tuna, yellowfin	*Thunnus albacares*	4.4	278799	209408	305930	188234	406393	927139	1191241	391994	1008884	560269	942359	1418235	3273414
Tuna, mixed		4.3				221	728	1824	58	816	1701	46		8210	131
Tunny, little	*Euthynnus alletteratus*	4.5	4523	48219	4775	8129	336714	103638	208802	120833	95407	43559	33370	40814	750
Wahoo	*Acanthocybium solandri*	4.4	5920	7780	5693	7515	9232	25016	29065	15031	9634	4961	10736	11643	7986
Total landings			**2979775**	**3143486**	**2900122**	**3892298**	**7206593**	**7957468**	**9508813**	**7304287**	**9172572**	**8129898**	**8308746**	**7857694**	**9231923**
Mean TL, per year			**3.81**	**3.81**	**3.79**	**4.03**	**3.85**	**3.86**	**3.84**	**3.82**	**3.86**	**3.87**	**3.93**	**3.88**	**4.00**