ZOOARCHAEOLOGICAL ANALYSIS OF VERTEBRATE REMAINS FROM FIVE LATE ARCHAIC SHELL RINGS ON THE GEORGIA COAST, USA

by

CAROL E. COLANINNO

(Under the Direction of Elizabeth J. Reitz)

ABSTRACT

This research documents human-animal interactions on the Georgia coast during the Late Archaic (3000-2000 cal B.C.). Results of multiple analyses indicate that Late Archaic people fished estuaries extensively, but fish populations were not impacted to the same extent, either anthropogenically or non-anthropogenically, as present-day fish populations. Archaeofaunal collections from five shell rings, which are shell-bearing archaeological formations with mounded shell arranged in a circular pattern around a shell-free center, are analyzed. The collections are from three sea islands and include: the Cannon's Point (9GN57) and West (9GN76) Rings, St. Simons Island; Ring III of the Sapelo Island Shell Ring complex (9MC23), Sapelo Island; and the St. Catherines (9LI231) and McQueen (9LI1648) Shell Rings, St. Catherines Island. The shell ring collections are dominated by estuarine fishes. Sea catfishes, mullets, and drums are the most abundant taxa; other fishes also are present, but to a lesser extent. Deer contribute very few individuals, but sometimes a large percentage of the biomass.

Late Archaic people used mass-capture technologies to exploit small-bodied, estuarine fishes. The fishes most frequently used reflect the local environmental parameters in each estuary. For example, fishes that prefer lower salinities are more common in shell ring

collections from St. Simons Island, which is surrounded by an estuary with a large freshwater input. At the St. Catherines Shell Ring, several zooarchaeological measures including abundance of taxa, diversity, richness, equitability, mean trophic level, and abundance of different fish body sizes and capture type are compared from multiple sections of the ring. The analysis suggests that sections of the ring itself are similar, while remains from the interior of the ring differ from those of the ring itself. The terminal increment in fish otoliths and $\delta^{18}O_{otolith}$ are used to establish the temperature the fish experienced at death. These analyses show that fishing occurred during all four seasons. The incremental structures of modern and archaeological hardhead catfish and Atlantic croaker otoliths suggest that fish grew more slowly in the past compared to present-day growth rates. Possible factors for changes in growth include anthropogenic environmental changes, such as pollution and overfishing, and non-anthropogenic environmental change.

INDEX WORDS: Zooarchaeology, Coastal archaeology, Late Archaic shell rings, Georgia, Otolith incremental formation, Oxygen isotope analysis, Optimal Foraging Models, Intrasite analysis, Seasonality, Fisheries, Human impacts on fish populations

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by

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CHAPTER 1:

AN INTRODUCTION TO THE HISTORICAL ECOLOGY OF THE LATE ARCHAIC GEORGIA COAST

Over the past several decades, researchers have identified a global crisis among marine ecosystems (Jackson et al. 2001; Pauly et al. 1998). Marine fauna, once thought of as inexhaustible resources, have experienced precipitous population declines (Hutchings and Reynolds 2004), changes in growth patterns (Morita and Fukuwaka 2007; Rijnsdorp and van Leeuwen 1992), and shifts in community structure (Jørgersen et al. 2007; Myers and Worm 2003). Some of these changes may be caused by anthropogenic environmental changes, such as over-exploitation, pollution, global climate change, habitat destruction, and the introduction of exotic species (Benning et al. 2002; Blais et al. 2005; Carlton 2003; Hutchings and Reynolds 2004; Kerr et al. 2010; Perry et al. 2005; Stirling et al. 1999).

Although the dire condition of numerous marine systems was recognized only over the last few decades, archaeological research documents instances of human impacts on marine environments extending thousands of years in the past (Rick and Erlandson 2008). Archaeological evidence indicates that human predation deleteriously impacted marine populations and ecosystems around the world (Braje et al. 2007; Broughton 1997; Burney 1997; Butler 2001; Jerardino 2010; Kennett et al. 2008; Kirch 1997, 2004; Leach and Davidson 2000; Miller et al. 1999; Nagaoka 2002; Quitmyer and Jones 2000; Reitz 2004a; Rick et al. 2008; Steadman 1989; Steadman and Jones 2007; Steadman et al. 1984; Wing and Wing 2001). In

other cases, however, the archaeological record suggests that humans maintained a long-term, sustainable relationship with marine systems (Campbell and Butler 2010; Carder et al. 2007; McNiven and Bedingfield 2008; Perdikaris and McGovern 2008; Reitz et al. 2008a), with little adverse impact on animal populations or abiotic environments (Kirch 1997).

These contrasting studies occur within two divergent and opposite positions of human-environmental interactions (Balée 1998). One view argues that small-scale societies lived in harmony with their surrounding environment, easily adjusting to changing environmental parameters in a way that is beneficial to the abiotic and biotic communities around them. This doctrine often is referred to as the "Ecologically Noble Savage" (Redford 1991).

The view of the "Ecologically Noble Savage" is featured in hunter-gatherer literature as the "original affluent society" (Sahlins 1968, 1972). Much like the "Ecologically Noble Savage," the view of hunter-gatherers as the original affluent society romanticizes the relationship between hunter-gatherers and the environment. This concept paints the picture of hunter-gatherer populations moving across the landscape lacking territorial boundaries, social stratification, and the need for personal property (Rowley-Conwy 2001). Under this view, hunter-gatherers have a "zen-like" relationship with the environment and the ability to prosper without destroying their surroundings (Lee and Daly 1999:1; Rowley-Conwy 2001).

However, hunter-gatherers do not always fit this model of affluence. A great degree of diversity is recognized among hunter-gatherer population sizes, foraging strategies, mobility, and social practices (Binford 1980; Kelly 1995:18; Rowley-Conwy 2001; Woodburn 1982), and the vast degree of social and political complexity among hunter-gatherers is acknowledged (Kelly 1995; Price and Brown 1985; Thompson 2006). Nor do hunter-gatherers populations fit a model of having a long-term, harmonious relationship with the environment, leading to the view of

Homo devastans (Balée 1996). Hunter-gatherer populations can be large (Kelly 1995:205-213), with limited mobility (Kelly 1995:148-152; Russo 1998), and use technologies that heavily impact animal and plant populations and the landscape (Pyne 1998). This understanding of hunter-gatherer social complexity leads to the question of whether archaeological populations of hunter-gatherers impacted local environments long before the industrialization of modern society.

Although human actions do not inevitably lead to environmental degradation or to improved environment conditions, humans play a pivotal role in shaping land and seascapes (Grayson 2001; Pyne 1998; Redman 1999). Given the deep history of humans in marine environments (Erlandson 2001), it is increasingly more important to contextualize present-day marine systems within a long-term framework that considers human social systems (Pauly 1995; Redman et al. 2004a). Furthermore, the relationship between humans and the environment should be viewed as a dialectical interaction, where both humans and the environment are joined through interactivity, rather than a one-sided dichotomy with either being an idle member in this relationship (Balée 1998; Crumley 1994; Gragson 1998).

Historical ecology provides such a theoretical framework. Historical ecology views human social systems and the biosphere as a historical dialogue where human actions and natural, environmental dynamics continuously interact with one another (Crumley 2001). Humans and the environment influence and respond to one another in a continuous cycle. Humans constantly respond to environmental fluctuations and oscillations, while abiotic and biotic communities continuously react to human actions. The historical processes of these continual human-environmental interactions are active agents in the manifestation of an ecosystem at any point in time (Kidder 1998). This dialogue is transferred to the land and

seascape and can be reconstructed using multiple lines of data and models from numerous disciplines (Crumley 1994, 2001). Historical ecology postulates that humans are keystone species impacting the biosphere even when human population densities are low. Humans have the potential to affect the biosphere in ways that differ from other life forms, whether their effects are negative or positive (Crumley 2001).

Human-environmental interactions can be studied through artifacts of human actions in relation to the environment, particularly the decisions humans make as to which animals to exploit. On a daily basis, humans choose animals to use and include in their diet among all available resources in the environment. These choices reflect how humans interact with their environment and changes in animal communities reflect how animals respond to the choices humans made. Similarly, the animals that humans exploit represent the environmental variability of the landscape. The interaction between past human populations and animal communities can be examined by studying animal remains (bones, teeth, and shells) from archaeological sites, a branch of archaeology known as zooarchaeology (Reitz and Wing 2008). Historical ecology provides the bridging framework to join several zooarchaeological and ecological measures and models that evidence past human-environmental interactions in marine systems.

Hunter-Gatherers of the Late Archaic Georgia Coast

The archaeological record of the Georgia coast offers an ideal case study for human-environmental interactions in marine systems and for documenting whether hunter-gatherer populations had an ecologically "noble" or "devastating" relationship with the environment. The Georgia coast has been occupied by humans for at least the past 5,000 years, generally with year-round human activity (Andrus and Crowe 2008; Quitmyer et al. 1985, 1997; Thompson 2006; Thompson and Andrus 2011). Earlier sites may exist on the portion of the continental shelf that

is below present-day sea levels, but these sites are currently not available for study (Thompson and Worth 2010).

There is also a pressing need to document the historical trajectory between humans and marine environments in this area because present-day fisheries data indicate that the Atlantic fisheries are part of a global fishery and overall marine ecosystem collapse (Pauly et al. 1998). However, the short time perspective of current fisheries data limits a comprehensive evaluation of the extent to which early human actions impacted modern fisheries (Jackson et al. 2001; Pauly et al. 1998).

The first step towards understanding this relationship is to examine the earliest archaeological evidence of human interactions with marine environments, the Late Archaic period (3000-2000 cal B.C.). The Late Archaic period of the southeastern United States is a dynamic time both culturally and environmentally. Human populations moved across the landscape and increased in numbers (Anderson 1996). As human populations expanded, they brought with them new technologies, subsistence systems, and social organizations that are not archaeologically recorded during previous time periods (Russo 1991, 2010:150-151; Sassaman 1993, 1996). Recent archaeological research reveals the extent of social, political, and economic complexity, sedentism, and ritualism among these fisher-hunter-gatherer populations (Reitz et al. 2009; Saunders 2004; Thompson 2006).

The Late Archaic period of the Georgia coast also represents a dynamic time environmentally. Fluctuations in temperatures and sea levels, in addition to other biogeochemical changes, occurred just prior to and during the Late Archaic period (Anderson et al. 2007; Jones et al. 2005; Thomas 2008a:42-47, 2010:179; Thompson and Turck 2009). These changes likely played a role in human behavior during the Late Archaic. These dynamic cultural and

environmental parameters of the Late Archaic Southeast are evidenced in the numerous shell rings along the South Carolina, Georgia, and Florida coasts (Russo 2004; Russo and Heide 2001). Late Archaic shell rings are shell-bearing archaeological formations with mounded shell arranged in a circular or semi-circular pattern around a generally shell-free center. Some shell rings have shell deposits and other features in the interior plazas (Russo and Heide 2001; Sanger and Thomas 2010). The function of the shell rings is unknown (Marquardt 2010a; Russo 2004; Sassaman 2004; Saunders 2004; Thompson 2007; Trinkley 1985). Recent research suggests that the shell rings were circular villages and the shell deposits represents accumulated secondary refuse (Thompson 2007). The function of the shell rings may have changed through time as rings evolved into complete, enclosed circular structures with cleared, central plazas (Thompson 2007). Others suggest that the shell rings served as entrapment areas for fresh water from rainfall and areas where wells were dug (Marquardt 2010a). Ground water levels in the past likely were much higher on the Georgia sea islands (Hayes and Thomas 2008), so this latter function seems unlikely. It is clear that further archaeological testing is needed (DePratter 2010: Marquardt 2010a). The cultural and environmental data from the Late Archaic shell rings provide an ideal opportunity to study early human-environmental interactions on the Georgia coast.

The Late Archaic Georgia Coast Zooarchaeological Research Design

The goal of this research is to document the interaction between past hunter-gatherers and marine environments, to determine which animal communities and populations were heavily exploited and to examine if hunter-gatherers had a deleterious impact on these animal populations of the Late Archaic Georgia coast. Emphasis is placed on the interaction humans had with the vertebrate community. Vertebrate faunal remains from five shell rings are the basis of this research. The collections examined are from three Georgia sea islands and include: the

Cannon's Point (9GN57) and West (9GN76) Rings, St. Simons Island; Ring III of the Sapelo Island Shell Ring complex (9MC23), Sapelo Island; and the St. Catherines (9LI231) and McQueen (9LI1648) Shell Rings, St. Catherines Island (Figure 1.1; Marrinan 1975, 2010; Reitz et al. 2009; Sanger 2010; Sanger and Thomas 2010; Thomas 2008b:555-557, 2010; Thompson et al. 2004; Thompson 2006).

By systematically examining archaeofaunal collections from these sites, five research objectives concerning human-environmental interactions are investigated. These objectives are: (1) to compare the archaeofaunal collections from the shell rings with human behavioral ecology models developed for the Georgia sea islands (Thomas 2008a), (2) to identify regional and local fishing practices, (3) to examine the horizontal distribution of vertebrate remains at the St. Catherines Shell Ring, (4) to examine seasonal use of fishes and compare these data to models of seasonal resource use of molluscs (Quitmyer et al. 1985, 1997; Thompson and Andrus 2011), and (5) to examine ichthyofaunal remains for evidence of anthropogenic and non-anthropogenic environmental change.

Human Behavioral Ecology and Vertebrate Fauna from the Shell Rings

Archaeological applications of optimal foraging models developed over the past several decades (Bettinger 1991; Kelly 1995). Derived from human behavioral ecology, optimal foraging models predict human behavior by applying principles of natural selection to explain how humans should behave ideally (Kaplan and Hill 1992). Optimal foraging models operate under the assumption that humans, during the course of decision making, choose the most economically rational decision by maximizing fitness-related currencies (Kaplan and Hill 1992). Optimal foraging models cover an extensive range of specific predictions such as resource selections, field processing, time allocation, and land use (Kennett 2005; Nagaoka 2005a, 2006;

Smith 1991; Smith and Winterhalder 1992; Winterhalder 2001; Winterhalder and Smith 2000). Each model employs a set of assumptions and constraints and each model tests hypotheses concerning human behavior under certain environmental parameters (Bettinger 1991:84).

The Diet Breadth Model

The diet breadth, or prey-choice, model predicts the dietary resources, or food items, a forager should select given: (1) the abundance of a resource, (2) the energy that the resource provides, (3) the amount of energy needed to acquire the resource, and (4) the amount of time needed to acquire that resource, once it is selected (Bettinger 1991:84). More simply, these parameters are defined as the number of calories gained per time (e.g., energy) minus the calories required to search, collect, and process the resource. This is also known as the post-encounter return rate (Bettinger 1991:84; Thomas 2008a:64). Under the diet-breadth model, all available resources are ranked according to their post-encounter return rate. Foragers should always select the highest ranking prey items when encountered. Lower ranking prey items are only added to the diet once encounter rates of highly ranked prey are insufficiently frequent. Under the diet-breadth model, it is assumed that resources are distributed without patchiness, known as the fine-grained search assumption (Thomas 2008a:63).

To establish a diet-breadth model, the return rates for potential prey are calculated. Estimates of return rates generally are obtained through ethnoarchaeological and experimental research (Lindström 1996; Lupo and Schmitt 2005; Smith 1991; Thomas 2008a:74-197; Ugan 2005a; Winterhalder 1981). Return rates for several marine taxa are calculated and some diet-breadth models are available for coastal areas (Braje et al. 2007; Broughton 1999, 2002; Butler 2001; Erlandson et al. 2005; Kennett 2005), including the Georgia coast (Thomas 2008a, 2008c). Some models suggest that, as with most terrestrial environments, large-bodied marine taxa are

the highest ranking because large-bodied taxa probably would yield the greatest number of calories given the time spent hunting and processing, or the greatest post-encounter return rates (Broughton 1999; Nagaoka 2002; Thomas 2008a:195). Others suggest that in environments where animals aggregate, aggregating taxa may provide higher post-encounter return rates relative to large-bodied taxa. This is because aggregating taxa can be captured en mass rather than individually, which reduces the time spent capturing these taxa and increases the quantity of calories captured (Kennett 2005:24; Madsen and Schmitt 1998; Rick et al. 2001). These two models are tested using the archaeofaunal collections from the shell rings.

The Patch-Choice and Hunt-Type Model

Resources are not always distributed homogeneously across the landscape as the diet-breadth model assumes. Where resources are located within discrete patches, the patch-choice model addresses which set of patches foragers should include in their foraging strategy (Bettinger 1991:87-90; Lupo 2007; Winterhalder 2001). A patch is defined as a "spatially bounded entity characterized by the set of prey (of one or more types) contained within it" (Smith 1991:249). The patch-choice model is very similar to the diet-breadth model and both models share the same constraints. The main difference with the patch-choice model is that rather than individually encountering prey items, foragers confront an assortment of patches that are ranked according to the profitability of the patch (Bettinger 1991:88). A forager should exploit the most profitable patch first, electing to move to other patches only when foraging in another patch becomes more profitable (Bettinger 1991:89).

Developed out of the patch choice-model, the hunt-type model (Smith 1991) may be more applicable to the archaeofaunal collections of the Late Archaic shell rings. Smith (1991:269) and Thomas (2008a:258) argue that foragers do not necessarily divide their foraging

landscape into habitats or patches (Smith 1991:268). Rather, foragers allocate their foraging efforts to "hunt types" (Smith 1991:156-169). Hunt types are defined as "a constellation of factors that indicate specialization in the foraging process and that lead to an expected foraging outcome that differs predictably from other types of foraging" (Smith 1991:156). Hunt types can be associated with a particular species, particular patch types, specialized methods of capture, such as terrestrial hunting or fishing, and seasonal or environmental conditions, or any combination of these variables (Smith 1991:156). The hunt-type model follows the same parameters and constraints as the patch-choice model, but allows for a broader definition of "patch" (Thomas 2008a:258). The phrase "hunt type" is used to refer to both hunting and fishing procurement strategies (Smith 1991:156) when vertebrate data from the shell rings are interpreted within the hunt-type model.

When not in reference to the hunt-type model, hunting refers to the chase and search of wild, non-fish taxa, and fishing refers to the search and capture of fishes. The term "fish" is used throughout this volume to refer to true fishes, also known as finfishes, or those with an endoskeleton. The term shellfishing is used to reference the search and capture of aquatic crustaceans and molluscs.

A hunt-type model developed for the Georgia coast suggests that saltwater fishing (fishing in Georgia estuaries) provides the greatest post-encounter return rate of the available hunt types (Thomas 2008a:258-260). This hunt-type model is tested using the archaeofaunal collections from the shell rings.

Fish Remains from the Late Archaic Shell Rings

Inferences about Late Archaic human-environmental interactions are made regarding the prey and patches humans exploited by testing the diet-breadth and hunt-type models for the

Georgia coast (Thomas 2008a). There are inherent constraints when operationalizing optimal foraging models in the archaeological context (Lyman 2003) and some of the nuances in foraging behaviors may be overlooked by only testing these two models. Further characterizations of the Late Archaic archaeofaunal collections offer information about other aspects of the human-environmental interaction.

Previous research suggests that fishes were an important subsistence resource for hunter-gatherers of the shell rings (Compton 2004; Marrinan 1975, 2010; Reitz 2008; Reitz et al. 2009). Archaeological fish remains reflect the choices humans made as to which fishes to exploit, which to ignore, the timing and location of fishing activities, technologies used for acquiring and processing fishes, and where to consume fish and dispose of the remains. These aspects of human behavior have important implications in documenting the interaction between Late Archaic human and fish populations and provide additional information as to which fish populations may have experienced impacts from environmental fluctuations, both anthropogenic and non-anthropogenic. To further explore how humans interacted with fish populations, three characterizations of the ichthyofaunal collections are assessed: (1) fish ubiquity, (2) relative abundance of fish families, and (3) expected fish mortality profiles for different fishing technologies.

Ubiquitous fish taxa, defined as taxa that are present in all five shell ring collections, are examined to identity which fishes were most heavily predated by human populations. Ubiquitous fish taxa provide valuable information regarding how humans interacted with fish populations, but the relative abundance of fishes in each collection furthers the interpretation of human-environmental interactions and also is examined. The suite of fishes that are ubiquitous with high

relative abundances provide information as to which aquatic habitats were frequently exploited, when fishing occurred, and what types of technologies were used to capture fishes.

Inferences made about fishing technologies through the ubiquity and relative abundance data are strengthened by examining the mortality profiles of three ubiquitous fish families. The mortality profile analysis of the size distribution of archaeological fish population is based on the relationship between the natural size or age structure of a living population and the non-random, size or age selectively of a hunting or fishing technology (Butler 1996; Byers and Hill 2009; Greenspan 1998). Mortality profiles of the archaeological fish populations are generated by reconstructing the size of fishes represented in the ichthyofaunal collections. The mortality profile of the archaeological fish populations are compared to the natural size distribution of the population. By comparing the differences in the size distributions, the types of fishing technologies used by Late Archaic inhabitants of the Georgia coast are identified based on the size-selective nature of fishing technologies (Balme 1983; Butler 1996; Greenspan 1998; Klein 1982; Noe-Nygaard 1983). Through these analyses, fish taxa that would most likely experience impacts from natural environmental fluctuations and human predation are identified and further documentation of the human-environmental interaction is recorded.

Intrasite Analysis of Vertebrate Fauna from the St. Catherines Shell Ring

The first two research goals are concerned with how humans interacted with vertebrate communities at a regional level (i.e., the Georgia coast). Although examining the archaeofaunal collections at the intersite level addresses regional interpretations of human-environmental interactions, it is also important to identify how humans interacted with vertebrate communities differently within the boundaries of an archaeological site. Different segments of the population at these shell rings may have interacted with the environment differently and different areas

within the shell rings may represent different activities areas. For example, some people could have had access to better fishing and hunting locations and technologies compared to other portions of the population. Alternatively, an intrasite analysis may provide information regarding activities areas. An intrasite analysis of non-faunal artifacts at Ring III of the Sapelo Island Shell Ring complex led to the conclusion that different areas within this ring were associated with different activities (Thompson 2007). Similar analysis of faunal and non-faunal artifacts has not been conducted at other shell rings and it remains unknown if distinct activity areas or differential access to resources within a shell ring site can be identified. Differential access to resources and activity areas within the shell rings may be represented in the horizontal distribution of animal remains.

These issues are addressed by comparing four archaeofaunal collections from different portions of the St. Catherines Shell Ring. Multiple contexts, sampled using identical methods, were excavated and studied from the St. Catherines Shell Ring which makes this ring ideal for an intrasite analysis. Three excavated clusters within the St. Catherines Shell Ring, known collectively as the Ring Area, and one area from the interior of the ring, the Interior Area, are compared to identify patterns in the horizontal distribution of vertebrate faunal remains. Several secondary zooarchaeological measures of the Ring and Interior Area collections are compared.

Seasonal Resource Use at the Shell Rings

Documenting patterns of seasonal movement is an integral step towards understanding how Late Archaic populations interacted with the environment. Humans often make choices regarding seasonal movement based on the timing and availability of resources. For the Georgia coast, research suggests that seasonal movement, for at least some segment of the Late Archaic

population, was limited and year-round exploitation of particular mollusc species is documented (Quitmyer et al. 1997; Thompson and Andrus 2011).

For example, Quitmyer and his colleagues (1985) used incremental banding of hard clams from the Cannon's Point Ring to determine that hard clams were harvested during all four seasons, with the heaviest exploitation in the spring. Thompson and Andrus (2011) conducted a similar study at the Sapelo Island Shell Ring complex and determined that at least some portion of the population occupied two of the shell rings, Rings II and III, throughout the year, while only winter and possibly fall occupations were represented in the collection studied from Ring I (Thompson and Andrus 2011). Although these studies advanced our understanding of the human-environmental interaction during the Late Archaic, only two aspects of the biotic environment, hard clams and oysters, were examined. No study has examined the seasonality of fishing at the shell rings. The seasonal movement of the Late Archaic populations in relation to fish communities has important implications for determining the extent to which humans had deleterious impacts on animal populations. Therefore, the fourth research goal is to document evidence of seasonal fishing at the shell rings.

Fishes that are seasonally sensitive were used at several shell rings to infer fishing seasonality, but such studies have limitations (Russo 1998). Generally, fishes occupying Georgia estuaries do so during multiple seasons and are not present during only one specific season. A more sensitive measure of seasonal fishing is needed. The seasonal periodicity of incremental banding and $\delta^{18}O$ profiles of fish otoliths are used to determine season of fish capture in other areas of the world (Higham and Horn 2000; Van Neer et al. 1999, 2004). The feasibility of these methods is evaluated for two estuarine fishes, hardhead catfishes (*Ariopsis felis*) and Atlantic croakers (*Micropogonias undulatus*), using modern collections and known time of capture.

These methods are then applied to archaeological otoliths to determine the season in which the fish was captured.

Year-round occupation, although documented at several shell rings, is not demonstrated at all of the shell rings (Thompson and Andrus 2011), and year-round occupation cannot be assumed. Seasonality data have not been examined for the West and McQueen Shell Rings and this research tests the year-round model of site occupation for these two sites. The implications for seasonal fishing patterns on fish populations also are explored.

Environmental Impacts on Late Archaic Fisheries

Numerous researchers report instances of profound impacts on past marine fisheries, most likely caused by human actions (Braje et al. 2007; Butler 2001; Rick et al. 2008). As previous studies document, vertebrate remains from the Late Archaic shell rings indicate a reliance on fishing (Compton 2004; Marrinan 1975, 2010; Reitz 2008; Reitz et al. 2009; Russo 2002). Because such a large portion of the subsistence economy relied on estuarine fishes, it is possible that some fish populations were overfished. The final research goal is to examine ichthyofaunal remains from the shell rings for evidence of human impacts on exploited fish populations.

Identifying human impacts on archaeological animal populations or communities is difficult. Several models that test human impacts on fish populations and communities are established in the archaeological literature. Two of the most widely applied models are resource depression, derived from the diet-breadth model, and a temporal decrease in fish sizes (Broughton 1997; Butler 2001; Carder et al. 2007). Although these models are useful and are applied successfully to numerous archaeofaunal collections, they cannot be applied to the archaeofaunal collections from the Georgia shell rings. This is because, in most cases, these

models depend on the assumption that humans selectively targeted large-bodied fishes as opposed to medium- and small-bodied fishes. This assumption cannot be applied to the shell ring ichthyofaunal collections, as previous research demonstrates that small-bodied, estuarine fishes were a major component of the fishing economy and that large-bodied fishes are rare in these collections (Compton 2004; Reitz and Quitmyer 1988).

Rather than favoring the resource depression or temporal reduction in fish sizes models, the density-dependent model, which states that as more fishes are removed from a population, fishes will reach larger sizes at younger ages, or experience faster growth rates, is favored. Increased growth rates are caused by the elimination of density-dependent controls on population (Jennings et al. 1999). Density-dependent controls affect growth rates of a population and vary with population density (Pianka 2000:182). When density-dependent controls are eliminated, individuals experience greater food or habitat availability and individuals reach larger sizes at younger ages.

To determine if overfishing occurred during the Late Archaic period of the Georgia coast, three parameters of archaeological fish populations are examined: (1) age distribution, (2) growth curves, and (3) growth rates. These parameters are examined in hardhead catfishes and Atlantic croakers. The results of these analyses are compared to modern hardhead catfish and Atlantic croaker populations to determine if there are changes in the age distribution, growth curves, and growth rates since the Late Archaic.

Although overfishing can alter the age distribution and growth rates of fish populations, natural environmental fluctuations not related to human predation also impact the age distribution and growth rates of fish populations (Attrill and Power 2002; Brunel and Boucher 2007; Hare and Able 2007; Marshall and McAdam 2007; Perry et al. 2005; Rose 2004;

Sandweiss et al. 2004; Ware and Thomson 2005). Before overfishing is inferred the environmental parameters in which these fish populations lived must also be considered. Therefore, age distribution, growth curves, and growth rates are examined in conjunction with stable oxygen isotopic profiles ($\delta^{18}O$) of fish otoliths to test for evidence of environmental change not related to human predation. Combined, these two lines of evidence provide the necessary data to evaluate human impacts on fisheries in the Late Archaic. These data advance understanding of the human-environmental relationship and provide the beginnings of the extended timeframe needed to evaluate present-day fisheries of the Georgia coast.

Overview and Organization of this Volume

This first chapter provides a review of the theoretical framework and research goals. Several methodological concerns of these research goals are reviewed in this chapter. Many of these issues resurface and are developed further in the forthcoming chapters.

The second chapter situates the Late Archaic shell rings both environmentally and culturally. Chapter 2 starts with a description of the physical and abiotic setting of the Georgia coast. An overview of the present-day biotic communities is presented. In this overview, emphasis is placed on taxa commonly identified in Georgia coastal archaeofaunal collections. Habitat preferences and seasonal movements of these taxa are provided. Chapter 2 concludes with a brief overview of the history of the Georgia coast prior to A.D 1500.

The zooarchaeological materials studied and methods employed are reviewed in Chapter 3. This chapter addresses the excavations techniques used to recover each archaeofaunal collection as well as how these collections are aggregated for analysis. The potential biases of these samples and the biases inherent to zooarchaeological research are briefly presented.

Criteria used to select otoliths for incremental growth and isotopic sampling and the methods used to conduct these analyses also are presented

The results of the vertebrate faunal analysis for the shell rings are presented in Chapter 4. The data presented in Chapter 4 are interpreted and elaborated in Chapters 5, 6, 7, 8, and 9.

In Chapter 5, the vertebrate faunal remains from these five collections are examined within the framework of human behavioral ecology, particularly the diet-breadth and hunt-type models. These data are used to test the subsistence predictions developed through experimental and ecological observations (Thomas 2008a). Taxa that most likely experienced overfishing during the Late Archaic are identified.

In Chapter 6, the ichthyofaunal collections from the five shell rings are compared. These data are used to infer differences in fishing environments and technologies. This chapter provides a broad characterization of Late Archaic fishing strategies and an explanation for regional variation of the fishing strategies.

In Chapter 7, further examinations of the human-environmental interactions are made through an intrasite analysis of variation in the horizontal distribution of faunal remains from the St. Catherines Shell Ring. This analysis is used to address explanations for the human behavior responsible for the formation of the shell ring, areas at the shell ring that may have been used for different activities, and deposits that may have represented non-egalitarian behavior.

Chapter 8 examines seasonal use of fishes at the shell rings. The feasibility of using incremental banding and oxygen isotopic profiles of fish otoliths is evaluated. Evidence for seasonal fishing is examined by characterizing the terminal increments and $\delta^{18}O$ of the terminal band for two fish species, the hardhead catfish and Atlantic croaker.

Evidence for environmental impacts on local fisheries, both anthropogenic and non-anthropogenic, are reviewed in Chapter 9. Evidence for environmental impacts is derived from age distribution, growth curves, and growth rates of hardhead catfishes and Atlantic croakers. Temperature regimes for the Late Archaic Georgia coast also are estimated using $\delta^{18}O$ calculated from fish otoliths. These data are compared with modern fish growth rates and temperature regimes. Evidence for deep-time fluctuations in these measures is reviewed and implications for overfishing are examined.

Chapter 10 reviews the data, research, and interpretations and relates these findings to the theoretical understanding of human-environmental interactions in marine systems. The significance of this research is reviewed both in terms of archaeological significance and of the larger scientific pursuit of documenting deep-past environmental variations and human resource use. Areas of future research also are explored and the research conclusions are presented.

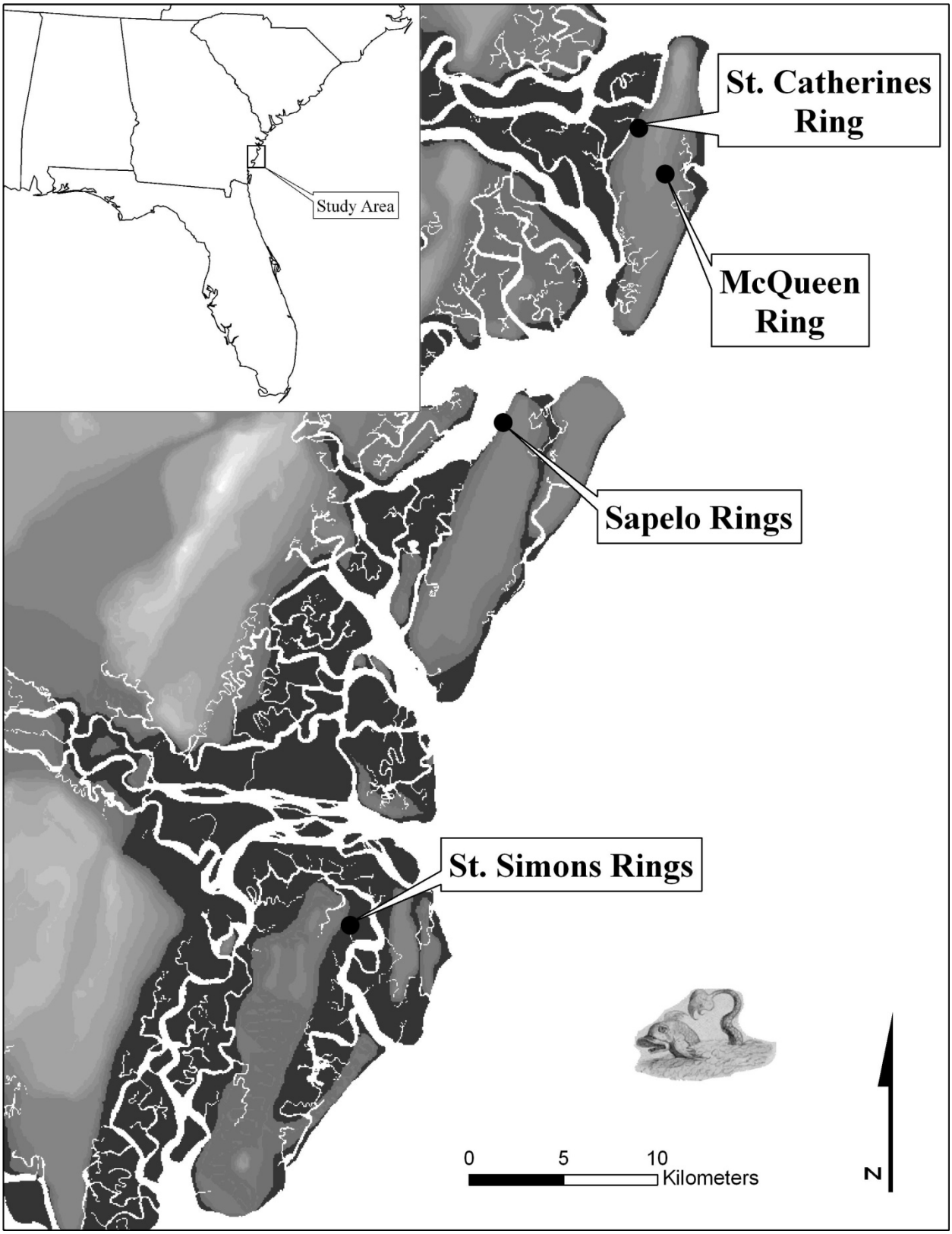


Figure 1.1: Map of study area showing location of the Late Archaic shell rings in this study.

CHAPTER 2:

THE NATURAL AND CULTURAL HISTORIES OF THE GEORGIA COAST

The environmental and cultural histories of the Georgia coast are dynamic and have been interrelated for at least the past 5,000 years. The coastal areas of Georgia, located within the Georgia Bight, continuously change in relation to tidal and seasonal cycles along with local and global climatic patterns. Although environmental factors do not determine human actions, local environments provide a background of available resources which humans selectively exploit. In turn, the choices humans make regarding their surroundings impact the environment, intentionally or unintentionally. The Georgia coast provides a rich resource base which human populations exploit. Coastal environments are very productive, containing an abundance of fishes, shellfishes, and other semi-aquatic animals. Additionally, the sea islands, protecting the coastline, support unique habitats for many terrestrial taxa. This chapter describes the major environmental features of the Georgia coast, summarizes some regional taxa with emphasis on those common to archaeofaunal collections of the area, and briefly reviews the cultural history of the Late Archaic and subsequent cultural periods prior to A.D. 1500.

The Environmental Setting of the Georgia Coast

The Abiotic and Biotic Communities

The coast of Georgia is part of a large, shallow embayment extending from Cape Hatteras, North Carolina to Cape Canaveral, Florida, known as the Georgia Bight. This portion of the Georgia Bight is characterized by a series of coastal, or barrier, islands separated from the

mainland by several kilometers of salt marshes, sounds, and tidal estuaries (Johnson et al. 1974:11; Reitz et al. 2008b:48). The barrier islands of Georgia range from 5-15 km in length, 1-5 km in width, and have island elevations around 8 m, although individual dunes can be much higher (Johnson et al. 1974:11).

Climatically, the Georgia coast is characterized as subtropical (Schubauer and Hopkinson 1984) with well defined seasons (Dame et al. 2000). The Georgia coast experiences short, mild winters when estuarine water temperatures can drop to less than 10°C (Dame et al. 2000). Summers are long, hot, and humid and water temperatures can well exceed 30°C during the hottest months, typically July and August (Dame et al. 2000). Rainfall averages around 1397 mm, with most of the precipitation occurring between June and September.

Geologically, the Georgia sea islands are characterized as Holocene beach-ridge barrier islands with Pleistocene cores (Linsley et al. 2008:26). However, each island formed from a series of sedimentary depositions and sea level fluctuations (Linsley et al. 2008:26). Generally, the sediments of Georgia sea islands are composed of fine to medium grained sands (Johnson et al. 1974:91; Linsley et al. 2008:26).

The interior portions of the islands contain a wide variety of habitats, including forests, fields, sloughs, and ponds (Hayes and Thomas 2008; Johnson et al. 1974). The forests of the island interiors include live oak, pine, mixed hardwood, cypress-gum, and bay communities (Johnson et al. 1974:45). Maritime live oak forests are dominated by live oaks that form closed canopies (Johnson et al. 1974:45). The understory of live oak forests is comprised of low, woody plants such as saw palmettos and vacciniums (Johnson et al. 1974:45).

The live oak forests of the Georgia barrier islands are important because they are prime habitats for white-tailed deer (*Odocoileus virginianus*); an animal that was a key subsistence

resource in the past (Thomas 2008c:948-955). In recent years, large populations of deer live on several of the sea islands. These populations are sustained mainly on mast from live and laurel oaks as well as other leafy green vegetation (Thomas 2008a:142-145). During the fall, acorns become abundant in maritime forests, supplying deer with the majority of their diet at that time (Osborne et al. 1992). In addition to white-tailed deer, other fauna, such as opossums (*Didelphis virginiana*), squirrels (*Sciurus* spp.), and turkeys (*Meleagris gallopavo*) inhabit maritime oak forests. Such fauna, although less common in archaeological sites than deer, were subsistence resources for past human populations.

Although deer and these other mammals are most commonly associated with live oak forests, they are found in nearly all terrestrial habitats of the sea islands, including pine forests, marsh edges, beaches, and dunes (Johnson et al. 1974:59). Pine forests occupy well-drained soils compared to live oak forests (Johnson et al. 1974:49). Pine forests tend to have open canopies, allowing herbaceous ground cover to dominate the understory (Johnson et al. 1974:49). Although not currently found on most of the sea islands, gopher tortoise (*Gopherus polyphemus*) prefer pine forest habitats.

Ponds and sloughs form in low-lying areas of the sea islands and contain fresh to brackish waters (Johnson et al. 1974:51). In some cases, these ponds and sloughs contain water throughout the year while others dry out during the drier months. Freshwater ponds and sloughs may have been more abundant on the Georgia sea islands before recent demands by urban development drew down groundwater. Prior to modern population expansions, freshwater was easily obtained by digging shallow wells into the nonartesian reservoirs of groundwater overlaying the Florida aquifer (Hayes and Thomas 2008:56-57). Particularly on St. Catherines Island, the distribution of soil types and the dendritic arrangements of old ground water outflows

indicates large, freshwater lagoon likely occupied the center of the island (Hayes and Thomas 2008: 58). Changes in mean sea level, land forms, and precipitation may have affected the location and size of freshwater sources over time.

Several animal taxa are attracted to such freshwater and other marshy areas. Among the native mammals of the Georgia sea islands, opossums, cottontail rabbits (*Sylvilagus* spp.), raccoons (*Procyon lotor*), river otters (*Lontra canadensis*), and minks (*Neovison vison*) are associated with ponds, sloughs, and freshwater marshes. Additionally, damp and swampy environments support numerous species of aquatic birds, many of which are migratory (Johnson et al. 1974:77). Herons (Ardeidae) and ducks (Anatidae) are found in damp areas. In the winter months, loons (*Gavia* spp.) occupy these habitats. They also support numerous reptiles. Turtles, particularly snapping (*Chelydra serpentina*), mud and musk (Kinosternidae), and pond turtles (Emydidae), are common to the fresh and brackish waters of the island's interior. The American alligator (*Alligator mississippiensis*) inhabits ponds and sloughs, though it can be found in salt marshes (Johnson et al. 1974:63-64; Thomas 2008a:149). If areas of fresh water were expansive in the past (Hayes and Thomas 2008), it is possible that these freshwater resources supported small populations of freshwater fishes, such as bowfins (*Amia calva*), freshwater catfishes (Ictaluridae), and sunfishes (Centrarchidae). Bowfins and sunfishes, in particular, need fresh water to sustain viable populations.

The estuaries and coastlines surrounding the Georgia sea islands provide a wide array of habitat types for numerous marine and, at times, freshwater taxa. The waters surrounding the Georgia barrier islands can be divided into two major habitats: the offshore zone and the inshore zone (Dahlberg 1975:4). The offshore zone extends from the beaches, eastward along the continental shelf (Dahlberg 1975:10). This habitat is characterized by sandy and sand-mud

bottoms (Dahlberg 1975:10). In the offshore areas, waters are generally warmer than inshore waters due to the flow of the Florida Current; therefore, tropical to subtropical fishes inhabit offshore waters (Dahlberg 1975:10; Reitz 1982). Although offshore areas host a wide array of marine organisms (Dahlberg 1975:10-11), there is no evidence that these areas were exploited until the advent of industrialized fishing in the twentieth century (Reitz 2004a:72; Reitz et al. 2008b).

The inshore zone of the Georgia coast includes the waters of the seaward beaches, salt marsh and riverine estuaries, deep sounds, and the maze of tidal creeks, pools, and marshes. This zone provides a wide range of highly productive and protected habitats for numerous aquatic organisms (Johnson et al. 1974:11). The seaward coastlines are characterized by sandy, gently sloping beaches and dunes, which are continuously reshaped by the winds, waves, and currents of the oceanic environment (Johnson et al. 1974:16-21). Although the tidal fluctuation is great, the coastlines of the sea islands experience moderate to low wave energy with average wave heights of less than 0.1 m (Hubbard et al. 1979; Johnson et al. 1974:24).

Several species of fishes and sea turtles are common in the waters adjacent to the beaches. Female sea turtles emerge from the oceanic waters to nest on the beaches from April through August where they could easily be preyed upon by humans (Ernst and Barbour 1972:234; Thomas 2008a:158). Hatchlings emerge from sand nests approximately two months after the eggs are deposited (Ernst and Barbour 1972:236). Five species of sea turtles inhabit the Atlantic waters of the Georgia coast. These include loggerhead (*Caretta caretta*), hawksbill (*Eretmochelys imbricata*), Kemp's ridley (*Lepidochelys kempii*), green (*Chelonia mydas*), and leatherback (*Dermochelys coriacea*) turtles (Thomas 2008a:156). Loggerheads are the most common of these species (Thomas 2008a:156).

The estuaries of the Georgia coast are connected with the Atlantic Ocean by the deep sounds that separate the islands. The saline waters of the sounds and estuaries are diluted by the influx of freshwaters from the major river drainages of the mainland. Estuaries that are directly associated with major rivers have greater salinity gradients compared to estuaries without a major river drainage (Frey and Howard 1986). The Georgia coastal estuaries can be divided into three areas based on the extent to which each experiences saline marine waters (Dahlberg 1972, 1975). These areas are the low, middle, and upper reaches. The lower reaches of the estuary are those furthest from the mainland and have the highest salinity levels. The upper reaches of the estuaries are closest to the mainland, having the lowest salinity levels. The middle reaches lay between the lower and upper reaches. The estuaries of the Georgia coast are characterized by a diverse array of habitats including salt marshes, mud flats, tidal creeks, and oyster bars.

Numerous marine and aquatic animals are found in the Georgia estuaries and are identified in archaeofaunal collections of the Georgia coast (Keene 2002, 2004; Marrinan 1975, 2010; Quitmyer and Reitz 2006; Reitz 1988; Reitz and Quitmyer 1988; Reitz 2008; Reitz et al. 2009, 2010). Two families of fishes, sea catfish (Ariidae) and drum (Sciaenidae) are commonly recovered from archaeological collections of the Georgia coast (Reitz et al. 2008b:52). While these two families are the most abundant, many other marine species are included in these assemblages (Reitz et al. 2008b:52-53). Vertebrate fauna typical to archaeological sites include cartilaginous fishes, such as sharks, skates, and rays (Chondrichthyes), gars (*Lepisosteus* spp.), herrings and shads (Clupeidae), mullets (*Mugil* spp.), killifishes (Cyprinodontidae), and sand flounders (Paralichthyidae). Although several families of commonly identified estuarine fishes are reviewed below, numerous other fishes are common to the waters surrounding the Georgia

sea islands. For example, trawls in the Sapelo Island estuary captured 70 species of fishes from 37 families (Dahlberg and Odum 1970).

Various cartilaginous species inhabit the inshore waters of the Georgia coast. Many of these species prefer warm waters and are only found inshore during the warmer months of the year (Dahlberg 1972:334). Sharks can be found in shallow beach waters as well as the deeper waters of the sounds and offshore areas (Dahlberg 1975:23). Skates (Rajiformes) and rays (Myliobatiformes) of the Georgia coast are bottom dwellers. Skates generally inhabit more saline waters, while rays tolerate varying levels of salinity. Although many species of rays and skates reside in the estuary throughout the year, several are sensitive to seasonal temperature and salinity changes (Dahlberg 1975:28-31).

Two species of gar, the longnose (*Lepisosteus osseus*) and Florida gar (*Lepisosteus platyrhincus*), are found in Georgia estuaries (Dahlberg 1972, 1975:32-33). Gars primarily reside in fresh waters (Dahlberg 1975:32-33); however, longnose gars are abundant in fresh and brackish waters surrounding the Georgia coast (Dahlberg 1972:334). The longnose gars occur throughout the year in Georgia estuaries (Dahlberg 1972:334). Florida gars are less frequent to Georgia coastal waters and only are recorded in the upper reaches of the estuaries (Dahlberg 1972:334).

Several species of herrings and shads (Clupeidae) are common to Georgia estuaries. Shads (*Alosa* spp.) reach the largest body size among the members of the clupeid family and are anadromous (Facey and Van Den Avyle 1986). Shads ascend the rivers of Georgia to mate throughout the late winter and spring, depending on the species (Dahlberg 1975:37; Facey and Van Den Avyle 1986). Menhadens (*Brevoortia* spp.) are common in Georgia coastal waters (Dahlberg 1975:37-38). Menhadens are schooling fishes that can be captured in many high-

salinity habitats along the beach and in high marshes, tidal canals, and tidal pools (Dahlberg 1975:38). Menhadens are likely found in Georgia coastal waters during warmer months, although the Atlantic menhaden (*Brevoortia tyrannus*) stays in the estuaries during the winter as well (Dahlberg 1972).

Catfishes (Siluriformes) are common in Georgia estuaries and are abundant in archaeological collections from the southeastern Atlantic coast. Three species of catfishes, one freshwater (Ictaluridae) and two marine (Ariidae), frequently are reported (Dahlberg 1975:42-43). The white catfish (*Ameiurus catus*) is the most commonly identified freshwater catfish in the Georgia estuaries (Dahlberg 1975:42). This species enters less saline areas of the Georgia estuaries during the cooler months of the year, particularly January and February (Dahlberg 1972). Several other species of freshwater catfish are found in the Georgia estuaries, but these are less abundant (Dahlberg 1972). Two species of sea catfishes inhabit the coastal waters throughout the southeastern United States: the hardhead catfish (*Ariopsis felis*) and the gafftopsail catfish (*Bagre marinus*). Hardhead catfishes are the more common of the two species and tolerate a greater range of temperatures and salinity levels (Muncy and Wingo 1983; NFEC 1975). Sea catfishes are commonly found in the lower reaches of the estuaries but also can be found in the middle reaches and along the beaches (Dahlberg 1972). Sea catfishes typically migrate offshore during the winter months for warmer, offshore waters, but small numbers of individuals stay in the estuaries throughout the year (Dahlberg 1972). Both hardhead and gafftopsail catfishes are bottom feeders. Gut contents indicate that both species principally consume decapods, fishes, and detritus (Kobelkowsky and Castillo-River 1995). Gafftopsails reportedly consume mainly fishes and detritus while hardhead catfishes consume more decapods,

particularly juvenile crabs (Darnell 1961; Kobelkowsky and Castillo-River 1995; Reid et al. 1956).

Another abundant taxon of estuaries is mullet (Dahlberg 1975:76). Two species of mullet, the striped mullet (*Mugil cephalus*) and the white mullet (*M. curema*), occur throughout estuaries, into the upper reaches, and occasionally into inland rivers (Dahlberg 1972). Striped and white mullets have similar habitat preferences and feeding habits. Both species are herbivores often feeding on the same food sources at the same locations (Collins 1985a). Striped mullets are the more common of the two species, tolerating a greater range of salinities and temperatures compared to white mullets (Dahlberg 1972). Striped mullets are collected from the Georgia estuaries throughout the year, although they are less common from September through April when they migrate offshore to spawn (Dahlberg 1972). White mullets are not found in the estuaries from January through March as they spawn offshore (Dahlberg 1972). Young mullets are abundant in shallow waters of the salt marshes, tidal creeks, and tidal pools, while adult mullets prefer deeper waters.

Killifishes are small-bodied fishes common to shallow waters throughout the estuaries (Dahlberg 1975:48-50). They tolerate a wide range of salinities and temperatures (Dahlberg 1972). Killifishes reside in estuaries throughout the year and rarely migrate far from their home range (Abraham 1985).

Members of the drum family are often the most common vertebrates recovered from archaeological sites along the Georgia coast and several species of this family remain important sport fishes (Dahlberg 1975:69; Thomas 2008a:119). Some members of the drum family migrate into Georgia estuaries as larvae. As small-bodied, juvenile fishes, the young drums use the estuaries of Georgia as nursery grounds because estuaries provide a refuge from the harsh

conditions of the ocean. Once these fishes reach maturity, they migrate in and out of estuaries, often for reproduction and feeding opportunities.

Silver perches (*Bairdiella chrysoura*) are among the most commonly captured member of the drum family from Georgia coastal waters (Dahlberg 1972). Silver perches occupy nearly all habitats of the lower and middle reaches of the estuary as well as waters along the beaches (Dahlberg 1972). They are captured throughout the year and feed on benthic invertebrates (Stickney et al. 1975). Silver perches spawn during April and May (Dahlberg 1972).

Three species of seatrouts (*Cynoscion* spp.) are common to the coastal areas of Georgia (Dahlberg 1975:70). The spotted seatrout (*C. nebulosus*) is present in coastal waters throughout the year (Johnson and Seaman 1986). Some spotted seatrouts migrate offshore during the winter months for warmer waters (Johnson and Seaman 1986). Spotted seatrouts are captured in the inner bays of the estuaries as well as along beaches and in the salt marshes (Dahlberg 1972). Silver seatrouts (*C. nothus*) are more common off beaches rather than in estuarine waters, although they enter the lower reaches of estuaries in May and reside there through July or August (Dahlberg 1972). Weakfishes (*C. regalis*) prefer deeper waters of the estuary in or near channels in high salinity areas of the lower and middle reaches (Dahlberg 1972; Mercer 1989). Weakfishes form aggregates and leave inshore waters during the cooler months of the year, specifically December through April (Dahlberg 1972; Mercer 1989).

Although rarely recovered from archaeological assemblages, the banded drum (*Larimus faciatus*) resides in coastal waters of Georgia throughout the year (Dahlberg 1972). This species is restricted to highly saline waters, particularly in the lower reaches and along the beaches (Dahlberg 1972).

Spots (*Leiostomus xanthurus*) are another fish of the drum family that are common to coastal waters of Georgia (Dahlberg 1975:71). Adult and juvenile spots occur in numerous areas of the estuarine benthos (Stickney et al. 1975). Adults are commonly found in deeper, saline waters, while juveniles are more abundant in oligohaline creeks, tidal pools, and tidal ditches (Dahlberg 1972). Spots are abundant in estuarine waters during the warmer months, migrating offshore from October through April to spawn (Hales and Van Den Avyle 1989).

Atlantic croakers (*Micropogonias undulatus*) are similar in appearance to spots, and have comparable benthic feeding habits. Atlantic croakers are opportunistic feeders (Stickney et al. 1975). They are found throughout the coastal habitats during the warmer months (Dahlberg 1972). Atlantic croakers move offshore from September through April for spawning, although they are reported in coastal waters throughout the year (Stickney et al. 1975). Atlantic croakers become abundant in Georgia estuaries between May and August (Dahlberg 1972).

Three species of kingfishes, the southern (*Menticirrhus americanus*), the Gulf (*M. littoralis*), and the northern (*M. saxatilis*), are found along the Georgia coast (Dahlberg 1975:71-72). All kingfish species can be found in the highly saline waters of the lower reaches and along the beaches (Dahlberg 1972). Southern kingfishes occasionally enter lower saline waters of the upper reaches (Dahlberg 1972). Southern kingfishes migrate out of the estuaries in March and April to spawn offshore (Dahlberg 1972). Gulf kingfishes can be captured along the beaches from May to November and spawns from April to September (Dahlberg 1972). Northern kingfishes are the least common kingfish in the Georgia estuaries (Dahlberg 1972). Northern kingfishes are most frequently found along the beaches in April and May.

The two largest-bodied species of drum common to the coastal waters of Georgia are black drums (*Pogonias cromis*) and red drums (*Sciaenops ocellatus*). Large black drums are

reported in the lower reaches of the Georgia estuaries, although very large individuals are rare (Dahlberg 1972). Smaller black drums are found in the estuaries throughout the year. Black drums spawn in deeper waters of the estuaries from winter to early spring (Sutter et al. 1986). Red drums are present in the estuaries throughout the year (Dahlberg 1972), though some species migrate out of the estuaries to nearshore waters in late summer and fall (Reagan 1985).

The star drum (*Stellifer lanceolatus*) is one of the most abundant fishes in the Georgia estuaries and is particularly plentiful in the lower reaches (Dahlberg and Odum 1972; Stickney et al. 1975). Although they are most abundant in the lower reaches, they also are found along the beaches and in the middle reaches of the estuaries. Star drums prefer more saline waters, and are rare in upstream, low salinity areas (Stickney et al. 1975). Star drums are most abundant during the warmer months and most leave estuarine waters during the winter months (Dahlberg 1972), although they are documented in estuaries throughout the year (Stickney et al. 1975). Star drums are a very small-bodied taxon that rarely reaches sizes over 17 cm (Dahlberg 1975:72).

Two families of flounders are present in Georgia estuaries, left-eyed flounders (Bothidae) and sand flounders (Paralichthyidae). All the species from these two families are bottom-dwelling carnivores. Although some species may leave estuaries during particular seasons, other species of both flounder families reside in estuaries throughout the year (Dahlberg 1975:92-96).

Although fishes are a major inhabitant of the Georgia estuaries, numerous other vertebrates reside in the estuaries. Reptiles, such as alligators, are commonly seen swimming throughout estuarine waters of Georgia. Diamondback terrapins (*Malaclemys terrapin*) are prominent in the brackish and salt waters of the Georgia coast. Diamondback terrapins are adapted to living in saline waters, but occasionally come on land and forge in tidal flats and salt marshes. Remains of coots and rails (Rallidae) are found among archaeological assemblages

from the Georgia coast. This family of birds nests in the cordgrass of the salt marshes and feeds along the mud flats (Johnson et al. 1974:76).

Invertebrates are also a major component of archaeological sites along the Georgia coast and compose the matrix of the Late Archaic shell rings. Few data are available for invertebrates from coastal southeastern archaeological sites (but see, Quitmyer and Reitz 2006; Reitz and Quitmyer 1988). Where invertebrate remains are reported, it is evident that molluscs and crustaceans common to shallow, estuarine waters were used extensively (Quitmyer and Reitz 2006; Reitz and Quitmyer 1988). These include species that frequently inhabit salt marshes, oyster bars, mud flats, and sandy bottoms. Some invertebrates that are common to archaeofaunal collections include: oysters (*Crassostrea virginica*), hard clams (*Mercenaria* spp.), blue crabs (*Callinectes* spp.), whelks (*Busycon* spp.), Atlantic ribbed mussels (*Geukensia demissa*), eastern mudsnails (*Ilynassa obsolet*), marsh periwinkles (*Littorina irrorata*), white and brown shrimps (*Penaeus* spp.), Carolina marsh clams (*Polymesoda caroliniana*), and stout tagelus (*Tagelus plebeius*).

The Late Archaic Period of the Georgia Coast

A primary goal among archaeologists is tracing human populations across time and space. This objective generated a large number of cultural nomenclatures used throughout the southeastern United States. Although such nomenclatures can be meaningless, if well-defined terminology is used by all researchers, a standardized framework can be established that characterizes who lived where, when, and what they were doing. I employ the terminology defined by Thomas (2008b), who drew upon the chronology proposed by DePratter (1979).

People lived on the Georgia sea islands by the Late Archaic period. Human populations likely occupied coastal areas before the Late Archaic period; however, sites predating this period

are currently inundated due to the sea-level rise associated with the Hypsithermal warming interval at the transition to the mid-Holocene (Anderson et al. 2007; Deevey and Flint 1957). The Late Archaic is locally known on the barrier islands as the St. Simons period (Thomas 2008b:410-412). Two phases are defined for the Late Archaic period. The earlier phase, the St. Simons I phase, dates from 2750 cal yr B.C. to 1980 cal yr B.C. (Thomas 2008b:406). This phase is marked by the predominance of St. Simons plain ceramics (Thomas 2008b:406). The St. Simons II phase is marked by both St. Simons plain and decorated ceramics. Neither of the Archaic phases are associated with plant cultivation.

It was during the St. Simons period that shell rings were constructed and an unambiguous, intensive, settlement of the Georgia coast occurred (Sanger and Thomas 2010; Thompson and Turck 2009; Thompson and Worth 2010). Other Late Archaic site types are non-ring shell middens and artifact scatters. During this time, groups of fishers, hunters, and gatherers occupied the islands throughout the year, focusing on coastal and estuarine resources (Thomas 2008c:927; Thompson and Turck 2009). The number of humans occupying the sea islands during this interval is unknown. Based on site density for the Georgia coast, Thompson and Turck (2009) propose relatively rapid population growth on the barrier islands given the large density of sites, which suggests a large number of humans. The island-wide transect survey on St. Catherines Island by Thomas (2008c:1048-1049), however, found that the St. Simon period had the lowest site density of all time periods on the island. It may be that individual islands supported a wide range of human population sizes during the Late Archaic.

The period following the Late Archaic is known regionally as the Early Woodland period and, on the sea islands, as the Refuge period (Thomas 2010:Table 8.1). Starting around 1350 cal yr B.C. (Thomas 2008b:406; Thomas and Sanger 2010), this period marks a change from the

subsistence and settlement patterns of the Late Archaic. During the Refuge period, there is a drastic reduction in the number of documented archaeological sites throughout the coastal areas of Georgia (Thompson and Turck 2009), although site densities on specific islands, including St. Catherines Island, may have increased (Thomas 2008c:1049). The reduction in archaeological site densities during the Refuge period may be related to a drop in sea level around 2300 cal yr B.C., which lasted until 1600 cal yr B.C. (Gayes et al. 1992; Thomas 2008a:42-47, 2010; Thompson and Turck 2009; Thompson and Worth 2010). Lowered sea levels likely changed the temperature and salinity levels of the waters surrounding the barrier islands. In turn, these abiotic changes impacted the aquatic plants and animals, possibly to the point where the islands could no longer sustain as many people (Thomas 2008c:1049; Thompson and Turck 2009; Thompson and Worth 2010).

Human populations eventually returned to the Georgia coast in larger numbers than in the Late Archaic period. This occurred during the regionally known Mississippian period. Locally, the Mississippian period is divided into the Savannah (A.D. 1200-1325) and Irene (A.D. 1325-1580) periods on the sea islands (Thomas 2008b:423). Population growth ultimately gave raise to large settlements and politically stratified chiefdoms during these periods. Human populations also expanded their subsistence economies to include maize cultivation, although the extent to which farming occurred on the sea islands is highly debated (Jones 1978; Keene 2004; Larson 1980; Thomas 2008a:22-23). The time periods following the Late Archaic are important in defining the historical trajectory of the Georgia coast, however, they are not part of this study.

Summary

The abiotic setting of the Georgia sea islands is a dynamic one and provides a productive environment for numerous plants and animals, including many mammals, birds, and turtles.

Likewise, the Georgia estuaries provided habitats for many bird, reptile, fish, and invertebrate species (Dahlberg 1972, 1975; Johnson et al. 1974). These habitats of the Georgia coast and the surrounding waters were the location for human settlements extending back approximately 5,000 years.

CHAPTER 3:

ZOOARCHAEOLOGICAL MATERIALS AND METHODS

Over the past several decades, archaeologists developed procedures that meet the standards of the scientific method. As part of any scientific endeavor, the materials and methods used to collect and interpret data must be appropriate to the research objectives. In this chapter, the materials and methods used for this study are reviewed. Each archaeological site is briefly described and the excavation techniques used to collect the archaeofaunal samples are presented. This chapter also describes the zooarchaeological research design including: (1) how the materials were selected for analysis, sampled, and aggregated, (2) how the results were generated and quantitatively summarized, and (3) the potential biases associated with recovery, aggregation, identification, and quantification of zooarchaeological remains.

A list of the collections and proveniences included in the zooarchaeological analysis conducted by the author as part of this study, as well as the sampling technique is presented as Appendix A. A list of taxonomic names for identified taxa and other classifications discussed in this and the following chapters is provided in Appendix B. Common names are used throughout the remainder of this volume. The reader should refer to Appendix B for specific taxonomic classifications.

Zooarchaeological Materials

Archaeological Excavations at the Cannon's Point and West Rings, St. Simons Island, Georgia

The Cannon's Point (9GN57) and the West Rings (9GN76) of St. Simons Island, Georgia are located on the northeastern end of the island on Cannon's Point (Figure 3.1; Table 3.1). The Cannon's Point Ring is the larger of the two rings with a diameter of 49 m and a height ranging from 1.8 to 1.3 m. The Cannon's Point Ring does not form an enclosed circle; the northeastern arc of the ring is open (Marrinan 1975:22). The West Ring is located approximately 85 m southwest of the Cannon's Point Ring. It has a diameter of 42 m and a height ranging from 0.65 to 0.45 m. The southern portion of the West Ring currently is under water and it is not known if the West Ring forms a continuous ring (Marrinan 1975:30).

Rochelle Marrinan excavated at the Cannon's Point and West Rings between 1972 and 1975 (Marrinan 1975, 2010). This research was pioneering as a coastal Late Archaic shell ring excavation. Analysis of the Cannon's Point and West Rings included zooarchaeological analysis of faunal remains recovered from six units (Marrinan 1975). A combination of 0.64 and 0.32 cm screens were used to recover vertebrate remains. Two excavation units, one from each of the rings, were exclusively screened with 0.32 cm screen. Vertebrate fauna from these units (Cannon's Point Ring, Unit 18N 0E and West Ring, Unit 5S 30E) are included in the Late Archaic shell ring research project presented as part of this analysis. Unit 18N 0E is a 3 x 3 m excavation unit located in the northwestern portion of the Cannon's Point Ring at the highest point of the ring (Marrinan 1975:28, 2010). Unit 5S 30E is a 2 x 2 m excavation unit located in the northern arc of the West Ring (Figure 3.2; Table 3.1). Both units were excavated in 5 cm arbitrary levels. Oysters from the Cannon's Point Ring indicate deposition between 2760 and

2200 cal B.C., while oysters from the West Ring indicate deposition between 2320 and 1970 cal B.C. (Marrinan 2010:Table 4.1).

Archaeological Excavations at the Sapelo Island Shell Ring Complex, Sapelo Island, Georgia

The Sapelo Island Shell Ring complex (9MC23) is located on the northwestern portion of Sapelo Island, Georgia (Thompson et al. 2004; Thompson 2006). The site consists of three large shell rings and numerous amorphous shell formations. The three rings are labeled III, I, and II from south to north (Figure 3.3). Ring I is a continuous ring and is the only visible ring, with a present-day elevation between 2 to 3 m above the ground's surface and a diameter of approximately 90 m (Thompson et al. 2004). Ring II has a diameter similar to Ring I and is located just north of Ring I. Ring III is located south of Ring I and is the smallest of the rings, with a diameter around 50 m (Thompson et al. 2004). Unlike Ring I, Rings II and III show little or no increase in surface elevation and are not continuous rings (Thompson 2007).

Victor D. Thompson conducted the most recent excavations at the Sapelo Island Shell Ring complex from 2002 through 2006. Thompson placed numerous excavation units in and around the three rings. Vertebrate fauna from the Unit 9, Ring III column sample (25 cm x 25 cm) are examined and reported in this study. The Unit 9 column sample was placed in the southwestern portion of Ring III in an area of dense shell (Thompson 2006:133). The column sample was excavated in 5 cm arbitrary levels and water-screened through fine-screen mesh (less than or equal to 0.32 cm). Vertebrate fauna from general-level excavations of Ring III, Unit 4 are also reported here. Unit 4 was a 1 x 1 m unit, excavated in 10 cm arbitrary levels and placed in the northwestern portion of Ring III in an area of dense shell deposits (Thompson 2006:118). Faunal remains from this analytic unit are not used in quantified analyses due to the large screen size (0.64 cm) used to recover fauna. This collection is examined only for presence/absence of

taxa. Screen sizes larger than 0.32 cm do not adequately recover remains of smaller fishes (Quitmyer 2003; Reitz 2004b:Table 1), which are abundant in Late Archaic shell ring matrix. Charcoal samples from Ring III indicate an occupation between 2332 and 1740 cal B.C. (Thompson 2007).

Archaeological Excavations at the St. Catherines Shell Ring, St. Catherines Island, Georgia

Archaeological investigations at the St. Catherines Shell Ring (AMNH504, 9LI231), formally known as the Long Field Crescent, were conducted by David Hurst Thomas of the American Museum of Natural History. The St. Catherines Shell Ring is located on the leeward side of the island, a few meters from the western marshes (Sanger and Thomas 2010). This site originally was investigated in the 1977-1979 transect survey of the island (Sanger and Thomas 2010; Thomas 2008a:303). Only information from the transect excavations were reported previously (Reitz 2008:627).

Additional, extensive archaeological mapping and excavations at the St. Catherines Shell Ring were conducted from 2006 to 2008 (Sanger and Thomas 2010). These investigations found that the shell ring was occupied between 2600 to 1770 cal B.C. (dates obtained from oyster; Thomas 2008b:556). Excavations were conducted in 10 cm arbitrary levels. Animal remains were recovered by water-screening matrix through a series of nested screens with meshes ranging from 2.54 to 0.32 cm.

Vertebrate fauna from six 1 x 1 m excavations units from the North Area, two 1 x 1 m units from the West Area, one 1 x 1 m from the East Area, and two features, 5 and 23, from the interior of the ring were identified. The units from each portion of the ring are designated as: the North Area, West Area, East Area, and Interior Area and were analyzed and quantified separately (Figure 3.4; Table 3.1). Excavations units from the North, West, and East Areas of the

ring generally are characterized by a matrix of densely packed shell. Animal remains from the top three levels were not included in the West Area analysis because these remains were possibly disturbed by a plantation-era boundary ditch (Sanger and Thomas 2010:52). The southern half of the St. Catherines Shell Ring was not excavated. Features 5 and 23 were located within the center of the St. Catherines Shell Ring and date to the primary accumulation period of the shell ring deposit (Sanger et al. 2007). The features are described as circular, with nearly straight walls and flat bottoms (Sanger and Thomas 2010:58). The two features contained large quantities of shell and bone, though not to the same extent as the matrix of the ring. Both features were slightly larger than 1 m in diameter and approximately 1 m in depth (Sanger et al. 2007). The function of these features is unknown (Sanger and Thomas 2010:58). These features may have been large holes where posts or storage pits were once located or possibly were areas for processing mast (Sanger and Thomas 2010:58). DePratter (2010:251) suggests that these features were intentionally excavated to bury something, such as animal remains, while Marquardt (2010b:258) speculates that they were freshwater wells dug during periods of drought.

Archaeological Excavations at the McQueen Shell Ring, St. Catherines Island, Georgia

The McQueen Shell Ring (AMNH 696, 9LI1648) was discovered on St. Catherines Island in 2007 (Sanger and Thomas 2010). The McQueen Ring is located on the seaward side of the island a few meters from the island's eastern marsh, known as McQueen Inlet (Sanger and Thomas 2010). The McQueen Ring has dimensions similar to those of the St. Catherines Shell Ring. The McQueen Shell Ring has a diameter of approximately 70 m and deposits extend from 30 to 70 cm below the surface. The McQueen Shell Ring dates overlap those of the St. Catherines Shell Ring. Radiocarbon dates for the McQueen Shell Ring range from 2300 to 1950

cal B.C. (dates taken from both shell and charcoal). Excavations are ongoing at the McQueen Shell Ring and more fine-grained dating may be developed at this ring.

Excavations at the McQueen Shell Ring followed the same procedures as those described for the St. Catherines Shell Ring. All units were excavated in 10 cm arbitrary levels and vertebrate animal remains were water-screened through a series of nested screens with meshes ranging from 2.54 to 0.32 cm.

Vertebrate remains from two 1 x 1 m excavations units, N213 E198 and N263 E179, were analyzed (Figure 3.5; Table 3.1). Unit N213 E198 is located in the southern arc of the ring, and Unit N263 E179 is located in the northwest arc. Both units were placed at the high points of the ring to maximize the amount of midden sampled.

Shell Ring Stratigraphy and Dating

It is unknown whether any or all of these rings were contemporaneous. The occupation dates for all the shell rings included in this study overlap (Table 3.1). This prohibits a longitudinal study of the shell ring collections over time within the Late Archaic period. Temporal sequences within each site are not established for all shell rings. Ongoing work at the McQueen Shell Ring may establish a detailed temporal sequence for this site, but similar temporal sequences currently are not available for the contexts studied here. Soil analysis of shell middens from other regions of North America suggest that shell midden soil stratigraphy may be related to the infiltration of ground water rather than human behavior and temporal sequences (Stein 1992, 1996). If fluctuations in ground water affected stratigraphy (Hayes and Thomas 2008:56-58), ground water infiltration may be a factor in the visual soil stratigraphy of the shell rings. Further work is needed to fully understand the complex stratigraphy in each shell ring and

how these shell rings temporally relate to each other. This necessary research is ongoing in some locations.

Zooarchaeological Methods

Methods of Zooarchaeological Identification and Primary Data

All vertebrate animal remains were identified following standard zooarchaeological methods (Reitz and Wing 2008). Identifications from Ring III of the Sapelo Island Shell Ring complex, the St. Catherines Shell Ring, and the McQueen Shell Ring were made using the comparative skeletal collection of the Zooarchaeology Laboratory, Georgia Museum of Natural History, University of Georgia by Carol Colaninno. Laboratory assistance in the form of sorting, weighing, and measuring some of the vertebrate remains was provided by Glenn A. Thomas. All vertebrate fauna from the Cannon's Point and West Rings were identified by Marrinan using the zooarchaeological comparative collection at the Florida Museum of Natural History (Marrinan 1975, 2010). These identifications are included in the regional vertebrate analysis of Late Archaic shell rings. The author re-tabulated Marrinan's (1975) zooarchaeological analysis, measured fish otoliths and atlases, and calculated several secondary data. Otoliths from the Cannon's Point and West Rings also were selected by the author for incremental and oxygen isotopic analyses.

A number of primary data classes were recorded during analysis. These include taxonomic identification, element representation, portion recovered, bilateral symmetry, anatomical indicators of age and sex, modifications, specimen weight, and measurements. The Number of Identified Specimens (NISP) refers to the number of identified specimens in the sample. Specimens that cross-mend are counted as a single specimen. Specimens identified as indeterminate vertebrate are not counted because these specimens tend to be highly fragmented.

Invertebrate fragments are present in the samples studied but are not reported because they do not represent all invertebrates in these collections.

During the identification stage, archaeological specimens are identified to the lowest possible taxonomic classification by comparing them to known reference skeletal specimens. Element representation, portion recovered, and bilateral symmetry also are recorded. After specimens are identified, all specimens are weighed to provide additional information about relative abundance of each taxon.

Anatomical features such as sex and age at death also are recorded during identification. Generally, there are few unambiguous indicators of sex present in zooarchaeological assemblages. Males are indicated by the presence of spurs on the tarsometatarsus of gallinaceous birds, antlers on deer, the baculum in those species that have one, and pelvic characteristics. Male turtles are indicated by a depression on the plastron that accommodates the female during mating. Females are recognized either by the absence of these features or by different shapes in these features. Female birds may also be identified by the presence of medullary bone (Rick 1975). Another approach is to compare measurements of identified specimens for evidence of specimens which fall into a male or female range; however, zooarchaeological collections are rarely large enough to accurately identify the sex of individuals using this approach.

Anatomical indicators of age are estimated based on the observed degree of epiphyseal fusion for diagnostic elements, tooth eruption, and tooth wear (Gilbert 1980:102; Reitz and Wing 2008:172-178; Severinghaus 1949). The relative age of mammal species in these collections is estimated from the degree of epiphyseal fusion. When animals are immature, a cartilaginous plate separates the shaft (diaphysis) of the element from the ends of the element (epiphyses). When maturity is reached and growth is completed, these cartilaginous plates ossify. While

environmental factors influence the actual age at which fusion is complete, elements fuse in a regular temporal sequence (Gilbert 1980; Purdue 1983; Reitz and Wing 2008:173-174; Schmid 1972; Watson 1978). During analysis, specimens are recorded as either fused or unfused and placed into one of three categories based on the age in which fusion generally occurs. Unfused elements in the Early-fusing category are interpreted as evidence for juveniles; unfused elements in the Middle-fusing and Late-fusing categories are usually interpreted as evidence for subadults, though sometimes characteristics of the specimen may suggest a juvenile. Fused specimens in the Late-fusing group provide evidence for adults. Fused specimens in the Early- and Middle-fusing groups are indeterminate. Clearly fusion is more informative for unfused elements that fuse early in the maturation sequence and for fused elements that complete fusion late in the maturation process than it is for other elements. An Early-fusing element that is fused could be from an animal that died immediately after fusion was complete or many years later. The ambiguity inherent in age grouping is somewhat reduced by recording each element under the oldest category possible. Tooth eruption data are also recorded (e.g., Severinghaus 1949).

Modifications can indicate butchering methods as well as site formation processes. Modifications are classified as pathological, hacked, cut, burned, calcined, worked, and rodent-gnawed. Although NISP for specimens identified as indeterminate vertebrate are not included in the species lists, modified indeterminate vertebrate specimens are quantified in the modification tables.

Hacked and cut specimens are the product of butchering and food preparation. Hack marks are evidence that a large tool was used. Presumably, a hatchet or axe was used to dismember the carcass before, rather than after, the meat was cooked. Cuts are small incisions across the surface of specimens. These marks were probably made by knives when meat was

removed before or after the meat was cooked. Cuts also may be left on specimens if attempts are made to disarticulate the carcass at joints. Some marks that appear to be made by human tools may actually be abrasions inflicted after the specimens were discarded. Distinguishing the source of small cuts requires higher powered magnification than is currently available at the Georgia Museum of Natural History (Shipman and Rose 1983).

Burned and calcined specimens are the result of exposure to fire when a cut of meat is roasted or if specimens are burned intentionally or unintentionally after discard. Burned specimens result from the carbonization of bone collagen and are identified by their charred-black coloration (Lyman 1994:384-385). Calcined specimens are usually indicated by white or blue-gray discoloration (Lyman 1994:385-386). Calcined bones are the result of two possible processes: burning at extreme temperatures (greater or equal to 600ºC) or leaching of calcite. Both processes are believed to have occurred in these assemblages, but no attempt was made to distinguish between them. Experimental studies indicate that the color of bone may be a poor indicator of the type of modification because it is difficult to precisely describe color variation and other diagenetic factors may alter bone color (Lyman 1994:385).

Worked specimens provide evidence of human modification probably not associated with butchery, such as the manufacture of tools, jewelry, and other items. Grooved and snapped specimens are also classified as worked bone. Grooved and snapped specimens display clear indications that the shaft of the bone was intentionally grooved to remove a portion of the bone from the whole element. Worked specimens briefly are discussed in the results sections. The entire worked bone assemblage is not represented in these collections as some worked bone was removed from the non-worked zooarchaeological remains prior to sending the collection for

zooarchaeological analyses. Therefore, the percentage of worked bones in these collections is underrepresented.

Gnawing by rodents indicates that specimens were not immediately buried after disposal. While burial would not ensure an absence of gnawing, exposure of specimens might result in gnawing. Rodents include such animals as mice, rats, and squirrels. Gnawing by rodents can result in loss of an unknown quantity of discarded material.

Measurements of archaeological specimens are important primary data and are recorded for those specimens with complete measureable features. Measurements of the greatest length, width, and thickness for fish otoliths are recorded, as well as the greatest anterior width of fish atlases (Reitz and Wing 2008:187). For sea catfish otoliths, an additional measurement of breadth is taken (Figure 3.6). These measurements are presented in Appendix C and are abbreviated as follows: length as Len, breadth as Brt, width as Wdh, and thickness as Th. Measurements for mammals and birds are recorded following Driesch (1976) and are reported in Appendix D.

Secondary Measures of Zooarchaeology

A number of secondary data are calculated from the primary data recorded during identification. These secondary measures include: minimum number of individuals (MNI); biomass; measures of diversity, richness, and equitability; presence/absence; ubiquity; mean trophic level, classification of fish taxa based on body size and aggregating or schooling behavior, and back calculating the standard length of archaeological fishes from the measurement of archaeological specimens.

The term "MNI" refers to the minimum number of individuals necessary to account for all the specimens of a given taxon (Grayson 1979:203-224; Reitz and Wing 2008:205-210;

White 1953). MNI is estimated based on paired elements, size, and age. MNI is estimated at the lowest possible taxonomic level except where a greater MNI estimation is suggested at a higher taxonomic level. Where MNI is estimated at a higher taxonomic level, the MNI estimate for the lower taxonomic level is provided in parentheses and is not included in subsequent calculations.

Although MNI is a standard zooarchaeological quantification, the measure has several well-known biases. For example, MNI skews the relative importance of certain taxa over others. This can be demonstrated in a hypothetical sample consisting of twenty mullets and one white-tailed deer. Although twenty mullets indicate emphasis on mullet, one deer likely supplied more meat. Estimates of MNI are also subject to identifiable biases. Some elements are more readily identifiable than others and the taxa represented by these elements may be incorrectly perceived as more significant to the subsistence economy than animals with less distinctive elements. Hardhead catfish neurocranium fragments are readily identified from very small fragments and exemplify this situation. Conversely, some taxa represented by large numbers of specimens may present few paired elements; hence, the number of individuals for these specimens may be underestimated. Turtle specimens, for example, are subject to this bias. MNI for these animals will usually be underestimated relative to the number of identified specimens. Basic to MNI is the assumption that the entire individual was utilized at the site. From ethnographic evidence, it is known that this is not necessarily true (O'Connell et al. 1990; Perkins and Daly 1968). This is particularly the case for large-bodied taxa, animals used for special purposes, and where food exchange was an important economic activity (Thomas 1971; White 1953).

In addition to these primary biases, MNI also is subject to secondary biases introduced by the way samples are aggregated during analysis (Grayson 1973). The aggregation of archaeological samples into analytical units allows for a conservative estimate of MNI, while the

"maximum distinction" method, applied when analysis discerns discrete sample units, results in a much larger MNI (Grayson 1973). For Ring III of the Sapelo Island Shell Ring complex and the St. Catherines and McQueen Shell Rings, archaeological excavation units that were spaced at least 10 m apart were analyzed separately (Table 3.1). It is possible that individual animals were shared throughout each site. Individuals reported for one area of these sites may be the same individual as those reported for another area of these sites.

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

$$Y = aX^b$$

(Simpson et al. 1960:397). In this equation, X is specimen weight, Y is the biomass, b is the constant of allometry (the slope of the line), and a is the Y-intercept for a log-log plot using the method of least squares regression and the best fit (Reitz et al. 1987; Reitz and Wing 2008:238-239). Many biological phenomena show allometry described by this formula (Gould 1966, 1971) so that a given quantity of skeletal material or a specific skeletal dimension represents a predictable amount of tissue due to the effects of allometric growth. Values for a and b are derived from calculations based on data at the Florida Museum of Natural History, University of Florida, and the Georgia Museum of Natural History, University of Georgia. Allometric formulae for biomass estimates are not currently available for amphibians and lizards so biomass

is not estimated for these taxa. Biomass was calculated for each analytical unit. The allometric formulae used to calculate biomass are presented in Appendix E.

To examine the variety of animals used in each assemblage and the evenness with which animals were used, richness, diversity, and equitability indices are calculated. Richness is the number of taxa in the assemblage. Diversity is calculated using the Shannon-Weaver Index:

$$H' = -\sum(p_i)(Log_e p_i)$$

where p_i is the number of the *ith* species, divided by the sample size (Shannon and Weaver 1949). Diversity ranges from zero to five with low values indicating the lowest diversity and high values indicating the greatest diversity. Diversity increases as the number of species and the evenness of the species abundance increases. Equitability is calculated using the formula:

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

where *H'* is the diversity index and *Log S* is the natural log of the number of observed species. Equitability ranges from zero to one with zero indicating extreme preference for one species over all others. These indices can be derived from either MNI or biomass.

Presence/absence and ubiquity are measures used to examine which species are present in a collection and the frequency in which that taxon is present in multiple collections. Presence/absence summarizes which taxa are identified in each analytical unit, but does not measure the relative abundance of these taxa in each analytical unit. Measures of ubiquity convert presence/absence into a ratio. Ubiquity is obtained by dividing the number of analytical units containing a specific taxon by the total number of analytical units. For the five assemblages from the Late Archaic shell rings, ubiquitous taxa are defined as those that are identified at all five shell rings, resulting in a Ubiquity Index (UI) of 1.0. Taxa that are considered frequent are those with a UI of 0.8. Common taxa have a UI of 0.6 to 0.4 and rare taxa have a UI of 0.2.

The mean trophic level provides additional information on the types of marine animals present in each collection (Quitmyer and Reitz 2006; Reitz 2004a). Marine species are characterized by a numerical value between one and five following FishBase 98 (Froese and Pauly 1998). The numerical value portrays the degree to which marine animals feed on producers (Pauly et al. 2000). Organisms such as plants and phytoplankton represent the base of the food chain and form the first trophic level. Organisms that feed on zooplankton and plants form the second trophic level, while carnivores comprise trophic levels three through five. For some taxa, trophic levels are not assigned in FishBase 98. In these cases, the trophic level for the closest taxonomic category is used. Freshwater fishes are excluded because trophic levels for such taxa are unavailable in FishBase. The mean trophic level (TL_i) is calculated with the following formula:

$$TL_i = \Sigma(\ TL_{ij})(MNI\ or\ Biomass_{ij})/\ \Sigma MNI\ or\ Biomass_i$$

Mean trophic level (TL_{ij}) of each taxon (j) for the collection (i) is multiplied by the estimated MNI or Biomass of the taxon (j) for the collection (i). This number is then divided by the summed MNI or Biomass for the collection ($MNI\ or\ Biomass_i$).

To further characterize the fish remains in the collections, fishes are placed in one of two categories based on the characterization of their body size, following Reitz et al. (2009). The only exceptions for this analysis are mullets and Atlantic croakers. Reitz and her colleagues classified mullets and Atlantic croakers as large-bodied individuals. Mullet and Atlantic croaker individuals from the Late Archaic shell rings are classified as small-bodied fishes due to the relatively small body size of the individuals represented in the collections. Where Reitz et al. (2009) did not classify a species recovered in the five shell ring assemblages; the species was placed in one of the categories based on recorded measurements and personal observations

(Dahlberg 1975). Fishes placed in the small-bodied category generally do not reach sizes greater than 250 mm standard length while residing in Georgia estuaries. Fishes placed in the large-bodied category tend to exceed 250 mm standard length. Fish growth is indeterminate, therefore some individuals in the small-bodied category may be larger than 250 mm standard length and some individuals in the large-bodied category are likely under 250 mm standard length.

Likewise, fish individuals are placed in one of two categories based on whether they are more likely taken using mass-capture or individual-capture techniques, following Reitz et al. 2009. Where Reitz et al. (2009) did not classify a species that was present in the Late Archaic shell ring assemblages, the species is placed in one of these categories based on schooling and aggregating behaviors and personal observations (Dahlberg 1975). It is noted that classification of fish taxa into such categories is problematic because fish growth is indeterminate. Fish body size and capture technique change with size and, generally, the age of the fish (Reitz and Wing 2008:266-272).

Allometric regression is used to back-calculate the standard length of fishes from three families ubiquitous to these assemblages: sea catfishes, mullets, and drums. Allometric regression is based on the scaled relationship between a living body dimension and skeletal dimension (Béarez 2000; Reitz et al. 1987; Reitz and Wing 2008:186-187). For this analysis, standard length was estimated allometrically from otolith width for sea catfishes and the greatest width of the anterior centrum of the atlases from mullets and drums. The allometric regression for estimating Standard Length (SL) from otoliths and atlases follows the formula:

$$Y = aX^b$$

Where Y is the Standard Length (in mm), X is the measure of otolith or atlas width of the archaeological specimen, a is the Y-intercept, and b is the slope of the line (Reitz and Wing

2008:187). Values for the allometric constants are derived from biological data of modern specimens from the Florida Museum of Natural History, University of Florida and the Georgia Museum of Natural History, University of Georgia and are presented in Appendix F.

Summarization of the Archaeofaunal Collections

The species identified are summarized into faunal categories based on vertebrate class to contrast the relative percentage of taxa in these assemblages. These categories are Sharks, rays, and bony fishes, Turtles, Snakes, Birds, White-tailed deer, Other mammals, and Commensals. In order to make comparisons of MNI and biomass estimates possible, the summary tables include biomass estimates only for those taxa for which MNI is estimated.

Taxa classified as commensal are animals that might be consumed, but that also commonly are found in close association with humans and their built environments (e.g., pets and vermin). It is possible that these animals also were consumed. Likewise, some of the animals included in the non-commensal categories may not have been consumed. Taxa tentatively classified as commensal include frogs and toads, Eastern spadefoot toad, and bullfrog, salamanders, lizards, green anoles, shrews, short-tailed shrew, least shrew, Eastern mole, southern flying squirrel, pine vole, New World mice and rats, rice rat, New World mouse, and Hispid cotton rat.

Patterns of skeletal element distribution may provide evidence of cultural practices such as butchering patterns, transportation decisions, and exchange networks. White-tailed deer elements identified at the St. Catherines and McQueen Shell Rings are summarized into categories by body parts. White-tailed deer from the Sapelo Island Shell Ring complex are not summarized in this way due to the limited number of white-tailed deer specimens in that assemblage. The Head category includes only skull fragments, including antlers and teeth. The

atlas and axis, along with other vertebrae and ribs, are placed into the Vertebra/Rib category. Forequarter elements include the scapula, humerus, radius, and ulna. Carpal and metacarpal specimens are presented in the Forefoot category. The Hindfoot category includes tarsal and metatarsal specimens. The Hindquarter category includes the innominate, sacrum, femur, and tibia. Metapodiae and podiae that could not be assigned to one of the other categories, as well as sesamoids and phalanges, are assigned to the Foot category.

The elements identified as white-tailed deer in each analytical unit from the St. Catherines and McQueen Shell Rings are summarized visually to illustrate their number and location in a carcass. Although the atlas and axis fragments are accurately depicted, other cervical, thoracic, lumbar, caudal and vertebrae and ribs are placed approximately on the illustration. The last lumbar location is used to illustrate vertebrae not otherwise classified. The last rib location is used to illustrate all ribs. Specimens identified only as sesamoids, metapodiae, podials, or phalanges are illustrated on the right hindfoot.

Sample Size and Archaeofaunal Collections

NISP, MNI, biomass, and all other secondary measures are subject to numerous well-known biases (e.g., Casteel 1977, 1978; Grayson 1979, 1981, 1984; Wing and Brown 1979). Sample size biases are of particular concern. All secondary measures derived from samples are dependent on sample size (Grayson 1984; Lyman and Ames 2007; Reitz and Wing 2008:113-114). As with all faunal collections, the larger the sample the greater the likelihood that it adequately reflects the population. When secondary measures are derived from a population that is not adequately sampled, these secondary measures may be distorted. No specific sample size ensures that all parameters of a sample population are adequately represented in the sampled

population (Lyman and Ames 2007). Most researchers accept that smaller samples are not representative (Grayson 1981).

Sample size biases are not considered a problem when interpreting these data because, as will be shown in subsequent chapters, sample sizes for all shell rings in this study are generally large. This bias may affect interpretations of smaller analytical units within sites due to the smaller sample sizes associated with these analytical units. These biases should be considered when evaluating interpretations of analytical units represented by smaller sample sizes. The effect that sample size has on MNI is demonstrated in Figure 3.7. This figure shows that as NISP for the shell ring collections increases, so too does MNI estimations; 90 percent of the variance in MNI is predicted by NISP.

Incremental and Isotopic Methods

In addition to the zooarchaeological analysis conducted at the five shell rings, incremental and isotopic analyses were conducted on modern and archaeological hardhead catfish and Atlantic croaker otoliths. Asteriscus otoliths of hardhead catfishes were used in the incremental and isotopic analyses, while sagitta otoliths of Atlantic croakers were used (Simmons 1986). These analyses provide growth data for these fishes, as well as estimated water temperatures. Archaeological and modern otoliths were selected for incremental and isotopic sampling based on several criteria. Archaeological otoliths were first examined for evidence of burning or calcite leaching. These taphonomic processes affect the oxygen isotopic values ($\delta^{18}O$) of the preserved calcium carbonate ($CaCO_2$) (Andrus and Crowe 2002a). Burned and leached otoliths were eliminated from this part of the study. Additionally, only complete otoliths with lengths greater than 7.00 mm were selected due to the difficulty in sectioning smaller otoliths. Otherwise, the full size range of otoliths in each collection was sampled. Only left otoliths of

both archaeological and modern individuals were sampled to ensure that each otolith represents a different individual. After the otoliths were excluded from the archaeological population based on these criteria, in most cases, only a few otoliths remained in the sample population. Otoliths for isotopic and incremental analyses then were selected randomly. A list of the archaeological otoliths, as well as the provenience information and standard measurements associated with each otolith analyzed for this study is provided as Appendix G.

For the modern otoliths, the original research design was to capture modern hardhead catfishes and Atlantic croakers each month for one year. Unfortunately, monthly fishing trips did not always result in the capture of a fish. To expand the modern otolith study, hardhead catfish and Atlantic croaker otoliths from fishes with known dates and locations of capture and biological measurements, curated in the zooarchaeological comparative collection of the Georgia Museum of Natural History and the Environmental Archaeology Laboratory of the Florida Museum of Natural History, were included in the incremental and isotopic analyses. Modern, curated specimens were selected based on the month of capture, the location of capture, and the size of the individual. Fishes that were captured as live fishes for the modern study were de-fleshed. The skeletons and otoliths were cataloged and the left otolith was removed for incremental and isotopic analysis. The right otoliths remain curated in the Georgia Museum of Natural History Zooarchaeological Collection for future studies. Twenty-four modern otoliths, twelve from each species, were analyzed. A list of the modern otoliths analyzed, including catalog number, location of collection, date captured, collector, and standard otolith measurements, is provided as Appendix H.

Before the otoliths were prepared for analysis, they were weighed and measured. Archaeological otoliths were immersed in distilled water for 15 hours and then brushed to

remove adhering sediments. All modern otoliths were immersed in 30 percent H_2O_2 solution for 12 hours, rinsed in distilled water, and brushed to remove organic contaminates before analysis following standard procedures (Andrus and Crowe 2002b).

After the otoliths were cleaned, the otoliths were cross-sectioned through the core with a Buehler Isomet low-speed diamond-wafering saw model 11-1280-160. Each thin-section was attached to a glass microscope slide with crystal bond, polished to a flat surface, and again rinsed with distilled water.

Incremental Methods

Fish form there otoliths through visually distinguishable incremental growth bands that result from fast and slow periods of growth (Beckman and Wilson 1995). One fast band and one slow band, or an annulus, are thought to occur annually. Therefore, the amount of growth that occurred in the otolith each year can be measured when the growth bands are exposed through cross-section. Measurements of growth bands in otoliths were made from the edge of each optically-dense increment and from the core to the terminal edge of growth. These measurements were made using the microscopic features of a New Wave/Merchantek micromill. The core of each otolith represents the growth at the time the fish was hatched until some point when the fish starts forming its first annulus (Campana et al. 1994). The exact timing of the transition from core to annulus formation is unknown.

When these growth band measurements taken with the microscopic features of a New Wave/Merchantek micromill were examined, they were found to be sporadic and inconsistent with documented patterns of fish growth. The poor lighting and pixilation of the viewing screen of the microscopic feature on the micromill made this method inaccurate; therefore, only measurements from the terminal edge to the first point of core formation are used. This

measurement was easily visible despite the poor lighting and pixilation of the viewing screen. Because this method was unsuccessful, another method was devised. The otolith cross-sections were scanned with an Epson Perfection 4490 scanner at 12,800 dpi resolution in gray scale to create an enlarged, digitized image of each otolith. This method was successful in most cases. The enlarged, digitized images clearly showed the growth bands in the otoliths. The images were then printed out on paper and the growth bands in each otolith were traced with a pencil and measured using a standard ruler to the nearest 0.1 mm. Using the known distance from the terminal edge to the first point of core formation, a scale factor for each otolith image was calculated. The measurement of the digitized otolith increment was multiplied by the scale factor to convert the enlarged measurement to the actual size.

Once all growth bands in each otolith were measured and converted to the actual size, the growth pattern represented in each otolith was examined. For each otolith, the amount of growth occurring within each band was added to the subsequent band. For example, the width of the core (representing age 1) was added to the width of the band bordering the core (representing age 1.5), which was then added to the next band in the otolith (representing age 2). This generated the size of the otolith at all ages represented for the individual. These data were used to plot growth curves, or the amount of growth in the otolith for each period of growth band formation.

The growth band measurements were used to calculate the growth rates of these fishes. The growth rates are used to calculate the rate of growth occurring per each period of band formation. To calculate growth rates, the von Bertalanffy growth equation (Bertalanffy 1957) is used:

$$l_t = L_\infty(1-e^{-K(t-t_o)}).$$

In this equation, l_t is the length at time t, L_∞ is the maximum known length in the population, t_o is time at initial growth, or zero, and K is the growth rate. By solving for K:

$$K = (log(L_\infty - L_t / L_\infty))/t - t_o$$

the growth rate is calculated. For this equation L_t is the amount of growth measured in the otolith after each incremental band formation. To calculate t, each growth band is added and assumed to represent 0.5 years of growth, with the exception of the core, which counts as one year of growth. For this population, L_∞ is 5.789 mm, or the largest otolith size in the sample population. The growth rates for each year of growth were then plotted through the life of the fish for the modern and archaeological populations of hardhead catfishes and Atlantic croakers. The last band in each otolith is excluded from the growth curve and growth rate analyses because it is not known if the last band represents an entire bi-annual period of growth.

Isotopic Methods

Isotopic analysis of fish otoliths was conducted at the University of Alabama Stable Isotope Laboratory under the supervision of Dr. C. Fred T. Andrus. Multiple drilling paths were interpolated between visible growth bands. Multiple drilling paths were sampled from each growth band, depending on the size of the band. However, in some cases, growth bands were too small to exclusively drill a single band and two bands were included in one isotopic drilling path. Incremental growth bands were sampled at regular intervals of approximately 0.1 to 0.2 mm, across the cross-sectioned surface of the otolith, parallel to the growth bands. For hardhead catfish otoliths, the entire cross-sectioned surface was sampled (Figure 3.8). For Atlantic croaker otoliths, the cross-sectioned surface from the medial surface (surface with sulcus) to the center core was sampled (Figure 3.9). The lateral surface of the Atlantic croaker otoliths was not sampled because portions of the knobby texture of the lateral surface often were not present on

archaeological specimens. The complete length, width, and medial surfaces were present on all Atlantic croaker otoliths included in this analysis. The location of each drilling path within the otolith and within the growth band was noted during isotopic sampling when the incremental bands were observed.

Samples were taken using a New Wave/Merchantek micromill. The microdrill was cleaned with compressed air after every sample was taken to prevent cross-contamination. By micromilling the cross-sectioned surface of the otolith, a powdered sample was produced, weighing between 0.040 and 0.200 μg. These samples were exposed to phosphoric acid to generate CO_2 gases, which were processed by a Finnigan Mat Delta-E isotope ratio mass spectrometer. Working standards were also processed after every seventh sample to ensure precision and accuracy of the mass spectrometer.

Results of this analysis yield raw carbon and oxygen isotopic signatures that are processed and reported in per mil (‰) units with respect to VPDB (Vienna Pee Dee Belemnite Standard). Precision was estimated and the data calibrated to VPDB through analysis of the NBS-19 standard. Precision for reported $\delta^{18}O_{otolith}$ is 0.37‰ or less. The carbon and oxygen isotopic profiles for all otolith samples, as well as the precision, are presented as Appendix I.

Temperature values were calculated from $\delta^{18}O_{otolith}$ following the Grossman and Ku (1986) aragonite precipitation equation where T is temperature in °C:

$$\delta^{18}O_{otolith\ (PDB)} = [(T-20.6/-4.34)] + \delta^{18}O_{water\ (SMOW)}.$$

Varying values for $\delta^{18}O_{water\ (SMOW)}$ are used in the following chapters and these different values are reported when used.

Summary

Zooarchaeological data are often influenced by numerous sampling, aggregating, and quantitative biases. The methods used in this research project are designed to limit the potential biases associated with zooarchaeological analysis, while providing comparable, quantified results. These methods are used in the following chapters to evaluate Late Archaic subsistence economies within the framework of human behavioral ecology (Chapter 5), fishing strategies and fishing technologies (Chapter 6), and intrasite variation in the horizontal distribution of animal remains at the St. Catherines Shell Ring (Chapter 7). The increment and isotopic analyses provide data used to examine seasonal resource use for hardhead catfishes and Atlantic croakers at the shell rings (Chapter 8), as well as age distribution, growth curves, and growth rates for Late Archaic and modern populations of hardhead catfishes and Atlantic croakers (Chapter 9). These analyses contribute to a more comprehensive understanding of the human-environmental interaction of the Late Archaic Georgia coast.

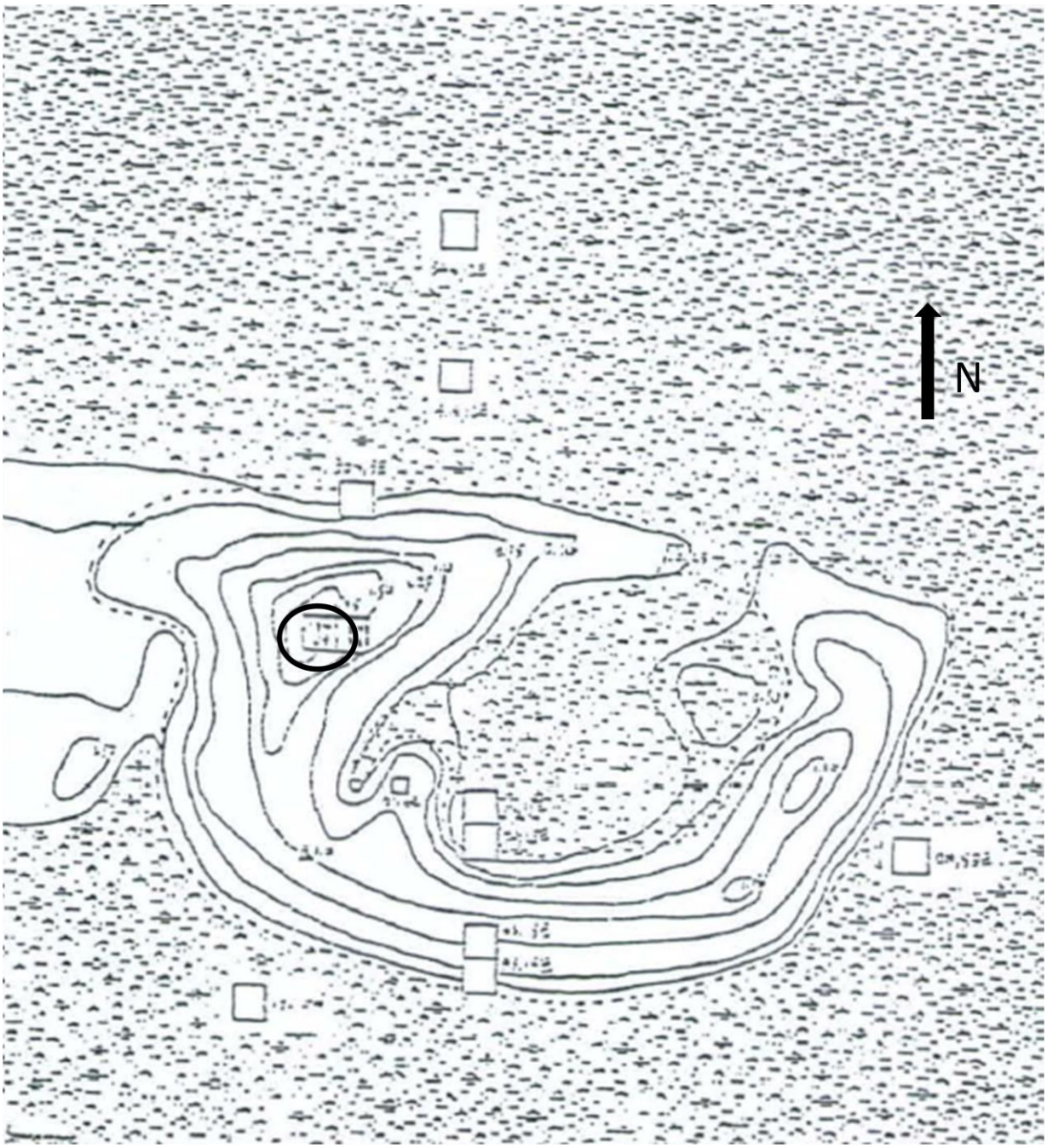


Figure 3.1: Map of the Cannon's Point Ring. Circled area indicates location of studied excavation unit, 18N 0E. Image from Marrinan (1975:26, 2010:75).

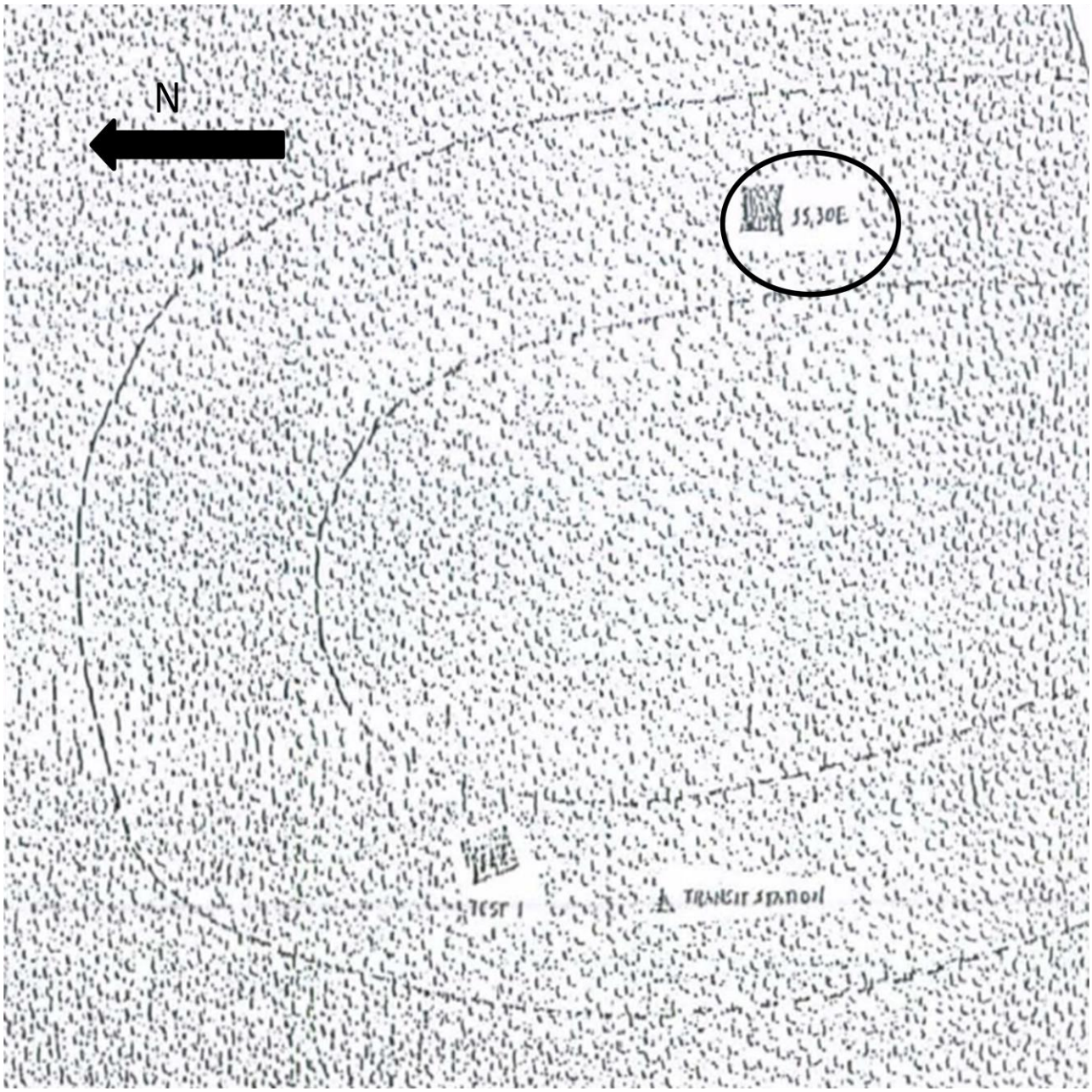


Figure 3.2: Map of the West Ring. Circled area indicates location of studied excavation unit, 5S 30E. Image from Marrinan (1975:31).

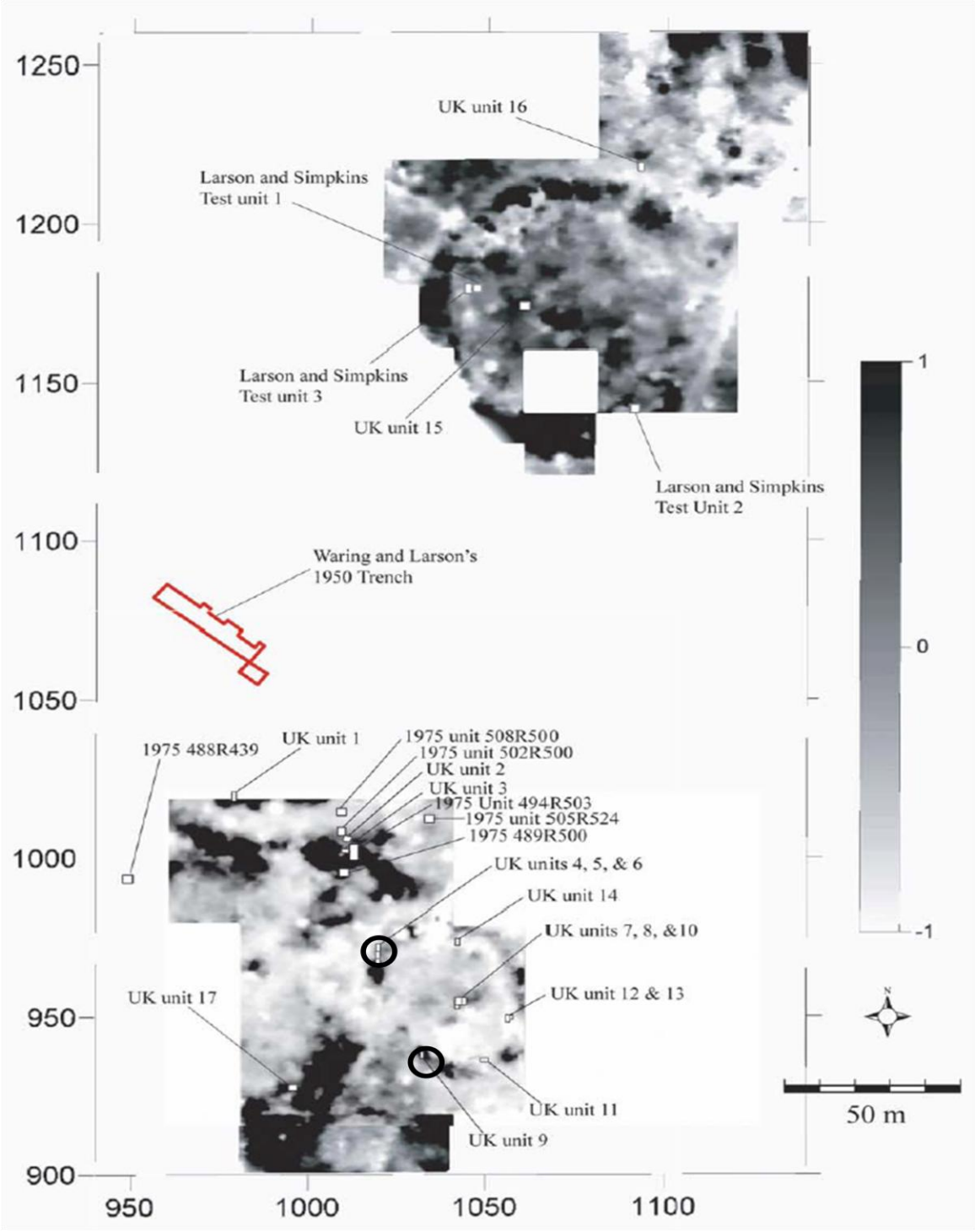


Figure 3.3: Map of the Sapelo Island Shell Ring Complex. Circled areas indicate location of studied excavation units. The southern-most circled area is Unit 9 and the northern-most circled area is Unit 4. Image from Thompson (2006:109).

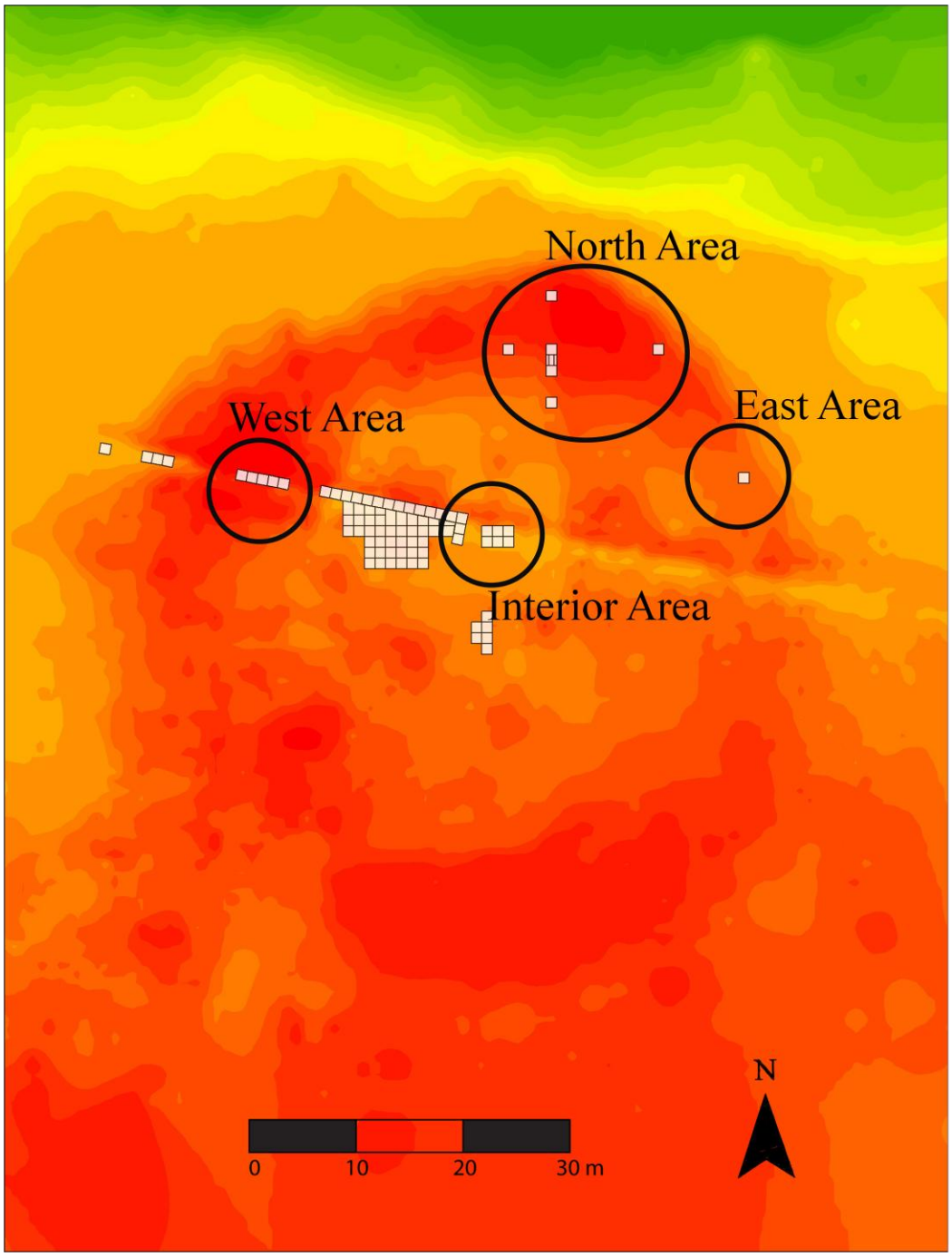


Figure 3.4: Map of the St. Catherines Shell Ring. Circled areas indicate location of studied excavation units. Image courtesy of Matthew C. Sanger.

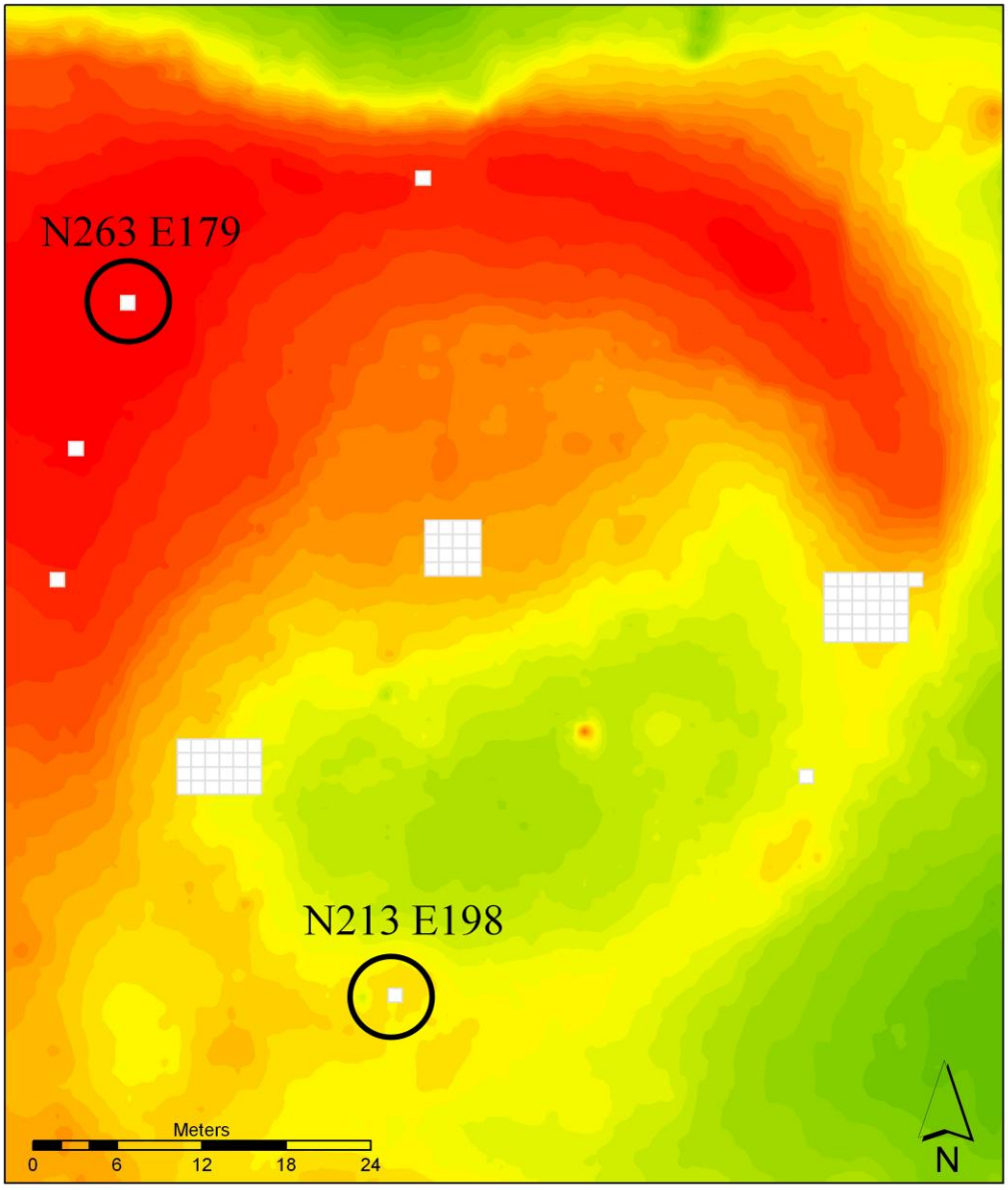


Figure 3.5: Map of the McQueen Shell Ring. Circled areas indicate location of studied excavation units. Image courtesy of Ginessa Mahar.

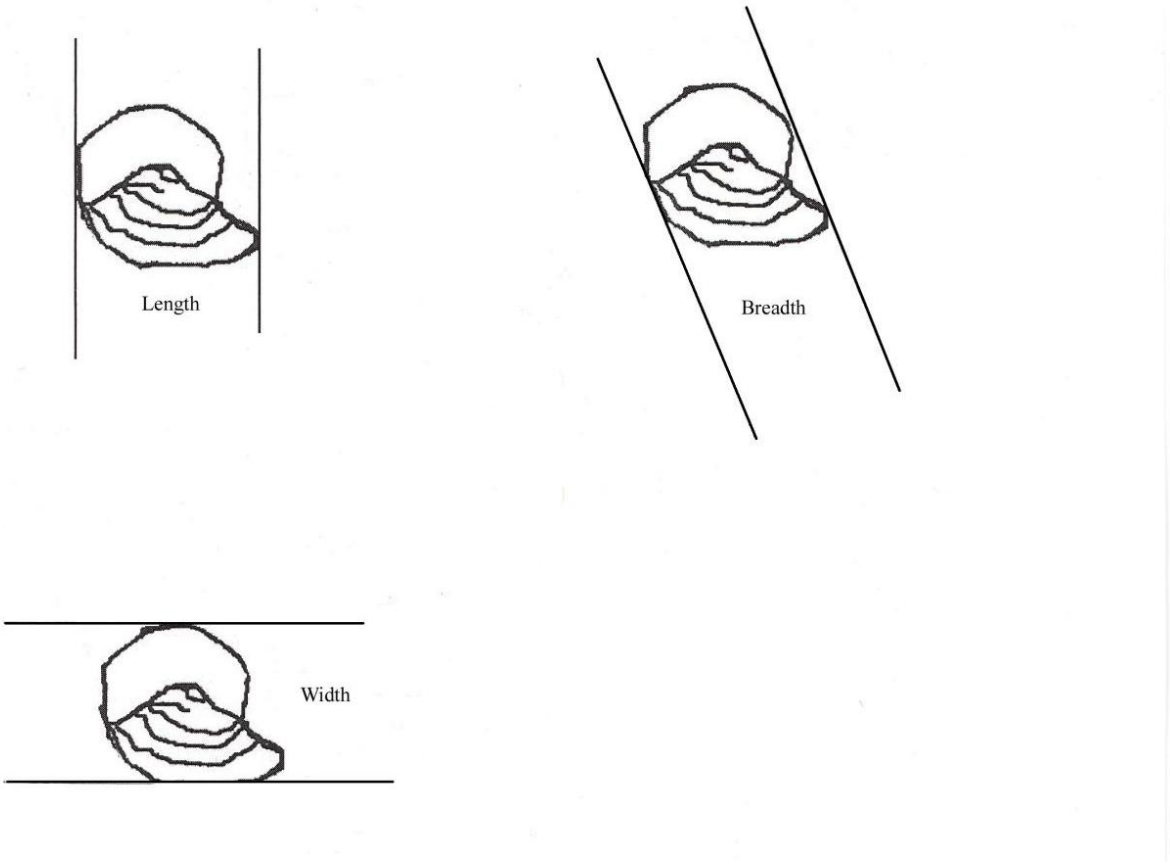


Figure 3.6: Measurements for sea catfish otoliths. Left otolith shown in image. Abbreviated for otolith measurements are length as Len, breadth as Brt, width as Wdh, and thickness as Th.

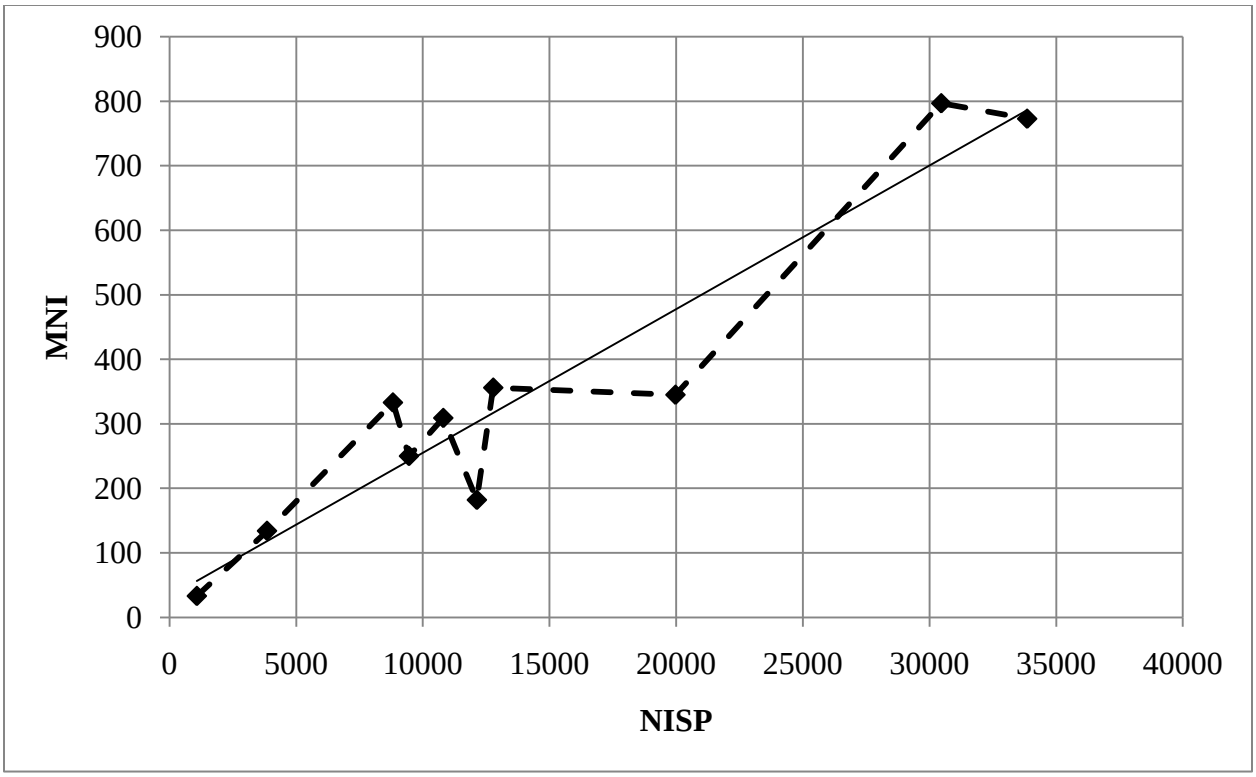


Figure 3.7: The effect of sample size on estimates of MNI. NISP is graphed on the x-axis and estimated MNI for each collection is graphed on the y-axis (dashed line). The trend line (solid line) indicates that as NISP increases, the estimated MNI increases and 90 percent of the variability in MNI is accounted for by NISP (y=0.0223x+32.262, R^2=0.9044).

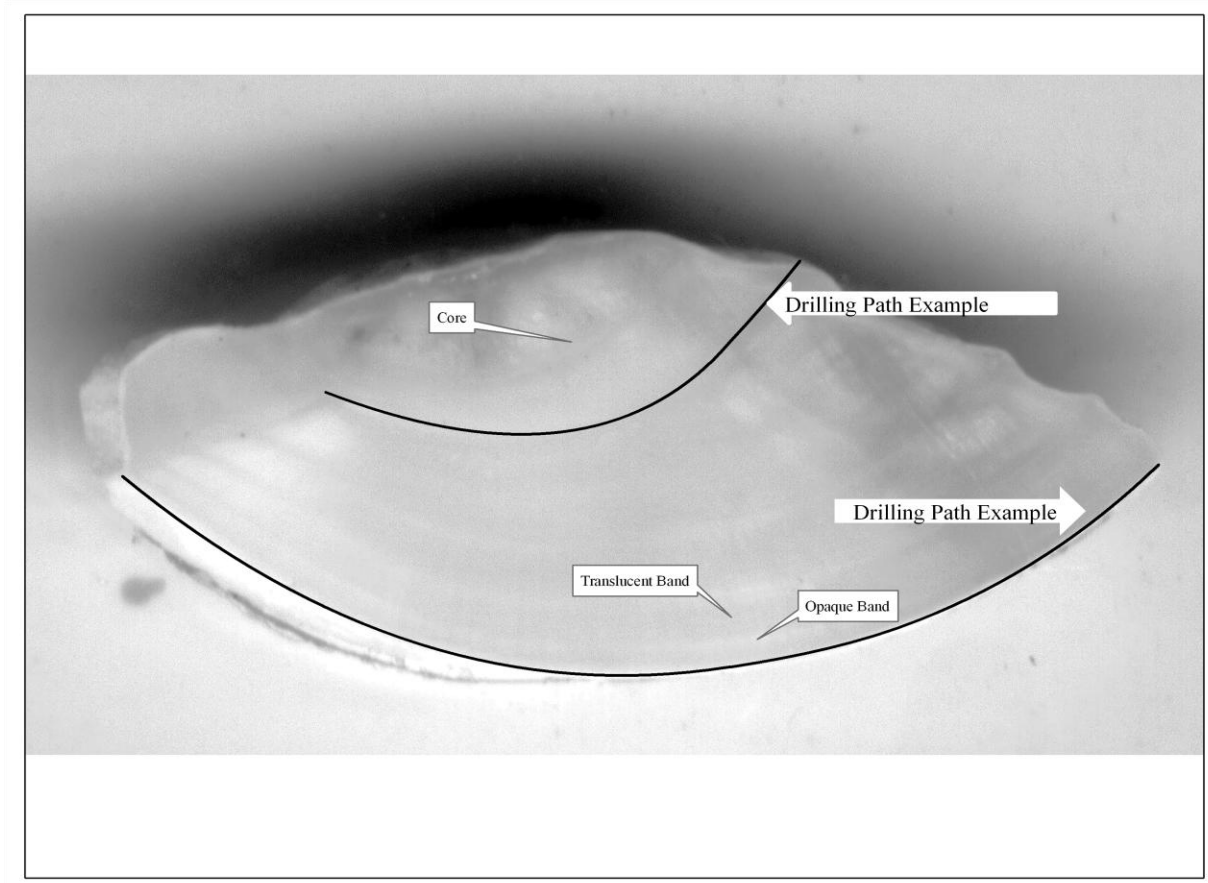


Figure 3.8: Cross-section of hardhead catfish otolith, FLMNH-EA 11341. Black lines represent examples of drilling paths for $\delta^{18}O$ sampling. Multiple drilling paths were taken from each otolith. For example, 28 drilling paths were sampled from FLMNH-EA 11341 across the entire surface of the otolith, parallel to the incremental bands.

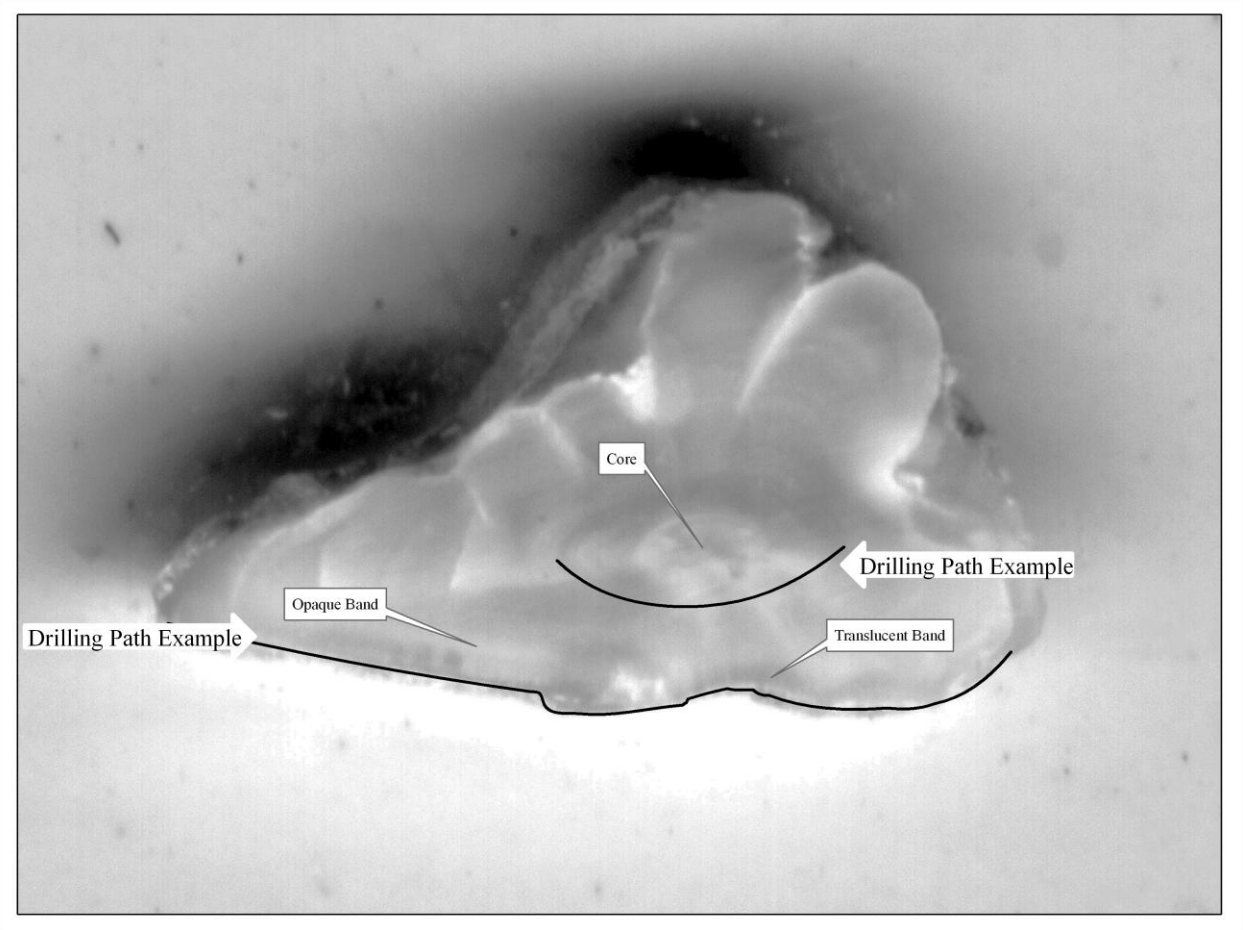


Figure 3.9: Cross-section of Atlantic croaker otolith, FLMNH-EA 11319. Black lines represent examples of drilling paths for $\delta^{18}O$ sampling. Multiple drilling paths were taken from each otolith. Nine drilling paths were sampled from FLMNH-EA 11319 across the medial surface (surface with sulcus) to the center core, parallel to the incremental bands.

TABLE 3.1

Site Information and Analytical Units

Site Name	Site Number	^{14}C cal B.C.	Recovery Method	Analytical Units	Units Included
Cannon's Point Shell Ring	9GN57	2760-2200	0.32 cm water screened	18N 0E	18N 0E
West Shell Ring	9GN76	2320-1970	0.32 cm water screened	5S 30E	5S 30E
Sapelo Island Shell Ring complex	9MC23	2332-1740	0.64 cm and < 0.32 cm water screened	Unit 4 general level	Unit 4 general level
				Unit 9 column sample	Unit 9 column sample
St. Catherines Shell Ring	9LI231	2600-1770	0.32 cm water screened	North Area	N779 E801
					N782 E801
					N784 E797
					N784 E801
					N784 E811
					N789 E801
				East Area	N771 E819
				West Area	Trench 281 W82 S2
					Trench 281 W84 S2
				Interior	Feature 5
					Feature 23
McQueen Shell Ring	9LI1648	2300-1950	0.32 cm water screened	N213 E198	N213 E198
				N263 E179	N263 E179

CHAPTER 4:

RESULTS OF THE ZOOARCHAEOLOGICAL ANALYSIS

Although zooarchaeological analysis was previously conducted at four of the five Late Archaic shell rings included in this study only limited samples were reported (Compton 2004; Marrinan 1975, 2010; Reitz 2008; Reitz et al. 2009; Thompson 2006; Waring and Larson 1968). The archaeofaunal collections included in this study, generally from larger samples recovered using fine-screening (less than or equal to 0.32 cm), expand upon these earlier studies and greatly advance the understanding of the Late Archaic shell rings. This analysis is based on 143,201 vertebrate specimens weighing 11,196.859 g. Remains from at least 3,512 individuals, representing 105 taxa were studied. The results provide a comprehensive and systemically quantified overview of human-environmental interactions on the Georgia coast during this time period.

St. Simons Cannon's Point (9GN57) and West Rings (9GN76)

Analyses of vertebrate remains from the Cannon's Point and West Rings were conducted by Rochelle Marrinan (Marrinan 1975, 2010; Reitz et al. 2009). Only a brief overview of these collections is provided here because a comprehensive summary, including modifications, is reported elsewhere (Marrinan 1975, 2010).

The Cannon's Point Ring, Unit 18N 0E (Marrinan 1975, 2010)

A total of 19,970 specimens weighing 1,253.5 g were identified from Unit 18N 0E of the Cannon's Point Shell Ring (Table 4.1; Marrinan 1975:148-150, 2010; Reitz et al. 2009). A

minimum of 345 individuals were identified from 45 taxa (Table 4.2). The vertebrate collection from Unit 18N 0E is characterized by the dominance of shark, ray, and bony fish individuals.

Fishes are the most abundant class represented, both in terms of individuals and biomass. An estimated 318 individual fishes from 25 taxa were identified (Table 4.3). Fishes from four families, herrings and shads, sea catfishes, mullets, and drums, dominate the collection, representing 93 percent of the fish individuals and 75 percent of fish biomass. One taxon restricted to freshwater, a bowfin, was among the Cannon's Point Ring taxa.

Although fishes comprise the majority of individuals in the collection, at least one deer is present, accounting for 27 percent of the biomass (Table 4.2). The collection also contains a wide array of turtles, snakes, birds, and other mammals. However, these taxa are less abundant compared to fishes.

The West Ring, Unit 5S 30E (Marrinan 1975, 2010)

From Unit 5S 30E of the West Ring, 9,453 specimens were identified weighing 369.6 g (Table 4.4; Marrinan 1975:192-193, 2010). An estimated 250 individuals were represented from 30 taxa (Table 4.5). The collection is dominated by sharks, rays, and bony fishes, which represent 94 percent of the individuals and 66 percent of the biomass (Table 4.5).

Sixteen taxa of fishes from 10 families are present in the 5S 30E collection (Table 4.6). Of these 10 families, species from four families, herrings and shads, sea catfishes, mullets, and drums, compose 97 percent of the fish individuals and 84 percent of the fish biomass.

One white-tailed deer individual is present in the collection and contributes 23 percent of the biomass (Table 4.5). Turtles, snakes, birds, and mammals also are present, but are rare in this collection, contributing three percent of the individuals and 11 percent of the biomass (Table 4.5).

Summary

The archaeofaunal collections from Cannon's Point and West Rings are dominated by fishes. Individuals from the herring and shad, sea catfish, mullet, and drum families dominated these two collections. Other taxa, such as turtles, snakes, birds, white-tailed deer, and other mammals are included in both collections, but are represented by only a few individuals.

Ring III of the Sapelo Island Shell Ring Complex (9MC23)

Unit 9 Column Sample

A total of 12,132 specimens weighing 262.359 g are present in the Unit 9 column sample (Table 4.7). Twenty-seven taxa, including a minimum of 182 individuals, are represented (Table 4.8). The collection is dominated by sharks, rays, and bony fishes common to estuarine and inshore habitats surrounding Sapelo Island.

Fishes are by far the most abundant group in terms of the individuals and biomass (Table 4.9). Fishes contribute nearly 97 percent of the individuals and biomass (Table 4.8). Twenty-one fish taxa from 13 families are present (Table 4.9). Sea catfishes and drums dominate the fish assemblage. Sea catfishes are the most abundant fish in terms of biomass, contributing 80 percent of the biomass, compared to 39 percent of the fish individuals (Table 4.9). The most abundant family of fishes in terms of individuals and taxa is the drum family, represented by at least 87 individuals from seven taxa (Table 4.9). Star drums are the most abundant species of the drum family with 68 estimated individuals.

Turtles, alligator, birds, and mammals are also present, but contribute only two percent of the individuals and three percent of the biomass (Table 4.8). Although reptiles, birds, and mammals are common in the maritime forests, marshes, and estuaries surrounding the Sapelo Shell Ring complex, they are not common in this collection (Table 4.8).

Modifications are observed on 139 of the specimens in the form of burning or calcination (Table 4.10). Of these, burning is more common, present on 76 percent of the modified specimens.

Unit 4 Fraction 0.64 cm

The Unit 4, 0.64 cm fraction from Ring III of the Sapelo Island Shell Ring complex contains a total of 8,819 specimens weighing 1399.128 g (Table 4.11). A minimum of 333 non-human individuals are identified from 31 taxa (Table 4.12). Three human cranium fragments are present in Levels 3 and 4 of Unit 4. The Unit 4 vertebrate collection is dominated by sharks, rays, and bony fishes.

Fishes are the most abundant class represented, both in terms of individuals and biomass (Table 4.13). An estimated 321 individual fishes from 21 taxa are present (Table 4.13). Sea catfishes dominate the collection, representing 80 percent of the fish individuals and 80 percent of fish biomass. Of the two sea catfish species, hardhead catfishes are more abundant, contributing 76 percent of the fish individuals and 68 percent of the fish biomass.

At least one deer is present in the Unit 4 collection and accounts for 13 percent of the biomass (Table 4.12). The collection also contains turtles and alligator, birds, and mammals. However, these taxa are far less abundant than fishes.

A total of 33 deer specimens are present in the Unit 4 collection (Table 4.14). The highest number of deer specimens is from the Head (NISP=17). The majority of these specimens are antler and tooth fragments. Specimens from meaty portions of the carcass, such as the Forequarter (NISP=2) and the Hindquarter (NISP=6), are less common (Table 4.14). Epiphyseal fusion data indicate that the single deer was at least 24 months of age at death (Table 4.15). Deer

antler fragments suggest that this animal was a male though none of the antler fragments were attached to skull fragments.

The most common modification in the Unit 4 collection is burning (NISP=39) (Table 4.16). One seatrout specimen has a pathology of unknown cause. Evidence of butchery is present in the form of hacks (NISP=2) and cut marks (NISP=2) on fish and mammal specimens. Seven specimens are worked. The turtle specimen is a carapace or plastron fragment with the internal surface removed. Two of the mammal specimens are polished and could be bone pin fragments. One mammal specimen is the top portion of a bone pin fragment with linear markings incised diagonally across the surface of the bone. Two antler tine fragments are worked, evidenced by striations at the extreme tips. A deer distal metapodial was grooved and snapped, indicating that the shaft was intentionally removed from the rest of the bone.

Summary

The archaeofaunal collections from Ring III of the Sapelo Island Shell Ring complex are dominated by fishes. Sea catfishes and star drums represent the majority of individuals and biomass from the Unit 9 column sample collection, while sea catfish comprise the majority of individuals from the Unit 4 fraction 0.64 cm collections. Other taxa, such as turtles, alligators, birds, and mammals are included in both collections, but are rare.

St. Catherines Shell Ring (9LI231)

A combined total of 49,587 specimens, weighing 6,063.005 g are identified from the St. Catherines Shell Ring (Table 4.17). The assemblage contains an estimate 1,249 non-human individuals (Table 4.18). Estuarine resources, especially fishes, are a major component of this assemblage (Table 4.19). Although fish represent the overwhelming number of individuals, white-tailed deer contributes 64 percent of the biomass (Table 4.18).

North Area

Fauna from the North Area of St. Catherines Shell Ring includes 33,849 specimens, weighing 3,327.592 g (Table 4.20). Fifty-seven non-human taxa are represented by a minimum of 773 individuals (Table 4.21). One specimen (lower, right 3rd premolar fragment) from a human is present in Unit N784 E811, Level 40-50 cm (Bag# 665). All human remains from the St. Catherines Shell Ring were returned to the American Museum of Natural History for repatriation. In terms of individuals, the North Area collection is dominated by sharks, rays, and bony fishes (Table 4.21). Although fish individuals are abundant, deer contributes 57 percent of the biomass.

Fishes are the most abundant group in terms of the number of individuals in the North Area, contributing over 92 percent of the MNI (Table 4.21). Twenty-six fish taxa are represented, many of which are common to the estuaries surrounding St. Catherines Island (Table 4.22). Sea catfishes contribute the greatest percentage of fish biomass (48 percent). Sea catfishes only contribute nine percent of the fish individuals (Table 4.22). Mullets and drums are the dominant fish families in terms of individuals. Combined, these two families contribute 80 percent of the fish individuals (Table 4.22). Although mullets and drums contribute a higher percentage of the individuals than do sea catfishes, their combined biomass contribution is less than that of sea catfishes.

The North Area collection includes 11 other marine fish taxa that are common to Georgia estuaries (Table 4.20). Four taxa of freshwater fishes are also represented. Of the freshwater fishes, all, with the exception of the bowfin, can be found in brackish waters (Dahlberg 1972).

Four dog specimens are represented in the North Area collections, including an upper left canine, a 4th premolar, and two left maxillary fragments. No wear was noted on the crown of the

teeth. These non-deciduous teeth suggest that the dog was at least older than a juvenile at death. The precise age of the dog cannot be determined from the limited number of specimens, however.

Although only three deer are represented in the North Area collection, deer account for 57 percent of the biomass (Table 4.21). Turtles, snakes, birds, and other mammals are also identified, but are relatively rare, contributing seven percent of the individuals and 15 percent of the biomass (Table 4.21). Gopher tortoise is identified in the North Area collection. Gopher tortoise was introduced to St. Catherines Island in recent years. The presence of gopher tortoises in Archaic deposits suggests that these tortoises once inhabited the island because there is no indication that these gopher tortoise remains are from recently deceased animals that burrowed into the shell ring.

A total of 282 deer specimens are present in the North Area collection (Figure 4.1, Table 4.23). The highest number of deer specimens is from the Head (NISP=152), mostly antler and tooth fragments. Specimens from meaty portions of the carcass, such as the Forequarter (NISP=7) and the Hindquarter (NISP=19), are less common (Table 4.23). Epiphyseal fusion data indicate that at least one individual was a juvenile at death, one individual was a subadult at death, and one individual was an adult (Table 4.24). Deer antler fragments and a frontal fragment that had the antler intentionally removed provide evidence of at least one male individual in the North Area collection.

The most common modification is burning (NISP=803) (Table 4.25). One mullet vertebra has a pathology of unknown cause. Hack (NISP=4) and cut marks (NISP=10) are observed on turtle and mammal specimens and provide evidence of butchery. Twenty-three mammal and four deer specimens are worked. Of the worked mammal specimens, 21 are bone pin fragments. Four

of the bone pin fragments have rounded tops, one of which has cross-diagonal incisions. Two worked mammal specimens are forms other than bone pins. One specimen is a flat, square-like fragment, grooved at one end and polished and rounded at the other end with evidence of use wear. The other worked form is a broad, short fragment modified into a fine point at one end. Five other mammal fragments are grooved. One deer antler has use-wear at the tine and a deer metatarsal is grooved and snapped. The previously mentioned frontal fragment of a deer was worked at the base of the antler pedicle. These marks demonstrate that a tool was used to remove the antler from the cranium. The marks are in a spiral pattern around the pedicle. A small crest-shaped mark is located anterior to the pedicle that is the proximate shape and size of a human thumb nail impression. Three specimens are rodent-gnawed, which may indicate that these specimens were not buried immediately after discard.

East Area

A total of 3,850 specimens, weighing 633.751 g are identified from the East Area, including 38 taxa and a minimum of 134 individuals (Table 4.26). Sharks, rays, and bony fishes dominate this collection in terms of individuals (Table 4.27), while deer account for 78 percent of the biomass.

Twenty-one fish taxa from twelve families are present in the East Area collection (Table 4.28). Fishes from two families, mullets and drums, contribute 74 percent of the fish individuals. These two families, combined with sea catfishes, comprise 80 percent of the fish biomass. In the East Area, four freshwater fish taxa are presented. Bowfins are the only fish in the East Area collection that are associated exclusively with fresh water. Twelve other taxa of fish are included in the East Area collection, all of which are common to the estuaries of the Georgia coast (Dahlberg 1972).

Turtles, snakes, birds, and other mammals also are identified, but are relatively uncommon, contributing only 11 percent of the individuals and nine percent of the biomass (Table 4.27).

A minimum of two deer are present in the East Area collection (Figure 4.2, Table 4.29). The highest number of deer specimens is from the Head (NISP=45) and the Forefoot (NISP=16). The majority of the specimens from the Head are antler fragments. Specimens from meaty portions of the carcass, such as the Forequarter (NISP=4) and the Hindquarter (NISP=2), are less common (Table 4.29). Epiphyseal fusion data provide evidence for at least one subadult and one adult (Table 4.30). Deer antler fragments suggest that at least one male deer is present in the East Area collection. None of the antler fragments were attached to the cranium.

The most common modification in the East Area collection is burning (NISP=43) (Table 4.31). One mullet vertebra has a pathology of unknown cause. One mammal specimen has a cut mark on it, indicating butchery. Twelve of the modified specimens are worked. Working was only noted on mammal specimens and all specimens are bone pin fragments.

West Area

A total of 10,807 specimens weighing 1,044.892 g are identified in the West Area collection, including 49 non-human taxa and 309 individuals (Table 4.32). One human specimen (an upper premolar fragment) is present in Unit W82 S2, Level 2.6-2.5 (Bag# 1280). The West Area collection is dominated by sharks, rays, and bony fishes (Table 4.33). Deer accounts for 51 percent of the biomass (Table 4.33).

Fishes are the most abundant group, representing 89 percent of the individuals (Table 4.34). Twenty-six fish taxa from 16 families are present (Table 4.34). Sea catfishes, mullets, and drums dominate the fish assemblage in both individuals and biomass. Sea catfishes comprise 27

percent to the fish biomass, but only contribute five percent of the fish individuals (Table 4.34). Mullets contribute to the greatest percentage of the fish individuals, followed by drums. Four taxa of freshwater fishes are present in the West Area collection, of which bowfins are the only fish exclusive to fresh water. Eleven other taxa of marine fishes are in the West Area collection, all of which are common to the estuaries of Georgia (Dahlberg 1972).

Turtles, snakes, birds, and other mammals are also present, but are relatively uncommon Combined, turtles, snake, birds, and mammals, other than deer, contribute seven percent of the individuals and 23 percent of the biomass (Table 4.33). One gopher tortoise specimen is in the West Area collection.

Thirty-seven deer specimens, representing at least two individuals, are present in the West Area collection (Figure 4.3, Table 4.35). One adult is indicated by a fused distal femur and a subadult by the presence of an unfused distal tibia (Table 4.36). Fragments of deer antler provide evidence for at least one male deer. None of the antler fragments were fused to the pedical. The highest number of deer specimens is from the Foot (NISP=15). Specimens from the Head (NISP=7), Vertebra/rib (NISP=4), Forequarter (NISP=1), Hindquarter (NISP=6), Forefoot (NISP=2), and Hindfoot (NISP=2) are also present, but in limited numbers (Table 4.35).

Burning is the most common modification in the West Area collection (NISP=119) (Table 4.37). Three indeterminate bony fish specimens display a pathology of unknown cause. Butchery is evidenced by the presence of cut marks (NISP=10) on snapping turtle, diamondback terrapin, mammal, and deer specimens. Two turtle, seven mammal, and two deer specimens are worked. The two worked turtle specimens are carapace or plastron fragments that are smoothed across the interior surface. Four worked mammal specimens are fragments of bone pins. Two of these fragments are incised with a diagonal, cross-hatching pattern. Three mammal specimens

are grooved and snapped, while one deer metapodial fragment is grooved and snapped. An antler fragment is worked into a pin.

Interior Features 5 and 23

Fauna from interior Features 5 and 23 include 1,081 specimens, weighing 1,056.770 g (Table 4.38). Thirty-three individuals from 26 taxa are represented. Sharks, rays, and bony fishes compose the majority of individuals in this collection, while deer accounts for 81 percent of the biomass in the both Feature collections (Table 4.39). Turtles, birds, and other mammals are also identified, but are less common than fishes and deer (Table 4.39).

In Features 5 and 23, fishes represent the largest number of individuals, 52 percent (Table 4.40). Fourteen fish taxa from 10 families are present (Table 4.40). Individuals from the drum family contribute the greatest percentage of individuals and biomass among the fishes. Sea catfishes and mullets also represent a large percentage of individuals, with both families separately representing 18 percent of the fish individuals (Table 4.40). Five other taxa of estuarine fishes and two taxa of freshwater fishes are also identified in the collections from Features 5 and 23.

One dog is represented by an upper, left 2nd molar. The age of the dog could not be determined, but moderate to heavy wear is noted on the crown and indicates that this individual was likely an adult at death.

Seventy-seven deer specimens represent at least three individuals. The highest number of deer specimens is from the Head (NISP=20) and the Hindquarter (NISP=15) (Figure 4.4, Table 4.41). Most of the specimens from the Head are tooth fragments. Specimens from the Vertebra/rib (NISP=12) and Forequarter (NISP=10) portions of the carcass also are represented. Specimens that represent less meaty portions of the carcass, such as the Forefoot (NISP=5),

Hindfoot (NISP=7), and Foot (NISP=8), are less common (Table 4.41). Of the three individuals, one was a subadult at death, and two individuals were adults (Table 4.42).

The most common modification in the collection from the Features is burning (NISP=27) (Table 4.43). Twenty-seven percent of the modified specimens are calcined (NISP=15). Evidence of butchery is present in the form of hacks (NISP=3) and cut marks (NISP=4) on mammal and deer specimens. Evidence of working is present on 11 percent of the modified specimens and is noted on five mammal specimens and one deer specimen. Three of the worked indeterminate mammal specimens are bone pin fragments and two are grooved and snapped. A deer metapodial shaft fragment is grooved and snapped.

Summary

The archaeofaunal collections from the St. Catherines Shell Ring are dominated by fish individuals. Marine fishes, particularly sea catfishes, mullets, and drums, constitute most of the individuals and biomass within the fish class. Freshwater fishes are present in all collections from the St. Catherines Shell Ring. Deer, although represented by few individuals, contribute most of the biomass in the St. Catherines Shell Ring assemblage.

McQueen Shell Ring (9LI1648)

A combined total of 43,240 specimens weighing 1,849.267 g is identified from the McQueen Shell Ring (Table 4.44). An estimated 1,153 individuals are represented from 58 taxa. Estuarine resources, especially fishes, were a large component of the subsistence economy (Table 4.45). Fish individuals comprise 96 percent of the assemblage (Table 4.46). Although the majority of individuals in the assemblage are fishes, white-tailed deer contribute 40 percent of the estimated biomass. Turtles, snakes, birds, and mammals, other than deer, are also identified in the McQueen Shell Ring collections, but are less common than estuarine fishes and deer.

Unit N213 E198

From Unit N213 E198, 12,780 specimens are identified, weighing 686.990 g (Table 4.47). A minimum of 356 individuals are represented from 37 taxa (Table 4.48). The collection is dominated by sharks, rays, and bony fishes, which represent 96 percent of the individuals (Table 4.48). Although only one white-tailed deer is present, deer comprises 42 percent of the biomass (Table 4.48). Turtles, snakes, birds, and other mammals are identified, but are rare, contributing three percent of the individuals and five percent of the biomass (Table 4.48).

Twenty-four taxa of fishes from 15 families are present in the N213 E198 collection (Table 4.49). Of these 15 families, species from three families, sea catfishes, mullets, and drums, contribute 94 percent of the fish individuals and 90 percent of the fish biomass. Sea catfishes contribute 18 percent of the fish individuals and 55 percent of the fish biomass (Table 4.49). Although sea catfishes comprise over half of the fish biomass, drum individuals contribute 53 percent of the fish individuals (Table 4.49). Similarly, mullets comprise 22 percent of the fish individuals, but only 12 percent of the fish biomass (Table 4.49).

In addition to the sea catfish, mullet, and drum families, 13 other taxa of fishes common to the estuarine waters surrounding St. Catherines Island are present in the collection from Unit N213 E198. Combined, fishes from these 13 taxa only contribute six percent of the fish individuals and 10 percent of the fish biomass. Gar, a fish regularly found in brackish waters, is the only freshwater fish present in the collection from N213 E198 (Dahlberg 1975:33).

A total of 12 deer specimens are present in the Unit N213 E198 collection (Figure 4.5, Table 4.50). The small number of deer specimens prevents a meaningful comparison of the skeletal portions recovered. Epiphyseal fusion data are only available for one specimen, a fused, distal humerus (Table 4.51). Distal humerii of deer fuse between 12-20 months of age, indicating

that this deer was at least a subadult at death (Reitz and Wing 2008:72). An antler fragment is present in the Unit N213 E198 collection, providing evidence of at least one male individual. This antler fragment is not attached to the cranium.

Burning is the most common modification and is observed on 88 percent of the modified specimens (NISP=69) (Table 4.52). Seven percent of the modified specimens are calcined (NISP=5). One hardhead catfish specimen displays a pathology of unknown cause. Butchery is evidenced by a cut mark on one indeterminate vertebrate specimen. Only one bone from this collection is worked. This worked bone is an indeterminate turtle specimen with the internal portion of the carapace smoothed. One mammal specimen is rodent gnawed and suggests that this specimen was not buried immediately after discard.

Unit N263 E179

A total of 30,460 specimens weighing 1,162.277 g are identified in the McQueen Shell Ring, Unit N263 E179 collection (Table 4.53). A minimum of 797 individuals from 54 taxa are identified (Table 4.54). The vertebrate collection from Unit N263 E179 is dominated by shark, ray, and bony fish individuals. Although fishes comprise the vast majority of individuals in the collection, at least two deer are present, accounting for 38 percent of the biomass (Table 4.54). Turtles, snakes, birds, and other mammals are also present, but uncommon.

Fishes are the most abundant class represented, both in terms of individuals and biomass (Table 4.54). An estimated 772 individual fishes from 34 taxa are present. Fishes from three families, sea catfish, mullet, and drum, dominate the collection; contributing 93 percent of the fish individuals and 86 percent of fish biomass (Table 4.54). Sea catfishes contribute seven percent of fish individuals, and 30 percent of the fish biomass (Table 4.54). Mullets contribute 49 percent of the fish individuals and 22 percent of the fish biomass (Table 4.54). Nine species of

drum are present in the N263 E179 collection, contributing 39 percent of the fish individuals and 34 percent of the fish biomass (Table 4.54). The remaining 22 taxa only represent 8 percent of the fish individuals and 14 percent of the fish biomass. Three species of freshwater fishes, gar, bowfin, and bullhead catfish, are present.

One dog, represented by a fused, complete, left ulna is also present. Ulnas fuse late in the fusion sequence; hence this dog was an adult at death.

Forty-one deer specimens represent at least two individuals (Table 4.56). The highest number of deer specimens is from the Head (NISP=18) (Figure 4.6, Table 4.56). Most of the Head specimens are tooth and antler fragments. Specimens from the Vertebra/rib (NISP=9), Hindquarter (NISP=10), Hindfoot (NISP=4), and Foot (NISP=6) portions of the carcass are also represented. Epiphyseal fusion data indicates that one juvenile and one adult are present (Table 4.57). Antler fragments provide evidence of at least one male deer, although none of the antler fragments are attached to the cranium.

Burning is the most common modification, present on 91 percent of the modified specimens (Table 4.58), followed by calcined specimens (NISP=73). An unknown pathology is noted on five indeterminate bony fish specimens. Evidence of butchery is found on six specimens as hack (NISP=1) and cut marks (NISP=5). Two specimens, a deer metapodial, which is grooved and snapped, and an indeterminate vertebrate specimen, which is incised with linear marks, are worked.

Summary

The archaeofaunal collections from the McQueen Shell Ring are dominated by fish individuals and biomass. Sea catfishes, mullets, and drums contribute the majority of individuals and biomass within the fish class. Freshwater fishes are also identified in the McQueen Shell

Ring assemblage. Deer are represented by only a few individuals, but contribute 40 percent of the biomass.

Presence/Absence and Ubiquity

Highly ubiquitous taxa in the Late Archaic shell ring collections are those identified in every collection (Ubiquity Index of 1.0) (Table 4.59). Of the 105 taxa, 14 have a UI of 1.0. Nine of these 14 ubiquitous taxa are fishes: herrings and shads, sea catfishes, mullet, and seven species of drums. Diamondback terrapins, rails and coots, opossums, raccoons, and white-tailed deer are the non-fish taxa with a UI of 1.0. Forty-two taxa have a UI of 0.2, meaning they are present in only one of the five collections. These taxa include a number of marine and freshwater fishes, turtles, birds, snakes, mammals, and several commensal taxa.

Overview of Collections

Overall, the vertebrate fauna from the shell rings are dominated by estuarine fishes. Sea catfishes, mullets, and drums are the most abundant fishes. Numerous other fish taxa, including both estuarine and freshwater species, supplement these dominant fishes. Although deer individuals only contribute small percentages of the individuals, deer consistently contribute over 20 percent of the biomass and, in two cases, over 60 percent. A wide array of other taxa, including turtles, snakes, birds, and non-deer mammals are also frequently recovered from the shell rings, but generally contribute small percentages of individuals and biomass.

These results are used to evaluate diet-breadth and hunt-type models developed from optimal foraging theory (Chapter 5). The fish remains in these collections are examined in Chapter 6 to evaluate fishing strategies and technologies as well as to determine which fish species were susceptible to overfishing. Archaeofaunal collections from the St. Catherines Shell Ring are examined for intrasite variation in Chapter 7. Finally, these data are used to explore

questions of seasonal resource use (Chapter 8) and growth curves and growth rates are established to evaluate evidence for overfishing (Chapter 9).

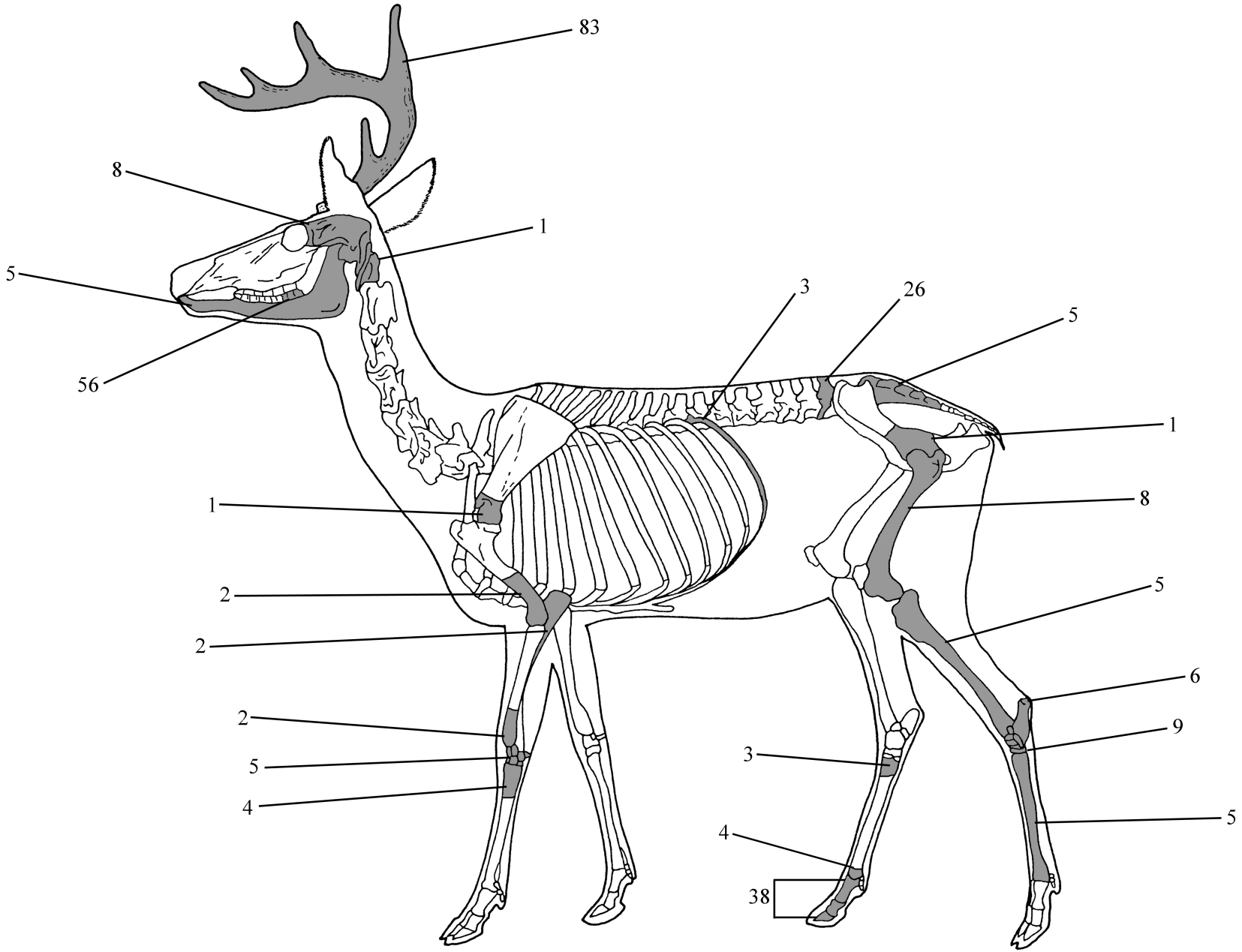


Figure 4.1: Deer Elements from the St. Catherines Shell Ring, North Area (NISP=282)

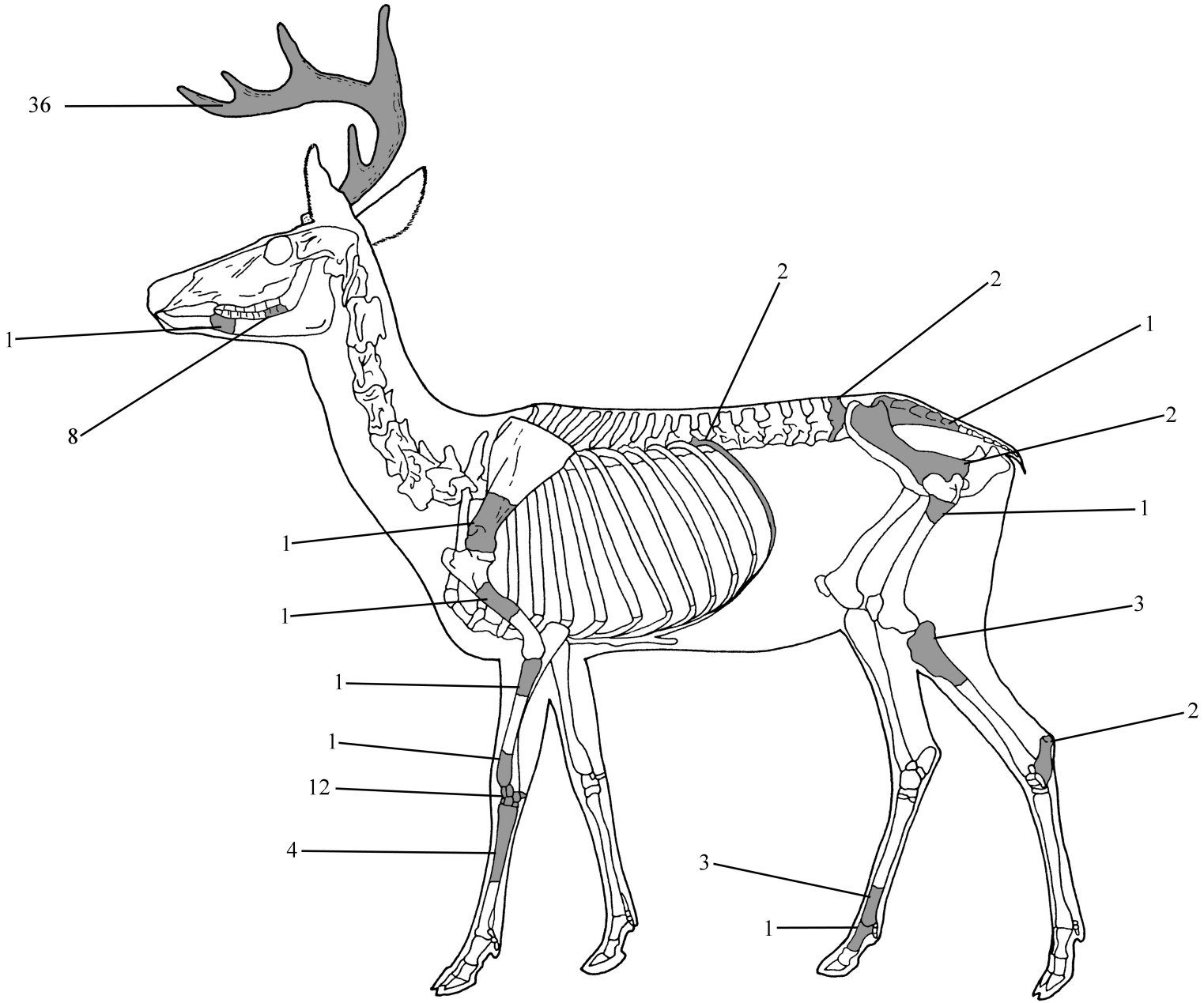


Figure 4.2: Deer Elements from the St. Catherines Shell Ring, East Area (NISP=82)

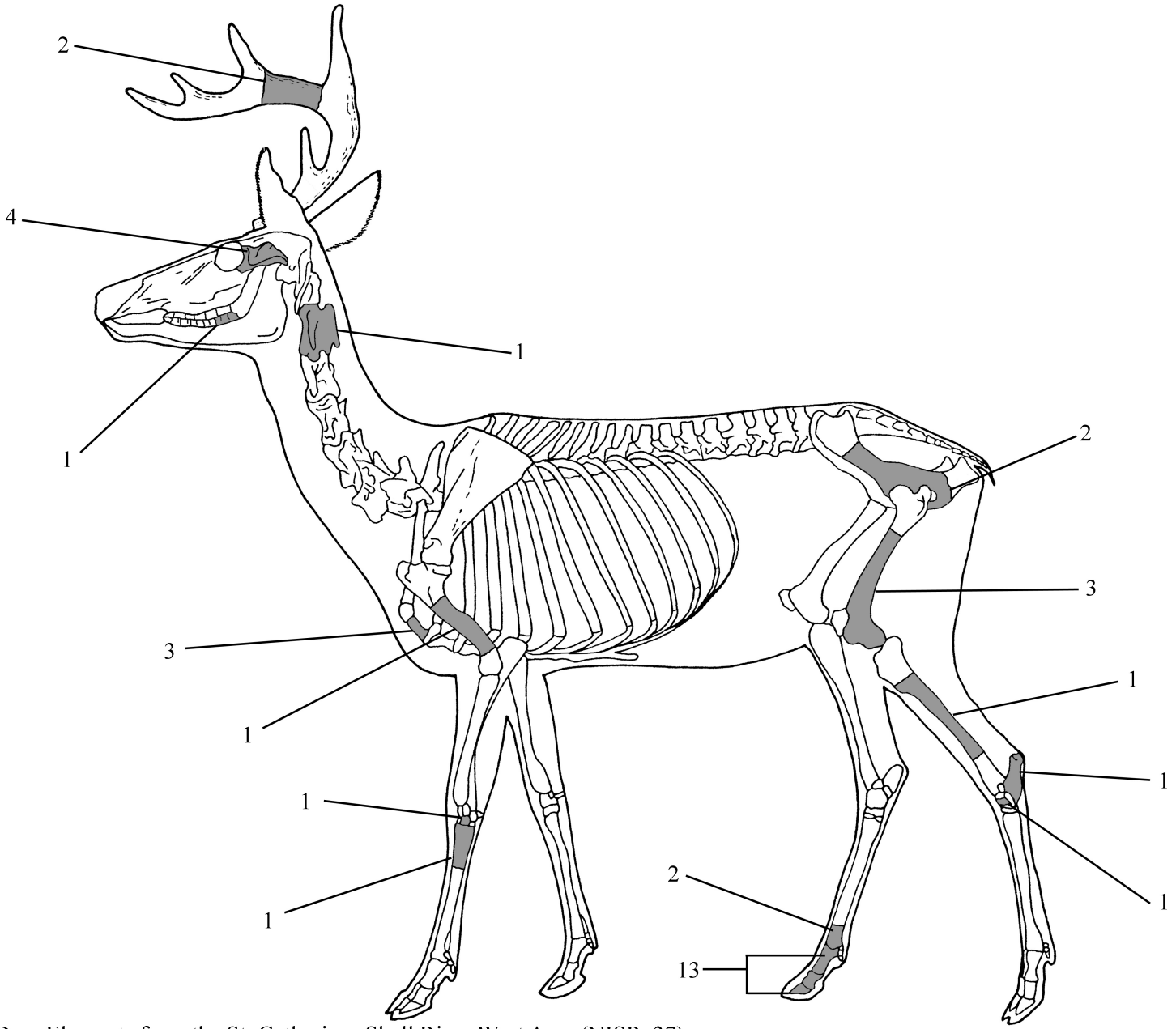


Figure 4.3: Deer Elements from the St. Catherines Shell Ring, West Area (NISP=37)

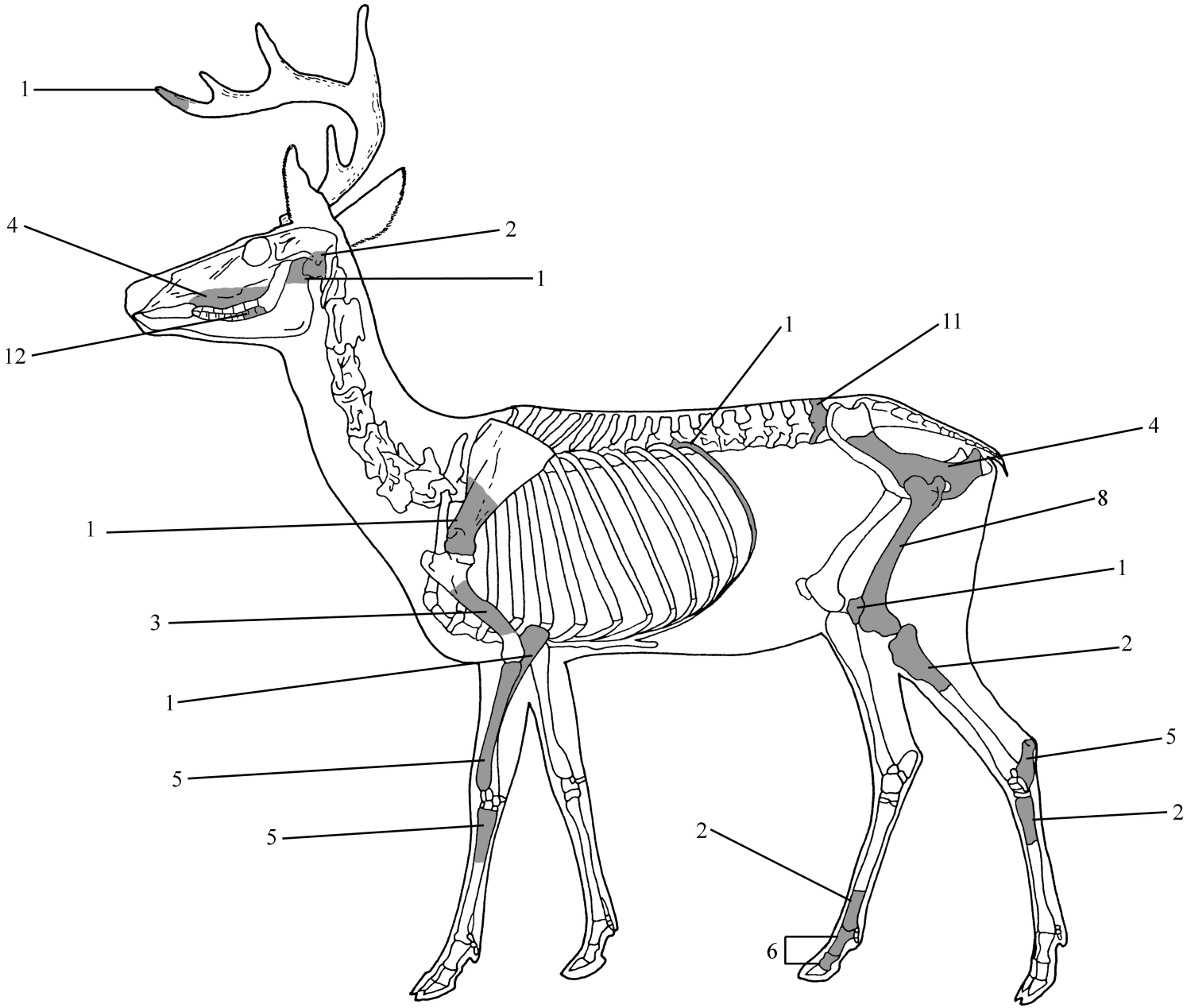


Figure 4.4: Deer Elements from the St. Catherines Shell Ring, Features (NISP=77)

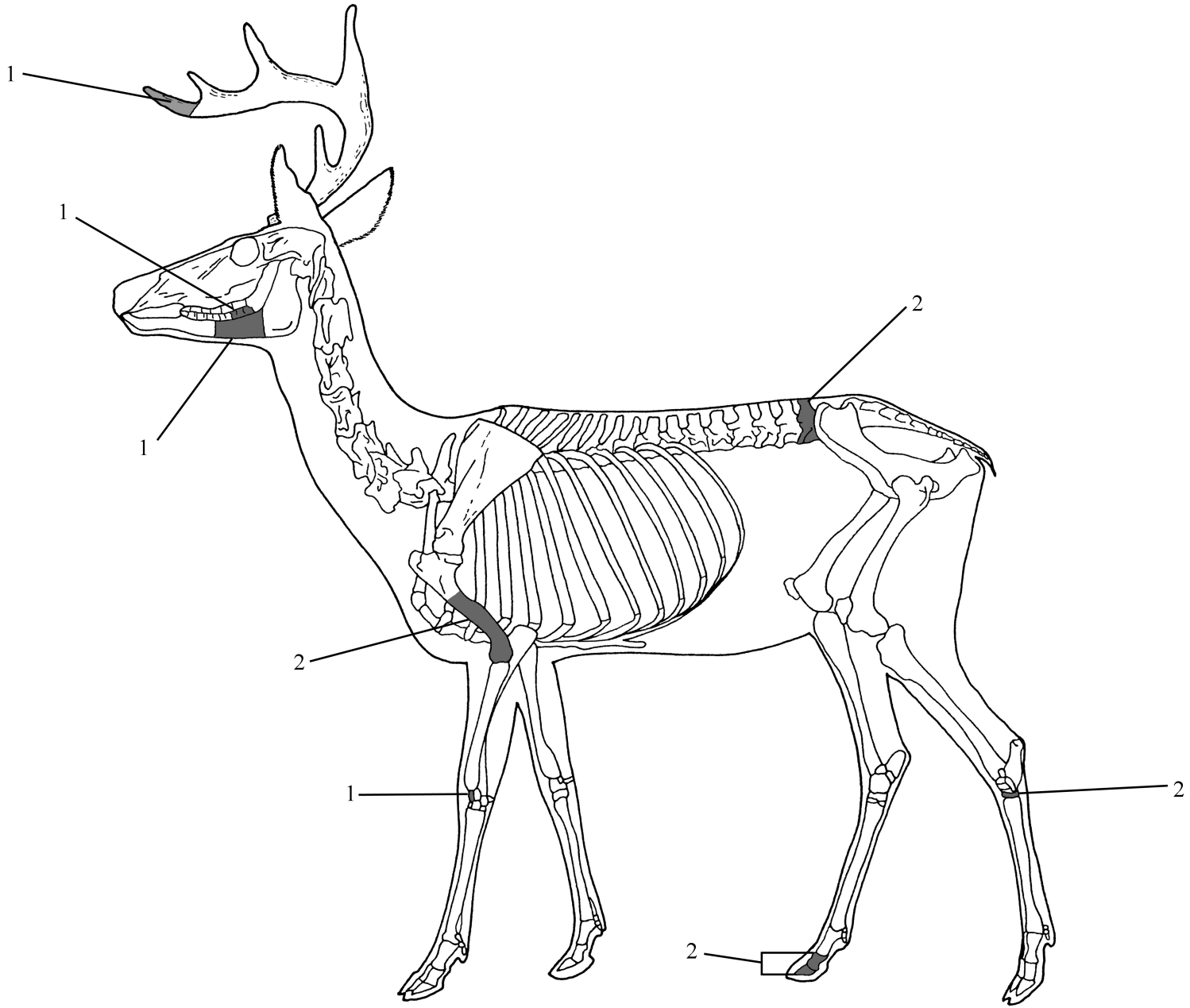


Figure 4.5: Deer Elements from the McQueen Shell Ring, N213 E198 (NISP=12)

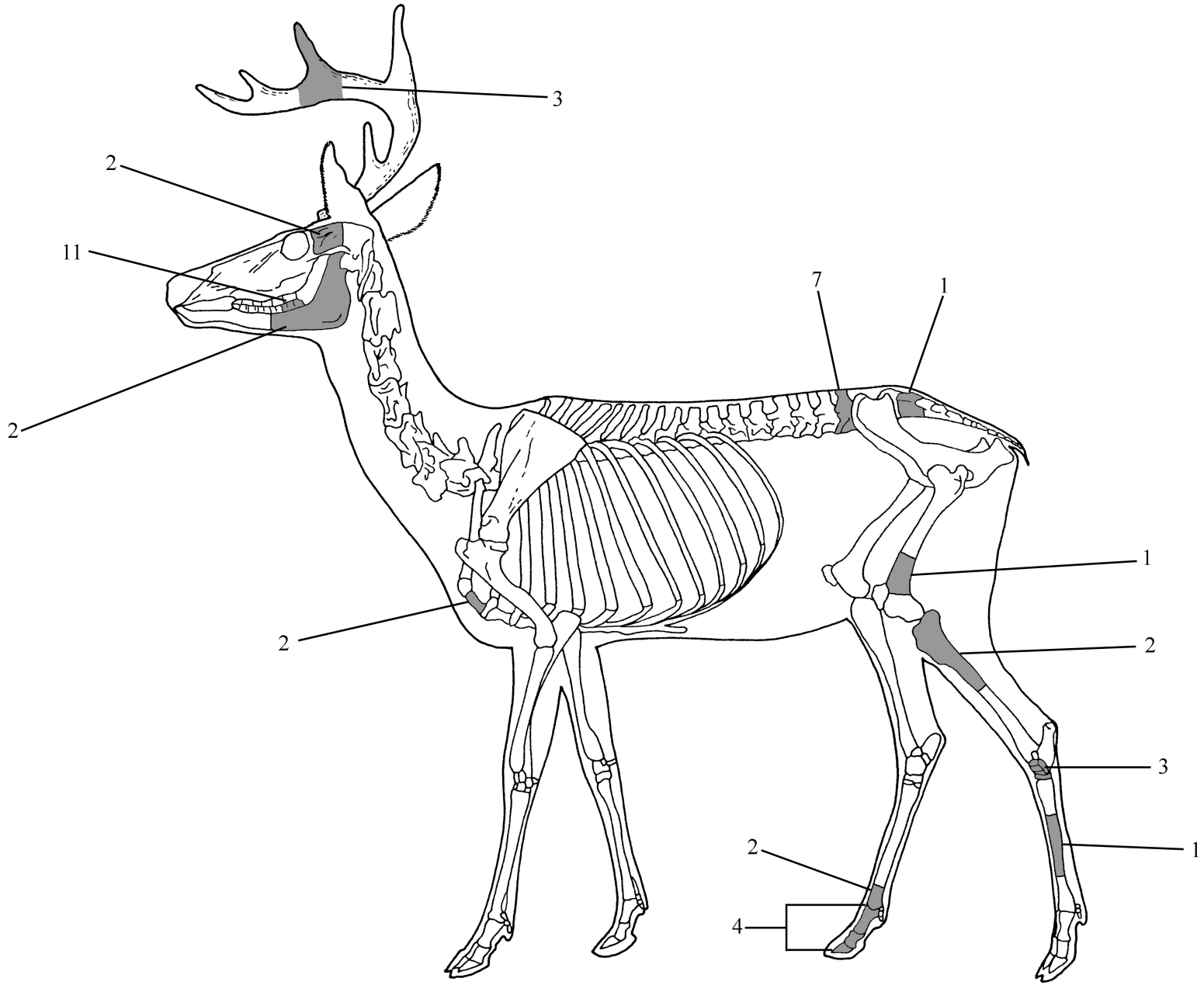


Figure 4.6: Deer Elements from theMcQueen Shell Ring, N263 E179 (NISP=41)

TABLE 4.1

St. Simons Cannon's Point Ring, 18N 0E: Species List

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Carcharhinidae	Requiem sharks	4	—	—	0.2	0.032
Galeocerdo cuvier	Tiger shark	95	1	0.3	2.8	0.305
Sphyrna sp.	Bonnethead shark	1	1	0.3	0.1	0.017
Myliobatidae	Eagle rays	223	3	0.9	9.2	0.849
Aetobatus narinari	Spotted eagle ray	1	(1)	—	1.1	0.137
Actinopterygii	Indeterminate bony fishes	12216	—	—	331.4	3.247
Lepisosteus spp.	Gar	58	1	0.3	4.0	0.111
Amia calva	Bowfin	4	1	0.3	0.5	0.003
Elops saurus	Ladyfish	9	1	0.3	0.7	0.022
Clupeidae	Herrings and shads	1154	40	11.6	11.7	0.216
Brevoortia spp.	Menhaden	2	(1)	—	0.2	0.008
Ameiurus sp.	Bullhead catfish	1	1	0.3	0.2	0.004
Ariidae	Sea catfishes	2383	38	11.0	204.4	3.126
Ariopsis felis	Hardhead catfish	58	—	—	12.4	0.218
Bagre marinus	Gafftopsail catfish	490	—	—	68.7	1.109
Opsanus spp.	Toadfish	10	3	0.9	0.6	0.020
Mugil spp.	Mullet	1495	79	22.9	31.2	0.479
Cyprinodontidae	Killifishes	101	4	1.2	0.8	0.025
Pomatomus saltatrix	Bluefish	1	1	0.3	0.1	0.005
Carangidae	Jacks and pompanos	2	1	0.3	0.2	0.009
cf. *Lagodon rhomboides*	Prob. pinfish	1	1	0.3	0.1	0.002
Sciaenidae	Drums	70	—	—	4.2	0.113
Bairdiella chrysoura	Silver perch	71	31	9.0	3.6	0.100
Cynoscion spp.	Seatrout	33	11	3.2	4.9	0.126
Leiostomus xanthurus	Spot	34	32	9.3	1.6	0.055
Menticirrhus americanus	Southern kingfish	3	2	0.6	0.4	0.020
Micropogonias undulatus	Atlantic croaker	133	51	14.8	8.7	0.193
Pogonias cromis	Black drum	12	5	1.4	1.7	0.058
cf. *Pogonias cromis*	Prob. black drum	1	—	—	0.1	0.007
Sciaenops ocellatus	Red drum	43	5	1.4	24.3	0.412
Stellifer lanceolatus	Star drum	4	2	0.6	0.2	0.012

TABLE 4.1—(*Continued*)

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Prionotus sp.	Searobin	1	1	0.3	1.0	0.010
Paralichthyidae	Sand flounders	69	2	0.6	9.8	0.201
Amphibia	Indeterminate amphibians	6	—	—	0.5	—
Anura	Frogs and toads	1	1	0.3	0.1	—
Testudines	Indeterminate turtles	319	—	—	42.0	0.387
Kinosternidae	Mud and musk turtles	65	2	0.6	38.1	0.362
cf. Kinosternidae	Prob. mud and musk turtles	1	—	—	0.2	0.011
Malaclemys terrapin	Diamondback terrapin	121	2	0.6	33.2	0.330
cf. *Malaclemys terrapin*	Prob. diamondback terrapin	1	—	—	0.6	0.022
Trachemys spp.	Pond slider	128	2	0.6	25.1	0.274
cf. *Trachemys* spp.	Prob. pond slider	2	—	—	1.7	0.045
Iguanidae	Lizards	1	—	—	0.1	—
Anolis carolinensis	Green anole	4	1	0.3	0.4	—
Serpentes	Indeterminate snakes	61	—	—	2.2	0.031
Coluber constrictor	Black racer	4	1	0.3	0.2	0.003
Lampropeltis spp.	Kingsnake	4	1	0.3	0.2	0.003
Nerodia sp.	Water snake	1	1	0.3	0.1	0.001
Aves	Indeterminate birds	66	—	—	6.1	0.106
Ardea herodias	Great blue heron	1	1	0.3	0.3	0.007
Rallidae	Coots and rails	13	3	0.9	1.4	0.028
Buteo lineatus	Red-shouldered hawk	1	1	0.3	0.3	0.007
Mammalia	Indeterminate mammals	247	—	—	63.7	1.106
Didelphis virginiana	Opossum	26	1	0.3	17.8	0.351
Soricidae	Shrews	3	—	—	0.1	0.003
Cryptotis parva	Least shrew	2	1	0.3	0.2	0.006
Sylvilagus spp.	Cottontail rabbit	7	1	0.3	1.3	0.033
Rodentia	Rodents	13	—	—	0.9	0.024
cf. Rodentia	Prob. rodents	2	—	—	0.2	0.006
Sciurus carolinensis	Gray squirrel	5	1	0.3	0.5	0.014
cf. *Neotoma floridana*	Prob. Eastern woodrat	1	1	0.3	0.2	0.006
Orzomys spp.	Rice rat	2	1	0.3	0.3	0.009
Peromyscus spp.	New World mouse	4	2	0.6	0.4	0.012

TABLE 4.1—(*Continued*)

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
cf. *Peromyscus* spp.	Prob. New World mouse	1	—	—	0.1	0.003
Procyon lotor	Raccoon	17	2	0.6	25.4	0.483
cf. *Procyon lotor*	Prob. raccoon	1	—	—	1.0	0.026
Odocoileus virginianus	White-tailed deer	55	1	0.3	201.6	3.119
cf. *Odocoileus virginianus*	Prob. white-tailed deer	1	—	—	0.4	0.012
Vertebrata	Indeterminate vertebrates	—	—	—	45.5	—
Total		19970	345	100%	1253.5	18.081

Data from Marrinan 1975, 2010; Reitz et al. 2009

TABLE 4.2

St. Simons Cannon's Point Ring, 18N 0E: Summary Table

Taxa	MNI	%	Biomass, kg	%
Sharks, rays, and bony fishes	318	92.2	6.380	55.8
Turtles	6	1.7	0.966	8.5
Snakes	3	0.9	0.007	0.1
Birds	5	1.4	0.042	0.4
White-tailed deer	1	0.3	3.119	27.3
Other mammals	6	1.7	0.887	7.8
Commensals	6	1.7	0.027	0.2
Total	345	100%	11.428	100%

Note: Amphibians and Lizards are included in the MNI estimates, but are not included in the biomass estimates because allometric formulae are not currently available for these taxa.

Data from Marrinan 1975, 2010; Reitz et al. 2009

TABLE 4.3

St. Simons Cannon's Point Ring, 18N 0E: Fish Summary Table

Taxa	# of Taxa	MNI	%	Biomass, kg	%
Herrings and shads	1	40	12.6	0.216	3.4
Sea catfishes	1	38	11.9	3.126	49.0
Mullets	1	79	24.8	0.479	7.5
Drums	8	139	43.7	0.976	15.3
Freshwater fishes	3	3	0.9	0.118	1.8
Other fishes	11	19	6.0	1.465	23.0
Total	25	318	100%	6.380	100%

Data from Marrinan 1975, 2010; Reitz et al. 2009

TABLE 4.4

St. Simons West Ring, 5S 30E: Species List

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Myliobatidae	Eagle rays	82	1	0.4	1.7	0.199
Actinopterygii	Indeterminate bony fishes	5568	—	—	105.5	1.285
Lepisosteus spp.	Gar	51	1	0.4	2.2	0.066
Elops saurus	Ladyfish	5	1	0.4	0.3	0.011
Clupeidae	Herrings and shads	783	30	12.0	6.6	0.136
Ariidae	Sea catfishes	725	28	11.2	54.5	0.890
Ariopsis felis	Hardhead catfish	113	—	—	6.8	0.123
Bagre marinus	Gafftopsail catfish	126	—	—	17.8	0.308
Mugil spp.	Mullet	980	30	12.0	13.4	0.242
Carangidae	Jacks and pompanos	1	1	0.4	0.1	0.005
Archosargus probatocephalus	Sheepshead	1	1	0.4	0.1	0.002
Sciaenidae	Drums	57	—	—	2.3	0.072
Bairdiella chrysoura	Silver perch	53	25	10.0	1.6	0.055
Cynoscion spp.	Seatrout	47	14	5.6	5.5	0.137
Leiostomus xanthurus	Spot	13	11	4.4	0.5	0.023
Micropogonias undulatus	Atlantic croaker	145	71	28.4	19.5	0.350
Pogonias cromis	Black drum	19	2	0.8	2.0	0.065
Sciaenops ocellatus	Red drum	17	4	1.6	4.0	0.109
Stellifer lanceolatus	Star drum	24	13	5.2	0.9	0.036
Paralichthyidae	Sand flounders	100	2	0.8	4.7	0.104
Amphibia	Indeterminate amphibians	14	1	0.4	0.3	—
Testudines	Indeterminate turtles	142	—	—	16.9	0.210
Kinosternon spp.	Mud turtle	4	1	0.4	0.9	0.029
Malaclemys terrapin	Diamondback terrapin	83	2	0.8	14.6	0.191
Trachemys sp.	Pond slider	1	1	0.4	0.1	0.007
Anolis carolinensis	Green anole	2	1	0.4	0.1	—
Serpentes	Indeterminate snakes	21	1	0.4	0.6	0.008
Aves	Indeterminate birds	46	—	—	3.3	0.061
Rallidae	Coots and rails	5	1	0.4	0.6	0.013
Mammalia	Indeterminate mammals	187	—	—	24.4	0.466
Didelphis virginiana	Opossum	4	1	0.4	1.0	0.026

TABLE 4.4—(*Continued*)

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Soricidae	Shrews	1	—	—	0.1	0.003
Blarina brevicauda	Short-tailed shrew	1	1	0.4	0.1	0.003
Sylvilagus spp.	Cottontail rabbit	4	1	0.4	1.6	0.040
Rodentia	Rodents	3	—	—	0.3	0.009
cf. *Peromyscus* spp.	Prob. New World mouse	1	1	0.4	0.1	0.003
Sigmodon hispidus	Hispid cotton rat	1	1	0.4	0.1	0.003
Procyon lotor	Raccoon	6	1	0.4	2.9	0.069
Odocoileus virginianus	White-tailed deer	17	1	0.4	47.5	0.849
Vertebrata	Indeterminate vertebrates	—	—	—	4.1	—
Total		9453	250	100%	369.6	6.208

Data from Marrinan 1975, 2010

TABLE 4.5

St. Simons West Ring, 5S 30E: Summary Table

Taxa	MNI	%	Biomass, kg	%
Sharks, rays, and bony fishes	235	94.0	2.430	66.2
Turtles	4	1.6	0.227	6.2
Snakes	1	0.4	0.008	0.2
Birds	1	0.4	0.013	0.4
White-tailed deer	1	0.4	0.849	23.1
Other mammals	3	1.2	0.135	3.7
Commensals	5	2.0	0.009	0.2
Total	250	100%	3.671	100%

Note: Amphibians and Lizards are included in the MNI estimates, but are not included in the biomass estimates because allometric formulae are not currently available for these taxa.

Data from Marrinan 1975, 2010

TABLE 4.6

St. Simons West Ring, 5S 30E: Fish Summary Table

Taxa	# of Taxa	MNI	%	Biomass, kg	%
Herrings and shads	1	30	12.8	0.136	5.6
Sea catfishes	1	28	11.9	0.890	36.6
Mullets	1	30	12.8	0.242	10.0
Drums	7	140	59.6	0.775	31.9
Freshwater fishes	1	1	0.4	0.066	2.7
Other fishes	5	6	2.6	0.321	13.2
Total	16	235	100%	2.430	100%

Data from Marrinan 1975, 2010

TABLE 4.7

Sapelo Shell Ring Complex, Ring III, Unit 9 Column Sample: Species List

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Myliobatiformes	Rays	3	—	—	0.025	0.005
Dasyatidae	Stingrays	1	1	0.5	0.011	0.003
Actinopterygii	Indeterminate bony fishes	6540	—	—	57.343	0.784
Anguilla rostrata	American eel	2	1	0.5	0.010	0.001
Clupeidae	Herrings and shads	3	1	0.5	0.003	0.000
Siluriformes	Catfishes	1483	—	—	24.143	0.411
Ariidae	Sea catfishes	764	—	—	28.624	0.483
Ariopsis felis	Hardhead catfish	2115	66	36.3	121.270	1.904
Bagre marinus	Gafftopsail catfish	21	3	1.6	1.644	0.032
Opsanus spp.	Toadfish	9	2	1.1	0.656	0.021
Mugil spp.	Mullet	169	5	2.7	2.019	0.052
Cyprinodontidae	Killifishes	25	3	1.6	0.085	0.004
Orthopristis chrysoptera	Pigfish	5	1	0.5	0.041	0.002
Archosargus probatocephalus	Sheepshead	2	1	0.5	0.405	0.007
Sciaenidae	Drums	324	—	—	2.316	0.072
Bairdiella chrysoura	Silver perch	27	5	2.7	0.726	0.031
Cynoscion spp.	Seatrout	32	3	1.6	1.512	0.053
Leiostomus xanthurus	Spot	19	4	2.2	0.204	0.012
Menticirrhus spp.	Kingfish	2	1	0.5	0.107	0.007
Micropogonias undulatus	Atlantic croaker	24	5	2.7	1.591	0.053
Sciaenops ocellatus	Red drum	2	1	0.5	0.235	0.013
Stellifer lanceolatus	Star drum	512	68	37.4	9.638	0.208
Peprilus spp.	Harvest and butterfish	4	1	0.5	0.024	0.005
Prinotus sp.	Searobin	1	1	0.5	0.004	0.001
Paralichthyidae	Sand flounders	2	—	—	0.098	0.003
Citharichthys spp.	Whiff	5	1	0.5	0.023	0.001
Paralichthys spp.	Southern flounder	7	2	1.1	0.495	0.014
Rana spp.	Bullfrog	1	1	0.5	0.006	—
Alligator mississippiensis	American alligator	1	1	0.5	0.136	0.002
Testudines	Indeterminate turtles	9	1	0.5	1.285	0.037

TABLE 4.7—(*Continued*)

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Aves	Indeterminate birds	1	1	0.5	0.065	0.002
Mammalia	Indeterminate mammals	14	—	—	2.613	0.062
Sigmodontinae	New World mice and rats	2	1	0.5	0.018	0.001
Procyon lotor	Raccoon	1	1	0.5	1.374	0.035
Vertebrata	Indeterminate vertebrates	—	—	—	3.610	—
Total		12132	182	100%	262.359	4.321

TABLE 4.8

Sapelo Shell Ring Complex, Ring III, Unit 9 Column Sample: Summary Table

Taxa	MNI	%	Biomass, kg	%
Sharks, rays, and bony fishes	176	96.7	2.424	96.9
Turtles and alligator	2	1.1	0.039	1.6
Snakes	—	—	—	—
Birds	1	0.5	0.002	0.1
White-tailed deer	—	—	—	—
Other mammals	1	0.5	0.035	1.4
Commensals	2	1.1	0.001	0.0
Total	182	100%	2.501	100%

Note: Amphibians and Lizards are included in the MNI estimates, but are not included in the biomass estimates because allometric formulae are not currently available for these taxa.

TABLE 4.9

Sapelo Shell Ring Complex, Ring III, Unit 9 Column Sample: Fish Summary Table

Taxa	# of Taxa	MNI	%	Biomass, kg	%
Herrings and shads	1	1	0.6	0.000	0.0
Sea catfishes	2	69	39.2	1.936	79.9
Mullets	1	5	2.8	0.052	2.1
Drums	7	87	49.4	0.377	15.6
Freshwater fishes	—	—	—	—	—
Other fishes	10	14	8.0	0.059	2.4
Total	21	176	100%	2.424	100%

TABLE 4.10

Sapelo Shell Ring Complex, Ring III, Unit 9 Column Sample: Modifications

Taxa	Pathology	Hacked	Cut	Burned	Calcined	Worked	Rodent gnawed
Indeterminate bony fishes	—	—	—	35	7	—	—
Herrings and shads	—	—	—	1	—	—	—
Catfishes	—	—	—	9	3	—	—
Sea catfishes	—	—	—	23	9	—	—
Hardhead catfish	—	—	—	18	8	—	—
Mullet	—	—	—	1	—	—	—
Drums	—	—	—	4	1	—	—
Silver perch	—	—	—	1	—	—	—
Star drum	—	—	—	1	—	—	—
Indeterminate turtles	—	—	—	9	—	—	—
Indeterminate vertebrates	—	—	—	4	5	—	—
Total	—	—	—	106	33	—	—

TABLE 4.11

Sapelo Shell Ring Complex, Ring III, Unit 4 Fraction 0.64 cm: Species List

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Carcharhinidae	Requiem sharks	1	1	0.3	0.240	0.037
Dasyatidae	Stingrays	1	1	0.3	0.085	0.015
Actinopterygii	Indeterminate bony fishes	1573	—	—	98.295	1.213
Anguilla rostrata	American eel	2	1	0.3	0.117	0.005
Siluriformes	Catfishes	484	—	—	32.731	0.549
Ariidae	Sea catfishes	730	—	—	76.487	1.229
Ariopsis felis	Hardhead catfish	4361	243	73.0	612.876	8.871
Bagre marinus	Gafftopsail catfish	438	15	4.5	98.423	1.561
Opsanus spp.	Toadfish	14	2	0.6	2.971	0.321
Mugil spp.	Mullet	200	9	2.7	13.470	1.178
Fundulus sp.	Killifish	1	1	—	0.016	0.004
Pomatomus saltatrix	Bluefish	3	1	0.3	0.116	0.020
Carangidae	Jacks and pompanos	1	1	0.3	0.052	0.003
Archosargus probatocephalus	Sheepshead	1	1	0.3	0.079	0.002
Sciaenidae	Drums	60	—	—	6.120	0.149
Bairdiella chrysoura	Silver perch	3	1	0.3	0.044	0.004
Cynoscion spp.	Seatrout	240	22	6.6	17.196	0.319
Leiostomus xanthurus	Spot	5	2	0.6	0.063	0.005
Menticirrhus spp.	Kingfish	3	1	0.3	0.244	0.014
Micropogonias undulatus	Atlantic croaker	14	5	1.5	0.970	0.038
Pogonias cromis	Black drum	1	1	0.3	0.197	0.012
Sciaenops ocellatus	Red drum	36	4	1.2	15.495	0.296
Stellifer lanceolatus	Star drum	38	4	1.2	0.653	0.028
Peprilus sp.	Harvest and butterfish	1	1	0.3	0.004	0.000
Paralichthys spp.	Southern flounder	67	4	1.2	14.579	0.286
Alligator mississippiensis	American alligator	15	1	0.3	17.880	0.258
Testudines	Indeterminate turtles	58	—	—	10.305	0.151
Kinosternidae	Mud and musk turtles	9	—	—	1.744	0.046
Kinosternon spp.	Mud turtle	17	2	0.6	3.795	0.077
Emydidae	Pond turtles	9	—	—	3.567	0.074

TABLE 4.11—(*Continued*)

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Malaclemys terrapin	Diamondback terrapin	2	1	0.3	2.094	0.052
Aves	Indeterminate birds	10	—	—	1.444	0.029
Ardeidae	Herons	1	1	0.3	0.080	0.002
Rallidae	Coots and rails	10	2	0.6	3.044	0.056
Mammalia	Indeterminate mammals	365	—	—	212.817	3.275
Didelphis virginiana	Opossum	2	1	0.3	1.213	0.031
Soricidae	Shrews	1	1	0.3	0.003	0.000
Sigmodontinae	New World mice and rats	1	1	0.3	0.088	0.003
Procyon lotor	Raccoon	5	1	0.3	5.646	0.125
Odocoileus virginianus	White-tailed deer	33	1	0.3	127.699	2.068
Homo sapiens	Human	3	—	—	4.088	—
Vertebrata	Indeterminate vertebrates	—	—	—	12.098	—
Total		8819	333	100%	1399.128	22.406

TABLE 4.12

Sapelo Shell Ring Complex, Ring III, Unit 4 Fraction 0.64 cm: Summary Table

Taxa	MNI	%	Biomass, kg	%
Sharks, rays, and bony fishes	321	96.4	13.019	83.0
Turtles and alligator	4	1.2	0.387	2.5
Snakes	—	—	—	—
Birds	3	0.9	0.058	0.4
White-tailed deer	1	0.3	2.068	13.2
Other mammals	2	0.6	0.156	1.0
Commensals	2	0.6	0.003	0.0
Total	333	100%	15.691	100%

Note: Amphibians and Lizards are included in the MNI estimates, but are not included in the biomass estimates because allometric formulae are not currently available for these taxa.

TABLE 4.13

Sapelo Shell Ring Complex, Ring III, Unit 4 Fraction 0.64 cm: Fish Summary Table

Taxa	# of Taxa	MNI	%	Biomass, kg	%
Herrings and shads	—	—	—	—	—
Sea catfishes	2	258	80.4	10.432	80.1
Mullets	1	9	2.8	1.178	9.0
Drums	8	40	12.5	0.716	5.5
Freshwater fishes	—	—	—	—	—
Other fishes	10	14	4.4	0.693	5.3
Total	21	321	100%	13.019	100%

TABLE 4.14

Sapelo Shell Ring Complex, Ring III, Unit 4 Fraction 0.64 cm: Element Distribution

Skeletal Element	Deer
Head	17
Vertebra/rib	—
Forequarter	2
Hindquarter	6
Forefoot	—
Hindfoot	2
Foot	6
Total	33

TABLE 4.15

Sapelo Shell Ring Complex, Ring III, Unit 4 Fraction 0.64 cm: Epiphyseal Fusion for Deer

	Unfused	Fused	Total
Early Fusing:			
Humerus, distal	—	—	—
Scapula, distal	—	—	—
Radius, proximal	—	—	—
Acetabulum	—	—	—
Metapodials, proximal	—	—	—
1st/2nd phalanx, proximal	—	2	2
Middle Fusing:			
Tibia, distal	—	—	—
Calcaneus, proximal	—	—	—
Metapodials, distal	—	1	1
Late Fusing:			
Humerus, proximal	—	—	—
Radius, distal	—	—	—
Ulna, proximal	—	—	—
Ulna, distal	—	—	—
Femur, proximal	—	—	—
Femur, distal	—	—	—
Tibia, proximal	—	—	—
Total	0	3	3

TABLE 4.16

Sapelo Shell Ring Complex, Ring III, Unit 4 Fraction 0.64 cm: Modifications

Taxa	Pathology	Hacked	Cut	Burned	Calcined	Worked	Rodent gnawed
Indeterminate bony fishes	—	—	1	2	—	—	—
Catfishes	—	—	—	1	—	—	—
Sea catfishes	—	—	—	3	—	—	—
Hardhead catfish	—	—	—	5	—	—	—
Gafftopsail catfish	—	—	—	1	—	—	—
Seatrout	1	—	—	1	—	—	—
Indeterminate turtles	—	—	—	9	—	1	—
Indeterminate mammals	—	2	—	13	1	3	—
White-tailed deer	—	—	1	1	—	3	—
Indeterminate vertebrates	—	—	—	3	—	—	—
Total	1	2	2	39	1	7	—

TABLE 4.17

St. Catherines Shell Ring, Combined Areas: Species List

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Chondrichthyes	Cartilaginous fishes	13	—	—	1.995	0.228
Carcharhiniformes	Ground sharks	6	—	—	0.410	0.058
Carcharhinidae	Requiem sharks	2	1	0.1	0.451	0.063
Myliobatiformes	Rays	34	1	0.1	0.727	0.096
Dasyatidae	Stingrays	15	3	0.2	0.513	0.071
Actinopterygii	Indeterminate bony fishes	20404	—	—	354.344	3.428
Lepisosteus spp.	Gar	107	4	0.3	10.925	0.200
Amia calva	Bowfin	194	4	0.3	8.370	0.065
Elops saurus	Ladyfish	24	3	0.2	0.267	0.010
Anguilla rostrata	American eel	170	5	0.4	3.225	0.076
Clupeidae	Herrings and shads	446	14	1.1	4.846	0.106
Siluriformes	Catfishes	2664	—	—	105.570	1.669
Ictaluridae	Freshwater catfishes	43	8	0.6	3.687	0.069
Ameiurus spp.	Bullhead catfish	115	8	0.6	9.282	0.166
Ameiurus catus	White catfish	4	(2)	—	0.815	0.016
Ariidae	Sea catfishes	728	—	—	56.566	0.922
Ariopsis felis	Hardhead catfish	1798	66	5.3	171.173	2.641
Bagre marinus	Gafftopsail catfish	510	25	2.0	86.103	1.375
Opsanus spp.	Toadfish	212	15	1.2	5.869	0.124
Mugil spp.	Mullet	11494	560	44.8	141.692	1.631
Cyprinodontidae	Killifishes	498	63	5.0	4.578	0.101
Fundulus spp.	Killifish	116	(46)	—	1.249	0.027
Centrarchidae	Sunfishes	15	—	—	0.273	0.006
Chaenobryttus gulosus	Warmouth	2	2	0.2	0.070	0.002
Lepomis spp.	Sunfish	2	1	0.1	0.026	0.001
Pomatomus saltatrix	Bluefish	23	2	0.2	0.448	0.015
Archosargus probatocephalus	Sheepshead	2	1	0.1	0.099	0.002
Lagodon rhomboides	Pinfish	6	3	0.2	0.143	0.003
Sciaenidae	Drums	425	—	—	10.950	0.229
Bairdiella chrysoura	Silver perch	426	143	11.4	12.983	0.259

TABLE 4.17—(*Continued*)

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Cynoscion spp.	Seatrout	235	22	1.8	22.203	0.386
Leiostomus xanthurus	Spot	145	64	5.1	1.833	0.061
Menticirrhus spp.	Kingfish	18	5	0.4	1.749	0.059
Menticirrhus americanus	Southern kingfish	1	1	10.0	0.090	0.007
Micropogonias undulatus	Atlantic croaker	155	49	3.9	11.919	0.243
Pogonias cromis	Black drum	66	6	0.5	38.827	0.583
Sciaenops ocellatus	Red drum	71	11	0.9	17.789	0.327
Stellifer lanceolatus	Star drum	73	21	1.7	3.037	0.089
Paralichthyidae	Sand flounders	82	—	—	3.018	0.070
Citharichthys spp.	Whiff	5	3	0.2	0.039	0.001
Paralichthys spp.	Southern flounder	83	7	0.6	9.729	0.199
Anura	Frogs and toads	56	—	—	0.865	—
Bufo spp.	Toad	5	2	0.2	0.165	—
Scaphiopus holbrookii	Eastern spadefoot toad	51	7	0.6	1.006	—
Rana spp.	Bullfrog	2	1	0.1	0.207	—
Caudata	Newts and salamanders	6	2	0.2	0.123	—
Reptilia	Indeterminate reptiles	6	—	—	0.341	—
Testudines	Indeterminate turtles	1487	—	—	198.608	1.096
Chelydra serpentina	Snapping turtle	10	3	0.2	8.953	0.137
Kinosternidae	Mud and musk turtles	23	—	—	4.456	0.086
Kinosternon spp.	Mud turtle	95	9	0.7	29.246	0.304
Sternotherus sp.	Musk turtle	1	1	0.1	0.200	0.003
Emydidae	Pond turtles	145	—	—	83.865	0.615
Deirochelys reticularia	Chicken turtle	15	4	0.3	27.138	0.289
Malaclemys terrapin	Diamondback terrapin	236	11	0.9	227.271	1.199
Pseudemys sp.	Cooter	1	1	0.1	0.696	0.025
Gopherus polyphemus	Gopher tortoise	5	2	0.2	27.084	0.288
Lacertilia	Indeterminate lizards	44	11	0.9	0.436	—
Anolis carolinensis	Green anole	5	(3)	—	0.080	—
Serpentes	Indeterminate snakes	72	1	0.1	1.773	0.025
Colubridae	Non-venomous snakes	171	2	0.2	4.910	0.069

TABLE 4.17—(*Continued*)

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Viperidae	Venomous snakes	4	1	0.1	0.294	0.004
Aves	Indeterminate birds	221	—	—	29.314	0.442
Gavia spp.	Loon	3	1	0.1	0.336	0.008
Ardea herodias	Great blue heron	1	1	0.1	1.013	0.021
Anatidae	Ducks, geese, and swans	1	1	0.1	0.726	0.015
Accipitridae	Eagles, hawks, and kites	2	2	0.2	0.258	0.006
Meleagris gallopavo	Turkey	4	2	0.2	15.461	0.247
Rallidae	Coots and rails	49	10	0.8	5.847	0.102
Laridae	Gulls and terns	1	1	0.1	0.204	0.005
Passeriformes	Perching birds	13	4	0.3	0.227	0.005
Mammalia	Indeterminate mammals	4573	—	—	1523.809	19.260
Didelphis virginiana	Opossum	90	6	0.5	49.970	0.889
Soricidae	Shrews	4	3	0.2	0.062	0.002
Cryptotis parva	Least shrew	1	(1)	—	0.012	0.000
Scalopus aquaticus	Eastern mole	2	2	0.2	0.231	0.007
Sylvilagus spp.	Cottontail rabbit	29	3	0.2	6.731	0.146
Rodentia	Rodents	35	—	—	1.058	0.028
Glaucomys volan	Southern flying squirrel	2	1	0.1	0.046	0.002
Sciurus spp.	Squirrel	55	5	0.4	7.862	0.168
Muridae	Mice, rats, and voles	2	—	—	0.183	0.006
Microtus pinetorum	Pine vole	2	1	0.1	0.165	0.005
Sigmodontinae	New World mice and rats	15	—	—	0.566	0.016
Neotoma floridana	Eastern woodrat	2	2	0.2	0.291	0.009
Peromyscus spp.	New World mouse	2	1	0.1	0.095	0.003
Sigmodon hispidus	Hispid cotton rat	5	1	0.1	0.358	0.010
Canis familiaris	Dog	5	2	0.2	8.447	0.179
Procyon lotor	Raccoon	114	9	0.7	160.425	2.540
Lontra canadensis	River otter	1	1	0.1	1.576	0.040
Neovison vison	Mink	1	1	0.1	0.087	0.003
Odocoileus virginianus	White-tailed deer	478	10	0.8	2341.702	28.353

TABLE 4.17—(*Continued*)

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Homo sapiens	Human	2	—	—	0.513	—
Vertebrata	Indeterminate vertebrates	—	—	—	179.831	—
Total		49587	1249	100%	6063.005	72.341

TABLE 4.18

St. Catherines Shell Ring, Combined Areas: Summary Table

Taxa	MNI	%	Biomass, kg	%
Sharks, rays, and bony fishes	1121	89.8	9.031	20.5
Turtles	31	2.5	2.245	5.1
Snakes	4	0.3	0.098	0.2
Birds	22	1.8	0.409	0.9
White-tailed deer	10	0.8	28.353	64.2
Other mammals	29	2.3	3.974	9.0
Commensals	32	2.6	0.029	0.1
Total	1249	100%	44.139	100%

Note: Amphibians and Lizards are included in the MNI estimates, but are not included in the biomass estimates because allometric formulae are not currently available for these taxa.

TABLE 4.19

St. Catherines Shell Ring, Combined Areas: Fish Summary Table

Taxa	# of Taxa	MNI	%	Biomass, kg	%
Herrings and shads	1	14	1.2	0.106	1.2
Sea catfishes	2	91	8.1	4.016	44.5
Mullets	1	560	50.0	1.631	18.1
Drums	9	322	28.7	2.014	22.3
Freshwater fishes	6	27	2.4	0.503	5.6
Other fishes	12	107	9.5	0.761	8.4
Total	31	1121	100%	9.031	100%

TABLE 4.20

St. Catherines Shell Ring, North Area: Species List

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Chondrichthyes	Cartilaginous fishes	8	—	—	1.774	0.206
Carcharhiniformes	Ground sharks	6	—	—	0.410	0.058
Carcharhinidae	Requiem sharks	2	1	0.1	0.451	0.063
Myliobatiformes	Rays	17	—	—	0.310	0.046
Dasyatidae	Stingrays	13	1	0.1	0.393	0.056
Actinopterygii	Indeterminate bony fishes	14386	—	—	228.584	2.403
Lepisosteus spp.	Gar	64	1	0.1	4.002	0.111
Amia calva	Bowfin	130	1	0.1	4.754	0.035
Elops saurus	Ladyfish	15	1	0.1	0.144	0.006
Anguilla rostrata	American eel	107	3	0.4	1.893	0.049
Clupeidae	Herrings and shads	395	12	1.6	4.235	0.095
Siluriformes	Catfishes	1932	—	—	80.783	1.294
Ictaluridae	Freshwater catfishes	27	—	—	2.169	0.042
Ameiurus spp.	Bullhead catfish	78	8	1.0	6.127	0.112
Ameiurus catus	White catfish	4	(2)	—	0.815	0.016
Ariidae	Sea catfishes	565	—	—	43.937	0.726
Ariopsis felis	Hardhead catfish	1348	46	6.0	132.228	2.067
Bagre marinus	Gafftopsail catfish	412	17	2.2	72.880	1.173
Opsanus spp.	Toadfish	182	10	1.3	5.152	0.111
Mugil spp.	Mullet	7569	365	47.2	92.511	1.155
Cyprinodontidae	Killifishes	326	38	4.9	2.841	0.069
Fundulus spp.	Killifish	89	(33)	—	0.911	0.027
Centrarchidae	Sunfishes	12	—	—	0.180	0.004
Lepomis spp.	Sunfish	2	1	0.1	0.026	0.001
Pomatomus saltatrix	Bluefish	10	1	0.1	0.131	0.006
Lagodon rhomboides	Pinfish	2	1	0.1	0.078	0.002
Sciaenidae	Drums	253	—	—	6.761	0.160
Bairdiella chrysoura	Silver perch	258	93	12.0	8.907	0.196
Cynoscion spp.	Seatrout	158	15	1.9	15.949	0.302
Leiostomus xanthurus	Spot	106	43	5.6	1.255	0.046

TABLE 4.20—(*Continued*)

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Menticirrhus spp.	Kingfish	13	3	0.4	1.546	0.054
Micropogonias undulatus	Atlantic croaker	93	30	3.9	6.273	0.151
Pogonias cromis	Black drum	44	3	0.4	25.189	0.424
Sciaenops ocellatus	Red drum	45	5	0.6	12.551	0.253
Stellifer lanceolatus	Star drum	39	11	1.4	1.781	0.060
Paralichthyidae	Sand flounders	39	—	—	1.385	0.035
Citharichthys spp.	Whiff	3	1	0.1	0.026	0.001
Paralichthys spp.	Southern flounder	47	3	0.4	5.135	0.113
Anura	Frogs and toads	39	—	—	0.590	—
Bufo spp.	Toad	2	1	0.1	0.129	—
Scaphiopus holbrookii	Eastern spadefoot toad	34	3	0.4	0.639	—
Rana spp.	Bullfrog	2	1	0.1	0.207	—
Caudata	Newts and salamanders	5	1	0.1	0.121	—
Reptilia	Indeterminate reptiles	5	—	—	0.148	—
Testudines	Indeterminate turtles	885	—	—	113.386	0.753
Chelydra serpentina	Snapping turtle	7	1	0.1	4.962	0.072
Kinosternidae	Mud and musk turtles	16	—	—	2.833	0.041
Kinosternon spp.	Mud turtle	64	5	0.6	19.530	0.282
Sternotherus sp.	Musk turtle	1	1	0.1	0.200	0.003
Emydidae	Pond turtles	57	—	—	20.368	0.294
Deirochelys reticularia	Chicken turtle	1	1	0.1	1.783	0.047
Malaclemys terrapin	Diamondback terrapin	121	5	0.6	122.690	0.793
Pseudemys sp.	Cooter	1	1	0.1	0.696	0.025
Gopherus polyphemus	Gopher tortoise	4	1	0.1	21.006	0.243
Lacertilia	Indeterminate lizards	39	7	0.9	0.387	—
Anolis carolinensis	Green anole	5	(3)	—	0.080	—
Serpentes	Indeterminate snakes	28	—	—	0.660	0.009
Colubridae	Non-venomous snakes	108	1	0.1	2.140	0.030
Viperidae	Venomous snakes	4	1	0.1	0.294	0.004
Aves	Indeterminate birds	167	—	—	14.322	0.230
Gavia spp.	Loon	3	1	0.1	0.336	0.008

TABLE 4.20—(*Continued*)

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Ardea herodias	Great blue heron	1	1	0.1	1.013	0.021
Rallidae	Coots and rails	33	6	0.8	4.145	0.074
Passeriformes	Perching birds	7	2	0.3	0.098	0.002
Mammalia	Indeterminate mammals	2935	—	—	949.000	12.576
Didelphis virginiana	Opossum	52	2	0.3	24.066	0.461
Soricidae	Shrews	3	2	0.3	0.050	0.002
Cryptotis parva	Least shrew	1	(1)	—	0.012	0.000
Scalopus aquaticus	Eastern mole	1	1	0.1	0.119	0.004
Sylvilagus spp.	Cottontail rabbit	24	1	0.1	3.847	0.088
Rodentia	Rodents	19	—	—	0.603	0.017
Sciurus spp.	Squirrel	14	1	0.1	1.048	0.027
Microtus pinetorum	Pine vole	2	1	0.1	0.165	0.005
Sigmodontinae	New World mice and rats	10	—	—	0.409	0.012
Peromyscus spp.	New World mouse	2	1	0.1	0.095	0.003
Sigmodon hispidus	Hispid cotton rat	5	1	0.1	0.358	0.010
Canis familiaris	Dog	4	1	0.1	8.217	0.175
Procyon lotor	Raccoon	54	3	0.4	72.132	1.237
Lontra canadensis	River otter	1	1	0.1	1.576	0.040
Neovison vison	Mink	1	1	0.1	0.087	0.003
Odocoileus virginianus	White-tailed deer	282	3	0.4	1056.451	13.851
Homo sapiens	Human	1	—	—	0.142	—
Vertebrata	Indeterminate vertebrates	—	—	—	101.975	—
Total		33849	773	100%	3327.592	43.170

TABLE 4.21

St. Catherines Shell Ring, North Area: Summary Table

Taxa	MNI	%	Biomass, kg	%
Sharks, rays, and bony fishes	714	92.4	6.711	27.7
Turtles	15	1.9	1.465	6.0
Snakes	2	0.3	0.034	0.1
Birds	10	1.3	0.105	0.4
White-tailed deer	3	0.4	13.851	57.2
Other mammals	10	1.3	2.031	8.4
Commensals	19	2.5	0.024	0.1
Total	773	100%	24.221	100%

Note: Amphibians and Lizards are included in the MNI estimates, but are not included in the biomass estimates because allometric formulae are not currently available for these taxa.

TABLE 4.22

St. Catherines Shell Ring, North Area: Fish Summary Table

Taxa	# of Taxa	MNI	%	Biomass, kg	%
Herrings and shads	1	12	1.7	0.095	1.4
Sea catfishes	2	63	8.8	3.240	48.3
Mullets	1	365	51.1	1.155	17.2
Drums	8	203	28.4	1.486	22.1
Freshwater fishes	4	11	1.5	0.259	3.9
Other fishes	10	60	8.4	0.476	7.1
Total	26	714	100%	6.711	100%

TABLE 4.23

St. Catherines Shell Ring, North Area: Element Distribution

Skeletal Element	Deer
Head	152
Vertebra/rib	30
Forequarter	7
Hindquarter	19
Forefoot	9
Hindfoot	20
Foot	45
Total	282

TABLE 4.24

St. Catherines Shell Ring, North Area: Epiphyseal Fusion for Deer

	Unfused	Fused	Total
Early Fusing:			
Humerus, distal	—	1	1
Scapula, distal	1	—	1
Radius, proximal	—	—	—
Acetabulum	—	1	1
Metapodials, proximal	—	3	3
1st/2nd phalanx, proximal	2	5	7
Middle Fusing:			
Tibia, distal	—	1	1
Calcaneus, proximal	1	2	3
Metapodials, distal	5	1	6
Late Fusing:			
Humerus, proximal	—	—	—
Radius, distal	—	1	1
Ulna, proximal	1	1	2
Ulna, distal	—	—	—
Femur, proximal	1	1	2
Femur, distal	—	—	—
Tibia, proximal	—	2	2
Total	11	19	30

TABLE 4.25

St. Catherines Shell Ring, North Area: Modifications

Taxa	Pathology	Hacked	Cut	Burned	Calcined	Worked	Rodent gnawed
Cartilaginous fishes	—	—	—	2	1	—	—
Ground sharks	—	—	—	1	—	—	—
Indeterminate bony fishes	—	—	—	87	3	—	—
Bowfin	—	—	—	2	1	—	—
American eel	—	—	—	—	1	—	—
Herrings and shads	—	—	—	1	—	—	—
Catfishes	—	—	—	19	1	—	—
Sea catfishes	—	—	—	31	1	—	—
Hardhead catfish	—	—	—	42	2	—	—
Gafftopsail catfish	—	—	—	17	4	—	—
Mullet	1	—	—	24	1	—	—
Killifishes	—	—	—	1	—	—	—
Drums	—	—	—	2	—	—	—
Silver perch	—	—	—	1	—	—	—
Seatrout	—	—	—	2	—	—	—
Spot	—	—	—	1	—	—	—
Atlantic croaker	—	—	—	1	—	—	—
Red drum	—	—	—	1	—	—	—
Sand flounders	—	—	—	1	—	—	—
Indeterminate turtles	—	—	—	197	6	—	—
Mud turtle	—	—	—	4	—	—	—

TABLE 4.25—(*Continued*)

Taxa	Pathology	Hacked	Cut	Burned	Calcined	Worked	Rodnet gnawed
Pond turtles	—	—	—	4	—	—	—
Diamondback terrapin	—	1	—	14	—	—	—
Venomous snakes	—	—	—	1	—	—	—
Indeterminate birds	—	—	—	13	2	—	—
Rails and coots	—	—	—	4	—	—	—
Indeterminate mammals	—	2	5	230	12	23	1
Opossum	—	—	—	2	—	—	—
Raccoon	—	—	—	3	—	—	—
White-tailed deer	—	1	3	6	—	5	1
Indeterminate vertebrates	—	—	2	89	4	—	1
Total	1	4	10	803	39	28	3

TABLE 4.26

St. Catherines Shell Ring, East Area: Species List

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Chondrichthyes	Cartilaginous fishes	1	—	—	0.053	0.010
Myliobatiformes	Rays	12	1	0.7	0.267	0.040
Actinopterygii	Indeterminate bony fishes	1456	—	—	26.132	0.415
Lepisosteus spp.	Gar	4	1	0.7	0.436	0.016
Amia calva	Bowfin	6	1	0.7	0.188	0.001
Anguilla rostrata	American eel	22	1	0.7	0.446	0.063
Clupeidae	Herrings and shads	20	1	0.7	0.175	0.007
Siluriformes	Catfishes	195	—	—	6.814	0.124
Ictaluridae	Freshwater catfishes	2	2	1.5	0.049	0.001
Ameiurus spp.	Bullhead catfish	4	(1)	—	0.187	0.004
Ariidae	Sea catfishes	52	—	—	3.951	0.074
Ariopsis felis	Hardhead catfish	118	8	6.0	8.682	0.155
Bagre marinus	Gafftopsail catfish	32	3	2.2	6.519	0.118
Opsanus spp.	Toadfish	8	1	0.7	0.116	0.005
Mugil spp.	Mullet	902	42	31.3	11.786	0.218
Cyprinodontidae	Killifishes	42	8	6.0	0.420	0.015
Fundulus spp.	Killifish	5	(4)	—	0.078	0.004
Sciaenidae	Drums	37	—	—	0.821	0.034
Bairdiella chrysoura	Silver perch	34	12	9.0	1.067	0.041
Cynoscion spp.	Seatrout	19	2	1.5	1.284	0.047
Leiostomus xanthurus	Spot	20	11	8.2	0.344	0.018
Menticirrhus sp.	Kingfish	1	—	—	0.054	0.004
Menticirrhus americanus	Southern kingfish	1	1	0.7	0.090	0.007
Micropogonias undulatus	Atlantic croaker	25	7	5.2	2.058	0.066
Pogonias cromis	Black drum	6	1	0.7	0.305	0.016
Sciaenops ocellatus	Red drum	1	1	0.7	0.792	0.033
Stellifer lanceolatus	Star drum	20	6	4.5	0.848	0.034
Paralichthyidae	Sand flounders	6	—	—	0.157	0.005
Citharichthys sp.	Whiff	1	1	0.7	0.002	0.000
Paralichthys spp.	Southern flounder	14	2	1.5	1.823	0.045

TABLE 4.26—(*Continued*)

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Anura	Frogs and toads	7	—	—	0.060	—
Scaphiopus holbrookii	Eastern spadefoot toad	1	1	0.7	0.008	—
Testudines	Indeterminate turtles	161	—	—	17.988	0.219
Chelydra serpentina	Snapping turtle	1	1	0.7	0.562	0.021
Kinosternon spp.	Mud turtle	5	1	0.7	0.968	0.031
Emydidae	Pond turtles	18	—	—	7.332	0.120
Deirochelys reticularia	Chicken turtle	2	1	0.7	1.861	0.048
Malaclemys terrapin	Diamondback terrapin	17	2	1.5	11.802	0.165
Lacertilia	Indeterminate lizards	1	1	0.7	0.008	—
Serpentes	Indeterminate snakes	1	1	0.7	0.020	0.000
Aves	Indeterminate birds	19	—	—	1.639	0.032
Rallidae	Coots and rails	10	2	1.5	1.394	0.028
Passeriformes	Perching birds	1	1	0.7	0.003	0.000
Mammalia	Indeterminate mammals	417	—	—	120.136	1.958
Didelphis virginiana	Opossum	8	1	0.7	1.054	0.028
Soricidae	Shrews	1	1	0.7	0.012	0.000
Scalopus aquaticus	Eastern mole	1	1	0.7	0.112	0.004
Sylvilagus sp.	Cottontail rabbit	1	1	0.7	0.101	0.003
Sciurus spp.	Squirrel	8	1	0.7	0.580	0.016
Sigmodontinae	New World mice and rats	4	—	—	0.112	0.004
Neotoma floridana	Eastern woodrat	1	1	0.7	0.270	0.008
Procyon lotor	Raccoon	17	2	1.5	11.178	0.231
Odocoileus virginianus	White-tailed deer	82	2	1.5	365.334	5.326
Vertebrata	Indeterminate vertebrates	—	—	—	15.273	—
Total		3850	134	100%	633.751	9.862

TABLE 4.27

St. Catherines Shell Ring, East Area: Summary Table

Taxa	MNI	%	Biomass, kg	%
Sharks, rays, and bony fishes	113	84.3	0.946	13.8
Turtles	5	3.7	0.265	3.9
Snakes	1	0.7	0.000	0.0
Birds	3	2.2	0.028	0.4
White-tailed deer	2	1.5	5.326	77.7
Other mammals	6	4.5	0.286	4.2
Commensals	4	3.0	0.004	0.1
Total	134	100%	6.855	100%

Note: Amphibians and Lizards are included in the MNI estimates, but are not included in the biomass estimates because allometric formulae are not currently available for these taxa.

TABLE 4.28

St. Catherines Shell Ring, East Area: Fish Summary Table

Taxa	# of Taxa	MNI	%	Biomass, kg	%
Herrings and shads	1	1	0.9	0.007	0.7
Sea catfishes	2	11	9.7	0.273	28.9
Mullets	1	42	37.2	0.218	23.0
Drums	8	41	36.3	0.262	27.7
Freshwater fishes	3	4	3.5	0.018	1.9
Other fishes	6	14	12.4	0.168	17.8
Total	21	113	100%	0.946	100%

TABLE 4.29

St. Catherines Shell Ring, East Area: Element Distribution

Skeletal Element	Deer
Head	45
Vertebra/rib	4
Forequarter	4
Hindquarter	7
Forefoot	16
Hindfoot	2
Foot	4
Total	82

TABLE 4.30

St. Catherines Shell Ring, East Area: Epiphyseal Fusion for Deer

	Unfused	Fused	Total
Early Fusing:			
Humerus, distal	—	1	1
Scapula, distal	—	1	1
Radius, proximal	—	1	1
Acetabulum	—	1	1
Metapodials, proximal	—	1	1
1st/2nd phalanx, proximal	—	—	—
Middle Fusing:			
Tibia, distal	—	—	—
Calcaneus, proximal	1	—	1
Metapodials, distal	—	2	2
Late Fusing:			
Humerus, proximal	—	—	—
Radius, distal	—	1	1
Ulna, proximal	—	—	—
Ulna, distal	—	—	—
Femur, proximal	1	—	1
Femur, distal	—	—	—
Tibia, proximal	—	2	2
Total	2	10	12

TABLE 4.31

St. Catherines Shell Ring, East Area: Modifications

Taxa	Pathology	Hacked	Cut	Burned	Calcined	Worked	Rodent gnawed
Indeterminate bony fishes	—	—	—	10	—	—	—
Sea catfishes	—	—	—	1	—	—	—
Gafftopsail catfish	—	—	—	1	—	—	—
Toadfish	—	—	—	2	—	—	—
Mullet	1	—	—	1	—	—	—
Drums	—	—	—	1	—	—	—
Silver perch	—	—	—	1	—	—	—
Indeterminate turtles	—	—	—	7	—	—	—
Mud turtle	—	—	—	1	—	—	—
Indeterminate mammals	—	—	1	5	—	12	—
Indeterminate vertebrates	—	—	—	13	1	—	—
Total	1	—	1	43	1	12	—

TABLE 4.32

St. Catherines Shell Ring, West Area: Species List

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Myliobatiformes	Rays	3	—	—	0.058	0.011
Dasyatidae	Stingrays	1	1	0.3	0.080	0.014
Actinopterygii	Indeterminate bony fishes	4498	—	—	89.726	1.127
Lepisosteus spp.	Gar	32	1	0.3	5.122	0.137
Amia calva	Bowfin	57	1	0.3	3.419	0.024
Elops saurus	Ladyfish	8	1	0.3	0.117	0.005
Anguilla rostrata	American eel	41	1	0.3	0.886	0.027
Clupeidae	Herrings and shads	31	1	0.3	0.436	0.015
Siluriformes	Catfishes	522	—	—	17.407	0.301
Ictaluridae	Freshwater catfishes	14	6	1.9	1.469	0.029
Ameiurus spp.	Bullhead catfish	33	(4)	—	2.968	0.056
Ariidae	Sea catfishes	109	—	—	8.630	0.155
Ariopsis felis	Hardhead catfish	321	11	3.6	29.548	0.498
Bagre marinus	Gafftopsail catfish	64	3	1.0	5.566	0.102
Opsanus spp.	Toadfish	21	3	1.0	0.573	0.019
Mugil spp.	Mullet	2974	150	48.5	36.718	0.546
Cyprinodontidae	Killifishes	127	16	5.2	1.289	0.036
Fundulus spp.	Killifish	22	(9)	—	0.260	0.010
Centrarchidae	Sunfishes	3	—	—	0.093	0.002
Chaenobryttus gulosus	Warmouth	2	2	0.6	0.070	0.002
Pomatomus saltatrix	Bluefish	13	1	0.3	0.317	0.012
Archosargus probatocephalus	Sheepshead	2	1	0.3	0.099	0.002
Lagodon rhomboides	Pinfish	4	2	0.6	0.065	0.001
Sciaenidae	Drums	132	—	—	3.171	0.091
Bairdiella chrysoura	Silver perch	134	38	12.3	3.009	0.088
Cynoscion spp.	Seatrout	57	4	1.3	4.863	0.125
Leiostomus xanthurus	Spot	17	9	2.9	0.194	0.012
Menticirrhus spp.	Kingfish	4	2	0.6	0.149	0.010
Micropogonias undulatus	Atlantic croaker	37	12	3.9	3.588	0.100
Pogonias cromis	Black drum	16	2	0.6	13.333	0.265
Sciaenops ocellatus	Red drum	23	4	1.3	2.671	0.080

TABLE 4.32—(*Continued*)

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Stellifer lanceolatus	Star drum	13	3	1.0	0.379	0.019
Paralichthyidae	Sand flounders	37	—	—	1.476	0.037
Citharichthys sp.	Whiff	1	1	0.3	0.011	0.000
Paralichthys spp.	Southern flounder	21	1	0.3	2.651	0.063
Anura	Frogs and toads	7	—	—	0.182	—
Bufo spp.	Toad	3	1	—	0.036	—
Scaphiopus holbrookii	Eastern spadefoot toad	15	2	0.6	0.353	—
Caudata	Newts and salamanders	1	1	0.3	0.002	—
Reptilia	Indeterminate reptiles	1	—	—	0.193	—
Testudines	Indeterminate turtles	414	—	—	62.801	0.507
Chelydra serpentina	Snapping turtle	2	1	0.3	3.429	0.072
Kinosternidae	Mud and musk turtles	5	—	—	1.297	0.038
Kinosternon spp.	Mud turtle	20	2	0.6	6.536	0.111
Emydidae	Pond turtles	64	—	—	54.275	0.459
Deirochelys reticularia	Chicken turtle	8	1	0.3	9.175	0.140
Malaclemys terrapin	Diamondback terrapin	87	3	1.0	82.699	0.609
Gopherus polyphemus	Gopher tortoise	1	1	0.3	6.078	0.106
Lacertilia	Indeterminate lizards	4	3	1.0	0.041	—
Serpentes	Indeterminate snakes	43	—	—	1.093	0.015
Colubridae	Non-venomous snakes	63	1	0.3	2.770	0.039
Aves	Indeterminate birds	24	—	—	3.124	0.058
Anatidae	Ducks, geese, and swans	1	1	0.3	0.726	0.015
Accipitridae	Eagles, hawks, and kites	1	1	0.3	0.045	0.001
Meleagris gallopavo	Turkey	2	1	0.3	1.417	0.028
Rallidae	Coots and rails	5	1	0.3	0.223	0.005
Laridae	Gulls and terns	1	1	0.3	0.204	0.005
Passeriformes	Perching birds	5	1	0.3	0.126	0.003
Mammalia	Indeterminate mammals	538	—	—	177.441	2.781
Didelphis virginiana	Opossum	20	2	0.6	18.272	0.359
Sylvilagus spp.	Cottontail rabbit	4	1	0.3	2.783	0.066
Rodentia	Rodents	9	—	—	0.230	0.007
Glaucomys volan	Southern flying squirrel	2	1	0.3	0.046	0.002

TABLE 4.32—(*Continued*)

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Sciurus spp.	Squirrel	7	1	0.3	0.576	0.016
Muridae	Mice, rats, and voles	2	—	—	0.183	0.006
Sigmodontinae	New World mice and rats	1	—	—	0.045	0.002
Neotoma floridana	Eastern woodrat	1	1	0.3	0.021	0.001
Procyon lotor	Raccoon	14	2	0.6	21.192	0.411
Odocoileus virginianus	White-tailed deer	37	2	0.6	295.241	4.397
Homo sapiens	Human	1	—	—	0.371	—
Vertebrata	Indeterminate vertebrates		—	—	51.255	—
Total		10807	309	100%	1044.892	14.280

TABLE 4.33

St. Catherines Shell Ring, West Area: Summary Table

Taxa	MNI	%	Biomass, kg	%
Sharks, rays, and bony fishes	277	89.6	2.231	25.9
Turtles	8	2.6	1.038	12.0
Snakes	1	0.3	0.039	0.5
Birds	6	1.9	0.057	0.7
White-tailed deer	2	0.6	4.397	51.0
Other mammals	7	2.3	0.853	9.9
Commensals	8	2.6	0.002	0.0
Total	309	100%	8.617	100%

Note: Amphibians and Lizards are included in the MNI estimates, but are not included in the biomass estimates because allometric formulae are not currently available for these taxa.

TABLE 4.34

St. Catherines Shell Ring, West Area: Fish Summary Table

Taxa	# of Taxa	MNI	%	Biomass, kg	%
Herrings and shads	1	1	0.4	0.015	0.7
Sea catfishes	2	14	5.1	0.600	26.9
Mullets	1	150	54.2	0.546	24.5
Drums	8	74	26.7	0.699	31.3
Freshwater fishes	4	10	3.6	0.192	8.6
Other fishes	10	28	10.1	0.179	8.0
Total	26	277	100%	2.231	100%

TABLE 4.35

St. Catherines Shell Ring, West Area: Element Distribution

Skeletal Element	Deer
Head	7
Vertebra/rib	4
Forequarter	1
Hindquarter	6
Forefoot	2
Hindfoot	2
Foot	15
Total	37

TABLE 4.36

St. Catherines Shell Ring, West Area: Epiphyseal Fusion for Deer

	Unfused	Fused	Total
Early Fusing:			
Humerus, distal	—	1	1
Scapula, distal	—	—	—
Radius, proximal	—	—	—
Acetabulum	—	1	1
Metapodials, proximal	—	1	1
1st/2nd phalanx, proximal	—	5	5
Middle Fusing:			
Tibia, distal	1	—	1
Calcaneus, proximal	—	1	1
Metapodials, distal	—	—	—
Late Fusing:			
Humerus, proximal	—	—	—
Radius, distal	—	—	—
Ulna, proximal	—	—	—
Ulna, distal	—	—	—
Femur, proximal	—	—	—
Femur, distal	—	1	1
Tibia, proximal	—	—	—
Total	1	10	11

TABLE 4.37

St. Catherines Shell Ring, West Area: Modifications

Taxa	Pathology	Hacked	Cut	Burned	Calcined	Worked	Rodent gnawed
Indeterminate bony fishes	3	—	—	7	—	—	—
Gar	—	—	—	1	—	—	—
Bowfin	—	—	—	2	—	—	—
Catfishes	—	—	—	3	2	—	—
Sea catfishes	—	—	—	2	1	—	—
Hardhead catfish	—	—	—	2	—	—	—
Mullet	—	—	—	2	—	—	—
Indeterminate turtles	—	—	—	56	1	2	—
Snapping turtle	—	—	1	—	—	—	—
Mud turtle	—	—	—	1	—	—	—
Pond turtles	—	—	—	1	—	—	—
Diamondback terrapin	—	—	1	1	1	—	—
Coots and rails	—	—	—	1	—	—	—
Indeterminate mammals	—	—	1	17	1	7	—
Opossum	—	—	—	1	—	—	—
White-tailed deer	—	—	1	—	—	2	—
Indeterminate vertebrates	—	—	—	22	2	—	—
Total	3	—	4	119	8	11	—

TABLE 4.38

St. Catherines Shell Ring, Features: Species List

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Chondrichthyes	Cartilaginous fishes	4	—	—	0.168	0.027
Myliobatiformes	Rays	2	—	—	0.092	0.016
Dasyatidae	Stingrays	1	1	3.0	0.040	0.008
Actinopterygii	Indeterminate bony fishes	64	—	—	9.902	0.189
Lepisosteus spp.	Gar	7	1	3.0	1.365	0.043
Amia calva	Bowfin	1	1	3.0	0.009	0.000
Elops saurus	Ladyfish	1	1	3.0	0.006	0.000
Siluriformes	Catfishes	15	—	—	0.566	0.012
Ariidae	Sea catfishes	2	—	—	0.048	0.001
Ariopsis felis	Hardhead catfish	11	1	3.0	0.715	0.015
Bagre marinus	Gafftopsail catfish	2	2	6.1	1.138	0.023
Opsanus sp.	Toadfish	1	1	3.0	0.028	0.002
Mugil spp.	Mullet	49	3	9.1	0.677	0.022
Cyprinodontidae	Killifishes	3	1	3.0	0.028	0.002
Sciaenidae	Drums	3	—	—	0.197	0.012
Cynoscion sp.	Seatrout	1	1	3.0	0.107	0.007
Leiostomus xanthurus	Spot	2	1	3.0	0.040	0.004
Sciaenops ocellatus	Red drum	2	1	3.0	1.775	0.059
Stellifer lanceolatus	Star drum	1	1	3.0	0.029	0.003
Paralichthys sp.	Southern flounder	1	1	3.0	0.120	0.004
Anura	Frogs and toads	3	—	—	0.033	—
Scaphiopus holbrookii	Eastern spadefoot toad	1	1	3.0	0.006	—
Testudines	Indeterminate turtles	27	—	—	4.433	0.086
Kinosternidae	Mud and musk turtles	2	—	—	0.326	0.015
Kinosternon spp.	Mud turtle	6	1	3.0	2.212	0.054
Emydidae	Pond turtles	6	—	—	1.890	0.048
Deirochelys reticularia	Chicken turtle	4	1	3.0	14.319	0.188
Malaclemys terrapin	Diamondback terrapin	11	1	3.0	10.080	0.149
Aves	Indeterminate birds	11	—	—	10.229	0.169
Accipitridae	Eagles, hawks, and kites	1	1	3.0	0.213	0.005
Meleagris gallopavo	Turkey	2	1	3.0	14.044	0.226

TABLE 4.38—(*Continued*)

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Rallidae	Coots and rails	1	1	3.0	0.085	0.002
Mammalia	Indeterminate mammals	683	—	—	277.232	4.155
Didelphis virginiana	Opossum	10	1	3.0	6.578	0.143
Rodentia	Rodents	7	—	—	0.225	0.007
Sciurus spp.	Squirrel	26	2	6.1	5.658	0.125
Canis familiaris	Dog	1	1	3.0	0.230	0.007
Procyon lotor	Raccoon	29	2	6.1	55.923	0.984
Odocoileus virginianus	White-tailed deer	77	3	9.1	624.676	8.632
Vertebrata	Indeterminate vertebrates	—	—	—	11.328	—
Total		1081	33	100%	1056.770	15.444

TABLE 4.39

St. Catherines Shell Ring, Features: Summary Table

Taxa	MNI	%	Biomass, kg	%
Sharks, rays, and bony fishes	17	51.5	0.192	1.8
Turtles	3	9.1	0.391	3.7
Snakes	—	—	—	—
Birds	3	9.1	0.233	2.2
White-tailed deer	3	9.1	8.632	80.6
Other mammals	6	18.2	1.259	11.8
Commensals	1	3.0	—	—
Total	33	100%	10.707	100%

Note: Amphibians and Lizards are included in the MNI estimates, but are not included in the biomass estimates because allometric formulae are not currently available for these taxa.

TABLE 4.40

St. Catherines Shell Ring, Features: Fish Summary Table

Taxa	# of Taxa	MNI	%	Biomass, kg	%
Herrings and shads	—	—	—	—	—
Sea catfishes	2	3	17.6	0.038	19.8
Mullets	1	3	17.6	0.022	11.5
Drums	4	4	23.5	0.073	38.0
Freshwater fishes	2	2	11.8	0.043	22.4
Other fishes	5	5	29.4	0.016	8.3
Total	14	17	100%	0.192	100%

TABLE 4.41

St. Catherines Shell Ring, Features: Element Distribution

Skeletal Element	Deer
Head	20
Vertebra/rib	12
Forequarter	10
Hindquarter	15
Forefoot	5
Hindfoot	7
Foot	8
Total	77

TABLE 4.42

St. Catherines Shell Ring, Features: Epiphyseal Fusion for Deer

	Unfused	Fused	Total
Early Fusing:			
Humerus, distal	—	—	—
Scapula, distal	—	—	—
Radius, proximal	—	2	2
Acetabulum	—	1	1
Metapodials, proximal	—	2	2
1st/2nd phalanx, proximal	—	4	4
Middle Fusing:			
Tibia, distal	—	—	—
Calcaneus, proximal	1	2	3
Metapodials, distal	—	1	1
Late Fusing:			
Humerus, proximal	—	1	1
Radius, distal	—	1	1
Ulna, proximal	—	—	—
Ulna, distal	—	—	—
Femur, proximal	—	1	1
Femur, distal	1	—	1
Tibia, proximal	—	2	2
Total	2	17	19

TABLE 4.43

St. Catherines Shell Ring, Features: Modifications

Taxa	Pathology	Hacked	Cut	Burned	Calcined	Worked	Rodent gnawed
Indeterminate bony fishes	—	—	1	—	1	—	—
Indeterminate turtles	—	—	—	—	2	—	—
Diamondback terrapin	—	—	—	1	—	—	—
Turkey	—	—	—	1	—	—	—
Indeterminate mammals	—	1	1	20	5	5	—
Raccoon	—	—	—	1	—	—	—
White-tailed deer	—	2	2	3	—	1	—
Indeterminate vertebrates	—	—	—	1	7	—	—
Total	—	3	4	27	15	6	—

TABLE 4.44

McQueen Shell Ring, Combined Units: Species List

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Chondrichthyes	Cartilaginous fishes	2	—	—	0.020	0.004
Raja eglanteria	Clearnose skate	1	1	0.1	0.021	0.005
Myliobatiformes	Rays	88	—	—	2.211	0.250
Dasyatidae	Stingrays	47	2	0.2	1.549	0.183
Rhinoptera bonasus	Cownose ray	2	1	0.1	0.053	0.010
Actinopterygii	Indeterminate bony fishes	23841	—	—	372.098	3.566
Lepisosteus spp.	Gar	8	2	0.2	0.614	0.614
Amia calva	Bowfin	1	1	0.1	0.008	0.000
Elops saurus	Ladyfish	44	2	0.2	0.502	0.017
Anguilla rostrata	American eel	53	4	0.3	1.115	0.032
Clupeidae	Herrings and shads	231	14	1.2	1.641	0.044
Siluriformes	Catfishes	2547	—	—	84.383	1.349
Ameiurus sp.	Bullhead catfish	1	1	0.1	0.034	0.001
Ariidae	Sea catfishes	958	—	—	49.697	0.816
Ariopsis felis	Hardhead catfish	1707	73	6.3	134.958	2.107
Bagre marinus	Gafftopsail catfish	687	39	3.4	79.694	1.277
Ophidiidae	Cusk-eels	4	4	0.3	0.040	0.002
Opsanus spp.	Toadfish	39	4	0.3	3.109	0.074
Mugil spp.	Mullet	8393	436	37.8	116.393	1.391
Belonidae	Needlefishes	7	1	0.1	0.171	0.007
Cyprinodontidae	Killifishes	139	16	1.4	1.034	0.030
Fundulus spp.	Killifish	15	(10)	—	0.110	0.005
Pomatomus saltatrix	Bluefish	40	6	0.5	0.803	0.025
Carangidae	Jacks and pompanos	20	1	0.1	0.152	0.007
Orthopristis chrysoptera	Pigfish	3	1	0.1	0.096	0.004
Archosargus probatocephalus	Sheepshead	11	2	0.2	2.340	0.035
Lagodon rhomboides	Pinfish	9	2	0.2	0.147	0.003
Sciaenidae	Drums	656	—	—	11.567	0.238
Bairdiella chrysoura	Silver perch	531	110	9.5	15.244	0.292
Cynoscion spp.	Seatrout	316	41	3.6	28.683	0.466

TABLE 4.44—(*Continued*)

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Larimus fasciatus	Banded drum	2	1	0.1	0.036	0.003
Leiostomus xanthurus	Spot	529	147	12.7	7.236	0.168
Menticirrhus spp.	Kingfish	35	7	0.6	1.761	0.059
Micropogonias undulatus	Atlantic croaker	162	49	4.2	10.967	0.229
Pogonias cromis	Black drum	26	4	0.3	42.016	0.619
Sciaenops ocellatus	Red drum	26	4	0.3	4.489	0.118
Stellifer lanceolatus	Star drum	620	121	10.5	17.364	0.322
Chaetodipterus faber	Atlantic spadefish	1	1	0.1	0.008	0.001
Peprilus spp.	Harvest and butterfish	15	1	0.1	0.069	0.003
Peprilus paru	Harvestfish	1	1	0.1	0.001	0.000
Paralichthyidae	Sand flounders	106	—	—	2.832	0.066
Citharichthys spp.	Whiff	28	1	0.1	0.158	0.005
Paralichthys spp.	Southern flounder	110	10	0.9	26.623	0.488
Symphurus spp.	Tonguefish	3	1	0.1	0.009	0.000
Anura	Frogs and toads	13	2	0.2	0.222	—
Bufo spp.	Toad	3	1	0.1	0.079	—
Scaphiopus holbrookii	Eastern spadefoot toad	2	1	0.1	0.037	—
Rana sp.	Bullfrog	1	1	0.1	0.059	—
Caudata	Newts and salamanders	2	1	0.1	0.069	—
Testudines	Indeterminate turtles	137	—	—	17.863	0.218
Kinosternidae	Mud and Musk turtles	2	—	—	0.235	0.012
Kinosternon spp.	Mud turtle	7	2	0.2	2.319	0.056
Emydidae	Pond turtles	11	—	—	2.381	0.057
Deirochelys reticularia	Chicken turtle	3	1	0.1	0.635	0.023
Malaclemys terrapin	Diamondback terrapin	2	2	0.2	2.663	0.061
Gopherus polyphemus	Gopher tortoise	2	2	0.2	0.604	0.023
Lacertilia	Indeterminate lizards	36	4	0.3	0.467	—
Serpentes	Indeterminate snakes	11	—	—	0.530	0.007
Colubridae	Non-venomous snakes	4	2	0.2	0.400	0.005
Aves	Indeterminate birds	124	—	—	6.989	0.120
Anatidae	Ducks, geese, and swans	1	1	0.1	0.504	0.011

TABLE 4.44—(*Continued*)

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Rallidae	Coots and rails	69	6	0.5	9.907	0.165
Passeriformes	Perching birds	3	1	0.1	0.040	0.001
Mammalia	Indeterminate mammals	623	—	—	224.854	3.441
Didelphis virginiana	Opossum	6	1	0.1	10.899	0.226
Sylvilagus spp.	Cottontail rabbit	8	2	0.2	3.263	0.076
Rodentia	Rodents	10	—	—	0.312	0.009
Sciuridae	Squirrels and chipmunks	2	—	—	0.058	0.002
Glaucomys volans	Southern flying squirrel	9	1	0.1	0.336	0.010
Sciurus spp.	Squirrel	10	2	0.2	0.961	0.025
Muridae	Mice, rats, and voles	5	—	—	0.474	0.013
Sigmodon hispidus	Hispid cotton rat	3	2	0.2	0.289	0.009
Canis familiaris	Dog	1	1	0.1	15.144	0.304
Procyon lotor	Raccoon	12	2	0.2	21.025	0.408
Odocoileus virginianus	White-tailed deer	53	3	0.3	437.991	6.271
Vertebrata	Indeterminate vertebrates		—	—	65.602	—
Total		43240	1153	100%	1849.267	26.484

TABLE 4.45

McQueen Shell Ring, Combined Units: Summary Table

Taxa	MNI	%	Biomass, kg	%
Sharks, rays, and bony fishes	1112	96.4	8.049	51.2
Turtles	7	0.6	0.163	1.0
Snakes	2	0.2	0.005	0.0
Birds	8	0.7	0.177	1.1
White-tailed deer	3	0.3	6.271	39.9
Other mammals	8	0.7	1.039	6.6
Commensals	13	1.1	0.019	0.1
Total	1153	100%	15.723	100%

Note: Amphibians and Lizards are included in the MNI estimates, but are not included in the biomass estimates because allometric formulae are not currently available for these taxa.

TABLE 4.46

McQueen Shell Ring, Combined Units: Fish Summary Table

Taxa	# of Taxa	MNI	%	Biomass, kg	%
Herrings and shads	1	14	1.3	0.044	0.5
Sea catfishes	2	112	10.1	3.384	42.0
Mullets	1	436	39.2	1.391	17.3
Drums	9	484	43.5	2.276	28.3
Freshwater fishes	3	4	0.4	0.023	0.3
Other fishes	20	62	5.6	0.931	11.6
Total	36	1112	100%	8.049	100%

TABLE 4.47

McQueen Shell Ring, N213 E198: Species List

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Chondrichthyes	Cartilaginous fishes	2	—	—	0.020	0.004
Myliobatiformes	Rays	28	—	—	1.009	0.127
Dasyatidae	Stingrays	33	1	0.3	0.664	0.089
Actinopterygii	Indeterminate bony fishes	6606	—	—	118.314	1.410
Lepisosteus spp.	Gar	3	1	0.3	0.148	0.006
Elops saurus	Ladyfish	28	1	0.3	0.343	0.012
Anguilla rostrata	American eel	21	2	0.6	0.688	0.022
Clupeidae	Herrings and shads	131	5	1.4	0.900	0.027
Siluriformes	Catfishes	1227	—	—	36.839	0.614
Ariidae	Sea catfishes	497	—	—	23.651	0.403
Ariopsis felis	Hardhead catfish	930	43	12.1	80.411	1.288
Bagre marinus	Gafftopsail catfish	379	19	5.3	39.310	0.653
Opsanus spp.	Toadfish	21	2	0.6	1.129	0.033
Mugil spp.	Mullet	1436	75	21.1	27.474	0.432
Cyprinodontidae	Killifishes	16	3	0.8	0.142	0.006
Fundulus spp.	Killifish	1	(1)	—	0.008	0.001
Pomatomus saltatrix	Bluefish	13	1	0.3	0.285	0.011
Orthopristis chrysoptera	Pigfish	3	1	0.3	0.096	0.004
Archosargus probatocephalus	Sheepshead	4	1	0.3	0.345	0.006
Lagodon rhomboides	Pinfish	3	1	0.3	0.023	0.000
Sciaenidae	Drums	267	—	—	5.669	0.140
Bairdiella chrysoura	Silver perch	172	40	11.2	5.746	0.142
Cynoscion spp.	Seatrout	125	21	5.9	13.300	0.264
Leiostomus xanthurus	Spot	79	38	10.7	1.550	0.054
Menticirrhus spp.	Kingfish	9	3	0.8	0.578	0.026
Micropogonias undulatus	Atlantic croaker	59	20	5.6	4.813	0.124
Pogonias cromis	Black drum	4	1	0.3	0.147	0.009
Sciaenops ocellatus	Red drum	6	1	0.3	0.388	0.019
Stellifer lanceolatus	Star drum	241	57	16.0	7.641	0.175
Peprilus spp.	Harvest and butterfish	3	1	0.3	0.018	0.001

TABLE 4.47—(*Continued*)

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Paralichthyidae	Sand flounders	48	—	—	0.733	0.020
Paralichthys spp.	Southern flounder	35	2	0.6	6.304	0.135
Anura	Frogs and toads	10	2	—	0.162	—
Bufo spp.	Toad	2	(1)	—	0.065	—
Testudines	Indeterminate turtles	71	—	—	8.664	0.134
Kinosternidae	Mud and musk turtles	2	—	—	0.235	0.012
Kinosternon spp.	Mud turtle	6	1	0.3	1.834	0.047
Emydidae	Pond turtles	3	—	—	0.548	0.021
Malaclemys terrapin	Diamondback terrapin	1	1	0.3	0.447	0.018
Gopherus polyphemus	Gopher tortoise	1	1	0.3	0.447	0.015
Lacertilia	Indeterminate lizards	6	3	0.8	0.066	—
Serpentes	Indeterminate snakes	9	—	—	0.483	0.007
Colubridae	Non-venomous snakes	1	1	0.3	0.043	0.001
Aves	Indeterminate birds	10	—	—	0.414	0.009
Rallidae	Coots and rails	5	1	0.3	1.187	0.024
Mammalia	Indeterminate mammals	198	—	—	69.815	1.201
Didelphis virginiana	Opossum	6	1	0.3	10.899	0.226
Sylvilagus spp.	Cottontail rabbit	1	1	0.3	0.159	0.005
Sciurus spp.	Squirrel	3	1	0.3	0.637	0.018
Sigmodon hispidus	Hispid cotton rat	1	1	0.3	0.201	0.006
Procyon lotor	Raccoon	2	1	0.3	0.365	0.011
Odocoileus virginianus	White-tailed deer	12	1	0.3	184.630	2.882
Vertebrata	Indeterminate vertebrates		—	—	27.003	—
Total		12780	356	100%	686.990	10.894

TABLE 4.48

McQueen Shell Ring, N213 E198: Summary Table

Taxa	MNI	%	Biomass, kg	%
Sharks, rays, and bony fishes	340	95.5	3.538	52.1
Turtles	3	0.8	0.080	1.2
Snakes	1	0.3	0.001	0.0
Birds	1	0.3	0.024	0.4
White-tailed deer	1	0.3	2.882	42.4
Other mammals	4	1.1	0.260	3.8
Commensals	6	1.7	0.006	0.1
Total	356	100%	6.791	100%

Note: Amphibians and Lizards are included in the MNI estimates, but are not included in the biomass estimates because allometric formulae are not currently available for these taxa.

TABLE 4.49

McQueen Shell Ring, N213 E198: Fish Summary Table

Taxa	# of Taxa	MNI	%	Biomass, kg	%
Herrings and shads	1	5	1.5	0.027	0.8
Sea catfishes	2	62	18.2	1.941	54.9
Mullets	1	75	22.1	0.432	12.2
Drums	8	181	53.2	0.813	23.0
Freshwater fishes	1	1	0.3	0.006	0.2
Other fishes	11	16	4.7	0.319	9.0
Total	24	340	100%	3.538	100%

TABLE 4.50

McQueen Shell Ring, N213 E198: Element Distribution

Skeletal Element	Deer
Head	3
Vertebra/rib	2
Forequarter	2
Hindquarter	0
Forefoot	1
Hindfoot	2
Foot	2
Total	12

TABLE 4.51

McQueen Shell Ring, N213 E198: Epiphyseal Fusion for Deer

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

TABLE 4.52

McQueen Shell Ring, N213 E198: Modifications

Taxa	Pathology	Hacked	Cut	Burned	Calcined	Worked	Rodent gnawed
Rays	—	—	—	1	—	—	—
Indeterminate bony fishes	—	—	—	18	—	—	—
Catfishes	—	—	—	7	1	—	—
Sea catfishes	—	—	—	13	—	—	—
Hardhead catfish	1	—	—	2	1	—	—
Mullet	—	—	—	3	—	—	—
Indeterminate turtles	—	—	—	4	—	1	—
Diamondback terrapin	—	—	—	1	—	—	—
Indeterminate mammals	—	—	—	6	—	—	1
Squirrel	—	—	—	1	—	—	—
Raccoon	—	—	—	1	—	—	—
Indeterminate vertebrates	—	—	1	12	3	—	—
Total	1	—	1	69	5	1	1

TABLE 4.53

McQueen Shell Ring, N263 E179: Species List

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Raja eglanteria	Clearnose skate	1	1	0.1	0.021	0.005
Myliobatiformes	Rays	60	—	—	1.202	0.147
Dasyatidae	Stingrays	14	1	0.1	0.885	0.113
Rhinoptera bonasus	Cownose ray	2	1	0.1	0.053	0.010
Actinopterygii	Indeterminate bony fishes	17235	—	—	253.784	2.616
Lepisosteus spp.	Gar	5	1	0.1	0.466	0.017
Amia calva	Bowfin	1	1	0.1	0.008	0.000
Elops saurus	Ladyfish	16	1	0.1	0.159	0.007
Anguilla rostrata	American eel	32	2	0.3	0.427	0.015
Clupeidae	Herrings and shads	100	9	1.1	0.741	0.023
Siluriformes	Catfishes	1320	—	—	47.544	0.782
Ameiurus sp.	Bullhead catfish	1	1	0.1	0.034	0.001
Ariidae	Sea catfishes	461	—	—	26.046	0.442
Ariopsis felis	Hardhead catfish	777	30	3.8	54.547	0.891
Bagre marinus	Gafftopsail catfish	308	20	2.5	40.384	0.670
Ophidiidae	Cusk-eels	4	4	0.5	0.040	0.002
Opsanus spp.	Toadfish	18	2	0.3	1.980	0.051
Mugil spp.	Mullet	6957	361	45.3	88.919	1.119
Belonidae	Needlefishes	7	1	0.1	0.171	0.007
Cyprinodontidae	Killifishes	123	13	1.6	0.892	0.027
Fundulus spp.	Killifish	14	(9)	—	0.102	0.005
Pomatomus saltatrix	Bluefish	27	5	0.6	0.518	0.017
Carangidae	Jacks and pompanos	20	1	0.1	0.152	0.007
Archosargus probatocephalus	Sheepshead	7	1	0.1	1.995	0.030
Lagodon rhomboides	Pinfish	6	1	0.1	0.124	0.002
Sciaenidae	Drums	389	—	—	5.898	0.145
Bairdiella chrysoura	Silver perch	359	70	8.8	9.498	0.206
Cynoscion spp.	Seatrout	191	20	2.5	15.383	0.294
Larimus fasciatus	Banded drum	2	1	0.1	0.036	0.003
Leiostomus xanthurus	Spot	450	109	13.7	5.686	0.141

TABLE 4.53—(*Continued*)

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Menticirrhus spp.	Kingfish	26	4	0.5	1.183	0.044
Micropogonias undulatus	Atlantic croaker	103	29	3.6	6.154	0.149
Pogonias cromis	Black drum	22	3	0.4	41.869	0.617
Sciaenops ocellatus	Red drum	20	3	0.4	4.101	0.111
Stellifer lanceolatus	Star drum	379	64	8.0	9.723	0.209
Chaetodipterus faber	Atlantic spadefish	1	1	0.1	0.008	0.001
Peprilus spp.	Harvest and butterfish	12	—	—	0.051	0.003
Peprilus paru	Harvestfish	1	1	0.1	0.001	0.000
Paralichthyidae	Sand flounders	58	—	—	2.099	0.051
Citharichthys spp.	Whiff	28	1	0.1	0.158	0.005
Paralichthys spp.	Southern flounder	75	8	1.0	20.319	0.384
Symphurus spp.	Tonguefish	3	1	0.1	0.009	0.000
Anura	Frogs and toads	3	—	—	0.060	—
Bufo spp.	Toad	1	1	0.1	0.014	—
Scaphiopus holbrookii	Eastern spadefoot toad	2	1	0.1	0.037	—
Rana sp.	Bullfrog	1	1	0.1	0.059	—
Caudata	Newts and salamanders	2	1	0.1	0.069	—
Testudines	Indeterminate turtles	66	—	—	9.199	0.140
Kinosternon sp.	Mud turtle	1	1	0.1	0.485	0.019
Emydidae	Pond turtles	8	—	—	1.833	0.047
Deirochelys reticularia	Chicken turtle	3	1	0.1	0.635	0.023
Malaclemys terrapin	Diamondback terrapin	1	1	0.1	2.216	0.054
Gopherus polyphemus	Gopher tortoise	1	1	0.1	0.157	0.009
Lacertilia	Indeterminate lizards	30	1	0.1	0.401	—
Serpentes	Indeterminate snakes	2	—	—	0.047	0.001
Colubridae	Non-venomous snakes	3	1	0.1	0.357	0.005
Aves	Indeterminate birds	114	—	—	6.575	0.113
Anatidae	Ducks, geese, and swans	1	1	0.1	0.504	0.011
Rallidae	Coots and rails	64	5	0.6	8.720	0.147
Passeriformes	Perching birds	3	1	0.1	0.040	0.001
Mammalia	Indeterminate mammals	425	—	—	155.039	2.463

TABLE 4.53—(*Continued*)

Taxa		NISP	MNI	%	Weight, g	Biomass, kg
Sylvilagus spp.	Cottontail rabbit	7	1	0.1	3.104	0.073
Rodentia	Rodents	10	—	—	0.312	0.009
Sciuridae	Squirrels and chipmunks	2	—	—	0.058	0.002
Glaucomys volans	Southern flying squirrel	9	1	0.1	0.336	0.010
Sciurus spp.	Squirrel	7	1	0.1	0.324	0.010
Muridae	Mice, rats, and voles	5	—	—	0.474	0.013
Sigmodon hispidus	Hispid cotton rat	2	1	0.1	0.088	0.003
Canis familiaris	Dog	1	1	0.1	15.144	0.304
Procyon lotor	Raccoon	10	1	0.1	20.660	0.401
Odocoileus virginianus	White-tailed deer	41	2	0.3	253.361	3.832
Vertebrata	Indeterminate vertebrates		—	—	38.599	—
Total		30460	797	100%	1162.277	17.059

TABLE 4.54

McQueen Shell Ring, N263 E179: Summary Table

Taxa	MNI	%	Biomass, kg	%
Sharks, rays, and bony fishes	772	96.9	5.178	51.4
Turtles	4	0.5	0.105	1.0
Snakes	1	0.1	0.005	0.0
Birds	7	0.9	0.159	1.6
White-tailed deer	2	0.3	3.832	38.0
Other mammals	4	0.5	0.788	7.8
Commensals	7	0.9	0.013	0.1
Total	797	100%	10.080	100%

Note: Amphibians and Lizards are included in the MNI estimates, but are not included in the biomass estimates because allometric formulae are not currently available for these taxa.

TABLE 4.55

McQueen Shell Ring, N263 E179: Fish Summary Table

Taxa	# of Taxa	MNI	%	Biomass, kg	%
Herrings and shads	1	9	1.2	0.023	0.4
Sea catfishes	2	50	6.5	1.561	30.1
Mullets	1	361	46.8	1.119	21.6
Drums	9	303	39.2	1.774	34.3
Freshwater fishes	3	3	0.4	0.018	0.3
Other fishes	18	46	6.0	0.683	13.2
Total	34	772	100%	5.178	100%

TABLE 4.56

McQueen Shell Ring, N263 E179: Element Distribution

Skeletal Element	Deer
Head	18
Vertebra/rib	9
Forequarter	—
Hindquarter	4
Forefoot	—
Hindfoot	4
Foot	6
Total	41

TABLE 4.57

McQueen Shell Ring, N263 E179: Epiphyseal Fusion for Deer

	Unfused	Fused	Total
Early Fusing:			
Humerus, distal	—	—	—
Scapula, distal	—	—	—
Radius, proximal	—	—	—
Acetabulum	—	—	—
Metapodials, proximal	—	—	—
1st/2nd phalanx, proximal	1	—	1
Middle Fusing:			
Tibia, distal	—	—	—
Calcaneus, proximal	—	—	—
Metapodials, distal	1	1	2
Late Fusing:			
Humerus, proximal	—	—	—
Radius, distal	—	—	—
Ulna, proximal	—	—	—
Ulna, distal	—	—	—
Femur, proximal	—	—	—
Femur, distal	—	—	—
Tibia, proximal	—	1	1
Total	2	2	4

TABLE 4.58

McQueen Shell Ring, N263 E179: Modifications

Taxa	Pathology	Hacked	Cut	Burned	Calcined	Worked	Rodent gnawed
Rays	—	—	—	9	1	—	—
Indeterminate bony fishes	5	—	1	349	21	—	—
Gar	—	—	—	1	—	—	—
Herrings and shads	—	—	—	2	—	—	—
Catfishes	—	—	—	73	13	—	—
Sea catfishes	—	—	—	54	6	—	—
Hardhead catfish	—	—	—	43	3	—	—
Gafftopsail catfish	—	—	—	11	3	—	—
Toadfish	—	—	—	1	—	—	—
Mullet	—	—	—	115	6	—	—
Killifishes	—	—	—	1	—	—	—
Bluefish	—	—	—	1	—	—	—
Sheepshead	—	—	—	2	—	—	—
Pinfish	—	—	—	1	—	—	—
Drums	—	—	—	2	—	—	—
Silver perch	—	—	—	5	—	—	—
Seatrout	—	—	—	11	—	—	—
Spot	—	—	—	5	—	—	—
Atlantic croaker	—	—	—	3	—	—	—
Black drum	—	—	—	3	—	—	—
Red drum	—	—	—	2	—	—	—

TABLE 4.58—(*Continued*)

Taxa	Pathology	Hacked	Cut	Burned	Calcined	Worked	Rodent gnawed
Star drum	—	—	—	6	—	—	—
Sand flounders	—	—	—	1	—	—	—
Indeterminate turtles	—	—	—	14	—	—	—
Pond turtles	—	—	—	1	—	—	—
Indeterminate birds	—	—	—	4	1	—	—
Coots and rails	—	—	—	2	—	—	—
Indeterminate mammals	—	1	1	62	10	—	—
Rodents	—	—	—	2	—	—	—
Squirrel	—	—	—	1	—	—	—
Mice, rats, and voles	—	—	—	1	—	—	—
Hispid cotton rat	—	—	—	1	—	—	—
Dog	—	—	1	—	—	—	—
Raccoon	—	—	1	—	1	—	—
White-tailed deer	—	—	1	5	1	1	—
Indeterminate vertebrates	—	—	—	72	7	1	—
Total	5	1	5	866	73	2	—

TABLE 4.59

Late Archaic Shell Ring Vertebrate Fauna of the Georgia Coast: Presence/Absence and Ubiquity

Common Name	Cannon's Point Ring	West Ring	Sapelo Ring III	St. Catherines Ring	McQueen Ring	Ubiquity Index
Requiem sharks			X	X		0.4
Tiger shark	X					0.2
Bonnethead shark	X					0.2
Clearnose skate					X	0.2
Rays				X		0.2
Eagle rays	X	X				0.4
Stingrays			X	X	X	0.6
Cownose ray					X	0.2
Gar	X	X		X	X	0.8
Bowfin	X			X	X	0.6
Ladyfish	X	X		X	X	0.8
American eel			X	X	X	0.6
Herrings and shads	X	X	X	X	X	1.0
Freshwater catfish				X		0.2
Bullhead catfish	X			X	X	0.6
Sea catfish	X	X				0.4
Hardhead catfish			X	X	X	0.6
Gafftopsail catfish			X	X	X	0.6
Cusk-eels					X	0.2
Toadfish	X		X	X	X	0.8
Mullet	X	X	X	X	X	1.0
Needlefishes					X	0.2

TABLE 4.59—(*Continued*)

Common Name	Cannon's Point Ring	West Ring	Sapelo Ring III	St. Catherines Ring	McQueen Ring	Ubiquity Index
Killifishes	X			X	X	0.6
Killifish			X			0.2
Warmouth				X		0.2
Sunfish				X		0.2
Bluefish	X		X	X	X	0.8
Jacks and pompanos	X	X	X		X	0.8
Pigfish			X		X	0.4
Sheepshead		X	X	X	X	0.8
Pinfish	X			X	X	0.6
Silver perch	X	X	X	X	X	1.0
Seatrout	X	X	X	X	X	1.0
Banded drum					X	0.2
Spot	X	X	X	X	X	1.0
Kingfish	X			X		0.4
Southern kingfish			X	X	X	0.6
Atlantic croaker	X	X	X	X	X	1.0
Black drum	X	X	X	X	X	1.0
Red drum	X	X	X	X	X	1.0
Star drum	X	X	X	X	X	1.0
Atlantic spadefish					X	0.2
Harvest and butterfish			X		X	0.4
Harvest fish					X	0.2
Searobin	X		X			0.4

TABLE 4.59—(*Continued*)

Common Name	Cannon's Point Ring	West Ring	Sapelo Ring III	St. Catherines Ring	McQueen Ring	Ubiquity Index
Sand flounders	X	X				0.4
Whiff			X	X	X	0.6
Southern flounders			X	X	X	0.6
Tonguefish					X	0.2
Indeterminate amphibians		X				0.2
Frogs and toads	X					0.2
Toad				X	X	0.4
Eastern spadefoot toad				X	X	0.4
Bullfrog			X	X	X	0.6
Newts and salamanders				X	X	0.4
American alligator			X			0.2
Indeterminate turtles			X			0.2
Snapping turtle				X		0.2
Mud and musk turtles	X					0.2
Mud turtle		X	X	X	X	0.8
Musk turtle				X		0.2
Chicken turtles				X	X	0.4
Diamondback terrapin	X	X	X	X	X	1.0
Cooter				X		0.2
Pond slider	X	X				0.4
Gopher tortoise				X	X	0.4
Indeterminate lizards				X	X	0.4
Green anole	X	X				0.4

TABLE 4.59—(*Continued*)

Common Name	Cannon's Point Ring	West Ring	Sapelo Ring III	St. Catherines Ring	McQueen Ring	Ubiquity Index
Indeterminate snakes		X		X		0.4
Non-venomous snakes				X	X	0.4
Black racer	X					0.2
Kingsnake	X					0.2
Water snake	X					0.2
Venomous snakes				X		0.2
Indeterminate birds			X			0.2
Loon				X		0.2
Herons			X			0.2
Great blue heron	X			X		0.4
Ducks, geese, and swans				X	X	0.4
Eagles, hawks, and kites				X		0.2
Red-shouldered hawk	X					0.2
Turkey				X		0.2
Coots and rails	X	X	X	X	X	1.0
Gulls and terns				X		0.2
Perching birds				X	X	0.4
Opossum	X	X	X	X	X	1.0
Shrews			X	X		0.4
Short-tailed shrew		X				0.2
Least shrew	X					0.2
Eastern mole				X		0.2
Cottontail rabbit	X	X		X	X	0.8

TABLE 4.59—(*Continued*)

Common Name	Cannon's Point Ring	West Ring	Sapelo Ring III	St. Catherines Ring	McQueen Ring	Ubiquity Index
Southern flying squirrel				X	X	0.4
Squirrel				X	X	0.4
Gray squirrel	X					0.2
Pine vole				X		0.2
New World mice and rats			X			0.4
Eastern woodrat	X			X		0.4
Rice rat	X					0.2
New World mouse	X	X		X		0.6
Hispid cotton rat		X		X	X	0.6
Dog				X	X	0.4
Raccoon	X	X	X	X	X	1.0
Otter				X		0.2
Mink				X		0.2
White-tailed deer	X	X	X	X	X	1.0

CHAPTER 5:

HUMAN BEHAVIORAL ECOLOGY AND VERTEBRATE FAUNA FROM THE SHELL RINGS

In this chapter diet-breadth and hunt-type models developed for the Georgia sea islands are applied to the Late Archaic shell ring archaeofaunal collections (Thomas 2008a, 2008c). The diet-breadth model predicts that foragers optimize a fitness-related currency associated with food acquisition (Smith and Winterhalder 1992). Similarly, the hunt-type model predicts that foragers optimize a fitness-related currency associated with prey, hunting or fishing technologies, and locations (Smith 1991). These models are based on the principle that economically rational foragers choose to acquire the most efficient resource from the most profitable habitat using the most proficient capture technique. In terms of diet, three predictions based on the diet-breadth model are tested. For the hunt-type model, the predication established by Thomas (2008a:258-260) is tested.

Optimal Foraging and Diet-Breadth Models

Optimal foraging models, based on the principles of human behavioral ecology, assert that, given certain environmental constraints, humans make decisions that maximize various fitness-related currencies (Bettinger 1991:84; Kaplan and Hill 1992; Thomas 2008a:62). Generally, the currency used in optimal foraging models is the overall rate of energetic return, although other currencies can be used (Hill 1988). The diet-breadth, or prey-choice model, is a basic model of optimal foraging theory. The model predicts which dietary resources a forager

should select as a function of resource abundance within a foraging patch and the amount of energy a resource should provide given the time it takes to search, pursue, handle, and process the resource, i.e., post-encounter return rates (Bettinger 1991:84). Predicting which dietary resources a forager should select is based on the post-encounter energetic return rates of potential food items. Foragers should include the highest-ranked resources in their diets, only adding lower-ranked resources as a function of the density of highest-ranked prey.

Post-Encounter Return Rates and Abundance Indices

In the archaeological context, estimating post-encounter return rates for the suite of potential prey is problematic. Often, it is assumed, or empirically tested, that large-bodied animals are the highest-ranked prey, providing the greatest number of calories given the search, handling, and processing costs up to a certain body size (Broughton 1994a; Ugan 2005a). The correlation of body size and post-encounter return rates has ethnographic and archaeological support (Broughton 1994a, 1994b; Cannon 2000; Hawkes et al. 1982; Jones 2004). This is particularly true in cases where exploiting large-bodied taxa is the basis of subsistence economies, such as large-mammal hunting or large-bodied fishing (Broughton 1994a, 1994b, 1997; Cannon 2000; Grayson 1991; Nagaoka 2002). In such instances, diet-breadth is evaluated by comparing the relative abundance, or abundance index (AI), of large, high-ranking taxa to all other prey taxa in the foraging area. The AI formula is as follows:

$$\Sigma \text{ Highly-Ranked Prey} / \Sigma \text{ (All Available Prey in the Patch)}$$

AI values range from zero to one. High values indicate efficient foraging strategies and low values indicate inefficient foraging strategies (Ugan and Bright 2001).

Although, the assumption that “big prey equals a big return” is empirically proven in several environments, examples that contradict this assumption exist (Bodmer et al. 1997;

FitzGibbon et al. 1995; Lindström 1996; Lupo and Schmitt 2005; Madsen and Kirkman 1988; Madsen and Schmitt 1998). An important exception is the return rate for taxa that can be mass collected (Butler 2001; Lindström 1996; Madsen and Kirkman 1988; Madsen and Schmitt 1998). Taxa that aggregate in large numbers can be captured as a group rather than individually, thus generating a high return rate. As Lindström (1996) notes, this is especially true for aggregating fishes. Fish often form large spawning and feeding aggregations that are spatially more predictable compared to highly mobile, terrestrial prey, thus reducing pursuit times. Additionally, fish may require little processing time relative to larger animals because fish can be boiled to make broth, dried, or consumed whole (Lindström 1996).

Post-Encounter Return Rates for the Georgia Sea Islands

The paradox between big prey equals a big return and mass-collected small prey equals a big return can be further examined with the Late Archaic shell ring vertebrate data. Here, three models are tested: (1) archaeofaunal samples from the Late Archaic shell rings indicate that foragers targeted those taxa identified as being the highest-ranking for the Georgia coast (Thomas 2008a, 2008c); (2) archaeofaunal samples from the Late Archaic shell rings indicate that foragers targeted large-bodied taxa, particularly large-bodied fishes; and (3) archaeofaunal samples from the Late Archaic shell rings indicate that foragers targeted taxa that could be exploited using mass-capture technologies.

Georgia Sea Island Diet-Breadth Model

Based on laboratory analysis of energetic and nutritional returns of the numerous potential prey items, as well as measured trials of search and handling times, a correlation between post-encounter return rates and body size was found for the habitats of St. Catherines Island (Thomas 2008a:195). That is, several large-bodied animals have large post-encounter

return rates in the environmental context of the Georgia sea islands. Seven taxa have the greatest caloric potential and possibly the greatest post-encounter return rate: black bears (*Ursus americanus*), alligators, white-tailed deer, sea turtles (Cheloniidae), red drums, stingrays, and sharks (Thomas 2008a:195).

Using zooarchaeological samples recovered from the island-wide transect survey (Reitz 2008), known as the transect sample, Thomas found that only one of these highest-ranking taxa was exploited heavily by prehispanic populations (Thomas 2008c:941). Black bear remains, although occasionally identified in other Georgia sea island archaeological collections, are not present in any St. Catherines Island collections (Thomas 2008c:941). Alligator and sea turtle remains are rare in the transect samples (NISP=2 and 5 respectively) and are uncommon in other sea island collections (Reitz 2008; Thomas 2008c:941). Although recovered somewhat more frequently (NISP=19), sharks, rays, and red drums also are rare in the transect samples (Reitz 2008). Of the highest-ranked taxa, white-tailed deer is the only taxon frequently recovered in the transect sample (Reitz 2008; Thomas 2008c).

Although the zooarchaeological data from the transect sample suggests that island inhabitants did target one of the highest-ranked resources, the white-tailed deer, problems exist with these data. Firstly, the transect data are from an island-wide survey representing all time periods and locations on the island. Although the sample size is fairly large, when these data are divided into time periods and locations, the sample size for each is very small (Reitz 2008). Additionally, 0.64 cm screen mesh was used for faunal recovery, which selectively samples large-bodied taxa, such as white-tailed deer, and excludes small-bodied taxa (i.e., low-ranking resources). These factors undoubtedly skew the results and further testing of this model should be conducted with a larger archaeofaunal sample recovered with finer-screen mesh. The

assemblages from the Late Archaic shell rings provide an excellent opportunity to further test the diet-breadth model developed for the Georgia sea islands and identify taxa that were heavily used by archaeological populations.

Ubiquity data for the five shell ring collections (Table 4.59) demonstrate that a diet based on highly-ranked, large-bodied taxa (i.e., black bear, alligator, sea turtle, white-tailed deer, red drum, stingray, and shark) is not characteristic of these collections. Black bear and sea turtle remains are not present in any of the samples from the five shell rings. Alligators have a UI of 0.2 (Table 4.59), and also are present in collections from the Cannon's Point Ring not included in this study (Marrinan 1975:Table 10). Sharks, identified at various taxonomic levels, have a UI of 0.6 (Table 4.59). White-tailed deer, red drum, and stingray remains are ubiquitous in the Late Archaic shell ring collections (Table 4.59), but not abundant.

Although white-tailed deer, red drums, stingrays, and sharks are present in every shell ring assemblage, do they contribute to the diet extensively as predicted by the Georgia sea island diet-breadth model? To answer this question, the AI for deer remains are evaluated as a component of the terrestrial fauna, and the AI for red drum, rays, and sharks are evaluated among marine fauna.

The terrestrial and marine taxa are divided into two separate measures so the fine-grained search assumption is not violated. The fine-grained search assumption asserts that "a forager searches for all prey simultaneously and encounters them randomly and sequentially within the environment" (Lupo 2007:147). In other words, resources are distributed without patchiness (Thomas 2008a:63). If prey types are not distributed homogenously, and different prey types are encountered in a nonrandom, predictable fashion, then the fine-grained search assumption is violated (Broughton 1994a). Determining whether the fine-grained search assumption is met

eludes most archaeological applications as it would require knowledge of the forager's methods for prey selection over time and space (Smith 1991:228). Evaluating the terrestrial taxa and marine taxa separately accounts for patchiness between terrestrial and marine habitats, although not within these two broad ecosystems.

Measures of NISP, MNI, and biomass are used in the AI formulae following established methods (Thomas 2008c:942). The AI formulae are as followed:

$$\Sigma \text{ White-Tailed Deer}_{NISP} / \Sigma (\text{White-Tailed Deer}_{NISP} + \text{Terrestrial Taxa}_{NISP})$$

$$\Sigma \text{ High-Ranking Marine Taxa}_{NISP} / \Sigma (\text{High-Ranking Marine Taxa}_{NISP} + \text{All Other Marine Taxa}_{NISP}).$$

AI is also estimated for these same resource groups using MNI and biomass as variables.

An AI value over 0.50 is selected as the significant value to indicate that the resource is high-ranking and signifies that the resource contributes at least 50 percent of the sample. This number may not be meaningful in terms of human behavior because other factors, apart from human actions, can influence AI values (Ugan 2005b; Ugan and Bright 2001). It does, however, offer a standardized value for comparison. If white-tailed deer were highest-ranking resource in the terrestrial patch, then it is expected that white-tailed deer would have AI values over 0.50. Likewise, if red drum, rays, and sharks were the highest-ranked resources in the marine patch, it is expected that they will have AI values over 0.50.

White-tailed deer AI

The white-tailed deer AI values vary among the collections (Table 5.1). In both the Cannon's Point and West Ring assemblages, the white-tailed deer AI values for NISP and MNI are low. Both indices suggest that deer did not contribute substantially to the diet. This is counter to the Georgia sea island diet-breadth model and indicates either deer were not a high-ranking

resource to the Late Archaic foragers or deer were a high-ranking resource that were pursued when encountered, but were encountered infrequently. The white-tailed deer AI values for biomass present a different scenario, however. The AI for deer biomass is much higher than those for NISP or MNI for the Cannon's Point and West Ring assemblages (Table 5.1). These data indicate that deer did contribute a large portion of the diet and was a high-ranking terrestrial resource.

Deer remains were not identified in the Ring III column sample from the Sapelo Island Shell Ring complex; therefore, the deer AI is zero for all measures (Table 4.7). Deer remains were identified in the Ring III, Unit 4, fraction 0.64 cm collection (Table 4.11) and are reported from Ring I (Thompson 2006:248; Waring and Larson 1968:Table 25). The lack of deer in the column sample collection may be due to the small area sampled from the Sapelo Island Shell Ring complex. Additional samples from the Sapelo Island Shell Ring complex are needed to thoroughly test diet-breadth models for these Late Archaic foragers.

The white-tailed deer AI for the St. Catherines and McQueen Shell Rings suggests deer played a greater role in the diet of the inhabitants of St. Catherines Island than St. Simons or Sapelo Island inhabitants. White-tailed deer AI values for MNI are low in collections from both St. Catherines Islands' rings. This can be attributed to the low numbers of deer individuals estimated for both collections. However, white-tailed deer AI for NISP and biomass are high. This is particularly true for deer AI biomass values (Table 5.1). As in the shell ring collections from St. Simons Island, the data for St. Catherines Island indicate that deer contributed a large portion of the diet and was a high-ranking terrestrial resource.

Overall, if the white-tailed deer AI values for biomass are the only measures examined, the data confirm the model developed by Thomas (2008a, 2008c) for terrestrial foraging. White-

tailed deer contribute the majority of the terrestrial biomass in four of the five collections. Other high-ranked terrestrial resources, such as black bear and alligator, rarely are reported in archaeological collections from coastal Georgia. The diet-breadth model for terrestrial foraging does not accurately predict the results. White-tailed deer biomass AI values are high, but given the low AI values for NISP and MNI, it appears that the terrestrial foraging diet-breadth model needs further refinement.

High-Ranking Marine Taxa AI

The high-ranking marine AI values show similar strategies were practiced at all shell ring sites (Table 5.2). In only one instance (AI biomass at the Cannon's Point Ring), does the highest-ranked marine AI value exceed 0.20 and none of the assemblages have AI values exceeding 0.25. Red drums, rays, and sharks were not heavily exploited. This indicates that foragers: (1) chose not to exploit these resources, (2) these resources were not frequently encountered in the marine environment, or (3) an assumption in the diet-breadth model is violated. Thus, the model developed for the Georgia sea islands for high-ranking marine taxa does not accurately predict the vertebrate results from the Late Archaic shell rings.

Large-Bodied Marine Taxa AI

Red drums, rays, and sharks are high-ranking resources in diet-breadth models developed for the Georgia sea islands because these taxa are large-bodied. However, as Thomas (2008c:972) explains that these three taxa are not the only fishes to reach large body sizes among the suite of potential prey fishes. It is possible that a greater range of large-bodied fishes were targeted, rather than just the three taxa identified as the highest-ranked here. To test this prediction, an AI formula for large-bodied fishes is developed:

$$\Sigma \text{ Large-Bodied Marine Taxa}_{NISP} / \Sigma \text{ (Large-Bodied Marine Taxa}_{NISP} + \text{All Other Marine Taxa}_{NISP}).$$

AI is also estimated for these same resource groups using MNI and biomass as variables.

If large-bodied fishes were high-ranking resources, it is expected that large-bodied fishes will be the dominant marine resources, with AI values over 0.50. Classification of "Large-Bodied Marine Taxa" follows Reitz et al. (2009) with the exceptions of mullets and Atlantic croakers. These two taxa are classified as small-bodied due to the small body sizes of these taxa in the shell ring collections. The classification of each taxon is listed in Appendix B.

Like the white-tailed deer AI values, the large-bodied marine taxa AI values vary among the collections and also vary depending on which variable (NISP, MNI, or biomass) is considered (Table 5.3). In the case of the Cannon's Point and West Ring assemblages, the large-bodied marine AI values indicate that large-bodied marine taxa could be high-ranking resources. The large-bodied marine AI values for NISP and MNI are low for the Cannon's Point and West Shell Ring assemblages; however, the AI biomass values are high. For Ring III of the Sapelo Island Shell Ring complex, the predication that large-bodied marine taxa are high-ranking resources is supported by the data for both NISP and biomass though not by the MNI value. In both the St. Catherines and McQueen Shell Ring collections, the large-bodied marine AI values for NISP and MNI are very low, though the biomass values are greater than 0.50.

Overall, biomass AI values of the expanded list of large-bodied marine taxa confirm that large-bodied marine taxa were high-ranking resources. Large-bodied marine taxa contribute most of the marine biomass in all shell ring collections. However, large-bodied marine AI values for NISP and MNI are less uniform among these collections. This suggests that large-bodied marine taxa were not high-ranking resources in all the marine environments of the Georgia sea islands,

or that large-bodied marine taxa were high-ranking, but were not encountered frequently. The marine foraging diet-breadth model needs further refinement.

Mass-capture AI for Marine Taxa

Thomas (2008a:68) explains that the large-bodied marine taxa model may violate the fine-grained search assumption, particularly from the perspective of fishing strategies on the Georgia sea islands. The fine-grained search assumption requires that prey items are encountered randomly and sequentially. As Thomas (2008a:68) notes, the fine-grained search assumption consists of two parts: (1) resources are distributed homogenously within a patch, and (2) foragers search for resources randomly, where the encounter of the next prey item is independent of previously encountered prey. That is, "because prey are encountered at random, finding one appropriate individual does not change the probability of encountering other items of that type." (Thomas 2008a:68). The fine-grained search assumption is violated when prey items clump within a patch. Schooling fishes are an obvious violation of the fine-grained search assumption. The likelihood of finding a single mullet increases the likelihood of finding many mullets because this species schools. Furthermore, if mass-collecting technologies are used to capture clumped prey items, prey are taken simultaneously rather than sequentially, again violating the fine-grained search assumption (Thomas 2008a:68). Thus body size may not be an appropriate proxy for prey rankings in the environmental setting of the Georgia coast.

Rather than relying exclusively on body size when developing a diet-breadth model, additional biological measures and behaviors of prey should be considered, including: abundance, accessibility, aggregating behaviors, and reproductive rates (Braje et al. 2007; Butler 2001; Erlandson et al. 2005; Kennett 2005:20; Lindström 1996; Madsen and Schmitt 1998). Ethnographic observations and foraging simulations indicate that small-bodied animals with high

reproductive rates occurring in predictable, large aggregations may yield higher post-encounter return rates compared to large-bodied, individually captured taxa (Lindström 1996; Winterhalder and Lu 1997). Many of the marine fauna present in the estuaries of the Georgia coast school or aggregate. These taxa may provide higher post-encounter return rates compared to large-bodied taxa; hence a mass-capture AI is generated. This AI is developed by placing fish taxa in one of two categories based on whether they were likely taken using mass-capture or individual-capture techniques dependent on schooling and aggregating behaviors (Reitz et al. 2009). If fishes that were easily taken with mass-capture technologies were high-ranking resources, then it is expected that these resources will form the majority of marine resources, demonstrated by AI values over 0.50.

$$\Sigma \text{ Mass-Captured Marine Taxa}_{NISP} / \Sigma \text{ (Mass-Captured Marine Taxa}_{NISP} + \text{All Other Marine Taxa}_{NISP}).$$

AI also is estimated for these same resource groups using MNI and biomass as variables.

The AI values for mass-captured marine taxa are consistently greater than 0.50 using all three measures (Table 5.4). These data confirm the diet-breadth model in which mass-capture resources are the highest-ranking resources. These data suggest that marine resources that could be taken using mass-capture technology were preferred in the marine patch. A similar foraging strategy, mass-collecting small-bodied marine taxa, is documented in other coastal areas as a means of subsistence (Losey et al. 2004; Orr 2007).

The Diet-Breadth Models and the Vertebrate Data from the Late Archaic Shell Rings

A diet-breadth model that ranks bears, alligators, and white-tailed deer as the highest-ranking resources is inconsistent with the data from the Late Archaic shell rings. Although

white-tailed deer yielded high AI values for biomass in four of the five collections, they are but one member of a large suite of terrestrial taxa that are recovered from all five shell rings.

Why doesn't this model predict hunting behavior more accurately? A possible explanation is that the taxa classified as terrestrial large-bodied were not abundant on the Georgia sea islands during the Late Archaic period. Schmitt and his colleagues (2004) argue for this explanation in their analysis of western areas of North America during the mid-Holocene Hypsithermal. They found that archaeofaunal deposits were composed mainly of rabbit (Leporidae) remains, instead of theoretically high-ranking large mammals (Schmitt et al. 2004). They propose that during this period of environmental transition, drought conditions limited large mammal populations (Schmitt et al. 2004). Humans focused their foraging efforts on the mass-collection of jackrabbit (*Lepus* sp.) populations, which flourish during dry conditions. Jackrabbits were likely ranked higher by their human predators than larger mammals due to the reduced search time associated with jackrabbits hunting (Schmitt et al. 2004).

This same scenario is possible for the Georgia coast, which experienced environmental variability, such as greater summer and fall temperatures (approximately 3.5°C higher than present-day conditions), greater seasonal extremes (Jones et al. 2005) and sea level fluctuations (Gayes et al. 1992; Thomas 2008a:42-47) during and at the termination of the Late Archaic period. However, it seems unlikely that the theoretically high-ranking taxa would be greatly impacted by such environmental conditions, because all of these taxa tolerate warmer parameters compared to the current climatic conditions. Today white-tailed deer and American alligator both are present in large numbers on those sea islands that do not have large human populations and urban development projects. It is possible that all sea islands sustained large populations of both taxa during the Late Archaic. Although Larson (1980:173-175) reports that black bears occur

with “some frequency” on the Georgia coast, Thomas (2008a:147-149) noted few occasions in which black bears are reported in large numbers today. It may be that black bear populations on the sea islands required costly search efforts.

Ethnographic accounts of carcass transport demonstrate that hunters field-process carcasses and transport only a fraction of the body back to the base camp (O’Connell et al. 1990; O’Connell and Marshall 1989). Such transport decisions are reflected in archaeofaunal assemblages (Bird and Bliege Bird 1997; Bird et al. 2002; Bunn et al. 1988; Nagaoka 2005a, 2006) and may explain the absence of black bear and alligator remains and the limited number of white-tailed deer remains (NISP and MNI) in the shell ring collections.

Among the Hadza hunter-gatherers of Tanzania and the Meriam shellfishers of the Meriam Islands, the choice to transport non-edible portions of the carcass, such as bone, back to base camp is partially dependent on the size of the carcass (Bird and Bliege Bird 1997; O’Connell et al. 1990). That is, the decision to field process and the number of parts moved from the kill location back to the base camp varies inversely with carcass size (O’Connell et al. 1990). This decision also depends on the amount of time needed to process the carcass, the relative utility (the proportion of resource that can be used from that portion of the carcass) of the carcass being field processed, and the means of transporting it to the base camp (Ames 2002; Bettinger et al. 1997; Thomas 2008a:216). If watercraft were a foraging technology for Late Archaic populations of the Georgia coast, the decision to field process may have been dependent on the size of the watercraft and the distance from the kill site to the watercraft (Ames 2002:39-40). Although watercraft have not been recovered archaeologically on the Georgia coast, Late Archaic populations likely had some form of aquatic transportation, minimizing the amount of field processing required (Thomas 2008a:226-230). Although field processing may have

occurred, experimental studies suggest that large-bodied taxa should rarely be field processed on the Georgia coast (Thomas 2008a:230-231).

If extensive field processing was not practiced by Late Archaic hunters, we would expect the remains of large-bodied taxa to be recovered from the shell ring. Only one alligator fragment was identified from the 143,201 vertebrate specimens; 0.0007 percent of the total assemblage. No bear remains are present. Deer specimens in the five shell ring assemblages constitute only 0.4 percent of the total sample (NISP=636). However, without knowing the distance from the kill site to the base camp, the emic relative utility (how much that carcass portion means to the hunter for meat and nonfood values) placed on different portions of the carcass, and the means of transportation, it is impossible to determine which bones from theoretically high-ranking prey would or would not be transported back to the shell rings.

Another explanation for the low AI values for high-ranking terrestrial prey may be based on human responses to subsistence failure (Kelly 1995:100). Foragers often are faced with unpredictable ecological variations (Kelly 1995:100). High-ranking resources may be plentiful one year and absent the subsequent year. Hayden (1981) argues that foragers diversify the range of resources taken in order to minimize the unpredictable nature of resource abundance. Winterhalder and his colleagues (1999) also identify resource diversification strategies among foragers attempting to minimize subsistence risk, combined with reciprocity, mobility, and storage. Late Archaic foragers on the Georgia coast may have diversified the range of animals taken to include more taxa that were theoretically low-ranking in order to minimize the unpredictable nature of deer and other large-bodied taxa.

In regards to marine foraging, the data support the diet-breadth model in which mass-capture resources, that is schooling and aggregating fishes, are highly ranked. Mass-capture AI

biomass values were lower compared to the large-bodied marine AI value in one instance, the Cannon's Point Ring collection, which requires further explanation.

A high percentage of the large-bodied biomass in the Cannon's Point Ring collection is contributed by eagle ray. Some members of this family form large aggregations (Dahlberg 1975) and it is possible that Cannon's Point eagle rays were taken using mass-capture technologies. Large numbers of cownose ray remains were recovered from Mississippian archaeofaunal collections from St. Simons Island and may suggest that mass-collecting members of the eagle ray family was a unique, localized fishing strategy to the inhabitants of this island (Weinand et al. 2000). Furthermore, many species classified as individually-captured can be taken en masse. Notably, I captured several species of rays and northern kingfish (*Menticirrhus saxatilis*) in seines along the North Beach of St. Catherines Island. Both of these taxa are classified as individually-captured taxa, but clearly, individuals that do not form schools or aggregations can be taken with mass-capture technologies.

Only vertebrate data are included in this marine foraging model because archaeological invertebrate samples have not yet been studied in sufficient detail to be included in this analysis. A vast array of marine invertebrates is recovered from coastal archaeological sites (Losey et al. 2004; Quitmyer and Reitz 2006). These species include decapods (Decapoda) such as crabs and shrimp. These taxa are commonly taken when capturing fishes en mass, in fact, shrimp are difficult to avoid. Because these animals are not included in the mass-capture AI values, the actual post-encounter return rates for mass-capturing marine fauna is likely much higher. If shrimp, for example, could be included, this would add further evidence in support of the argument that marine taxa that could be taken en mass were high-ranking taxa.

Although sharks are considered high-ranking marine taxa following the Georgia sea island diet-breadth model (Thomas 2008a, 2008c), shark remains are rare in the shell ring collections. The limited evidence for sharks may be due to several factors. One factor is that sharks are cartilaginous fishes and have few ossified elements that might preserve archaeologically (Rick et al. 2002). Additionally, ethnographic accounts of fish butchery suggest that large-bodied fishes, such as sharks, are more likely to be butchered at the kill site (Belcher 1994). If this same butchery method was practiced by the Late Archaic shell ring populations, shark remains at the shell rings would be limited. However, shark skin may have functional value (Hudson 1976), which would reduce field-processing.

The propensity for sharks and alligators to damage nets may have caused Late Archaic fishfolker to net in areas less frequented by these animals and may explain the rarity of shark and alligator remains in the Late Archaic shell rings collections. The limited evidence for sharks may be related to mass-capture technologies and the location of fishing. If marine foraging was based on the use of mass-capture technologies (e.g., dip, gill, and seine nets) in the shallow tidal creeks of the salt marshes, sharks may have been avoided. Sharks are frequently captured in the open waters of the beaches and sounds (Dahlberg 1972) and are less likely to be captured in shallow tidal creeks where schooling fishes regularly occur. Additionally, sharks are fast swimmers that can avoid slow moving seine and dip nets and can back away from stationary gill nets, making their capture with these technologies less likely. When sharks are captured in nets, they aggressively thrash and bite, damaging the net. The cost of repairing a damaged net may have been greater than the potential energetic return from capturing a shark. Late Archaic people may have fished in areas where sharks were not frequently encountered to avoid damaging their nets.

The same may hold true for alligators. Alligators, although less likely to be captured while netting, will damage nets and people if they are captured in one.

Optimal Foraging and the Hunt-Type Model

Thomas's hunt-type model for foraging on the Georgia coast predicts that saltwater fishing would provide foragers with the highest potential post-encounter return rate of all available hunt types (Thomas 2008c:974). The vertebrate data from the Late Archaic shell rings can be used to test Thomas's predication. If saltwater fishing provided the greatest post-encounter return rate compared to all other hunt types, then it is expected that fishes captured when fishing in salt water will form the majority of resources; yielding AI values over 0.50. To test this predication, Thomas developed a Marine/Terrestrial Index (Thomas 2008c:975). I slightly modified Thomas's Marine/Terrestrial Index to include taxa that cannot be capture during terrestrial or marine foraging. These include taxa such as freshwater fishes, which were identified in most of the shell ring collections and would not be captured during terrestrial or marine foraging (Table 4.59). The modified Marine/Terrestrial Index is as follows:

$$\Sigma\ Marine\ Fishes_{\ NISP} / \Sigma\ (Marine\ Fishes_{\ NISP} + All\ Other\ Taxa_{\ NISP}).$$

AI also is estimated for these same resource groups using MNI and biomass as variables.

The AI values for marine fishes are consistent with Thomas's predictions with the exception of one biomass value (Table 5.5). All AI values for NISP and MNI indicate that saltwater fishing formed the basis of hunting activities; all values are greater than 0.90. The AI values for biomass are less uniform though, with the exception of the St. Catherines Shell Ring, all have AI values over 0.50, supporting Thomas's model.

For the St. Catherines Shell Ring, the AI biomass is very low, 0.21; suggesting that hunt types other than saltwater fishing were preferred strategies. The AI value for the St. Catherines

Shell Ring is exceptionally low due to the large quantity of deer biomass. Deer biomass consistently contributes over 50 percent of the biomass in all four collections from the St. Catherines Shell Ring, including collections from the ring itself and features from the interior plaza of the ring. Further explanation as to the high percentage of deer biomass among the St. Catherines Shell Ring collections is needed.

The high percentage of deer biomass in the St. Catherines Shell Ring collections suggests that terrestrial hunting was more profitable than saltwater fishing in this location. The environment surrounding the St. Catherines Shell Ring may have been ideal for deer, increasing the frequency in which deer were encountered, making deer hunting more efficient and profitable than saltwater fishing.

Previous zooarchaeological research of St. Catherines Island assemblages, from numerous locations on the island and from all cultural time periods, suggests that the ecology of St. Catherines Island supported a large number of deer compared to other sea islands (Reitz 2008:656). The high percentage of deer biomass in the St. Catherines Shell Ring assemblage supports this assessment. However, the McQueen Shell Ring, which is also on St. Catherines Island, has high saltwater fishing AI values, indicating that saltwater fishing was a more profitable hunt type compared to terrestrial foraging and contradicts the assertion that deer are abundant in the St. Catherines Shell Ring collection because of a native abundance of deer. The values for the McQueen Shell Ring are also low, 0.51 compared to the other shell ring collections, with the exception of the St. Catherines Shell Ring collection (Table 5.5). Deer biomass contributes 40 percent of the biomass in the McQueen assemblage. The McQueen Shell Ring is on the seaward side of the island, while the St. Catherines Shell Ring is on the leeward side. The different locations on St. Catherines Islands provided different habitats adjacent to each

ring. The area nearest to the St. Catherines Shell Ring may have provided more preferable habitats for deer, making them high-ranking prey for the populations of the St. Catherines Shell Ring, while areas immediate to the McQueen Shell Ring may have sustained a smaller number of deer, making saltwater fishing a more profitable hunt type. The St. Catherines Shell Ring was located next to a freshwater stream. The freshwater stream may have attracted deer which were hunted by the human populations of the St. Catherines Shell Ring.

Problems and Criticisms of Human Behavioral Ecology

Human behavioral ecology and optimal foraging theory provide simple, yet comprehensive, models for explaining and testing human behavior in a number of ecological and cultural settings. Although optimal foraging theory expands our understanding of human behavior, problems with optimal foraging models, particularly in coastal applications, are evident.

One problem is their simplicity. Many theorists argue that accounting for human behavior based solely on evolutionarily rational decisions glosses over cultural values, individualism, and the complexities of human cognition (Durham 1981; Leach 2006:283). This criticism of archaeological applications has significant merit. Archaeological data are often aggregated data, spanning many years, numerous seasons, and accumulations of innumerable complex individual behaviors (Grayson and Delpech 1998; Lyman 2003). In an evolutionary framework, the unit of analysis should be an individual (Kelly 1995). Each individual within a society has a personal basis for making decisions, reflecting the forager's age and sex, physical and mental conditions, marital status, number of children, nutritional requirements, social standing, and fishing, foraging, and hunting skills, among other factors (Bird 1999; Lupo and Schmitt 2005). Archaeological data cannot distinguish among the countless individual decisions made each day

by Late Archaic foragers. This criticism is not overcome by data presented here. Nonetheless, archaeological applications of optimal foraging models provide information on variability in human foraging behavior spanning time and space (Lupo 2007) and are valuable perspectives on Late Archaic subsistence economies.

Operationalizing all constraints on optimal foraging models posed by the archaeological record is difficult (Lyman 2003). Models have predictive limitations due to inaccurate estimates of search, handling, and processing times (Bettinger and Baumhoff 1983; Madsen and Schmitt 1998), as well as imprecise biological and demographic data for prey resources. Additionally, the use of energy or calories as currencies may be a source of error (Yesner 1981). As Leach (2006:285) points out, "Obtaining a balanced diet is far more important to all animals in the long run than just abundance of any one food commodity." In other words, acquiring a variety of foods that provide a nourishing diet is key to human evolutionary success rather than obtaining the greatest amount of calories per time and energy output. Other subsistence preferences, practices, and requirements, such as water, carbohydrates, fats, vitamins, nutrients, taste, social value, resource reliability, and non-food yield can be factors in the selection of resources and should also be considered when evaluating the return rates of potential prey (Durham 1981; Leach 2006:273; Yesner 1981).

Some researchers demonstrate that variables other than the maximization of return rates influence foraging behavior (Allen 2002; Bird and Bliege Bird 1997; Hilderbrandt and McGuire 2002, 2003; Hill et al. 1987). For example, men often specialize in hunting resources that are the largest and least predictable, even though foraging for other resources would generate calories more efficiently, a foraging strategy referred to as the "show-off" model (Hawkes 1993). These foraging strategies, with a high risk of failure, may not be the most efficient foraging strategy,

but men are able to share these resources, which may increase their evolutionary fitness (Bird 1999; Hawkes 1993). Show-off foraging is observed among Meriam fishermen who tend to pursue large taxa that are highly risky and have a high rate of foraging failure (Bird 1999). Late Archaic fishermen could have engaged in similar behavior, although large-bodied fishes that are risky to capture, such as sharks and offshore fishes, are absent or present in very low precentages in the shell ring collections. There is no evidence to suggest Late Archaic fisherman fished to "show off" as do the Meriam fishermen. Deer hunting may have had a higher risk of failure compared to fishing and could have been a showing-off foraging strategy, but the intent of male hunters of the Late Archaic is unknown and social objectives cannot be recognized in these archaeological data.

The environment complexity of Georgia estuaries limits operationalizing diet-breadth and hunt-type models. The estuaries of Georgia are highly intricate. The abiotic parameters and biotic communities in estuaries oscillate on daily, seasonal, and yearly cycles. As animal communities change with environmental oscillations, those animals that might be considered high-ranking prey also may change. Some large-bodied (i.e., sharks) and aggregating (i.e., sea catfishes) fishes are generally absent or inaccessible in estuaries during cold months of the year, but other taxa and age cohorts become abundant. These shifts in animal communities are difficult to quantify or incorporate into diet-breadth and hunt-type models. The relationship between human decisions and animal behaviors are complex. Optimal foraging models should be customized rigorously to the cultural and natural environments in order to develop comprehensive hypotheses (Durham 1981:225; Keene 1981).

Despite the criticisms and problems that are apparent in optimal foraging models, many studies demonstrate that optimal foraging models have significant predictive power (Braje et al.

2007; Broughton and Bayham 2003; Hawkes et al. 1982; Hill et al. 1987; O'Connell and Hawkes 1981) and aid in the formulation of novel questions regarding human behavior (Hawkes 1993). Further research on the Georgia coast should incorporate numerous fishing methods (both mass- and individual-capture) in a variety of seasons and island localities to refine post-encounter return rates for these variables. Such data could be used to determine post-encounter return rates for mass-capture versus individual-capture fishing technologies, which then can be used to predict the fishing methods most likely used Late Archaic populations.

Summary and Conclusions

Despite criticisms of human behavioral ecology, optimal foraging models provide a framework for testing zooarchaeological data against predicted foraging behaviors. When different diet-breadth models are applied to the archaeofaunal collections from the shell rings, a diet focused on relatively small-bodied marine fishes that can be captured en masse is supported. Similar foraging strategies are characteristic of other coastal environments, indicating that resources that could be mass-captured were preferred by human populations on the Georgia coast. This contradicts models based on the capture of large-bodied individuals. The zooarchaeological data from the shell rings are consistent with Thomas's hunt-type model (Thomas 2008a, 2008c). The data confirm that saltwater fishing was the optimal hunt type in most cases. Because fishing was the basis of the Late Archaic vertebrate economy and diet, variations in the ichthyofaunal collections among the five shell rings will be examined further in Chapter 6. Additionally, fishing technologies, derived from estimated body sizes of sea catfishes, mullets, and drums, are explored. Closer analysis of fishing and fishing technologies at the Late Archaic shell rings may provide evidence of cultural practice and local estuarine conditions. This information is important for evaluating how human populations interacted with fish populations

and may indicate which taxa experienced impacts from environmental variations, including anthropogenic overfishing, during the Late Archaic period.

TABLE 5.1

White-tailed Deer AI for Late Archaic Shell Rings of the Georgia Coast

	Cannon's Point	West	St. Catherines	McQueen
NISP	0.13	0.12	0.34	0.48
MNI	0.06	0.11	0.12	0.14
Biomass	0.63	0.70	0.81	0.84

TABLE 5.2

High-Ranking Marine Taxa for Late Archaic Shell Rings of the Georgia Coast

	Cannon's Point	West	Sapelo, Ring III	St. Catherines	McQueen
NISP	0.06	0.03	0.01	0.01	0.01
MNI	0.03	0.02	0.01	0.01	0.01
Biomass	0.25	0.13	0.01	0.06	0.04

TABLE 5.3

Large-Bodied Marine Taxa for Late Archaic Shell Rings of the Georgia Coast

	Cannon's Point	West	Sapelo, Ring III	St. Catherines	McQueen
NISP	0.49	0.34	0.73	0.21	0.23
MNI	0.23	0.23	0.45	0.16	0.18
Biomass	0.82	0.65	0.84	0.71	0.69

TABLE 5.4

Mass-Capture Marine Taxa for Late Archaic Shell Rings of the Georgia Coast

	Cannon's Point	West	Sapelo, Ring III	St. Catherines	McQueen
NISP	0.91	0.91	0.99	0.94	0.97
MNI	0.92	0.95	0.94	0.93	0.95
Biomass	0.69	0.77	0.97	0.77	0.79

TABLE 5.5

Saltwater Fishing for Late Archaic Shell Rings of the Georgia Coast

	Cannon's Point	West	Sapelo, Ring III	St. Catherines	McQueen
NISP	0.93	0.95	1.00	0.91	0.99
MNI	0.94	0.96	0.98	0.92	0.98
Biomass	0.56	0.66	0.97	0.21	0.51

CHAPTER 6:

FISH REMAINS FROM THE LATE ARCHAIC SHELL RINGS

Human behavioral ecology models demonstrate that foraging strategies focused on schooling and aggregating fishes are optimal on the Georgia coast. Such strategies are found in all of the Late Archaic shell ring vertebrate collections, indicating that fishing was an important component of the coastal subsistence economy. Variations in the fish remains may indicate differences in cultural practice as well as differences in local estuarine conditions at each location. To further explore the economies represented in the five shell ring collections, three measures are examined: (1) fish ubiquity, (2) relative abundance of high ubiquity fish taxa, and (3) estimates of fish size for members of three fish families. These data indicate the estuarine habitat most heavily exploited and the types of fishing technologies used. This information is important for evaluating how human populations interacted with fish populations and may indicate which taxa most likely experienced anthropogenic and non-anthropogenic environmental impacts during the Late Archaic period.

Ubiquity of Fish Taxa at the Shell Rings

The ubiquity of fish taxa from the shell rings is used to make general observations about the fishing strategies. Fish taxa are classified as ubiquitous (1.0), frequent (0.8), common (0.6 to 0.4), or rare (0.2). Of the 49 fish taxa identified in the shell ring collections, nine are ubiquitous. These are: herrings and shads, mullets, silver perches, seatrouts, spots, Atlantic croakers, black drums, red drums, and star drums (Table 4.59). These ubiquitous fishes are all regular inhabitants

of Georgia estuaries and occupy numerous areas throughout the estuaries, depending on the maturity of the individual as well as annual, monthly, and daily environmental cycles (Dahlberg 1972, 1975).

Six taxa are frequent in these collections. These are gars, ladyfishes, toadfishes, bluefishes, jacks, and sheepsheads. Of these fishes, gars are unusual because they primarily reside in fresh waters; however, gars frequently enter low salinity, brackish waters of the Georgia estuaries (Dahlberg 1972:334). The high gar UI suggests that people fished in lower salinity waters in addition to higher salinity waters where spots, Atlantic croakers, and star drums can be captured (Stickney et al. 1975).

Common fishes in the shell ring collections include 19 taxa. Of these, 17 taxa regularly occupy the Georgia estuaries and are found in numerous estuarine habitats. Two of these taxa are freshwater fishes: bowfins and bullhead catfishes. Certain species of the bullhead catfish genus migrate into Georgia estuaries during colder months (Dahlberg 1972). Bowfins are freshwater fishes that do not tolerate saline water (Pearson and Ward 1972). Bowfins in the Cannon's Point, St. Catherines, and McQueen Shell Rings collections suggest that freshwater sources capable of supporting a bowfin population were located near these shell rings. Alternatively, people could have traveled above the upper reaches of the estuary to procure bowfins; a trip of approximately 40 km. It seems unlikely people traveled to such a distant source to acquire bowfins or that it was a popular trade item.

Sea catfishes, including hardhead and gafftopsail catfishes, are present in all of the shell ring collections, but have a UI of 0.6. This lower UI is a consequence of estimating MNI at the family level for sea catfishes, rather than the species, in the Cannon's Point and West Ring

collections. Despite the UI of 0.6, hardhead and gafftopsail catfish remains are abundant in all of the shell ring collections and are considered ubiquitous for this analysis.

Fifteen taxa are rare. Of these 15 taxa, four are taxa that are included in ubiquity classifications at a different level of taxonomic identification and at a greater UI. Four of the rare taxa are cartilaginous fish that are common to Georgia estuaries. Cartilaginous fishes have few elements that are highly ossified, making their rarity expected (Rick et al. 2002). Two members of the sunfish family are included among the rare taxa, a warmouth and a sunfish. These two freshwater sunfishes are in the St. Catherines Shell Ring collection, further documenting the presence of a freshwater source on St. Catherines Island during the Late Archaic.

The ubiquity data are consistent with previous studies of the fishing economies of the Georgia coast (Reitz 1988; Reitz et al 2009, 2010). Ubiquitous fishes among the shell ring collections include herrings and shads, sea catfishes, mullets, and drums. These taxa are abundant in shallow, near-shore waters of the Georgia estuaries. In the Late Archaic shell ring collections studied for this research, freshwater fishes have a UI of 0.8. This suggests that non-estuarine areas were fished or that fresh waters of the upper reaches of the estuary were fished. The ubiquity data provide a broad characterization of the fishing economies practiced at the Late Archaic shell rings. A comparison of quantified relative abundance of the four ubiquitous fish families can further evaluate fishing activities at the Late Archaic shell rings.

Relative Percentage of Fish Families among the Shell Rings

Herrings and shads, sea catfishes, mullets, and drums are represented in all the shell ring collections. Individuals from these four families contribute 75 percent or more of the fish individuals and biomass in every collection (Table 6.1). The relative abundance of these four

families varies among the five collections, providing additional information about fishing activities and local environments during the Late Archaic.

The same suite of fishes are present among the collections but in different proportions (Table 6.1). In all collections, sea catfish biomass contributes the highest percentage of fish biomass. Beyond that, the percentages are variable. Fishes from three families, herrings and shads, mullets, and drums contribute to the greatest percentage of individuals in the Cannon's Point and West Ring collections. In the Ring III of the Sapelo Island Shell Ring complex and the St. Catherines and McQueen Shell Ring collections, sea catfishes, mullets, and drums are the three most abundant families. The Sapelo collection is dominated by fishes from the sea catfish and drum families (Table 6.1). In the St. Catherines and McQueen Shell Ring collections, mullet and drum individuals are abundant and sea catfishes are less abundant (Table 6.1).

Fish remains from archaeological sites reflect the choices humans made as to which fishes to exploit, which to ignore, the timing and location of fishing activities, technologies used for acquiring and processing fishes, where to consume fish, and how to dispose of the remains. Although distinguishing among these factors may be difficult, several explanations as to the differences in the relative frequency among these four fish families can be offered.

The seasonal timing of fishing activities at these sites may explain the differences in the relative abundance of the fish families. Many fishes common to the estuaries of Georgia are seasonal, rather than year-round, residents (Dahlberg and Odum 1970). However, most members of the four dominant families occupy Georgia estuaries throughout the year. It is unclear whether seasonal timing of fishing efforts can explain the different proportions of fishes. Considering the abundance of fish taxa alone is not an accurate means for assessing seasons in which fishing occurred. The seasonality of fishing is examined further in Chapter 8.

The location of fishing activities is another possible explanation for the different relative abundances of fish families among these collections. The relative abundances are most similar among collections located on the same island. For example, the Cannon's Point and West Ring collections, both located on St. Simons Island, have similar proportions of fishes, as do the St. Catherines and McQueen Shell Ring collections, both on St. Catherines Island. Ring III, the one collection from Sapelo Island, is different compared to collections from the other two islands. This suggests that local estuarine environments associated with each island supported different proportions of these families, which in turn is reflected in the Late Archaic faunal collections.

This hypothesis is supported by the distribution of marine species sensitive to saline waters. Estuarine fishes that prefer lower salinities are common in both the Cannon's Point and West Ring collections. This includes species such as herrings and gafftopsail catfishes. The Altamaha River drains into the waters surrounding St. Simons Island. This dilutes the higher-salinity oceanic waters, creating a more favorable habitat for species that prefer lower salinities (Johnson et al. 1974:86). These species, in turn, were fished by the occupants of the Cannon's Point and West Rings. Similarly, the two most abundant fishes in the Sapelo, Ring III collection are hardhead catfishes and star drums. Both of these species tolerate very high salinity levels. There is no direct freshwater drainage into Sapelo Island waters, which are more saline compared to those surrounding St. Simons Island. This indicates that the fisherfolk associated with the Sapelo Shell Ring complex procured fishes that prefer high salinity levels, which likely were more common off Sapelo Island.

The abiotic preferences of fishes change as fish mature and the age classes of fishes in each collection may more adequately characterize estuarine habitats than relative abundance of fish taxa. Analyzing the age of fishes is possible, but this requires incremental analysis of a very

large sample of fish skeletal elements. Such an analysis was conducted on selected hardhead catfish and Atlantic croaker otoliths, but extending this analysis to all elements with visible increments is beyond the scope of this project.

The relative abundance of fishes suggests that fishing was dependent on the suite of fishes available to people in each estuarine system. Fishing technologies, cultural preferences, as well as totemic associations could affect which fishes are represented archaeologically. Cultural preferences and totemic associations are difficult to examine archaeologically and undoubtedly explain some of the variations in the fish remains among the five shell ring collections. Despite this, some aspects of these collections suggest fishing technologies employed and are considered next.

Inferences of Fishing Technologies from Ichthyofaunal Collections

Studies of fishing technologies are strengthened by combining attributes of ichthyofaunal assemblages with the material culture associated with fishing (Allen 1992; Rick et al. 2001; Walker 2000). Evidence of fishing-related material culture is rare for the entire Georgia coast. Perhaps this is because fishing technologies were made from organic materials. The depositional context of shell middens (i.e., slightly alkaline) is not favorable for the preservation of organic remains (Wilkinson and Stevens 2003:43). Additioanlly, some fishing devices, such as net weights and floats, might not be recognized unless they were extensively modified and some accounts of preindustrialized fishing suggest that fishing devices would not be highly modified (Rostlund 1952:83). Therefore, inferences of fishing technologies must be based on the ichthyofaunal collections themselves. These inferences rely on behaviors and habitat preferences of the fishes identified. The size-selective nature of fishing technologies and the mortality profiles associated with them also can be used to infer fishing technologies.

Before inferences are made as to which fishing technologies were used at the shell rings, a brief review of fishing technologies as well as the suite of physical characteristics associated with each technology is provided.

Fishing Technologies

A wide array of fishing technologies is recorded ethnographically and archaeologically throughout the world (Oswalt 1976:91-101; Wheeler and Jones 1989:167-176). Each fishing technology is specific to the targeted species or suite of species, the location of fishing, and the number of people involved in the fishing activity (Wheeler and Jones 1989:168; Wing and Reitz 1982). The diversity of fishing technologies makes determining the specific fishing technologies employed at a given location difficult, although generalizations are possible. Historically, fishing technologies such as fish weirs, fences and traps; gill, dip, and seine nets; spears; leisters and harpoons; trot lines; poisons, and line fishing were used on the Atlantic coast (Thomas 2008a:122-131).

Fish weirs, fences, and traps are devices that require little attention once constructed and set (Wheeler and Jones 1989:171) although they must be staffed with fishers and repaired when damaged. Weirs and fences operate by blocking an area of moving water, such as tidal creeks, and corralling the fishes passing through the waterway. Numerous species and size classes can be taken with weirs, fences and traps, including small-bodied, schooling fishes as well as large-bodied, benthic feeders (Tveskov and Erlandson 2003). The indiscriminate nature of these devices makes detecting them with ichthyofaunal collections difficult, although high richness may be an indication of weir fishing.

Traps are often used in conjunction with weirs and fences or can be set individually. Traps allow fishes to enter the trap, but restrict passage out. The size of the mesh-openings of the

trap makes traps size-selective. Large-meshed traps allow small-bodied fishes to swim free of the trap, while small-meshed traps catch both small and large-bodied fishes.

Nets come in an array of sizes and shapes and capture an assortment of fishes (Wheeler and Jones 1989:169). Nets, including gill, seine, and dip nets, were likely used along the Georgia coast (Thomas 2008a:126-127). Gill nets are staked out vertically in the water and are stationary, not requiring the active attention of the fisher (Lindström 1996). Fishes caught in gill nets are entangled as they attempt to swim through the mesh. Fishes that are smaller than the gauge generally swim through the net, and large-bodied fishes can back away from the net unharmed (Balme 1983; Greenspan 1998). Gill nets tend to capture medium-sized fishes. Seine and dip nets are also size-selective. Seines and dip nets select fishes that are too large to escape through the gauge of the net; hence the mesh size of the net determines the size of the fish that is captured. Unlike gill nets, seine nets capture large-bodied fishes if they cannot flee the active movement of the net. Dip nets often capture small-bodied fishes, as the movement of the wader scares large-bodied fishes.

Three types of spears are known from the Atlantic coast: simple spears, leisters, and harpoons (Thomas 2008a:127). Spears, leisters, and harpoons are most effectively used in shallow, clear waters where fishes are easily seen. Spear fishing takes individual fish rather than groups and exclusively targets fish that are large-bodied and easily hit with a spear (Noe-Nygaard 1983; Wheeler and Jones 1989:174). This is unlike weirs, fences, traps, and nets (depending on the mesh size for traps and nets) that target a greater size range of fishes, including small-bodied ones. Spears, leisters, and harpoons can be used in conjunction with weirs. As fish become trapped in the weir, fisherfolk capture large-bodied fishes individually with spears, leisters and harpoons, while small-bodied fishes can be caught in nets.

Hook-and-line and trot-line fishing are similar to spear fishing techniques in that these methods target large-bodied fishes. Both hook-and-line and trot-line fishing require the use of a baited hook to capture fish. These methods usually only capture carnivorous fishes that are large enough to take the hook used (Wing and Reitz 1982).

Two trends are observed among these fishing methods. Weirs, fences, nets, and traps constructed with small-mesh sizes capture a wider range of fish sizes and they take small-bodied fishes more effectively than spears and hooks.

Fishing Technologies and the Late Archaic Shell Rings

To infer fishing methods based on the biological characterization, fish individuals are grouped into one of two categories, individual-captured or mass-captured. This categorization is based on whether the species forms schools or aggregates (Reitz et al. 2009). Fish taxa that school or aggregate are more likely taken with mass-capture technologies such as weirs, traps, or nets. Fishes forming schools and aggregates also can be taken with individual-capture technologies. Hardhead catfish, an aggregating species, was captured by the author on a hook-and line, an individual-capture technology, as well as with a seine net, a mass-capture technology.

Based on the individual versus mass-capture characterization, ichthyofaunal collections from all shell rings suggest that primarily mass-capture technologies were used (Figure 6.1). Most fish individuals recovered in all collections are fishes that school or aggregate. Additionally, several fish taxa in these collections are unlikely to be taken with individual-capture technologies such as hooks. Herbivorous species, like herrings and mullet, are difficult to take with hooks and contemporary fisherfolk typically use nets to capture these species (Collins 1985b). The abundance of small-bodied taxa such as killifishes, silver perches, spots, and star

drums, which are too small to take hooks, further indicates use of mass-capture technologies such as fine-gauge nets or basketry scoops. The large number of small-bodied drum individuals in these collections lends additional support to this interpretation.

Fishing Technologies and Mortality Profiles

Mortality profiles are used by archaeologists to infer hunting and fishing strategies (Balme 1983; Butler 1996; Byers and Hill 2009; Greenspan 1998; Klein 1982; Noe-Nygaard 1983). These analyses are based on the relationship between the natural size or age structure of a living population and the non-random size or age selectively targeted by a hunting or fishing technology (Greenspan 1998). For example, trap fishing non-randomly selects medium-sized fishes within a prey population, while spear fishing non-randomly selects medium and large-bodied fishes. Because these different fishing technologies target particular fish size classes, the mortality profiles of trap versus spear fishing are different and detectable in the archaeological record if the size classes of the represented fishes are examined (Figure 6.2). If the mortality profile of a fishing technology is known, the archaeological mortality profile can be compared to the known profile and the fishing technology used can be inferred.

Generally, fish populations have a multi-modal size distribution, with the greatest number of individuals in the smallest size range (Craig and Oertel 1966; Sheldon 1965). Small-bodied individuals usually form the youngest age cohort within a population. The frequency of individuals with larger body sizes progressively decreases relative to the smaller-bodied individuals (Figure 6.2). Among fishes, the size of an individual does not directly correlate with the age of that individual (Wootton 1998:116-117), but this is not a concern because the following mortality profile analysis is based on the size selectivity of fishing technologies, rather than the age selectivity of fishing technologies.

Mortality profiles of fishes taken with weirs should reflect the size distribution of the natural prey populations, with the largest cohort consisting of small-bodied individuals. The mortality profiles for fishes taken in traps are likely to have the same distribution as weirs although lacking the extremely small-bodied and large-bodied individuals in the prey population. Nets should have a multimodal distribution with high numbers of small- and medium-bodied fishes targeted, while hooks and spears should have a unimodal distribution with a high frequency of large-bodied individuals.

Based on these predictions, an examination of the mortality profiles among these five ichthyofaunal collections may indicate the fishing technologies used at each location. Standard length (SL), defined as the length from the tip of the snout to the posterior end of the last vertebra, of individuals from the sea catfish, mullet, and drum families is estimated using allometric formulae to back-calculate the standard length of fishes from skeletal dimensions. The allometric formulae used in this analysis are presented in Appendix F. For sea catfishes, the width of the right otolith is used. Right otoliths represent the greatest number of individuals and the exclusion of left otoliths ensures that individuals are considered only once. The greatest width of the anterior centrum of the atlas is used for mullets and drums because this element represents the largest number of individuals from these families. All measurable atlases of species in the drum family are grouped together.

Results of the Mortality Profiles

The mortality profiles for sea catfishes differ among the collections (Figure 6.3). The sea catfish mortality profile for the Cannon's Point Ring has a poorly defined peak and the size classes are evenly distributed. The average size of sea catfishes from the Cannon's Point Ring also is higher compared to the other collections (Table 6.2). The sea catfish mortality profiles for

the West, Ring III, and St. Catherines Shell Rings are similar, all having multiple peaks in the distribution. The size distribution for Ring III is skewed towards small-bodied individuals and the mean sea catfish size is smaller, while the means for the West and St. Catherines rings are greater. The sea catfish mortality profile for the McQueen Shell Ring collection is the only unimodal distribution with the sizes clustered between 130 and 190 mm.

The mortality profiles for mullets in the shell ring collections are similar to one another. All profiles are unimodal and skewed towards a greater frequency of small-bodied individuals (Figure 6.4). The mean standard lengths of mullets are clustered according to their associated estuarine system (Table 6.2). The means for the Cannon's Point and West Ring collections are greater compared to the St. Catherines and McQueen Ring collections. That is, the means for the Cannon's Point and West Ring collections are similar and those from the St. Catherines and McQueen Ring collections are similar. Measureable mullet atlases are not identified in the Sapelo Island Ring III collection and a mortality profile cannot be generated for this collection.

The drum mortality profiles are very similar for all the shell ring collections (Figure 6.5). All collections have a unimodal distribution with peaks between 140 and 160 mm (Table 6.2). The mean sizes of drums are all between 154.3 and 159.3 mm (Figure 6.5).

Overall, the mortality profiles suggest that nets, hooks, and spears were used by the people who formed these shell rings. The sea catfish mortality profiles differ among the collections, suggesting that different technologies were used to capture catfishes, the size range of catfishes occupying the estuarine waters surrounding each island were different, or there was a different mixture of technologies types used to capture fish. The Cannon's Point Ring sea catfish mortality does not resemble any of the expected mortality profiles. The mortality profiles for sea catfishes in the West, Ring III, and St. Catherines Shell Ring collections are bi-modal and

resemble the expected mortality profiles for weirs and traps, while the McQueen sea catfish mortality profile resembles the profile from netting, hooking, or spearing. The mortality profiles for both mullets and drums in all the collections are unimodal and resemble the expected curves for netting or hooking/spearing. However, this interpretation of the mortality curves is weakened by several factors.

The success of mortality profiles is dependent on knowing the size distribution of the prey population (Greenspan 1998). For fishes, this is assumed to be a multi-modal distribution, with a maximum peak of the distribution curve skewed towards small-bodied individuals. This is the size distribution in many fish populations, especially those populations that follow r-strategies (Craig and Oertel 1966; Sheldon 1965). Under the r-strategist model, many offspring are produced with a low probability of survival (Pianka 2000:184-187). This is the case for mullets and drums and the hypothetical size-class distribution (Figure 6.2) should adequately describe the size distribution of fishes from these two families. Sea catfishes, however, are not r-strategists. Sea catfishes produce a small number of eggs that are orally gestated. Small egg clutches and oral gestation decrease the number of small-bodied individuals within the population (Gunter 1947; Ward 1957) thus the frequency in which small-bodied sea catfishes can be captured is lower compared to r-strategists. The assumed size distribution of a multi-modal population, with a maximum peak skewed towards small-bodied individuals, may not describe the natural size distribution of sea catfishes and decreases the reliability of mortality profiles for this taxon.

The Georgia estuaries are nursery grounds and many of the fishes in estuaries are extremely small, generally the young of the year. As Dahlberg and Odum (1970:Table 3) show, star drums, a species ubiquitous in the archaeological collections, are seldom captured over sizes

of 82 mm from modern estuarine populations. In contrast, star drums smaller than 100 mm SL are not represented in the archaeological collections. The absence of fishes under 100 mm SL may be explained by patterns of consumption and preparation for very small-bodied fishes. Small-bodied fishes are frequently consumed whole or boiled to make a fish broth. These cooking and consumption methods increase the likelihood that fishes less than 100 mm SL are absent from the archaeological record as the bones would be digested by people or destroyed by boiling (Lindström 1996; Nicholson 1996; Wheeler and Jones 1989:67). Additionally, elements from extremely small-bodied fishes may be lost because the zooarchaeological samples were passed through mesh screens of various sizes after excavations (Table 3.1). Numerous studies show that this procedure does not sample elements of extremely small-bodied fishes (Nagaoka 2005b; Quitmyer 2003). The absence of fishes less than 100 mm SL in these archaeological collections may be due to archaeological recovery rather than the selectivity of capture methods. It is unknown whether extremely small-bodied fishes, common to the Georgia estuaries, were originally captured, but cooking and consumption methods and archaeologically sampling techniques biased the recovery of extremely small-bodied fishes. If these extremely small-bodied fishes were captured, the mortality profiles would be more similar to those associated with weirs or traps (Figure 6.2b).

The interpretation of the mortality profiles also is hampered by time and space averaging (Lyman 2003). The size distribution of fishes captured during a particular season will be different compared to another season just as fishing in one location yields different size classes compared to fishing at another location. The differences in size classes that can be attributed to fishing seasonality and location are not reflected in the aggregated zooarchaeological samples reported here because of time and space averaging. Occupation dates for the shell rings indicate

that deposition occurred over hundreds of years (Table 3.1), although the exact duration of deposition or frequency, if not continuous, is unknown. The multiple seasons and fishing locations represented in these collections obscure the nuances in size distribution needed for more specific inferences of fish capture methods. The seasonality of fishing is examined further in Chapter 8, in which some of the issues associated with fish body-sizes, growth, and fishing may be resolved.

Despite these limitations, it is clear from the mortality profiles and biological characteristics of these fishes that mass-capture technologies such as weirs, traps, and nets were used by the occupants of these sites.

Summary and Conclusions

The archaeofaunal collections from the shell rings are dominated by fish individuals common to nearby, shallow waters of the Georgia estuaries. This is consistent with other archaeofaunal collections of the area (Keene 2002:116-119, 2004: Marrinan 1975:77; Quitmyer and Reitz 2006; Reitz 1982, 1985, 1988; Reitz and Quitmyer 1988; Reitz et al. 2009; Russo 2002:146; Thompson 2006:259). The ichthyofaunal collections indicate herrings and shads, sea catfishes, mullets, and drums are ubiquitous. The relative abundance of these four fish families suggests that the suite of fishes in the collections is most likely dependent on the local environments of each estuarine system. Biological characteristics of the fish species as well as mortality profiles for sea catfishes, mullets, and drums suggest that mass-capture technologies, including weirs, traps, and nets were used. It is also possible that hook and spear devices were employed in conjunction with mass-capture technologies.

It is expected that estuarine fishes, taken with mass-capture technologies were most vulnerable to overfishing. Before overfishing is considered, other parameters of the human-

environmental interaction are evaluated. These include evidence of activity areas within shell rings (Chapter 7), the seasonality of fishing (Chapter 8), the age distribution and growth rates of Late Archaic fishes, and the factors that impact fish growth (Chapter 9).

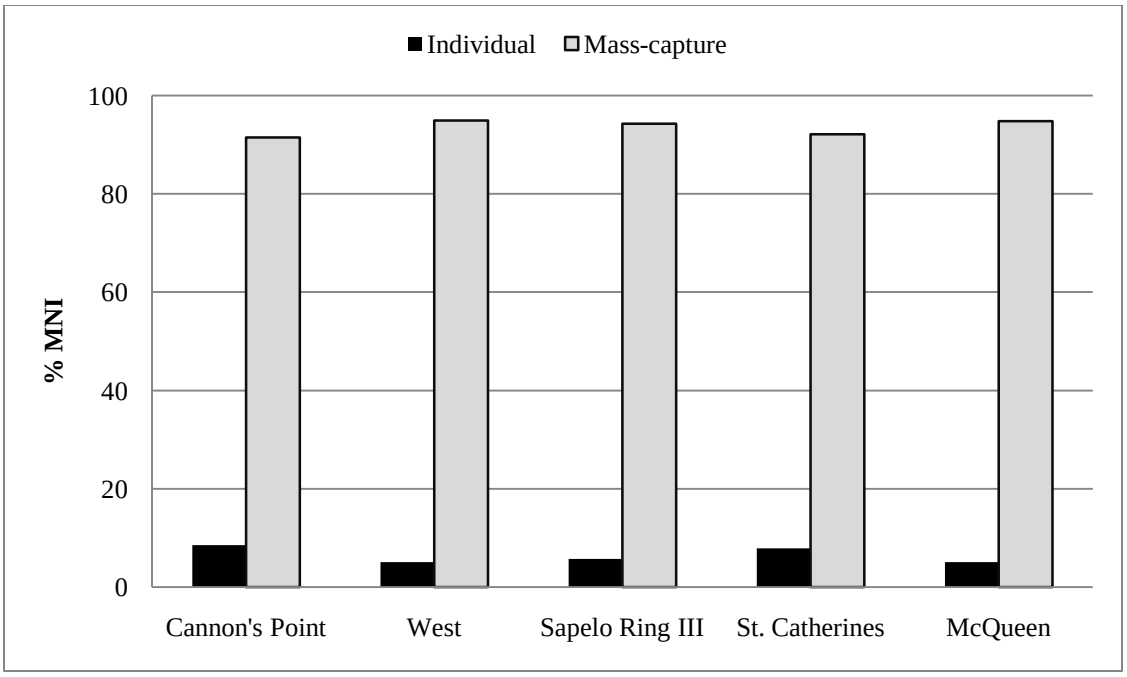
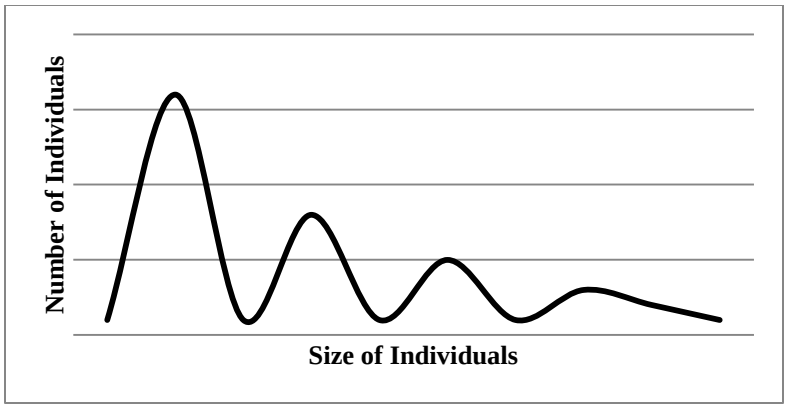
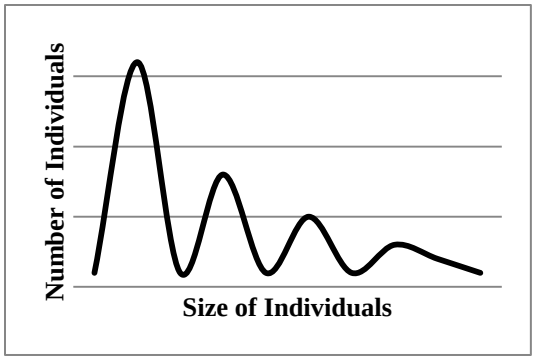


Figure 6.1: The percentage of fish individuals based on individual versus mass-capture technique.

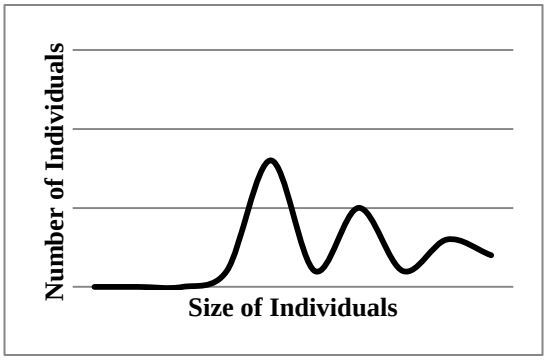
(a)



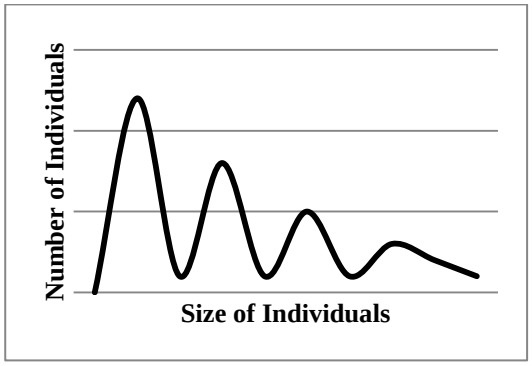
(b)



(c)



(d)



(e)

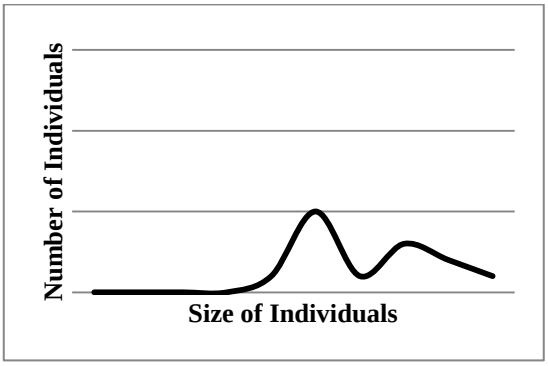


Figure 6.2: Hypothetical size distribution for fish populations and hypothetical mortality profiles for different fishing technologies following Greenspan (1998), (a) hypothetical size distribution for the population; (b) hypothetical mortality profile for a population captured with weirs and fences; (c) hypothetical mortality profile for a population captured with traps; (d) hypothetical mortality profile for a population captured with nets; (e) hypothetical mortality profile for a population captured with hooks and spears.

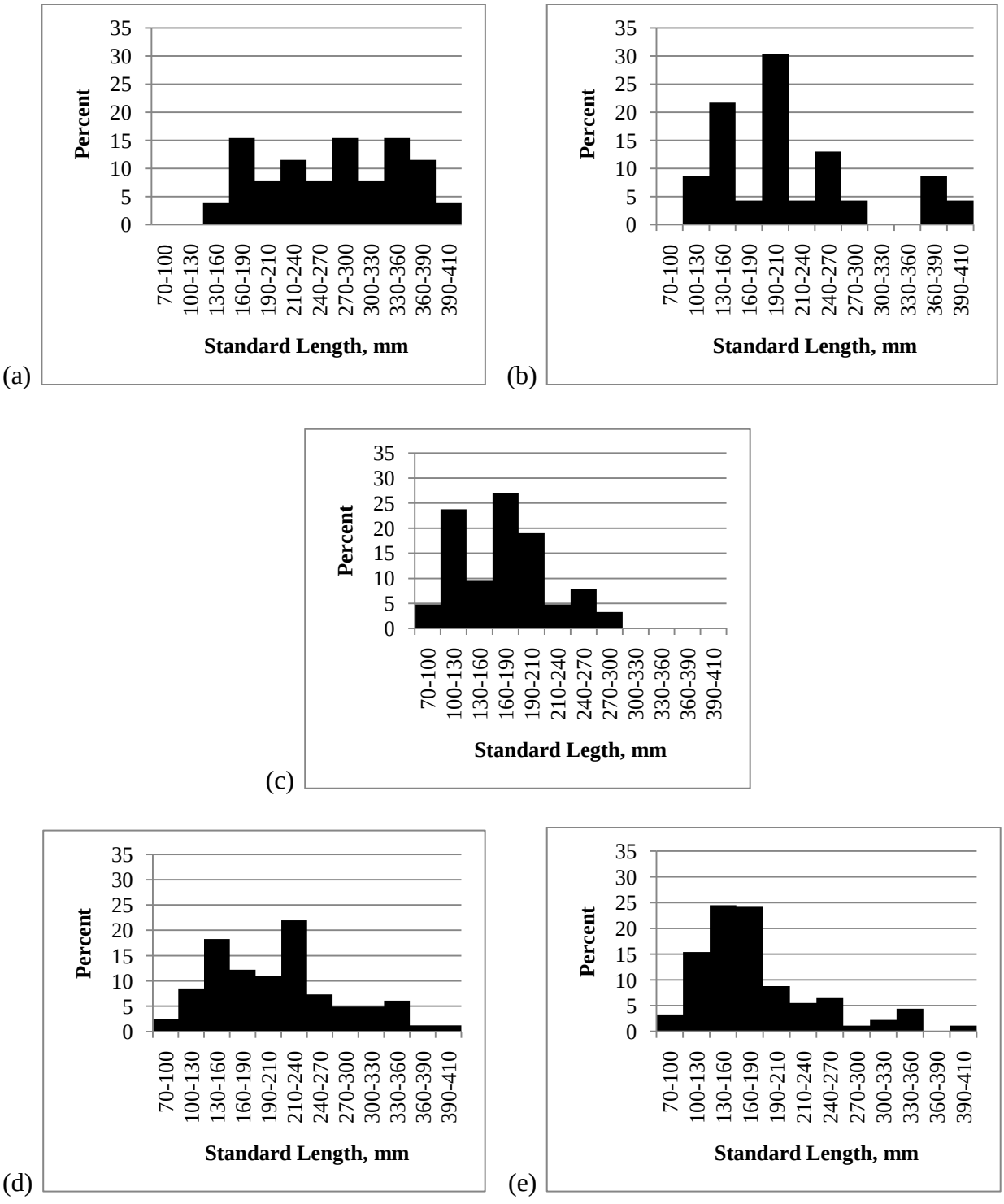


Figure 6.3: Mortality profiles for sea catfishes in the shell ring collections, (a) Cannon's Point Ring; (b) West Ring; (c) Sapelo, Ring III; (d) St. Catherines Shell Ring; (e) McQueen Shell Ring.

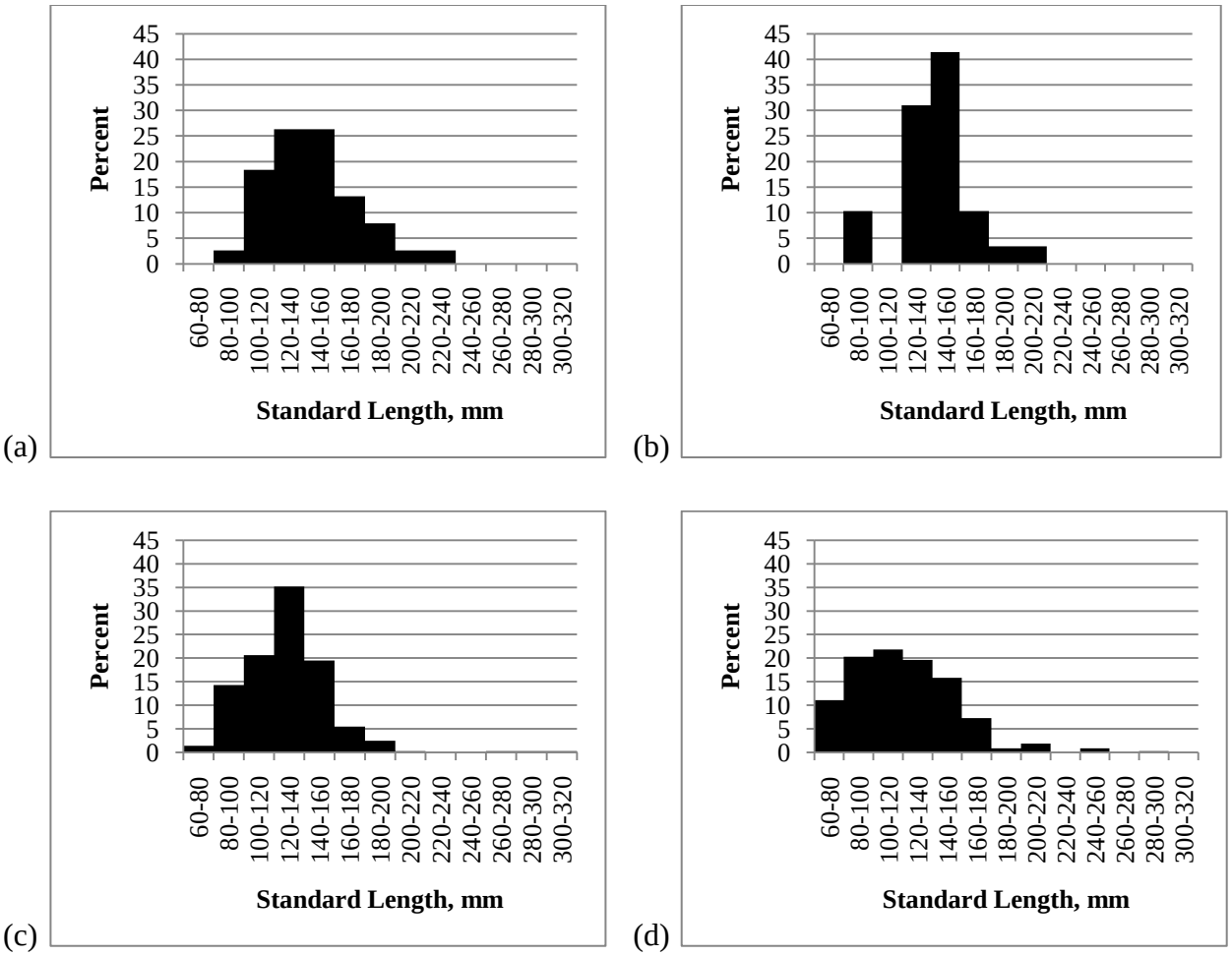


Figure 6.4: Mortality profiles for mullets in the shell ring collections, (a) Cannon's Point Ring; (b) West Ring; (c) St. Catherines Shell Ring; (d) McQueen Shell Ring.

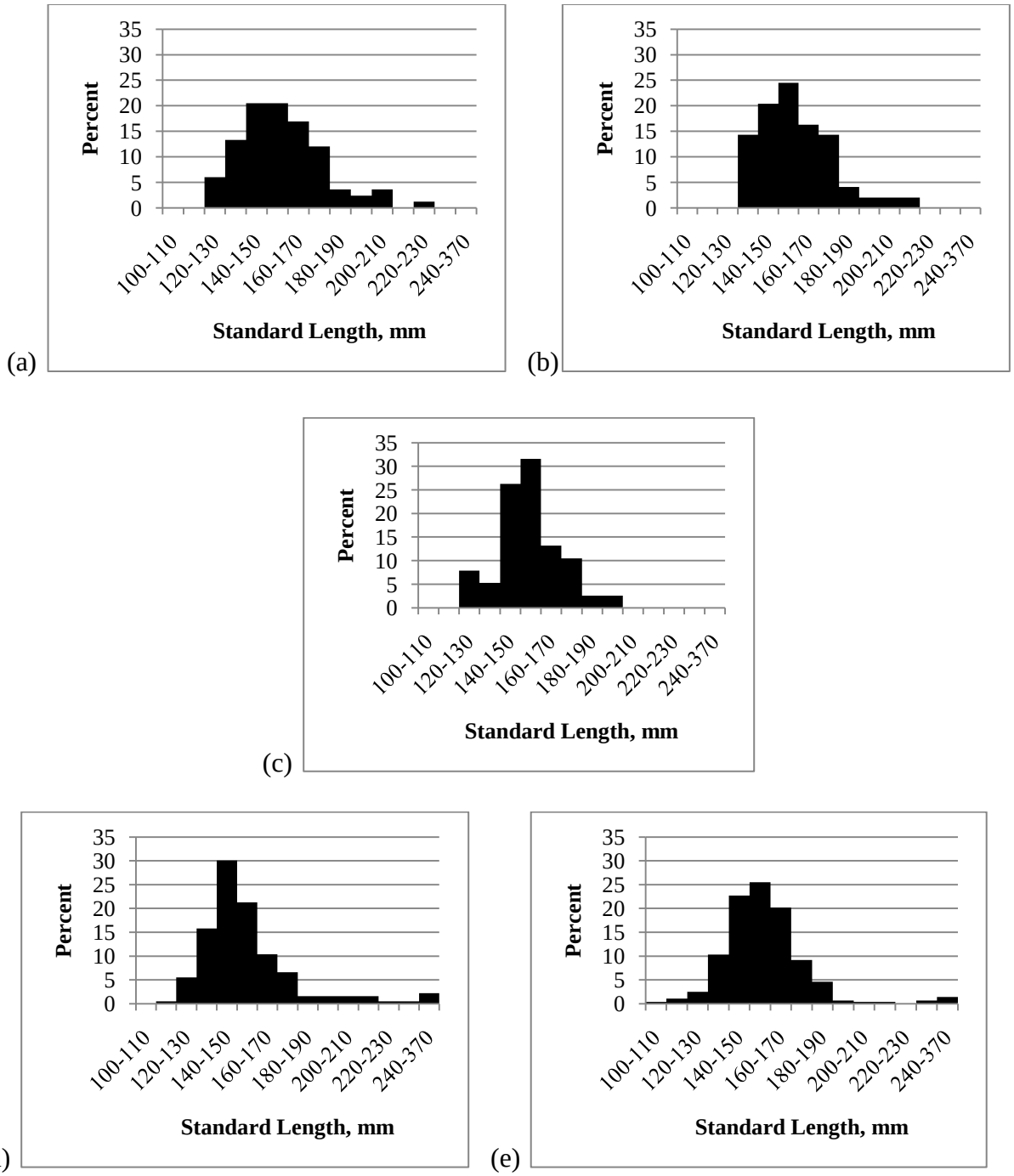


Figure 6.5: Mortality profiles for drums in the shell ring collections, (a) Cannon's Point Ring; (b) West Ring; (c) Sapelo, Ring III; (d) St. Catherines Shell Ring; (e) McQueen Shell Ring.

TABLE 6.1

Late Archaic Shell Rings: Relative Abundance Fish Summary Table

	Cannon's Point Ring		West Ring		Sapelo Ring III		St. Catherines Ring		McQueen Ring	
	MNI	Biomass	MNI	Biomass	MNI	Biomass	MNI	Biomass	MNI	Biomass
Herrings and shads	12.6	3.4	12.8	5.6	0.6	0.0	1.2	1.2	1.3	0.5
Sea catfishes	11.9	49.0	11.9	36.6	39.2	79.9	8.1	44.5	10.1	42.0
Mullets	24.8	7.5	12.8	10.0	2.8	2.1	50.0	18.1	39.2	17.3
Drums	43.7	15.3	59.6	31.9	49.4	15.6	28.7	22.3	43.5	28.3
Freshwater fishes	0.9	1.8	0.4	2.7	—	—	2.4	5.6	0.4	0.3
Other fishes	6.0	23.0	2.6	13.2	8.0	2.4	9.5	8.4	5.6	11.6

TABLE 6.2

Late Archaic Shell Rings: Sea Catfishes, Mullets, and Drums Size Data (mm)

	Cannon's Point	West	Sapelo Ring III	St. Catherines	McQueen
Sea catfishes					
Mean	271.9	213.4	169.9	207.8	179.0
Range	143.3-395.9	117.0-398.1	76.8-287.7	92.9-381.8	79.0-387.9
Standard deviation	75.1	80.8	48.7	70.4	65.4
N	26	23	63	82	91
Mullets					
Mean	146.2	142.4	—	128.3	120.8
Range	96.8-234.9	86.2-215.3	—	73.2-304.4	68.9-287.4
Standard deviation	30.7	25.8	—	28.0	34.9
N	38	29	—	364	316
Drums					
Mean	157.1	159.3	154.3	156.8	157.8
Range	125.1-220.2	135.0-213.6	124.7-195.8	112.9-370.3	106.8-323.8
Standard deviation	19.8	17.9	15.4	33.6	22.3
N	83	49	38	183	282

CHAPTER 7:

A COMPARISON OF VERTEBRATE FAUNA FROM DIFFERENT AREAS OF THE ST. CATHERINES SHELL RING

The previous two chapters demonstrate that similar vertebrate remains are recovered from all five shell rings. The archaeofaunal collections suggest that small-bodied, estuarine fishes that form schools or aggregates were used heavily. Deer and other vertebrates supplemented the diet to varying degrees. This chapter presents an intrasite comparison of the horizontal distribution of faunal remains from a single shell ring: the St. Catherines Shell Ring. An intrasite comparison of vertebrate remains has not been conducted at any shell ring, thus it is not unknown whether there are patterns in the horizontal distribution of fauna from different areas of these sites and what such patterns might represent if they exist. The collections from the St. Catherines Shell Ring are used in this analysis because multiple contexts were sampled and studied using identical methods. Three areas within the ring of the St. Catherines Shell Ring and one area from the interior of the ring are compared to identify patterns in the horizontal distribution of vertebrate faunal remains. The three areas of the St. Catherines Shell Ring are the North, East, and West Areas. When the North, East, and West Areas are referenced together, they are referred to as the Ring Areas. The interior of the ring is represented by two features, 5 and 23. These two features are grouped together to form a contrast with behavior that resulted in the deposition of the ring itself. The features have similar dimensions and visually similar densities of shell (shell from these features have not been quantified), although the function of

these features is unknown (Sanger and Thomas 2010:59). The archaeofaunal assemblage from the features is referred to as the Interior Area (Figure 3.4; Table 7.1).

Intrasite Analysis at Shell Rings

The spatial relations of animal remains reflect former site formation processes and non-human processes within archaeological sites (Simek 1984). This extends to the shell rings of the Georgia coast; however, the spatial patterning of animal remains and other material culture usually is ignored, with the exception of a study of ceramic sherds conducted at Ring III of the Sapelo Island Shell Ring complex (Thompson 2007).

Thompson (2007) examined the spatial relationship between ceramic sherds and shell densities within Ring III. Based on this analysis, Thompson (2007) suggests that different portions of the ring itself were associated with different activities. For example, portions of the ring composed of high-density shell deposits consistently have lower ceramic densities while portions of the ring with low-density shell deposits have higher concentrations of ceramic sherds (Thompson 2007). This spatial patterning suggests that high-density shell deposits within the ring resulted from secondary refuse associated with shellfish processing and/or disposal. Thompson (2007) further suggests that low-density shell areas resulted from the primary deposition of household refuse. From this spatial relationship, Thompson (2007) concludes that houses within Ring III created low-density shell areas as house floors were kept relatively clear of debris and high-shell density areas were shellfish processing locations and trash middens adjacent to these houses.

A similar spatial analysis can be conducted at the St. Catherines Shell Ring using the vertebrate collections to define activities areas. Shell density appears similar throughout the excavated areas of the ring, although shell density has not been quantified. Nonetheless,

vertebrate fauna from the excavated areas may represent different activity areas or households. By comparing the archaeofaunal collections from within the St. Catherines Shell Ring and comparing the Ring Area collections with the Interior Area collection, different activities associated with animal use at the St. Catherines Shell Ring may be defined.

Measures of Analysis

Six measures are selected to compare the collections from the Ring Area and the Interior Area. These include: (1) the relative abundance of animal classes, (2) diversity, richness, and equitability of individuals, (3) mean trophic level of marine individuals, (4) the relative abundance of large-bodied versus small-bodied fishes, (5) the relative abundance of individual- versus mass-captured fishes, and (6) the mean standard length of sea catfishes, mullets, and drums. Allometric formulae, included in Appendix F, are used to calculate the standard length of fishes from the width of sea catfish otoliths and the width of the anterior centrum of mullet and drum atlases. For this analysis, all complete sea catfish otoliths, including both rights and lefts, are used. This step is necessary to generate larger sample sizes, but the standard length of one catfish may be included twice in the calculation of mean.

Differences in the archaeofaunal collections from the Ring Area and the Interior Area of the St. Catherines Shell Ring are observed by comparing these six measures. These differences may be the result of site formation processes associated with human behavior or non-human processes.

Results of the Intrasite Comparison

Relative Abundance of Classes

The relative abundance of animal classes from the North, East, and West Areas is very similar. All three collections are dominated by fish individuals, as fishes contribute at least 84

percent to the individuals from each portion of the Ring Area (Table 7.2). The archaeofaunal collection from the Interior Area is different compared to the Ring Area. Fishes comprise 52 percent of the individuals in the Interior Area collection (Table 7.2). The relative abundance of biomass among the animal classes from the North, East, West and Interior Area collections is different. White-tailed deer contributes 50 percent or more of the biomass in the North and West Area collections, while white-tailed deer represents 78 and 81 percent of biomass from the East and Interior Areas, respectively (Table 7.2). The similarity between deer contribution in samples from the North and West Areas suggests that similar processes related to animal use took place in both areas. The deer biomass contribution in the East and Interior collections suggests that different formation processes related to animal use occurred in the East and Interior Areas compared to the North and West Areas.

Diversity, Equitability, and Richness

Diversity, equitability, and richness for the North and West Areas are very similar (Figure 7.1). The North and West Area collections are moderately diverse, moderately equitable, and rich. The East Area collection is more diverse, more equitable, and less rich. Collections from the Ring Area are markedly different from the Interior collection. The diversity and equitability of the Interior collection indicate a very diverse collection with equitable distribution among these taxa. The Interior Area collection is less rich compared to the other collections. These data clearly distinguish between the Interior Area and the Ring Area, suggesting that the archaeofaunal collection from the Interior represents different formation processes compared to the Ring Area.

Relative Abundance of Small-bodied, Mass-captured, and Mean Trophic Level of Fishes

The relative abundance of small-bodied fishes within the Ring Area is very similar and distinctive from that in the Interior Area (Figure 7.2). In the Ring Area collections, the percentage of small-bodied individuals is high compared to that in the Interior Area collection. The relative abundance of mass-captured fishes displays the same pattern as the small-bodied fishes. Mass-captured fishes comprise the vast majority of fishes in the Ring Area collections whereas only about half of the fishes in the Interior Area collection are characterized as mass-captured fishes. The mean trophic levels also are different between the Ring Area and the Interior Area collections. The Interior Area collection has the highest mean trophic value of all these collections. These data suggest that the Interior Area collection is different compared to the Ring Area and that different formation processes related to fishes occurred in the Ring Area and the Interior Area.

Average Standard Length of Sea Catfishes, Mullets, and Drums

There are few differences in the mean standard length of individuals within each family from the Ring Area (Figure 7.3). The mean standard length of sea catfishes ranges from 192.7 to 214.3 mm, with a difference in the means of less than 22 mm (Table 7.3). The mean standard length of mullets ranges from 123.5 to 128.5 mm; the difference in means is less than 6 mm. The mean standard length for drums ranges from 153.6 to 157.7 mm. The difference in the means is very small, less than 5 mm. The comparison of fish mean standard lengths from the North, East, and West Area collections indicates no noteworthy difference in the mean size of fishes within each family from the Ring Area. Unfortunately, there are too few measurable elements from the Interior Area collection to make a meaningful comparison with the Ring Area (Table 7.3). Of the five specimens that were measurable in the Interior Area collection, the mean standard length for

sea catfishes and mullets is greater than the other three areas (measurable drum atlases were not recovered from the Interior), but all reconstructed standard lengths fall within the ranges from the Ring Area collections. These data suggest that formation processes related to fishes were similar within the Ring Area.

Summary

In most cases, the vertebrate data from within Ring Area are very similar and contrast with the vertebrate data from the Interior Area. Diversity, equitability, richness, the relative abundance of small-bodied and mass-captured fishes, and the mean trophic level of marine organisms are similar among the Ring Area collections, but the Interior Area collection is markedly different by comparison. The mean standard length of fishes from the sea catfish, mullet, and drum families are similar among the North, West, and East Areas of the ring. The relative abundance of animal classes is slightly different among the Ring Area collections. For the North and West Area collections, the relative abundance of animal classes is similar, while the East and Interior Area collections differ in the relative abundance of animal classes compared to the North and West Areas.

Overall, these data suggest that formation processes were similar throughout the ring. The archaeofaunal collections from the Ring Area and the Interior Area are markedly different in all measures. This suggests that the processes that formed the ring were different from the processes that produced the features within the interior of the ring. The processes that led to the formation of the St. Catherines Shell Ring and the features within the ring are unknown at this time.

Implications

The goal of this analysis is to identify activity areas by noting similarities and differences in the vertebrate animal remains from different portions of the ring and in the interior of the ring.

There are few differences in the animal remains within the Ring Area and the archaeofaunal collections from the ring are noticeably different from the collection recovered from the Interior Area features. This observation has several implications for current models of shell ring function and formation.

Thompson's (2007) analysis of Ring III of the Sapelo Island Shell Ring complex suggested that areas of Ring III were associated with two types of human activity: (1) house occupational areas and (2) processing/disposal areas. He further suggests that the interior portion of Ring III was used primarily for secular activities as evidenced by numerous features, as well as the high density of ceramic and lithic artifacts (Thompson 2007). The observation that the Ring Area of the St. Catherines Shell Ring is similar to each other in several zooarchaeological measures suggests similar formation processes produced the Ring Area. This does not support the model Thompson (2007) proposed for Ring III. However, Thompson (2007, 2010) and others suggest that the type of occupation and the functional purpose of places can change through time (Binford 1982). Thompson's model, in which shell rings change function through time, is referred to as the developmental model (Thompson 2007). If the developmental model is applied to Ring III and the St. Catherines Shell Ring, it appears that these two rings were in different stages of development when each was abandoned.

If the St. Catherines Shell Ring is viewed as a village with associated middens, the fact that the Ring Area collections are similar has several implications. As others have documented, social hierarchy within a population may result in distinctions among faunal deposits within an archaeological site (Jackson and Scott 1995, 2003; Kelly 2001; VanDerwarker 1999). Elite members of society may consume different food types compared to non-elite members. In fact, social inequality among Late Archaic populations is proposed as a factor in the formation of

shell rings. Russo (2004) argues that the large and small shell piles forming shell rings are associated with individuals or groups. The largest piles of shell were formed by individuals or groups with the greatest social power and the ability to obtain the greatest quantity of food, while the smaller piles were formed by individuals or groups with less prestigious social standing.

If Russo's (2004) model is applied to the vertebrate fauna from the St. Catherines Shell Ring, evidence for social inequality is doubtful. The similarities observed in the spatial distribution of animal remains within the St. Catherines Shell Ring imply that groups and individuals living here had similar access to resources, technologies, and processing methods.

It is possible that social inequalities are not detectable by examining vertebrate remains alone and other aspects of the archaeological record, including invertebrate fauna, should be investigated. Furthermore, different scales of analysis may yield different results. It may be that the resolution used here is too large to detect spatial patterning and finer resolution is needed to detect faunal concentrations associated with particular groups or activities (Enloe et al. 1994). The vertical stratigraphic distribution of animal remains also may reveal spatial patterning associated with ring activities, formation, and use over time.

Limitations

When comparing archaeofaunal collections, several factors bias the results. Sample size is particularly important. The sample sizes within the Ring Area and between the Ring Area and the Interior Area differ greatly (Table 7.1). All secondary measures derived from these samples are dependent on the size of the sample (Grayson 1984; Lyman and Ames 2007; Reitz and Wing 2008:113-114). When secondary measures are derived from a population that is not adequately sampled, these secondary measures may be distorted. Such distortion could be responsible for the observed differences in the collections from the Ring Area and the Interior Area collections

(Figure 7.4). This issue could be resolved with more zooarchaeological identifications from the interior of the ring.

The differences between the Ring Area and the Interior Area collections may be the result of abiotic processes. The soil conditions, specifically the acidity or alkalinity of soil, measured as pH, can explain differences between the Ring Area and Interior Area collections. Soils that are highly acidic or alkaline dissolve bone minerals, causing the bone to decay (Gordon and Buikstra 1981; Reitz and Wing 2008:141). Bone preservation is best in slightly alkaline conditions. Mollusc shells provide this slight increase in soil pH levels, creating the ideal pH levels for bone preservation (Stiner et al. 2001). The Ring Area collections of this study are from matrices composed largely of mollusc shells, which create excellent conditions for bone preservation. The Interior Area features also include mollusc shells, although to a lesser extent compared to the matrices of the Ring Areas. The varied amounts of molluscs shell from the Ring Area and the Interior Area may result in different pH levels of the soils, causing differential bone preservation. Particularly, in soils lacking shell, elements that are the least-calcified would be destroyed first and denser remains would preserve better (Reitz and Wing 2008:141). This pattern of preservation is observed in the Ring and Interior Areas. A higher percentage of mammal individuals (dense bone) are present in the Interior Area collections compared to the Ring Area collections, while fish individuals are less abundant in the Interior Area collection (Table 7.3). At this time, soil pH cannot be discounted as an explanation for the differences between the Ring and Interior Area collections.

Other natural and human forces that move archaeological remains within and beyond a site should also be considered when examining spatial distribution (Yellen 1996). Animal remains are subject to a number of biotic and abiotic disturbances that may distort the original

temporal and spatial placement of the remains (Fowler et al. 2004; Marean and Bertino 1994). Such processes are dependent on the type of deposit, the condition in which the animal remains were deposited, the biological and geological conditions surrounding the sites, as well as anthropogenic changes, such as site reoccupation (Bamforth et al. 2005:572; Schiffer 1972; Wood and Johnson 1978). It is expected that some movement of all specimens after discard or deposition occurred, although the degree of movement is unknown.

Further analysis at the St. Catherines Shell Ring is needed to understand how these similarities extend to other facets of the archaeological assemblage such as invertebrate remains, lithics, ceramics, the spatial distribution of stratigraphy and other features, and radiocarbon dates. These components of the archaeological assemblage have implications for assessing the activities that occurred at the St. Catherines Shell Ring although such an analysis requires detailed analysis of all aspects of the site including the material culture and stratigraphic analyses, which are not yet completed.

Summary and Conclusions

The archaeofaunal comparison of the North, East, and West Areas and the Interior Area of the St. Catherines Shell Ring suggest uniformity within the Ring Area, while the Interior Area collection differs from the Ring Area collections. From these results, it is inferred that the site formation processes that created the ring were similar in the three portions of the Ring Area. If the ring is interpreted as a village, as others suggest (Thompson 2006, 2007; Trinkley 1985; Waring and Larson 1968:273), the uniformity in the horizontal distribution of animal remains indicates that individuals and groups occupying the ring itself had similar access to hunting and fishing locations, technologies, processing, and disposal methods. When the archaeofaunal collections from the Ring Area are interpreted with regards to models that link ring formation

with social inequalities among the individuals and groups who formed the ring (Russo 2004), marked social inequalities are not reflected in the distribution of animal remains the St. Catherines Shell Ring. These data may suggest that the Late Archaic populations were egalitarian.

The Interior Area of the St. Catherines Shell Ring is zooarchaeologically different from the Ring Area collections. This suggests that the activities related to animal use that formed the Ring Area differ from those activities that occurred within the Interior Area, although these activities are unknown. Taphonomic processes, such bone decay due to soil acidity or alkalinity, may also explain the differences in the Ring Area and Interior Area collections. Further analysis at the St. Catherines Shell Ring is needed to understand how these similarities extend to other facets of the archaeological assemblage such as invertebrate remains, lithics, ceramics, the spatial distribution of features, stratigraphy and the radiocarbon dates (Bamforth et al. 2005).

The analysis presented here confirms that different portions of the ring itself at this site have similar horizontal distribution of vertebrate remains. The results from the vertebrate analysis of the three Ring Area collections may be extrapolated to suggest that fish individuals comprise the majority of vertebrate remains at the St. Catherines Shell Ring. With such large numbers of fish individuals, it is clear that fish populations experienced heavy predation by Late Archaic peoples and that overfishing may have occurred. Evidence for overfishing is examined in Chapter 9; however, before overfishing is examined, patterns of seasonal fishing are studied (Chapter 8).

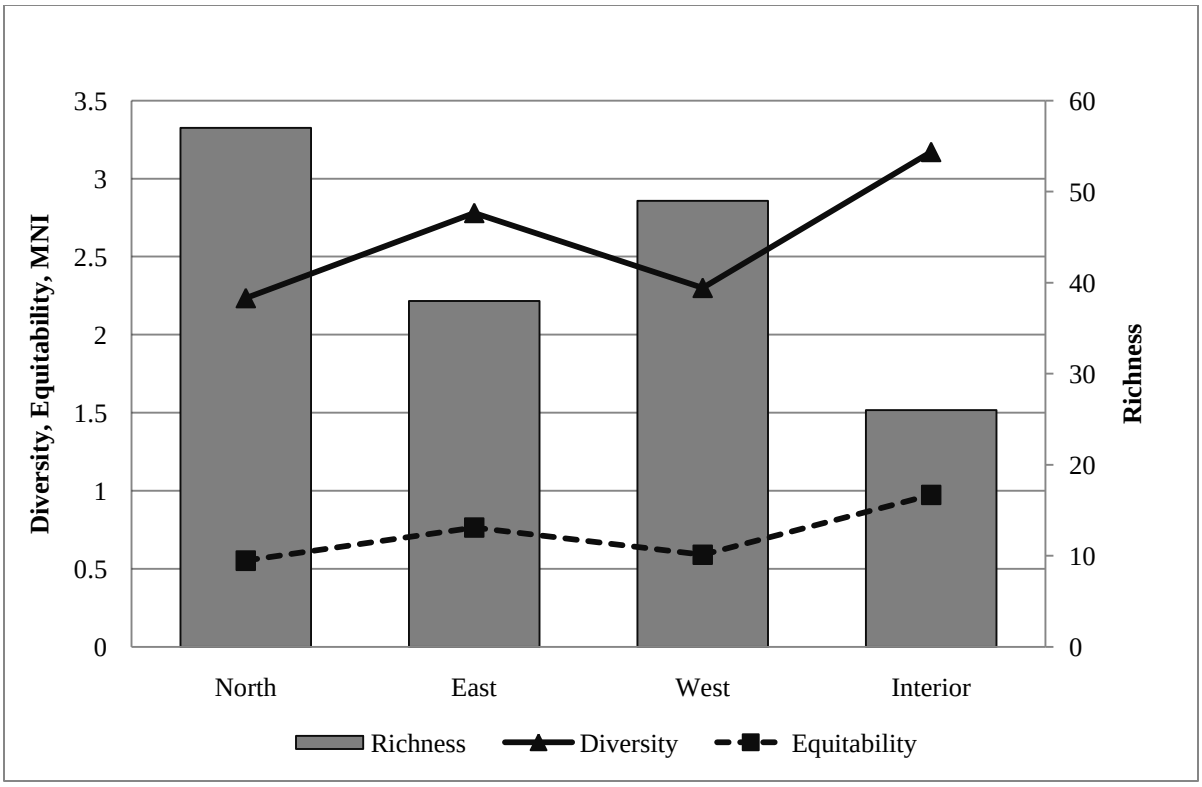


Figure 7.1: Measures of richness, diversity, and equitability for the four areas of the St. Catherines Shell Ring.

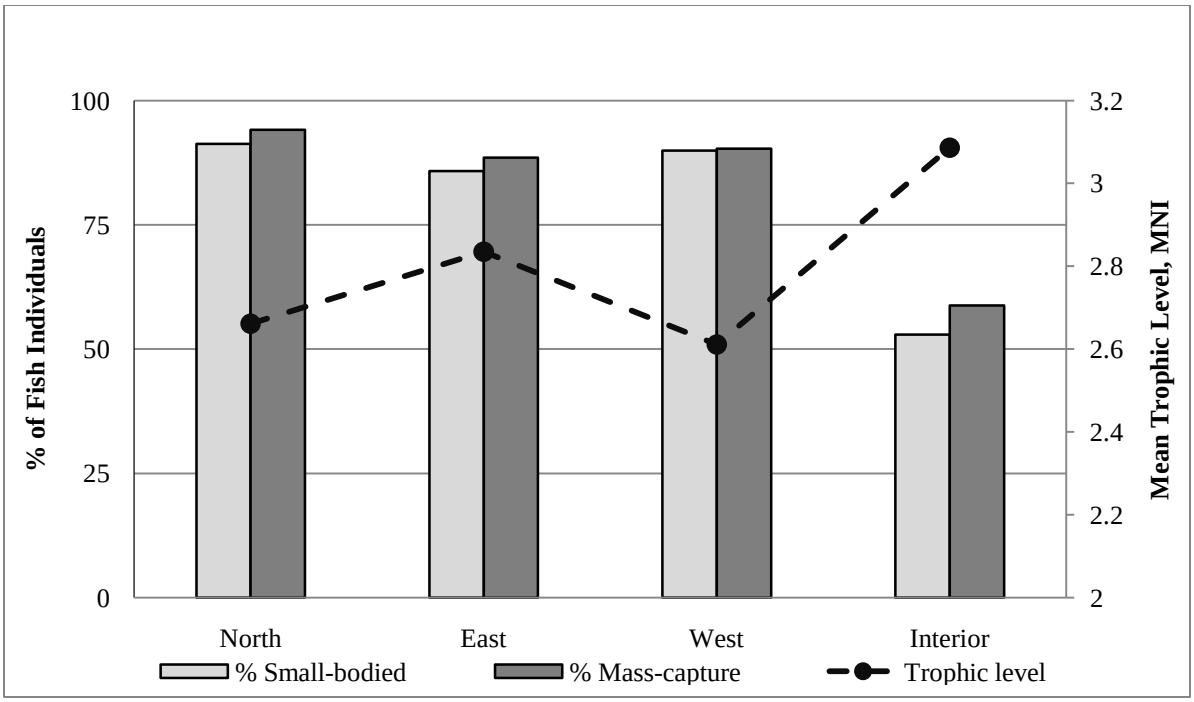


Figure 7.2: Percentage of fish individuals classified as small-bodied, mass-captured, and the mean trophic level for the four areas of the St. Catherines Shell Ring.

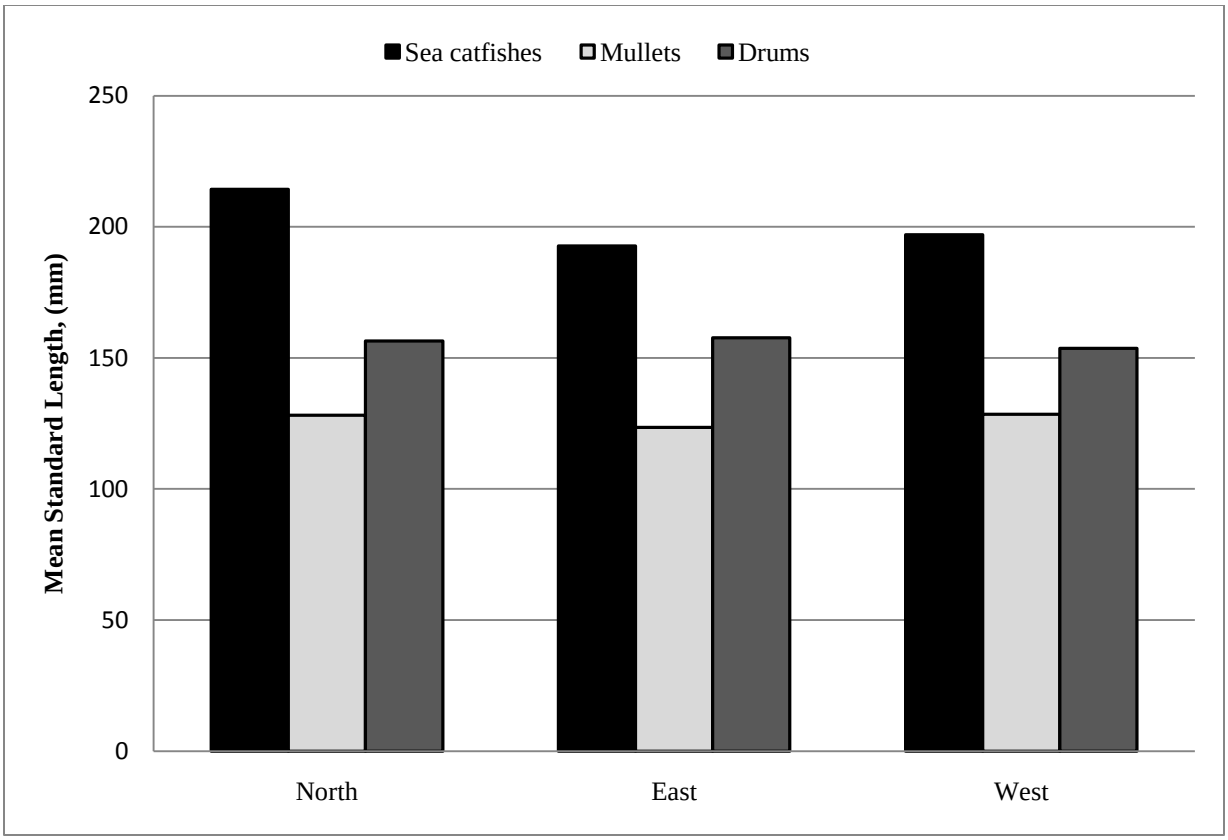


Figure 7.3: Calculated mean standard length (mm) of sea catfishes, mullets, and drums for the four areas of the St. Catherines Shell Ring.

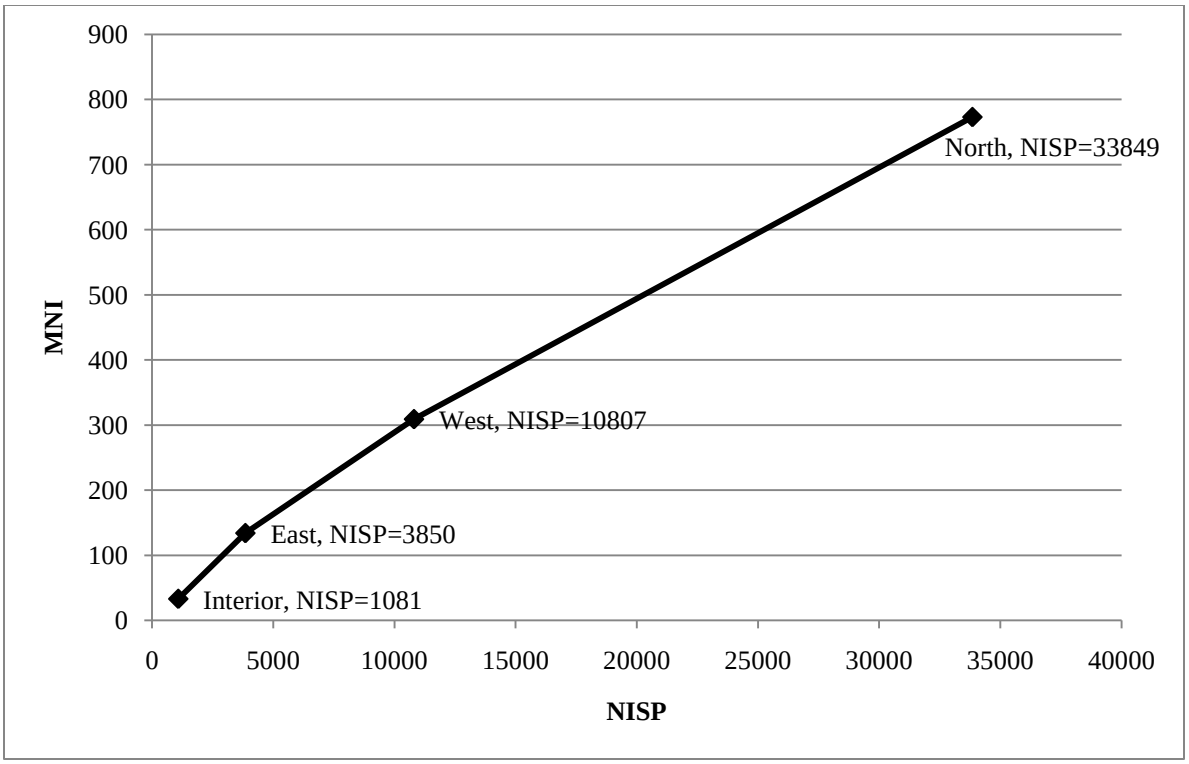


Figure 7.4: The effect of NISP on MNI for the four areas of the St. Catherines Shell Ring.

TABLE 7.1

St. Catherines Shell Ring: Analyzed Areas

Area	Units Included	Excavated Area	NISP	MNI	Number of Taxa
Ring Areas					
North	N779 E801	6.0 m^2	33849	773	57
	N782 E801				
	N784 E797				
	N784 E801				
	N784 E811				
	N789 E801				
East	N771 E819	1.0 m^2	3850	134	38
West	Trench 281 W82 S2	2.0 m^2	10807	309	49
	Trench 281 W84 S2				
Interior Area		1.6 m^2			
	Features 5		1081	33	26
	Feature 23				

TABLE 7.2

St. Catherines Shell Ring Percentages for Ring and Interior Areas

	Ring Areas						Interior Area	
	North		East		West		Interior	
	MNI	Biomass	MNI	Biomass	MNI	Biomass	MNI	Biomass
Fishes	92.4	27.7	84.3	13.8	89.6	25.9	51.5	1.8
Turtles	1.9	6.0	3.7	3.9	2.6	12.0	9.1	3.7
Birds	1.3	0.4	2.2	0.4	1.9	0.7	9.1	2.2
Deer	0.4	57.2	1.5	77.7	0.6	51.0	9.1	80.6
Other mammals	1.2	8.4	4.5	4.2	2.3	9.9	18.2	11.8
Other	2.9	0.5	3.7	0.1	2.9	0.5	3.0	0.0

Note: Other includes snakes and commensal taxa.

TABLE 7.3

St. Catherines Shell Ring: Sea Catfishes, Mullets, and Drums Size Data (mm)

	Ring Areas			Interior Area
	North	East	West	Interior
Sea catfishes				
Mean	214.3	192.7	197.0	231.2
Standard deviation	73.0	61.1	70.6	85.6
N	53	11	17	3
Mullets				
Mean	128.2	123.5	128.5	129.4
Standard deviation	27.4	33.8	26.1	4.4
N	270	26	104	2
Drums				
Mean	156.5	157.7	153.6	—
Standard deviation	38.6	20.8	21.1	—
N	120	21	53	—

CHAPTER 8:

THE LATE ARCHAIC SHELL RINGS AND SEASONAL USE OF HARDHEAD CATFISHES AND ATLANTIC CROAKERS

Understanding seasonal resource use is a central step towards documenting human-environmental interactions and has implications for recognizing evidence for over-predation by human populations and other ecological stressors. For coastal archaeofaunal collections, several taxa are used to determine season of death and by extension, season of occupation (Andrus and Crowe 2000, 2008; Quitmyer et al. 1997). Seasonality studies using incremental banding and oxygen isotopic profiles of clams and oyster were conducted at some of the Late Archaic shell rings. These studies concluded that shell rings were used by some portion of the population during multiple seasons (Marrinan 1975:99; Thompson and Andrus 2011), and, in some instances, throughout the year (Quitmyer et al. 1985; Thomas 2008c:927; Thompson 2006).

These data suggest a model of year-round invertebrate use and multi-season if not actual year-round human activity at most shell rings. Importantly, these data imply a sustained, year-round interaction between humans and marine communities. In addition they provide evidence that human populations impacted hard clams at the Cannon's Point Ring (Quitmyer and Jones 2000). It remains unknown whether humans used vertebrate communities in a similar pattern and what the implications of seasonal use may be for fish populations and estuarine communities. In this chapter, year-round human use of vertebrates is documented for additional shell rings.

This chapter focuses on the seasonal use of two fishes at the Late Archaic shell rings: the hardhead catfish and Atlantic croaker. These two species were selected because they are ubiquitous in the shell ring collections and are common in other archaeofaunal collections throughout coastal areas of the southeastern United States. Two research goals are investigated: (1) the feasibility of using the incremental bands of otoliths as proxies for season of capture is tested and applied to archaeological otoliths from the shell ring collections, and (2) the feasibility of using oxygen isotopic signatures of the terminal increment of fish otoliths as proxies for season of capture is tested and applied to oxygen isotopic signatures of archaeological otoliths. The implications of fishing schedules for overfishing also are reviewed.

Seasonality Studies in Archaeology

Seasonality studies often postulate or presume a "sedentary" versus "mobile" dichotomy. However, humans are quite mobile and categorizing a society as "sedentary" or "mobile" is unrealistic (Bar-Yosef and Rocek 1998). Rather than categorizing the populations of the shell rings as sedentary or mobile, these collections are examined for seasonal resource use of hardhead catfishes and Atlantic croakers. To examine the degree of mobility among shell ring populations, the full range of Late Archaic settlements in the region should be considered, which is not currently possible.

Following Monks (1981:178), seasonality is defined as the time of year when a particular event or activity most likely occurred. The absence of evidence cannot prove that resource use did not occur during other seasons. Additionally, defining a season of resource use does not mean the entire population of the shell ring used these sites during that season or throughout the entire season.

Among archaeofaunal collections, four kinds of animals remains provide direct evidence of seasonality: (1) hard tissue present during a single season, such as antlers in deer, (2) hard tissues that wear down at a known rate, such as tooth wear in mammals, (3) species or age-cohort presence that are available during a particular time of the year, such as migratory fishes, and (4) hard tissues that undergo identifiable structural or chemical changes during specific times of the year, such as incremental growth structures and oxygen isotopic profiles of hard clams and fish otoliths (Morales 1998). Two direct methods can determine the seasonal fishing patterns for otoliths: (1) the physical, visual characteristics of the terminal increment of the otolith can be examined and characterized to determine the season of death, and (2) the ratio of ^{18}O to ^{16}O (expressed as $\delta^{18}O$) of the terminal increment in fish otoliths can characterize the season of death.

Otolith Incremental Banding

Otoliths are $CaCO_2$ structures in the form of aragonite found in the inner ear of teleost fishes (Wootton 1998:111). Otoliths form incremental bands through ontogeny, representing fast and slow periods of growth. Generally, incremental growth correlates with some parameter in the fish's environment (Pannella 1980). For fishes in temperate environments, incremental growth often correlates with seasonal temperature fluctuations (Wheeler and Jones 1989:154-155). For example, in periods of fast growth, during the season of optimum temperatures for the fish, a fast-growth band is formed. In general, translucent, or dark, (under reflected light) formation occurs during spring and summer for fishes living in temperate environments (Beckman and Wilson 1995). Fish generally form an opaque, or light, zone during slow growth when less optimal temperatures are present (Beckman and Wilson 1995). Therefore, if the type of incremental banding (opaque or translucent) is known to occur during specific yearly seasons for

a specific species, the terminal band can be used to infer the season in which the fish was captured (Hales and Reitz 1992; Higham and Horn 2000; Smith 1983).

Although this method was applied successfully to fish species in several regions (Higham and Horn 2000; Smith1983; Van Neer et al. 1999), problems are reported (Surge and Walker 2005; Van Neer et al. 2004; Walker and Surge 2006). Previous researchers using otolith incremental banding found that bands do not always correlate with seasonal temperature fluctuations (Surge and Walker 2005). Others found that the timing of incremental formation is highly variable (Van Neer et al. 2004). Factors such as the fish's habits and habitat preferences; yearly, rather than seasonal, fluctuation in environmental conditions; spawning seasons; food resources; and the age of the fish can cause band formations that do not correlate with seasonal temperature fluctuations (Beckman and Wilson 1995; Van Neer et al. 2004).

To evaluate the usefulness of otolith increments as a proxy for season of capture, modern hardhead catfishes and Atlantic croakers were studied. Further details of the modern otoliths used in this study are presented in Chapter 3 and Appendix H. These same modern otoliths are used in the modern $\delta^{18}O$ presented in this chapter, as well as the study presented in Chapter 9.

Modern Incremental Results

Characterization of the terminal incremental formation for both hardhead catfishes and Atlantic croakers is inconclusive. Twelve modern otoliths from each species (for a total of 24 modern otoliths) were examined.

Hardhead Catfish Terminal Incremental Formation

For the hardhead catfishes, individuals were only captured during five months of the year (May, June, July, August, and September) representing two seasons, spring and summer (Table 8.1). One otolith from a hardhead catfish captured in May has a translucent terminal increment.

The remaining 11 otoliths were all from hardhead catfishes captured during the summer. Of these otoliths, all had terminal increments with translucent terminal bands. These data indicate that all individuals within the sampled population formed the same increment type during the same season of the year. Translucent increments indicate a warm period of growth. Unfortunately, no hardhead catfishes were captured during the formation of an opaque increment. This could mean that opaque formation occurs during the two seasons not represented in the capture data, winter and fall. Without direct proof that opaque formations occur in winter and fall, it is premature to make this interpretation; however, translucent increments do form during warm periods. With this limited data set, the characterization of an edge type may not be a sufficient proxy for season of capture. Further sampling is needed to correlate incremental formation with seasonal temperature fluctuations or other biological parameters.

Atlantic Croaker Terminal Incremental Formation

Season of death for Atlantic croakers in the modern collection includes croakers that died in spring and summer. Fall and winter are not represented in the modern Atlantic croaker collection. The otoliths from the fishes captured in spring contained two otoliths in core information, yielding inconclusive results, and one otolith in translucent formation (Table 8.1). The otoliths from the Atlantic croakers captured in summer had both opaque and translucent terminal increments. One otolith was in opaque formation, four were in translucent formation, and two were in core formation.

These data indicate that translucent increments generally are formed during the spring and summer; however, without direct proof that opaque formations occur in winter and fall, it is impossible to draw this conclusion. Additionally, one fish captured in the summer was in opaque formation. This may mean that some individuals are in opaque formation when others are in

translucent formation. This is documented in other fish species (Van Neer et al. 2004) and could occur in Atlantic croakers. Further sampling is needed to correlate incremental formation and seasonal growth patterns in Atlantic croakers.

Incremental Formation and Archaeological Implications

The modern incremental study yielded inconclusive results, but generally, translucent bands are formed during warmer periods. Presently, data are not available to determine which band type is formed during cool temperatures for hardhead catfishes and Atlantic croakers. With this limitation in the data, the archaeological use of terminal incremental characteristics to determine season of capture cannot be attempted. Obtaining larger sample sizes and individuals from all seasons of the year are needed to explore incremental formation and seasonal periodicity.

$\delta^{18}O_{otolith}$ Fractionation Factors and Estuarine Environments

The use of $\delta^{18}O_{otolith}$ in the terminal increment of fish otoliths has been used to determine season of capture (Hufthammer et al. 2010; Van Neer et al. 1999) and may provide more accurate results compared to the visual characterization of the terminal increment. Fishes precipitate $CaCO_2$ in their otoliths in oxygen isotopic equilibrium with the ambient waters in which the otolith forms (Devereux 1967; Hoefs 1997; Thorrold et al. 1997). $\delta^{18}O_{otolith}$ co-varies with water temperature and $\delta^{18}O_{water}$. Therefore, if $\delta^{18}O_{water}$ can be held constant, $\delta^{18}O_{otolith}$ can be used to determine the temperature of the water in which the fish lived (Andrus and Crowe 2002b; Andrus et al. 2002; Patterson et al. 1993; Thorrold et al. 1997). When $\delta^{18}O_{otolith}$ is plotted through ontogeny, seasonal temperature oscillations should be observed, and the $\delta^{18}O_{otolith}$ samples prior to and at the terminal edge of growth can determine the temperature trends the fish experienced when it was captured.

For estuarine environments, such as those of the Georgia Bight, $\delta^{18}O_{water}$ is not constant. This is because the $\delta^{18}O_{water}$ is altered by salinity. Estuaries are, by definition, areas of partly enclosed water with freshwater and oceanic inputs. In some areas, freshwater inputs are the result of seasonal precipitation and salinity fluctuations can be used to determine season of capture (Kennett and Voorhies 1996). To understand oscillations in $\delta^{18}O_{otolith}$, modern oscillations in $\delta^{18}O_{water}$, temperature, and salinity for the Georgia estuaries is considered.

Water temperatures of the Georgia estuaries (Figure 8.1) generally oscillate over a seasonal range of approximately 20°C (Andrus and Crowe 2008; http://cdmo.baruch.sc.edu/ data from Marsh Landing, Sapelo Island water data year 1996 and 2003). The warmest temperatures occur from June to August, while the coolest temperatures occur from December to February (Andrus and Crowe 2008; http://cdmo.baruch.sc.edu/ data from Marsh Landing, Sapelo Island water data year 2003). Salinity also varies spatially and temporally (Figure 8.2). Monthly average salinity can range between approximately 16‰ to 31‰ (http://cdmo.baruch.sc.edu/ data from Marsh Landing, Sapelo Island water data years 1996 and 2003), although lower salinities are reported (Thompson and Andrus 2011). Unlike temperature oscillations, salinity does not vary seasonally and no regular salinity cycle, apart from daily tidal cycles, is observed (Figure 8.2).

Unpredictable salinity fluctuations make an accurate estimation of temperature using $\delta^{18}O_{otolith}$ problematic. If $\delta^{18}O_{water}$ values can be held constant, $\delta^{18}O_{otolith}$ can be used to estimate temperatures, and with this, the $\delta^{18}O_{otolith}$ of the terminal increment in conjunction with the increment just prior to the terminal increment can be used to establish temperature trends at capture. This is demonstrated using environmental data from Andrus and Crowe (2008) and the Grossman and Ku (1986) aragonite precipitation equation. With recorded temperature, salinity,

and a constant $\delta^{18}O_{water}$ value (the constant $\delta^{18}O_{water}$ is generated from the averaged $\delta^{18}O_{water}$ values measured monthly from Andrus and Crowe [2008]) for the Georgia coast, a model is generated to predict $\delta^{18}O_{otolith}$.

As seen in Figure 8.3, when $\delta^{18}O_{water}$ is held constant, the $\delta^{18}O_{otolith}$ accurately reflects seasonal temperature oscillations. That is, the most enriched $\delta^{18}O_{otolith}$ would precipitate during the coolest months, in winter, while the most depleted $\delta^{18}O_{otolith}$ would precipitate during the warmest months, in summer.

Figure 8.3 demonstrates the ideal circumstances for using $\delta^{18}O_{otolith}$ to estimate season of capture, but this is not what actually occurs in Georgia estuaries. $\delta^{18}O_{water}$ fluctuates due to both seasonal temperature oscillations and erratic salinity fluctuations. Thus, the $\delta^{18}O_{otolith}$ profiles are more complex than Figure 8.3 suggests.

Using actual, monthly measured $\delta^{18}O_{water}$ values, rather than the constant value (Figure 8.3), a model (Figure 8.4) is generated based on Grossman and Ku (1986) (monthly measured $\delta^{18}O_{water}$ values are from Andrus and Crowe [2008]). From Figure 8.4, a semi-sigmoidal pattern in the estimated $\delta^{18}O_{otolith}$ is seen. The estimated $\delta^{18}O_{otolith}$ values are most depleted during the warmest months, while the most enriched values occur during the coldest months. However, salinity complicates the estimated $\delta^{18}O_{otolith}$ values. For example, in October, the estimated temperature is at 22.8°C, while $\delta^{18}O_{water}$ is relatively depleted due to low salinity levels, generating more depleted $\delta^{18}O_{otolith}$ values.

To understand how the estuarine waters of Georgia affect $\delta^{18}O_{otolith}$ of hardhead catfishes and Atlantic croakers, modern fishes of these two species were collected seasonally. These data will determine whether $\delta^{18}O_{otolith}$ accurately tracks seasonal temperature oscillations or if fluctuations in $\delta^{18}O_{water}$, caused by erratic salinity fluctuations, alter $\delta^{18}O_{otolith}$.

$\delta^{18}O$ of Modern Otoliths

Modern Hardhead Catfish Otoliths

When the modern hardhead catfish $\delta^{18}O_{otolith}$ are plotted through ontogeny, oscillations in $\delta^{18}O_{otolith}$ are observed that reflect seasonal temperature oscillation (Figure 8.5; Table 8.2). In 75 percent of the examined otoliths, the terminal and penultimate $\delta^{18}O_{otolith}$ values for hardhead catfishes can establish temperature trends (i.e., seasonal temperature transitions) and the temperature fish experienced at the season of death regardless of the characterization of the terminal band (translucent or opaque). These data can therefore establish the season in which the fish was captured (Table 8.2).

Modern Atlantic Croaker Otoliths

Like the modern hardhead catfish $\delta^{18}O_{otolith}$, the modern Atlantic croaker $\delta^{18}O_{otolith}$ show sigmoidal oscillations in $\delta^{18}O_{otolith}$ when plotted through ontogeny (Figure 8.5; Table 8.3). More of the terminal and penultimate increments of Atlantic croaker $\delta^{18}O_{otolith}$ accurately predicts the season of capture, 83 percent, compared to the terminal and penultimate increments of hardhead catfish $\delta^{18}O_{otolith}$.

$\delta^{18}O$ of Archaeological Otoliths

In most cases (75 percent of modern hardhead catfish otoliths and 83 percent of modern Atlantic croaker otoliths), the modern $\delta^{18}O_{otolith}$ of the terminal and penultimate increment can be used to predict the season in which the fish died. This allows the $\delta^{18}O_{otolith}$ profiles of archaeological specimens to be used to determine the season in which the fish was captured. The archaeological $\delta^{18}O_{otolith}$ sample just before terminal growth and at terminal growth, in addition to $\delta^{18}O_{otolith}$ fluctuations experienced through ontogeny, are used to determine the approximate temperature trends occurring when the fish died. Because little to no temperature difference is

noted between the days of seasonal transitions, for example March 20 (the last day of winter) and March 21 (the first day of spring), seasonal classifications are not used (Figure 8.1). Rather, archaeological $\delta^{18}O_{otolith}$ are used to estimate temperature trends which are classified as: (1) cold, (2) cold/warm transition, (3) warm, and (4) warm/cold transition. If all four temperature trends are represented in the archaeological $\delta^{18}O_{otolith}$ profiles, it is interpreted as evidence that fishing occurred during all four seasons.

The Cannon's Point Shell Ring

Only one of the two otoliths examined from the Cannon's Point Ring yielded conclusive results, FLMNH-EA Acc. No. 01550585 (Table 8.4). This Atlantic croaker otolith indicates that the fish died while temperatures were cold (Figure 8.6). This suggests that fishing by some portion of the population occurred during a cold period at the Cannon's Point Ring.

The West Shell Ring

Eight archaeological otoliths, two hardhead catfish and six Atlantic croakers, were analyzed for $\delta^{18}O_{otolith}$ profiles from the West Ring (Table 8.4). One of the Atlantic croaker otoliths yielded inconclusive results, FLMNH-EA Acc. No. 01610231. One hardhead catfish was captured during warm temperatures (FLMNH-EA Acc. No. 01610161) and one was captured during the warm/cold temperature transition (FLMNH-EA Acc. No. 01610027). Three Atlantic croakers were captured during cold temperatures (FLMNH-EA Acc. No. 01610169, 01610194, and 01610214), one was captured during the cold/warm transition (FLMNH-EA Acc. No. 01610214), and one was captured during the warm/cold transition (FLMNH-EA Acc. No 01610169). These data suggest that fishing by some portion of the population occurred during temperatures that likely represent all four seasons at the West Ring (Figure 8.6).

The St. Catherines Shell Ring

A total of 25 otoliths from the St. Catherines Shell Ring were selected for isotopic analysis (Table 8.4). Of these, 16 are hardhead catfish otoliths and nine are Atlantic croaker otoliths. Sixteen of the archaeological otoliths yielded results of temperature trends at the death of the individual. One $\delta^{18}O_{otolith}$ from a hardhead catfish indicates that the fish was captured during cold temperatures (GMNH Acc. No. 02381373), four hardhead catfish otoliths (GMNH Acc. No. 02380115, two otoliths from 02380118 and 02381373) were captured during the cold/warm transition, and two were captured during the warm/cold transition (two otoliths from GMNH Acc. No. 02381373). The $\delta^{18}O_{otolith}$ from the archaeological Atlantic croakers (Figure 8.6) indicate that one individual was captured during cold temperatures (GMNH Acc. No. 02381348), two were captured during the cold/warm transition (GMNH Acc. No. 02381477 and 02381554), four were captured during warm temperatures (GMNH Acc. No. two from 02381444, 02380999, and 02381886), and two were captured during the warm/cold transition (GMNH Acc. No. 02381203 and 02381516). These data suggest that fishing by some portion of the human population occurred during all four seasons at the St. Catherines Shell Ring.

The McQueen Shell Ring

Seven otoliths, two hardhead catfish and five Atlantic croaker, were analyzed for $\delta^{18}O_{otolith}$ profiles from the McQueen Shell Ring assemblage. All of the archaeological otoliths yielded results regarding temperature trends at the death of the individual (Table 8.4). One hardhead catfish was capture during the cold/warm temperature transition (GMNH Acc. No. 02420216), while the other was captured during the warm/cold temperature transition (GMNH Acc. No. 02420047). Of the five archaeological Atlantic croaker otoliths from the McQueen Shell Ring, two were captured during cold temperatures (GMNH Acc. No. 02420227 and

02420261), two were captured during the cold/warm transition (GMNH Acc. No. 02420057 and 02420100), and one was captured during warm temperatures (GMNH Acc. No. 02420187). These data indicate that fishing by some portion of the population occurred during all four seasons at the McQueen Shell Ring.

Summary

The $\delta^{18}O_{otolith}$ profiles of the archaeological specimens indicate that fishing occurred during sea temperatures characteristic of all four seasons at the West, McQueen, and St. Catherines Shell Rings. For the Cannon's Point Ring, the limited sample of one otolith prevents interpretations of seasonal fishing behaviors.

$\delta^{18}O_{otolith}$, Estuarine Environments, and Archaeological Implications

The Modern $\delta^{18}O_{otolith}$: The Problems

In most cases, the modern $\delta^{18}O_{otolith}$ accurately determined the season in which the fish died; however, problems with the modern $\delta^{18}O_{otolith}$ seasonal estimations are observed and explanations of these problems are needed.

Shackleton (1973) outlined six requirements that must be met for the successful archaeological application of $\delta^{18}O_{carbonate}$ to determine season of capture. Fishes, particularly estuarine fishes, do meet some of Shackleton's requirements, but not all are met. This may explain why some of the modern $\delta^{18}O_{otolith}$ did not accurately record the season of capture.

Shackleton notes that the isotopic composition of the water in which the animal lived must remain constant. If $\delta^{18}O_{water}$ does not remain constant, $\delta^{18}O_{otolith}$ will co-vary with both $\delta^{18}O_{water}$ and temperature (Shackleton 1973:134, requirement b). The $\delta^{18}O_{water}$ in which hardhead catfishes and Atlantic croakers live does not remain constant independent of temperature. To adequately characterize seasonal fishing of this region, this requirement should be overcome, but

cannot be because the Georgia coast is an extensive estuarine system. The zooarchaeological record of the Georgia coast indicates that estuarine fishes, living in waters with $\delta^{18}O$ fluctuations due to temperature and salinity, were an important component of the diet (Reitz et al. 2009, 2010:54-57). Fishing efforts focused exclusively on estuarine fishes, while fishes from other habitats, such as offshore areas with more stable $\delta^{18}O_{water}$ values, were not exploited. It is possible that a more comprehensive environmental understanding of Georgia estuaries can generate better $\delta^{18}O_{otolith}$ models in relation to temperature, salinity, and $\delta^{18}O_{water}$ (see Andrus and Crowe 2008; Culleton et al. 2009; Patterson et al. 1993; Surge and Walker 2005; Thorrold et al. 1997; Walker and Surge 2006). At present, monthly water samples, in addition to water temperature data, are being collected and $\delta^{18}O$ analysis will be conducted on these samples. These data may help resolve this issue, but further work is needed.

Fluctuations in $\delta^{18}O_{water}$ are confounded by the fact that fishes are mobile animals. Both hardhead catfishes and Atlantic croakers move within and beyond estuaries (Dahlberg 1972; Hare and Able 2007; Muncy and Wingo 1983). Fish movement complicates documenting environmental oscillations within Georgia estuaries. Each individual fish may experience different environmental parameters as it moves from one location to another. Alternatively, these species may have a specific set of preferred environmental conditions, including temperature and salinity, within which the fish moves. Perhaps, as temperatures in one location become marginal, the fish moves to a different location with more desirable environmental parameters. This behavior, known as thermoregulatory movement, is documented in other fish species and could be characteristic of these two species (Jones and Campana 2009). If hardhead catfishes and Atlantic croakers have thermoregulatory movements, the full temperature range of Georgia estuarine waters may not be recorded in $\delta^{18}O_{otolith}$. Developing better models to predict $\delta^{18}O_{otolith}$

through further study of $\delta^{18}O_{water}$, temperature, and salinity may resolve some of the confounding factors of temperature and salinity on $\delta^{18}O_{water}$, but seasonal temperature oscillations will be difficult to detect if hardhead catfishes and Atlantic croakers engage in thermoregulatory movement.

The second requirement established by Shackleton (1973:134, requirement d) that may be violated is that otolith formation may not occur throughout the year. Stops in otolith growth are reported in other fish species (Fowler 1995) and could occur in hardhead catfishes and Atlantic croakers. This is particularly true for hardhead catfishes. The males of this species house their eggs and young in their mouth for approximately 60 to 80 days after reproduction (Dahlberg 1972). Oral gestation occurs during the late spring through early fall (Gunter 1947; Lee 1937; Ward 1957). During this period, males stop eating and somatic growth may not occur. Otolith growth cessation is further suggested by the fact that only one (9 percent) of the archaeological hardhead catfish otoliths indicated that the fish was captured during warm temperatures. This is surprising because hardhead catfish are most abundant in Georgia estuaries during warm months (Dahlberg 1972) and modern hardhead catfish $\delta^{18}O_{otolith}$ generally indicate formation does occur during the warmer months. Additional modern sampling of both males and females, in known states of reproduction, is required to fully understand the consequences of reproduction on somatic growth and otolith formation.

Thirdly, Shackleton (1973:134-135, requirement e) notes that growth rates of the carbonate structure must be large enough to sample isolated increments covering no more than a few weeks of growth. This requirement was clearly not met in some of the archaeological otoliths, particularly those from older fishes. The effect of growth increments that cover no more than a few weeks is seen in FLMNH-EA Acc. No. 01610231 (Figure 8.7). According to the

number of increments, this individual was 18.5 years of age at death and formed 1.07 mm of non-core otolith (from the terminal edge of the otolith to the outer edge of the core). Assuming an average rate of growth over the 17.5 years of non-core growth, only 0.06 mm of otolith growth occurred per year, or 0.01 mm every three months or per season. Isotopic drilling paths for both modern and archaeological otoliths were placed between 0.1 and 0.2 mm apart. With so little growth occurring each season in older individuals, determining season of capture is difficult. Because fishes generally grow most rapidly during their first few years of life (Wootton 1998:116), otoliths from younger individuals should provide higher-resolution trends in the temperature oscillations experienced by the fish.

Overall the results from the modern $\delta^{18}O_{otolith}$ indicate that oscillations in $\delta^{18}O_{otolith}$ can be used to estimate temperature trends experienced by the fish just prior to and at the time of capture. Further research is needed to understand the environmental oscillations, particularly the correlation between temperature, salinity, and $\delta^{18}O_{water}$ of the Georgia estuaries, and the biological and environmental factors that affect otolith growth in these two species.

Archaeological Implications

Clam and oyster incremental formation and $\delta^{18}O$ profiles analyses were conducted at several Late Archaic shell rings, including several of the shell rings included in the vertebrate study (O'Brien and Thomas 2008; Quitmyer et al. 1985; Thompson and Andrus 2011). These studies concluded that shellfish harvesting took place during multiple seasons by human populations occupying the shell rings (Marrinan 1975:99; Thompson and Andrus 2011), and in some instances, throughout the year (Quitmyer et al. 1985; Thomas 2008c:927; Thompson 2006; Thompson and Andrus 2011). These data suggest a model of year-round shellfish harvesting at most shell rings, although not all. Thompson and Andrus (2011) only found evidence of fall and

winter shellfishing using multiple clams and oysters from Ring I of the Sapelo Island Shell Ring complex.

The archaeological $\delta^{18}O_{otolith}$ also suggests year-round fishing. At shell rings where several otoliths were sampled, the $\delta^{18}O_{otolith}$ profiles just prior to and at the time of capture indicate that fishes were caught during multiple temperature regimes: cold, cold/warm transition, warm, and warm/cold transition (Table 8.4). The multiple temperature regimes identified at the West, McQueen, and St. Catherines Shell Rings suggest that people fished the Georgia estuaries during multiple seasons. This is not surprising given our current understanding of shell rings and the multi-season harvesting of shellfishes. Additionally, researchers working in other coastal areas have documented a similar pattern of year-round resource use by archaeological populations (Keene 2004; Orr 2007; Russo 1998; Yesner 1980).

Although a pattern of year-round fishing is defined for the West, McQueen, and St. Catherines Shell Rings, this does not mean that everyone associated with each ring lived there throughout the year. Segments of the population could be absent partaking in other activities elsewhere. Such seasonal patterns of movement by only segments of a population are documented among modern hunter-gatherer populations, but would be difficult to document archaeologically (Kelly et al. 2005; Meehan 1982:31-41). Additionally, temperature regimes at the time of capture represent a discrete time interval during a period of three to four months. The extent to which people occupied the shell rings or moved to other locations throughout one season cannot be determined using archaeological $\delta^{18}O_{otolith}$ profiles. It is possible that people only deposited fish remains at the shell rings for a day, week, or month out of the three to four month period that can be defined using archaeological $\delta^{18}O_{otolith}$. However, given the large quantity of faunal remains and the depth of the deposits at these sites, an extended, year-round

occupation is possible, if not probable. With this sustained fishing strategy, fish populations were likely impacted.

Zooarchaeologists often equate seasonal migratory habits of animals with seasonal occupation of sites (Morales 1998; Russo 1998). Hardhead catfishes regularly are used as seasonal proxies on the Georgia coast (Crook 1984; Reitz 2008:Table 22.72; Russo 2002; Thomas 2008b:580, 2008c; Thompson 2006:258-259). Hardhead catfish tend to migrate out of the estuaries during the cooler months and return in large numbers during the spring, summer, and early fall (Dahlberg 1972; Muncy and Wingo 1983). For this reason, archaeologists have based interpretations of warmer weather seasonal occupation on the presence of hardhead catfish remains (Reitz 2008:Table 22.72; Russo 2002; Thomas 2008b:580, 2008c; Thompson 2006:258-259). The $\delta^{18}O$ profile of one hardhead catfish otolith from the St. Catherines Shell Ring (GMNH Acc. No. 02381373-O7) indicates that this individual was captured when estuarine waters were cold, likely winter (Table 8.4). This suggest that all the hardhead catfishes did not leave the estuary during cool months, the seasonal migratory pattern of this species has changed since the Late Archaic, or this individual was not precipitating $CaCO_2$ when it was caught, giving a false indication of season of capture. This $\delta^{18}O_{otolith}$ should serve as a warning for using the presence of seasonally sensitive taxa as the sole means of interpreting season of occupation. Previous interpretations based on the presence of hardhead catfish need to be reevaluated. Although the presence of hardhead catfish remains in an archaeofaunal collection likely can indicate a warm weather occupation, cold weather occupations cannot be eliminated.

Summary and Conclusions

Identifying proxies to determine the season in which animals were captured is a continuing aspiration of archaeologists. Although visually characterizing the terminal increment

of clams is an accurate means of determining season of capture for this mollusc (Quitmyer et al. 1997), this same method when applied to fish otoliths currently is inconclusive. Other researchers found similar problems when visually characterizing the terminal increment of fish otoliths to determine season of capture (Van Neer et al. 2004). Additional research is needed to determine whether the shortcomings of using visual characterization of increments in fish otoliths to determine season of capture can be overcome. More otoliths should be examined, representing fish sampled throughout the year.

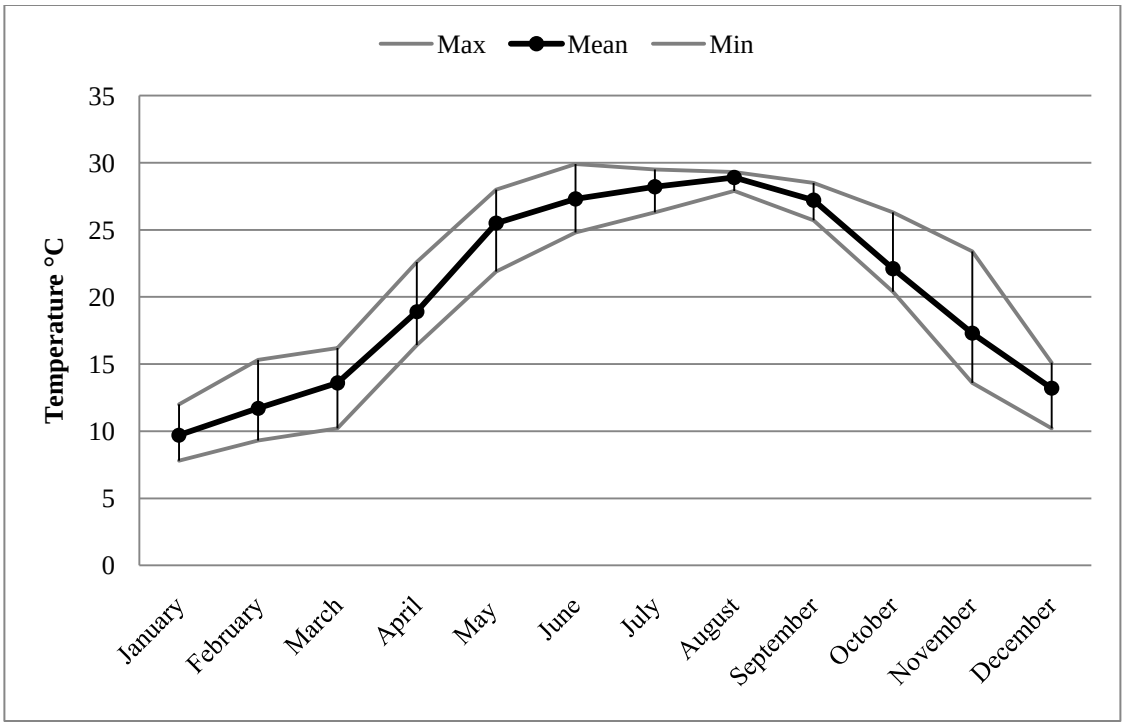
The use of $\delta^{18}O_{otolith}$ as a means to determine season of capture was more successful compared to solely characterizing the terminal edge type of the otolith. Although the initial results of the oxygen isotopic analysis are promising, further research is needed. The factors that control $\delta^{18}O_{otolith}$ for the Georgia estuaries must be documented further and a greater understanding of the biological and environmental factors that control otolith formation must be gained.

The modern $\delta^{18}O_{otolith}$ profiles indicate that in most cases the $\delta^{18}O_{otolith}$ can determine the temperature regime the fish experienced at the time of capture. When the archaeological $\delta^{18}O_{otolith}$ profiles are examined, the temperature regime the fish experienced at time of capture can be determined.

These data indicate that hardhead catfishes and Atlantic croakers were taken during multiple seasons, and probably throughout the year. This means that fishes were subjected to heavy, possibly year-round, human predation, although fishing pressures may have been more or less intensive during specific times of the year. This sustained, year-round fishing increases the likelihood that fishes experienced stress related to human use. To determine if Late Archaic populations had adverse impacts on fish populations, their age distributions, growth curves, and

growth rates are examined for Late Archaic populations of hardhead catfishes and Atlantic croakers and are compared to modern populations (Chapter 9).

(a)



(b)

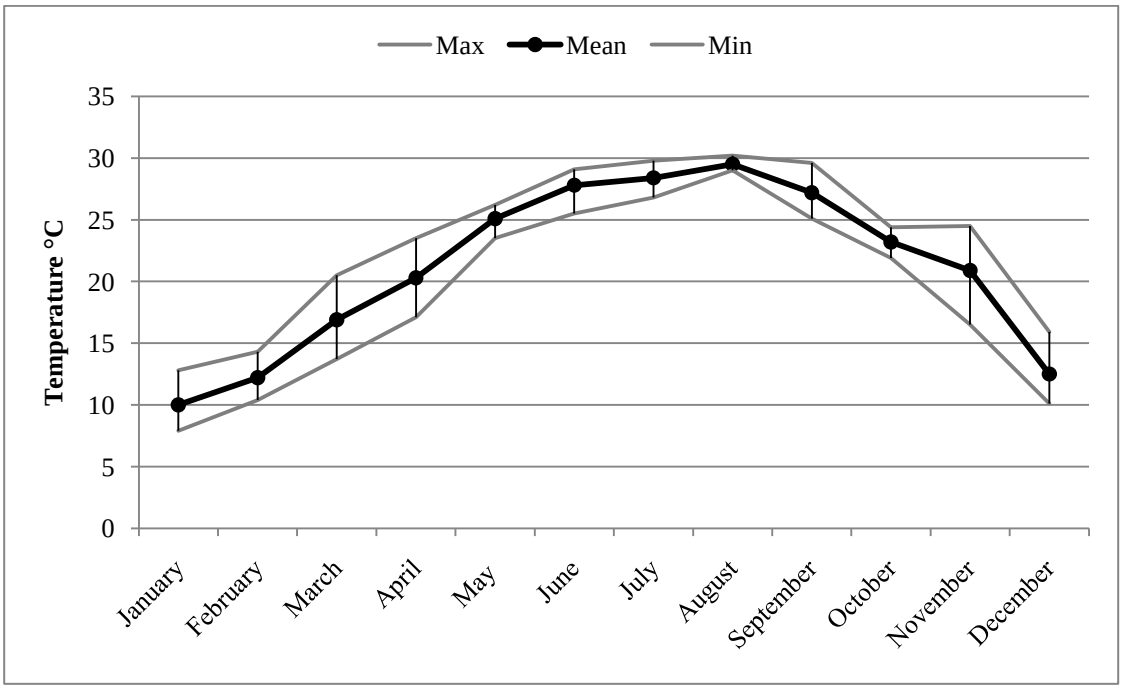
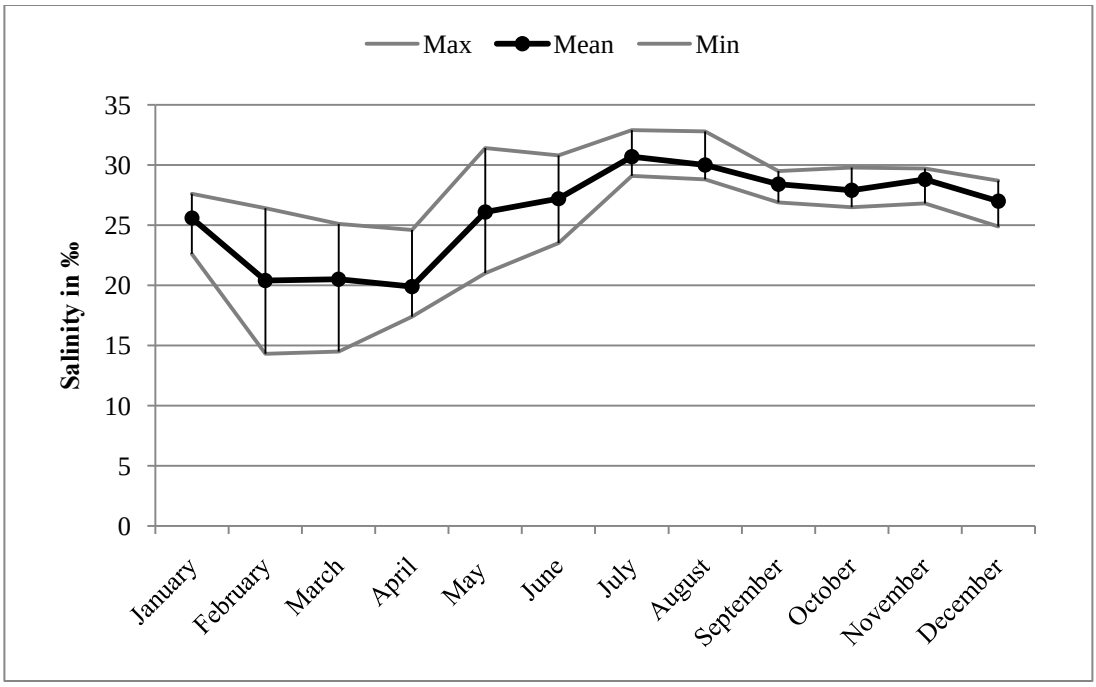


Figure 8.1: Monthly mean temperature with maximum and minimum temperatures recorded for the Sapelo Island Marsh Landing in (a) 1996 and (b) 2003. Data are from http://cdmo.baruch.sc.edu.

(a)



(b)

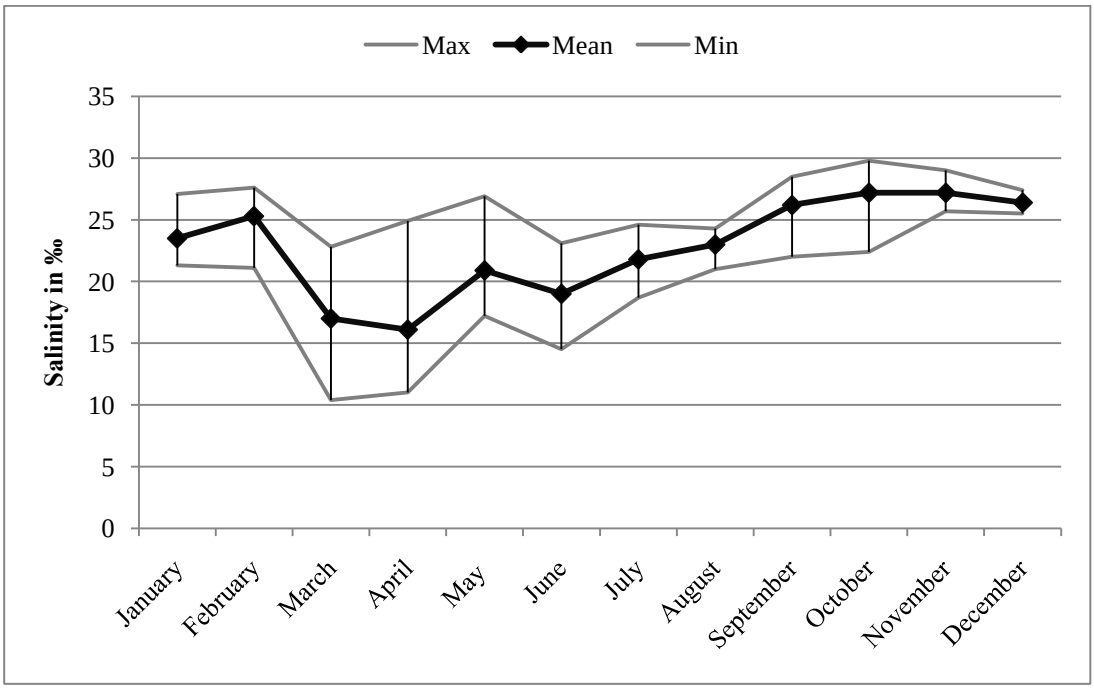


Figure 8.2: Monthly mean salinity with maximum and minimum salinity recorded at the Sapelo Island Marsh Landing in (a) 1996 and (b) 2003. Data are from http://cdmo.baruch.sc.edu/.

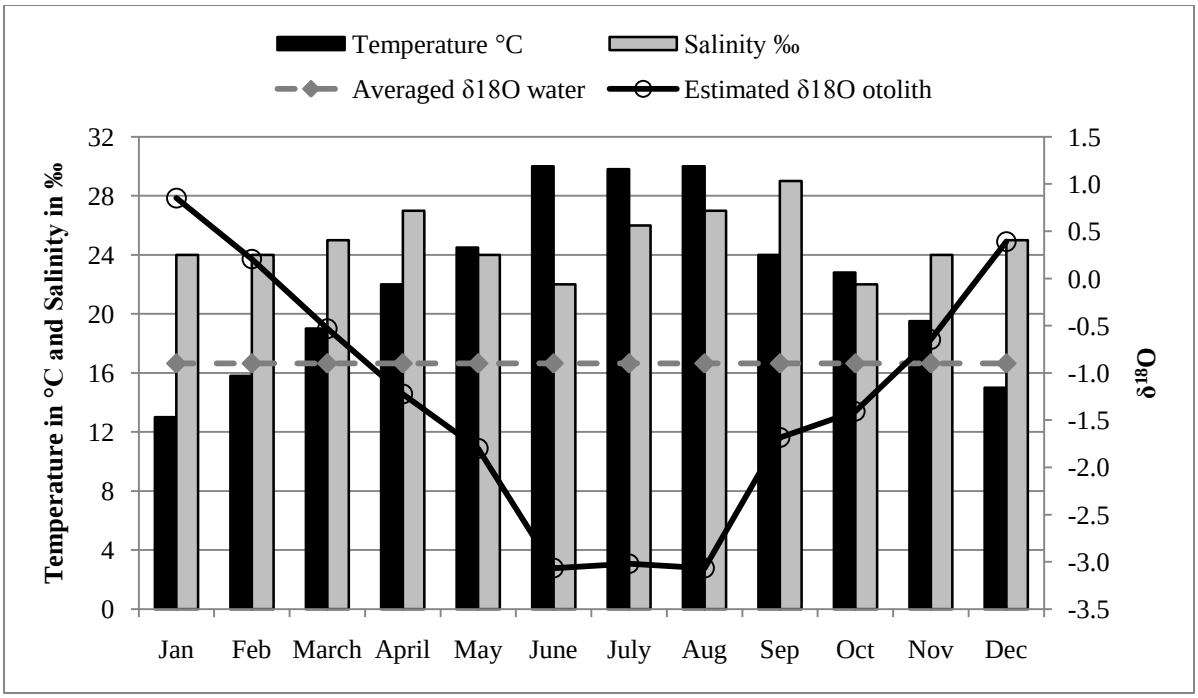


Figure 8.3: Estimated $\delta^{18}O_{otolith}$ when $\delta^{18}O_{water}$ is held constant using the average $\delta^{18}O_{water}$ reported in Andrus and Crowe (2008).

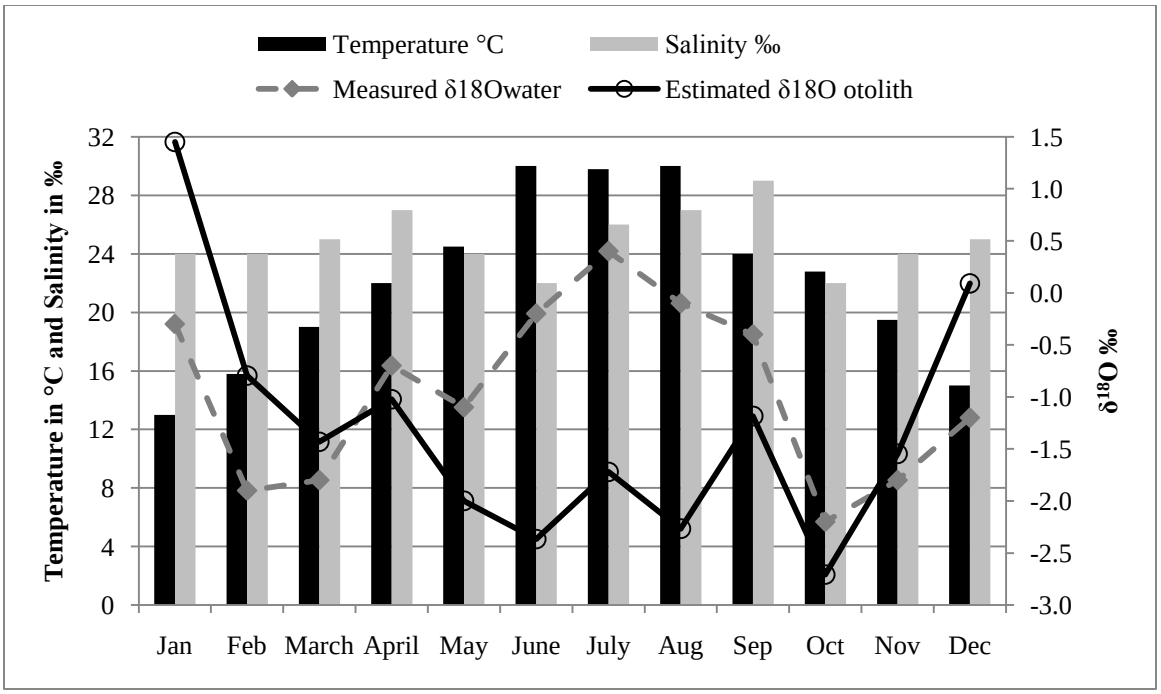
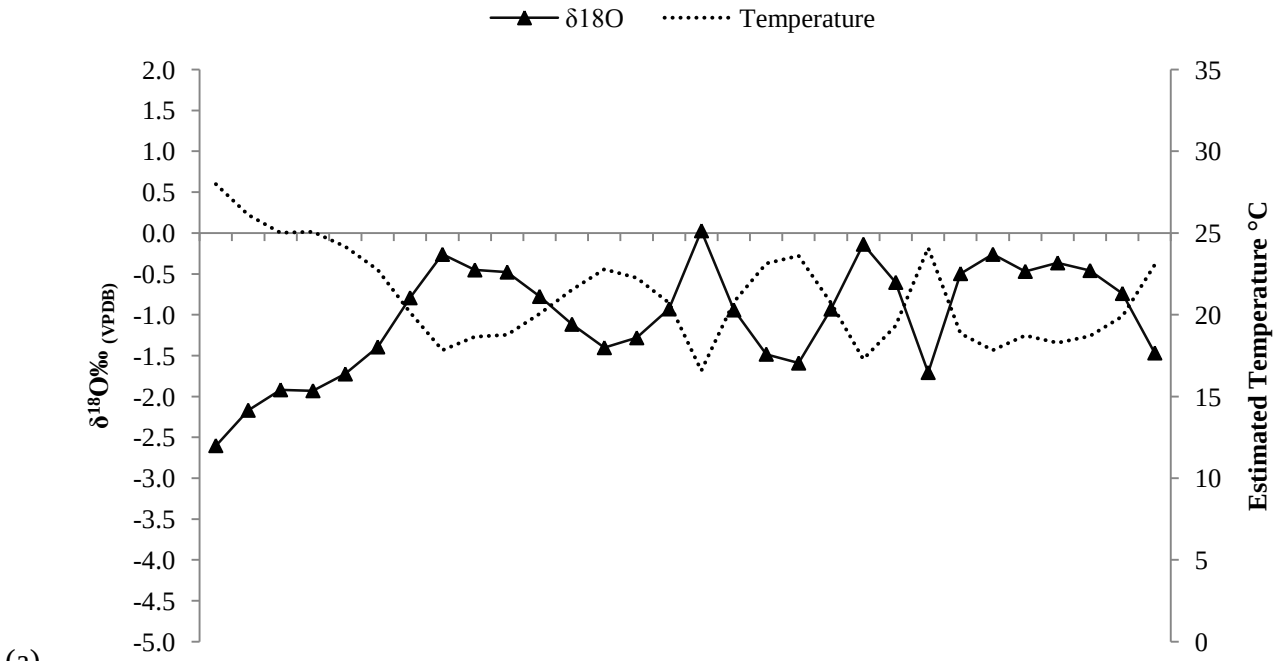
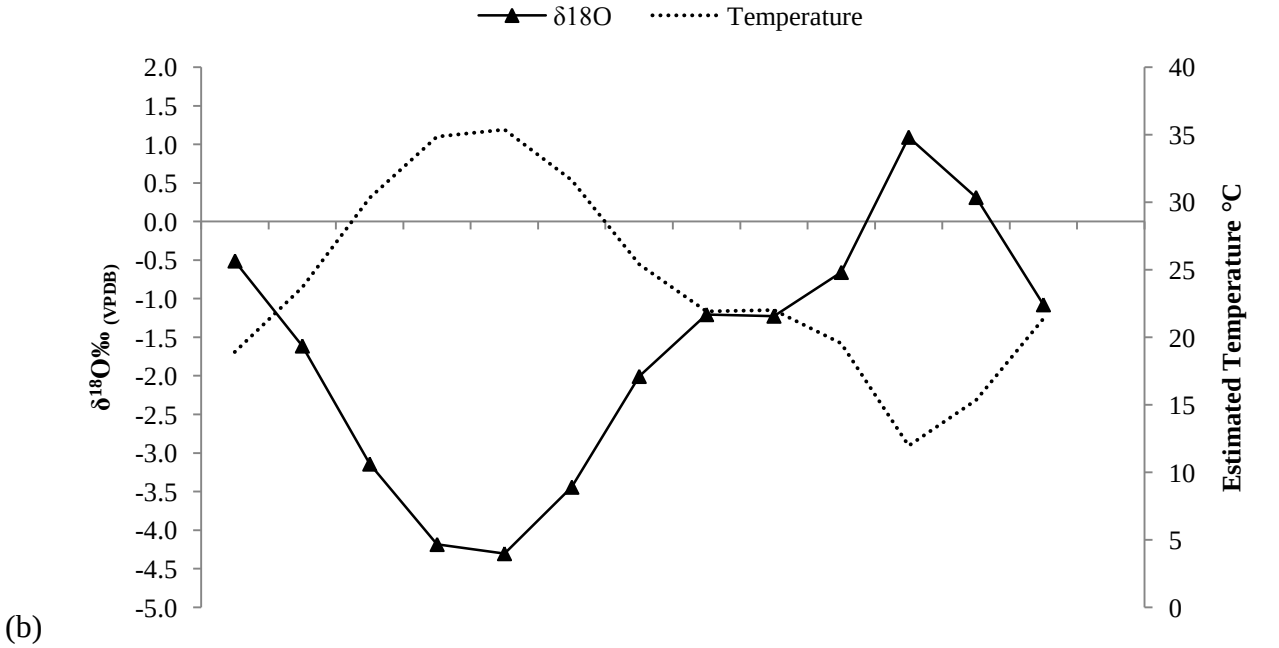


Figure 8.4: Estimated $\delta^{18}O_{otolith}$ when measured $\delta^{18}O_{water}$ is used to calculate $\delta^{18}O_{otolith}$. Measured values of $\delta^{18}O_{water}$ are reported in Andrus and Crowe (2008).



(a)



(b)

Figure 8.5: $\delta^{18}O_{otolith}$ through ontogeny, (a) is a modern hardhead catfish $\delta^{18}O_{otolith}$ captured in August 1979, Walburg Creek, St. Catherines Island (FLMNH11271). $\delta^{18}O_{otolith}$ indicates that this individual was captured when water temperatures were warm. (b) Modern Atlantic croaker $\delta^{18}O_{otolith}$ captured in June 2009, North Beach, St. Catherines Island (GMNH 4462). $\delta^{18}O_{otolith}$ indicates that this individual was captured when water temperatures were warm.

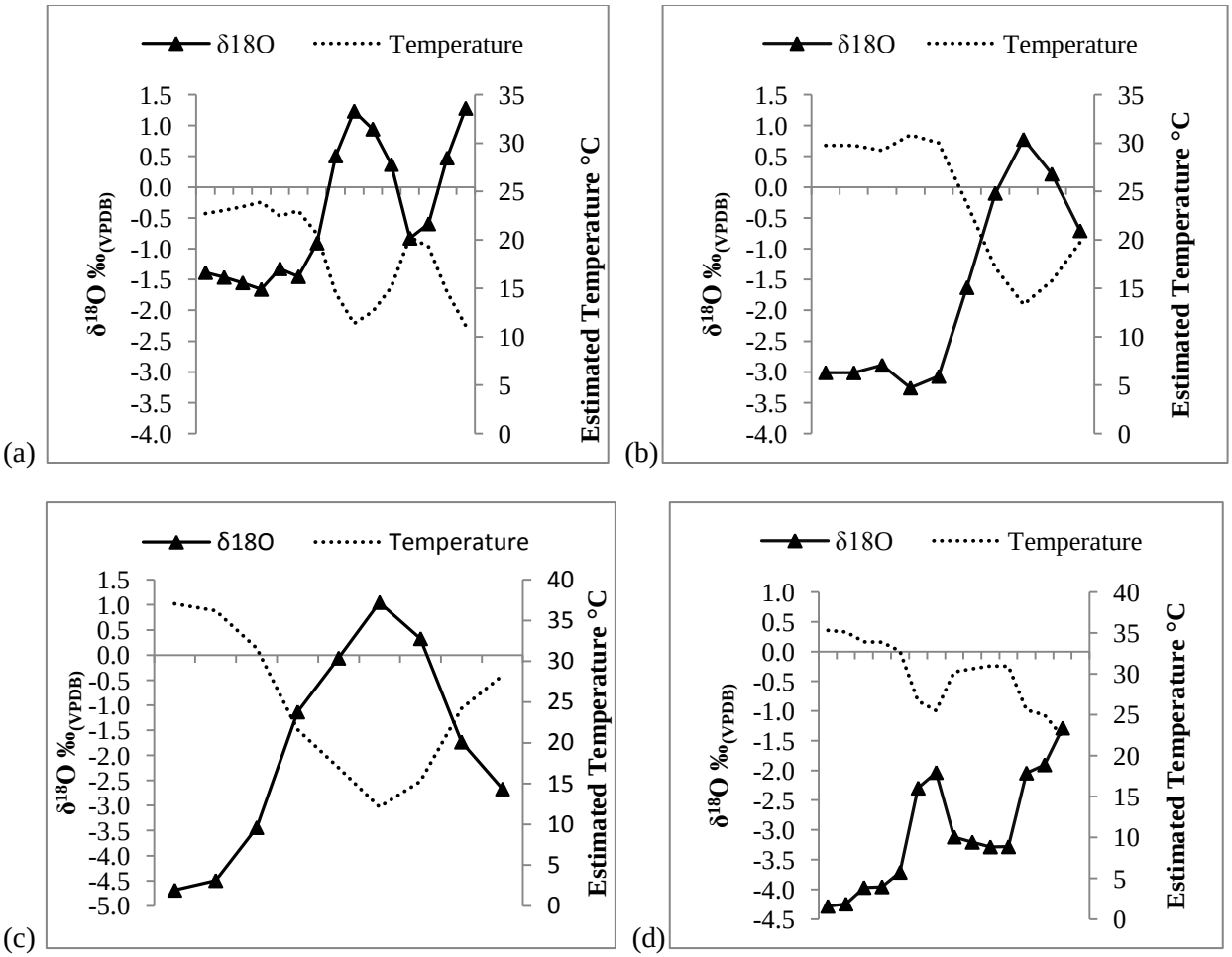


Figure 8.6: $\delta^{18}O_{otolith}$ through ontogeny, (a) is an Atlantic croaker with a cold temperature at death from the Cannon's Point Ring (b) is an Atlantic croaker with a cold/warm transition temperature at death from the West Ring. Figure (c) is an Atlantic croaker with a warm season at death from St. Catherines Shell Ring (d) is an Atlantic croaker with a warm/cold transition temperature of death from the West Ring.

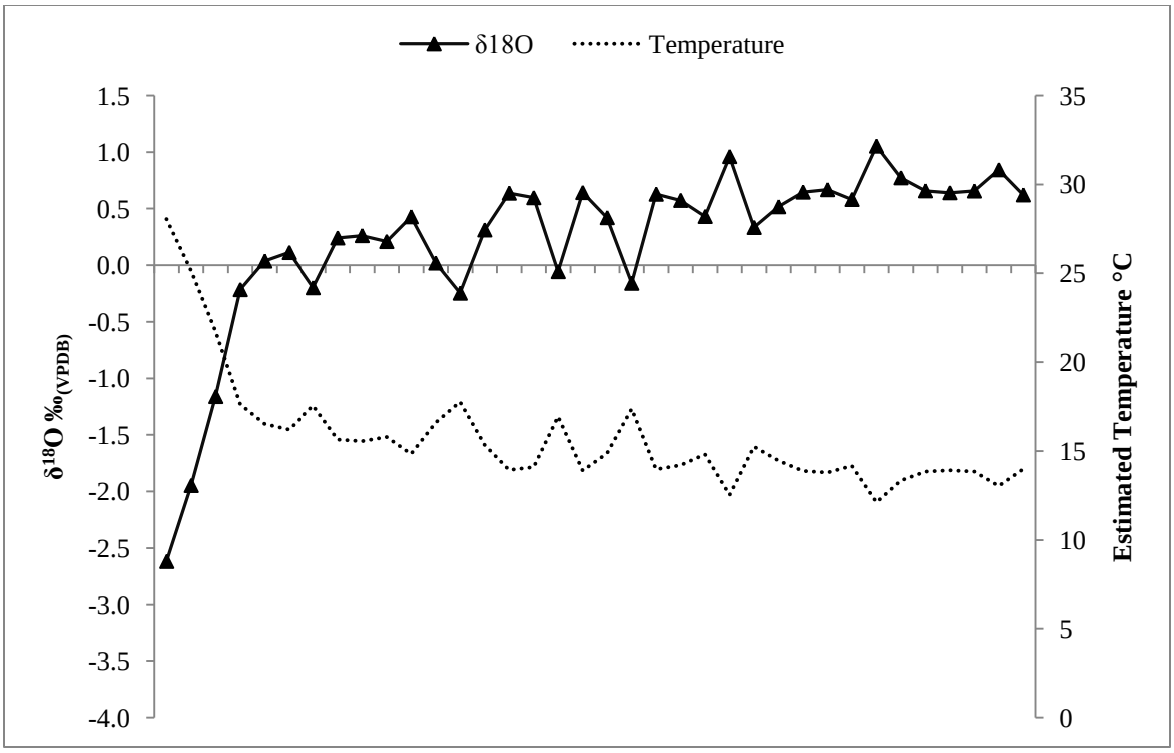


Figure 8.7. Archaeological $\delta^{18}O_{otolith}$ of an Atlantic croaker approximately 18.5 years of age. During the 17.5 years of non-core growth $\delta^{18}O_{otolith}$ ranges between -0.25‰ to1.05‰ or a 5.7 °C difference in experienced temperatures.

TABLE 8.1

Number of Terminal Edge Type: Modern Otoliths

Species	Edge Type	March	April	May	June	July	August	September
Hardhead catfish								
	Opaque							
	Translucent			1	1	2	5	3
Atlantic croaker								
	Core Only	1	1	1			1	1
	Opaque						1	
	Translucent			1	1		3	

Table 8.2

Modern Hardhead Catfishes Otolith Season of Capture and Estimated Season of Capture

Catalog #	Date Captured	Season Captured	Estimated Season Captured $\delta^{18}O_{otolith}$
GMNH 2172	5/10/1981	Spring	Warm/cold transition
GMNH 4457	6/27/2009	Summer	Warm/cold transition
GMNH 1732	7/25/1980	Summer	Warm
GMNH 4269	7/31/2003	Summer	Warm
FLMNH-EA 11162	8/9/1979	Summer	Warm
FLMNH-EA 11271	8/9/1979	Summer	Warm
FLMNH-EA 11341	8/9/1979	Summer	Warm
GMNH 4472	8/22/2009	Summer	Warm
GMNH 4470	8/22/2009	Summer	Warm
GMNH 4295	9/16/2003	Summer	Cold/warm transition
GMNH 4469	9/19/2009	Summer	Warm
GMNH 4468	9/19/2009	Summer	Warm

Table 8.3

Modern Atlantic croaker Otolith Season of Capture and Estimated Season of Capture

Catalog #	Date Captured	Season Captured	Estimated Season Captured $\delta^{18}O_{otolith}$
GMNH 1075	3/1/1980	Winter	Cold
GMNH 4475	4/25/2009	Spring	Cold/warm transition
GMNH 4458	5/23/2009	Spring	Cold/warm transition
GMNH 3762	5/29/1987	Spring	Cold/warm transition
GMNH 4462	6/27/2009	Summer	Cold/warm transition
FLMNH-EA 11313	8/8/1979	Summer	Warm
FLMNH-EA 11318	8/8/1979	Summer	Warm
FLMNH-EA 11319	8/8/1979	Summer	Warm
GMNH 4473	8/27/2009	Summer	Warm
GMNH 4474	8/27/2009	Summer	Warm
GMNH 4471	9/18/2009	Summer	Indeterminate
GMNH 4476	9/18/2009	Summer	Warm

Table 8.4

Archaeological Otolith Estimated Season of Capture

				$\delta^{18}O$ ‰$_{(VPDB)}$		
Accession #	Ring	Species	Otolith #	Penultimate	Terminal	Estimated Temperature Trend
FLMNH-EA 01551061	Cannon's Point	*A. felis*	Cannon's 1	-0.93	—	Indeterminate
FLMNH-EA 01550585	Cannon's Point	*M. undulatus*	Cannon's 3	0.47	1.28	Cold
FLMNH-EA 01610027	West	*A. felis*	West 1	-0.70	-0.7	Warm/cold transition
FLMNH-EA 01610161	West	*A. felis*	West 2	-0.44	-0.96	Warm
FLMNH-EA 01610169	West	*M. undulatus*	West 3	-1.90	-1.28	Warm/cold transition
FLMNH-EA 01610169	West	*M. undulatus*	West 4	-0.30	1.51	Cold
FLMNH-EA 01610194	West	*M. undulatus*	West 5	-0.39	1.19	Cold
FLMNH-EA 01610214	West	*M. undulatus*	West 8	0.21	-0.71	Cold/warm transition
FLMNH-EA 01610214	West	*M. undulatus*	West 9	-0.14	1.12	Cold
FLMNH-EA 01610231	West	*M. undulatus*	West 10	0.84	0.62	Indeterminate
GMNH 02420216	McQueen	*A. felis*	McQueen 1	-0.31	-0.43	Cold/warm transition
GMNH 02420047	McQueen	*A. felis*	McQueen 3	-0.86	-0.68	Warm/cold transition
GMNH 02420227	McQueen	*M. undulatus*	McQueen 2	1.05	0.31	Cold
GMNH 02420187	McQueen	*M. undulatus*	McQueen 4	-1.52	-1.62	Warm
GMNH 02420261	McQueen	*M. undulatus*	McQueen 5	-0.75	0.69	Cold
GMNH 02420057	McQueen	*M. undulatus*	McQueen 6	0.28	-0.81	Cold/warm transition
GMNH 02420100	McQueen	*M. undulatus*	McQueen 7	0.51	-0.45	Cold/warm transition
GMNH 02380115	St. Catherines	*A. felis*	0115-O1	-0.73	-0.54	Indeterminate
GMNH 02380115	St. Catherines	*A. felis*	0115-O2	-0.39	-0.95	Cold/warm transition
GMNH 02380118	St. Catherines	*A. felis*	0118-O3	-0.69	-0.76	Cold/warm transition
GMNH 02380118	St. Catherines	*A. felis*	0118-O4	-1.39	—	Indeterminate

Table 8.4 — (*Continued*)

Accession #	Ring	Species	Otolith #	$\delta^{18}O_{otolith}$ nple Before Term	Terminal	Estimated Temperature Trend
GMNH 02380118	St. Catherines	*A. felis*	0118-O5	-0.59	-0.46	Indeterminate
GMNH 02380118	St. Catherines	*A. felis*	0118-O6	0.02	-1.01	Cold/warm transition
GMNH 02380122	St. Catherines	*A. felis*	0122-O7	-0.66	—	Indeterminate
GMNH 02380120	St. Catherines	*A. felis*	0120-O8	0.06	—	Indeterminate
GMNH 02381373	St. Catherines	*A. felis*	1373-O4	-0.14	-0.18	Warm/cold transition
GMNH 02381373	St. Catherines	*A. felis*	1373-O5	-0.28	-0.33	Cold/warm transition
GMNH 02381373	St. Catherines	*A. felis*	1373-O6	-0.30	-0.28	Warm/cold transition
GMNH 02381373	St. Catherines	*A. felis*	1373-O7	0.12	0.40	Cold
GMNH 02381437	St. Catherines	*A. felis*	1437-O8	—	-0.08	Indeterminate
GMNH 02380494	St. Catherines	*A. felis*	0494-O14	-0.67	—	Indeterminate
GMNH 02380989	St. Catherines	*A. felis*	0989-O17	-0.23	—	Indeterminate
GMNH 023801037	St. Catherines	*A. felis*	1037-O19	—	-1.11	Indeterminate
GMNH 02381348	St. Catherines	*M. undulatus*	1348-O3	-0.17	0.32	Cold
GMNH 02381444	St. Catherines	*M. undulatus*	1444-O9	-1.97	-1.90	Warm
GMNH 02381444	St. Catherines	*M. undulatus*	1444-O10	-0.53	-1.07	Warm
GMNH 02381477	St. Catherines	*M. undulatus*	1477-O11	-0.81	-0.74	Cold/warm transition
GMNH 02381516	St. Catherines	*M. undulatus*	1516-O12	-1.34	-0.75	Warm/cold transition
GMNH 02381554	St. Catherines	*M. undulatus*	1554-O13	0.63	-0.74	Cold/warm transition
GMNH 02380999	St. Catherines	*M. undulatus*	0999-O21	-1.07	-1.28	Warm
GMNH 02381203	St. Catherines	*M. undulatus*	1203-O25	-1.41	-0.08	Warm/cold transition
GMNH 02381886	St. Catherines	*M. undulatus*	1886-O26	-1.74	-2.67	Warm

CHAPTER 9:

HUMAN IMPACTS ON LATE ARCHAIC FISHERIES OF THE GEORGIA COAST

As demonstrated in the previous chapters, fishes were an important subsistence resource during the Late Archaic on the Georgia coast. Late Archaic populations focused on relatively small-bodied fishes that could be exploited with mass-capture technologies in shallow, estuarine waters. Fishes were exploited during multiple seasons; possibly throughout the year. Although fishing practices, technologies, and regulations have changed since the Late Archaic period, the suite of fishes exploited by Late Archaic peoples continues to be important to modern-day people. As more researchers recognize the dire state of the current global fisheries due to overfishing and global climate changes (Hutchings and Reynolds 2004; Jackson et al. 2001; Jørgensen et al. 2007), it is imperative that long-term changes to these fish populations be documented (Pauly 1995; Pauly et al. 1998, 2000; Rick and Erlandson 2008). In this chapter, age distribution, growth curves, and growth rates of two ubiquitous and heavily exploited fishes, hardhead catfishes and Atlantic croakers, are studied. The age distribution, growth curves, and growth rates from both Late Archaic and modern populations are compared to assess changes in growth and possible causes such as overfishing. Fish growth is affected by factors apart from human fishing pressures; therefore, additional explanations for changes in fish growth also are considered (Attrill and Power 2002; Rose 2004). In particular, climatic fluctuations are examined using $\delta^{18}O$ of fish otoliths from both Late Archaic and modern samples.

Archaeological Proxies for Human Overexploitation

Archaeologists recently established models and methods to identify deleterious impacts on animal populations caused by anthropogenic and non-anthropogenic stressors on fisheries. These methods and models rely on proxies in archaeofaunal collections such as changes in the species composition, the relative frequency of selected taxa, and several derived indices including richness, diversity, and targeted trophic levels (Anderson 2008; Braje et al. 2007; Erlandson and Rick 2008; Quitmyer and Jones 2000; Reitz 2004a; Wing and Wing 2001). These proxies have changed in modern fish populations experiencing overexploitation and may reflect stresses on earlier fish populations and communities (Jörgensen et al. 2007; Pauly et al. 1998). Biological measures of skeletal elements within an archaeofaunal collection also can indicate overfishing. These include shifts in mean body sizes (Broughton 1997; Butler 2001), growth rates (Bailey et al. 2008), and ontogenetic age structures of animal populations (Quitmyer and Jones 2000). Although these models and methods were used successfully to detect overexploitation in other regions, such applications may not be useful when applied to Georgia coastal ichthyofaunal collections due to the complex environment of the Georgia Bight.

One approach to evaluating anthropogenic and non-anthropogenic impacts on animal populations and communities employs optimal foraging models to detect evidence of resource depression (Braje et al. 2007; Broughton 1994a, 1994b, 1997; Butler 2000, 2001; Butler and Campbell 2004; Nagaoka 2002). In the prey-choice model, taxa are classified by their return rates. The premise of this model is that if high-ranking prey items (i.e., those with the highest return rates) are overexploited, these prey items will be encountered less frequently because humans, or other environmental stressors, selectively removed them from the population. This process is known as resource depression. As the high-ranking prey are removed from the

environment, foragers increasingly use lower ranking taxa, expanding the breadth of their diet. This increasing diet breadth is referred to as resource intensification. When an increase in lower-ranking prey and/or an expansion in the diet breadth (i.e., resource intensification) is observed, and other causal factors such as non-anthropogenic environmental change or differential bone attrition are eliminated, human overexploitation is inferred (Braje et al. 2007; Broughton et al. 2007; Ugan 2005b).

Although the resource depression model has merit, it may be less applicable to the ichthyofaunal collections of the Georgia coast. The resource depression model is dependent on estimated return rates. In cases where post-encounter return rates are easily established (such as where there is a clear distinction between small-bodied, or low-ranking, prey and large-bodied, or high-ranking, prey), a decline in large-bodied, high-ranking prey may easily be attributed to human predation (Broughton 2002; Cannon 2000; Nagaoka 2002). As discussed in Chapter 5, the most efficient vertebrate prey type for the Georgia coast is schooling and aggregating fish communities that can be taken en mass. These communities consist of generally small-bodied fishes, although they can also include large-bodied taxa. The distribution of schooling and aggregating fishes in Georgia estuaries naturally and frequently changes daily with the tidal cycle as well as seasonally (Dahlberg and Odum 1970). Therefore, fishes that rank highest could be available for mass-capture during particular times of the day, week, month, or year, but may not be easily captured during other times. As fish mature, their schooling behaviors change as do habitat preferences and feeding behaviors; therefore, a fish species might be high-ranking prey at a certain age, time of the year, or location, but lower ranking at other ages, times of the year, and locations.

With the behavioral complexity of Georgia estuarine fishes, developing return rates for Georgia coastal fishes must consider the size and age of the fish in addition to the time and location of fishing. These factors cannot be assessed solely using archaeofaunal remains; therefore, the resource depression model is too course-grain to distinguish between human-induced stressors and stressors not associated with humans.

Archaeologists also use declines in the mean body size of fishes in archaeofaunal collections to infer human overexploitation (Broughton 1997; Butler 2001; Wing and Wing 2001). Declines in the maximum and average body sizes are documented in modern fish populations thought to be overexploited (Beverton and Holt 1957). However, this model assumes preferential selection of larger fishes over smaller ones; a practice known as size-selective fishing. Under size-selective fishing models, larger individuals are removed from the breeding population. The removal of larger individuals from the breeding population favors the reproduction of smaller individuals and causes human-induced evolution towards fish populations that have smaller body sizes compared to those that are not subject to human predation (Conover 2000; Conover and Munch 2002; Jörgensen et al. 2007; Marshall and McAdam 2007). This leaves only small-bodied fishes in the prey population. These small-bodied fishes will be added to the diet as the large-bodied fishes are removed from the environment through human predation. Although these arguments for small-bodied fishes as evidence of human predation are based on different theoretical understanding of fish responses to human fishing pressures, both the resource depression and large-bodied, size-selective fishing models suggest that a trend towards small-bodied fish sizes is an indication that fish populations were overfished.

The large-bodied, size-selective model could be used for the Late Archaic ichthyofaunal collections, but size-selective fishing of large-bodied individuals is not observed (Chapters 5 and 6). Smaller-bodied fishes are more frequently identified among the faunal assemblages from the Late Archaic shell rings just as they are for other ichthyofaunal collections from all time periods on the Georgia coast (Quitmyer and Reitz 2006; Reitz 1985, 1988; Reitz et al. 2009). Although a reduction in the mean body size through time could suggest overexploitation, other models of overfishing that also account for fish body size at age should be considered.

Fish ecological theory predicts that as more individual fishes from a population are removed through natural mortality or predation, individuals grow faster, reaching larger sizes at younger ages. Increased growth rates are caused by the elimination of density-dependent controls on the population (Jennings et al. 1999). Density-dependent controls affect growth rates of a population and vary with population density (Pianka 2000:182). If population densities decline, perhaps due to human exploitation, more food and better habitat becomes available as competition declines. This allows the remaining individuals in the population to grow within more optimal parameters. Hence individuals reach larger sizes at younger ages. Growth rates in some species of fishes are directly and negatively correlated with increased population (Jenkins et al. 1999). Increased growth rates are documented in modern populations subjected to overfishing and likely would be observed in overfished archaeological populations (Bailey et al. 2008; Rijnsdorp and van Leeuwen 1992).

To determine if growth patterns changed from Late Archaic to present day, fish size at age is estimated using incremental growth structures of fish otoliths. The incremental structures of fish otoliths are suitable proxies for examining growth rates because fish form their otoliths in response to environmental and biological conditions such as temperature, food availability, and

reproductive efforts (Pannella 1971, 1980; Van Neer et al. 2004; Wootton 1998:111-116). Fluctuations in the environmental and biological conditions that the fish experiences generally occur annually, causing the fish to grow quickly or slowly during particular times of the year. For example, the ideal temperature, or other environmental factor, for growth in a specific fish taxon may occur during late winter to early spring. During this time, the species grows rapidly. For the remainder of the year, the species experiences less optimal temperatures, and grows more slowly. Alternations between fast and slow periods of growth cause fish to deposit the $CaCO_2$ in their otoliths in a visually different way (Beckman and Wilson 1995). The exact timing of the transition from fast to slow growth may not be the same for all individuals within a population; nonetheless, one fast band and one slow band should represent an annual growth cycle. Under reflected light, fast growth appears as translucent, or dark, bands, while slow periods of growth are opaque, or light (Figure 3.8 and 3.9). One translucent band and one opaque band, or an annulus, represents one year of growth (Pannella 1980:546-549; Wootton 1998:111). Therefore, the amount of growth that occurred in the otolith for each year the fish lived can be measured when the incremental growth bands of the otolith are exposed visually in cross-section. If density-dependent controls on exploited populations were eliminated due to overfishing, fish should show larger body sizes at younger ages in their incremental growth structures.

Mean Age, Growth Curves, and Growth Rates

Comparing Late Archaic and Modern Growth in Hardhead Catfishes

A total of 12 modern and 21 archaeological hardhead catfish otoliths were cross-sectioned to expose increments for age distribution, growth curve, and growth rate analysis. Growth curves are used to graphically display the amount of growth in the otolith for each period of incremental formation, while growth rates calculate the rate of growth occurring per each

period of incremental formation. Archaeological individuals were sampled from every shell ring included in this study, with the exception of Ring III of the Sapelo Island Shell Ring complex. More otoliths were taken from some shell rings than others (Table 9.1). The number of otoliths sampled per site depended on the number of whole specimens that were well-preserved and showed no evidence they had experienced some chemical-altering taphonomic process (e.g., burning and leaching). All of the modern hardhead catfish otoliths had increments visible in cross-section, but only 18 of the 21 archaeological otoliths yielded readable increments (Table 9.1). These are the same otoliths used in the seasonality study presented in Chapter 8.

Two measures of fish growth are examined: growth curves and growth rates. For this analysis, only somatic growth occurring as the formation of incremental structures within the otolith is described. Energy consumed by fishes, and not dissipated as metabolic or waste processes, is expended as somatic or gonadal growth (Wootton 1998:65). Somatic growth occurs as growth in the body of the fish, exclusive of the gametes, while gonadal growth occurs as growth in the gametes for reproduction (Wootton 1998:141). Gonadal growth is an important biological measure that provides information as to the health of fish populations; however, measures of gonadal growth are not accessible using archaeological proxies.

The age data from this analysis suggests that hardhead catfish individuals in modern populations tend to live to older ages compared to individuals in the archaeological population. In the modern population, the mean age is 6.3 years with a minimum age of 2.5 years and a maximum age in the sample population of 10.5 years (Table 9.2). Of the 18 archaeological individuals examined, the mean age is 5.2 years with a minimum age of 3 years and a maximum age of 7.5 years (Table 9.2).

The growth curves for the modern and archaeological populations are shown in Figure 9.1. For both populations, the growth curves indicate that hardhead catfishes grow rapidly during the first few years of life and that growth decreases as individuals reach older ages (Figure 9.1). This pattern of growth is consistent with growth curves observed in other fish populations (Wootton 1998:117) and suggests that the incremental structures in hardhead catfish otoliths correspond to growth cycles. This figure indicates that the modern hardhead catfish population reaches larger body sizes at comparable ages compared to the archaeological populations. For example, the average otolith cross-sectioned length for the modern population at age 5 is 4.16 mm, while the same measurement in the archaeological population at age 5 is 3.45 mm.

The von Bertalanffy (1957) growth equation also indicates that growth rates for the modern hardhead catfish population are faster compared to the archaeological population (Figure 9.2). By solving for *K* in the von Bertalanffy growth equation, faster average growth rates for all ages are observed in the modern population compared to the archaeological population. For instance, *K* is 0.103 mm/year at age 5 in the modern population, while the growth rate at 5 years for the archaeological hardhead catfishes is 0.074 mm/year (Figure 9.2).

Comparing Late Archaic and Modern Growth in Atlantic Croakers

Both modern and archaeological Atlantic croaker otoliths were subjected to incremental analysis. A total of 12 modern Atlantic croaker otoliths were examined, although only 11 otoliths had definable increments. In the calculation of the Atlantic croaker growth curve, 5 modern otoliths were excluded because only core formation is present. Otoliths with only core formation are excluded from these analyses because it is not known if the core represents the entire first year of growth or only a small period during the first year of growth. Twenty archaeological Atlantic croaker otoliths were cross-sectioned, with 18 otoliths providing readable increments.

Two archaeological Atlantic croaker otoliths were excluded from the growth curve and growth rate analyses because only core formation was observed.

The incremental analysis of the age data indicates that the individuals in modern populations tend to live to younger ages compared to individuals in the archaeological population. The mean age in the modern Atlantic croaker population is 1.5 years with a minimum age of 1 year and a maximum age of 3.5 years (Table 9.2). For the 16 archaeological Atlantic croaker otoliths examined, the mean age is 2.9 years with a minimum age of 1 year and a maximum age of 18.5 years (Table 9.2). The mean age for the archaeological Atlantic croakers is skewed by the one individual that is 18.5 years old. If this individual is removed from the population, the mean age for the archaeological population is 1.9 years. This still indicates that the archaeological population lived to older ages.

The growth curves for the modern and archaeological Atlantic croaker populations suggest that modern Atlantic croaker individuals are growing to larger sizes at particular ages and have faster growth rates compared to archaeological populations (Figures 9.3 and 9.4). The Atlantic croaker growth curves indicate that at age one, the modern and archaeological croakers grow to approximately the same size. At year 1.5, archaeological Atlantic croakers grow to large sizes compared to the modern croakers. This trend of faster growth in the archaeological population does not continue past year 1.5. Instead, at year 1.5, the modern Atlantic croaker population attained larger sizes compared to the archaeological population (Figure 9.3). Individuals over the age of 3 years are not present in either the modern and archaeological populations of Atlantic croakers, excluding the 18.5 year individual. The limited sample of individuals over age 3 generates a curve that contains only one individual at the older end of the scale, rather than an average of many individuals.

The growth rate, *K*, calculated using the von Bertalanffy (1957) growth equation, mirrors that of the growth curves for Atlantic croakers (Figure 9.4). Nearly identical growth rates in both populations are calculated for the first year of growth. A slightly faster growth rate is observed in the archaeological population at year 1.5. After year 1.5, faster growth rates are seen in the modern population compared to the archaeological population.

Age Distribution, Growth Curves, and Growth Rate Summary

Overall, the age distribution, growth curves, and growth rates for the archaeological fishes are different compared to the modern populations. For the hardhead catfishes, the archaeological population is, on average, younger compared to the modern population. The hardhead catfish archaeological population also grew to smaller sizes at all ages and have slower growth rates compared to the modern population. For the Atlantic croakers, the archaeological population was older compared to the modern population. With the archaeological population of Atlantic croakers, individuals tend to obtain smaller sizes at particular ages, and have slower growth rates after year 1.5 compared to the modern population.

Changing Growth: Understanding the Factors Impacting Growth

For both species, the age distribution, growth curves, and growth rates for the archaeological fishes differ from those in modern populations. These are parameters of a fish population that can be impacted by human fishing pressures. Two contrasting models of human predation on fish populations in the literature were presented: (1) If large-bodied fishes were taken out of the breeding population, fishes should grow to smaller body sizes at particular ages, known as the size-selective model; or (2) If density-dependent controls on exploited populations were eliminated due to overfishing, fish should show larger body sizes at particular ages, known as the density-dependent model. The age distribution, growth curves, and growth rates of the

archaeological hardhead catfish and Atlantic croaker populations fit both models. But the smaller body sizes at particular ages and slower growth rates for the archaeological hardhead catfish and Atlantic croaker populations cannot be evidence for both human overfishing and an absence of overfishing.

If the archaeological hardhead catfish and Atlantic croaker populations are interpreted within the framework of human overfishing, the data fit the size-selective model. That is, individuals grew to smaller sizes at given ages compared to the modern population. If the size-selective model is favored, this suggests that large-bodied individuals were taken out of the breeding population, resulting in a population of more small-bodied fishes. However, size-selective fishing for large-bodied individuals does not appear to be the fishing strategy of Late Archaic fisherfolk. Rather, the fish body size data presented in Chapter 6 suggests that Late Archaic fishing strategies selected small-bodied individuals. Because size-selective fishing by the Late Archaic fisherfolk cannot be demonstrated, this model does not explain the age distribution, growth curves, and growth rates data.

Rather than interpreting the Late Archaic age distribution, growth curves, and growth rates as evidence of over-predation, modern populations of hardhead catfishes and Atlantic croakers may be experiencing heavier predation pressures and environmental stressors compared to Late Archaic populations. This explanation favors the density-dependent model. Modern overfishing and other environmental stressors may result in the elimination of density-dependent controls on the population. The elimination of density-dependent controls on today's population would allow modern hardhead catfishes and Atlantic croakers to grow faster and reach larger sizes at particular ages. This seems a more likely explanation given the current harvest pressures faced by both modern hardhead catfishes and Atlantic croakers.

Hardhead catfishes are not considered a commercial fish for human consumption today; however, they are often taken as by-catch; that is they are unintentionally caught in fisheries targeting other taxa. Numerous commercial bottom-fishing operations sell by-caught hardhead catfishes to industries that manufacture products not intended for human consumption (Muncy and Wing 1983). Harvesting pressures may be less intense for hardhead catfishes compared to recreational and commercial fishes, but the number of individuals captured today is significant. For example, in 2001 over 60,000 hardhead and gafftopsail individuals are reported in the catch of a five-county area of the south Florida coast (http://www.sms.si.edu/IRLSpec/Ariops_felis.htm). Additionally, over the last several years, hardhead catfish populations have declined drastically (Lambert 2007). Few hardhead catfishes are caught by local residents and researchers observe that they are now absent where they formerly were abundant (Lambert 2007). This is in sharp contrast to just 10 years ago, when hardhead catfishes were abundant and readily captured. It is possible that modern mortality rates for hardhead catfish, due to human fishing pressures, outweigh those experienced by this species during the Late Archaic. Although the zooarchaeological samples reported in this research only represent a fraction of the sea catfish remains at each of these sites, or taken during the Late Archaic period, it is unlikely that over 60,000 sea catfish individuals were harvested in a single year by human populations on the Georgia coast prior to commercial fishing. Given the heavy modern-day predation on hardhead catfishes, the interpretation that current fishing pressures explain the faster growth rates in modern hardhead catfish populations is plausible.

Similarly, modern Atlantic croakers may be subjected to significant fishing pressures; therefore, density-dependent controls on modern Atlantic croakers are eliminated and individuals obtain faster growth rates. Unlike hardhead catfishes, Atlantic croakers are marketed for human

consumption and are part of recreational fisheries (Lassuy 1983). Commercial hauls of Atlantic croaker can reach over 7,000 kg per year for Georgia fisheries (Hare and Able 2007). It is unlikely that over 7,000 kg of Atlantic croaker biomass was harvested each year by Late Archaic populations. Therefore, the faster growth rates of modern population suggest that growth rates changed sometime during the past 4,000 years. These modern changes in growth rates may be the result of recent human fishing pressures.

A reduction in the mean age and younger ages at maturation are among the consequences of modern fishing practices in other fish populations (Jörgensen et al. 2007). The older ages represented in the modern hardhead catfish population are unexpected given the heavy, modern predation pressures. Further explanations may account for the different older age distributions of the modern hardhead catfish population or may indicate that the density-dependent model does not capture all the variables related to human fishing pressures and age distribution, growth curves, and growth rates.

The capture techniques used to procure these hardhead catfishes may explain the different age distributions. As explained in Chapter 6, different fishing technologies result in different size classes and possibly age classes in the archaeological materials. If different technologies were used to capture the modern hardhead catfish populations studied in different areas of the estuary, different size and age classes could be represented. Mass-capture technologies were likely used to fish for hardhead catfishes in shallow, estuarine waters during the Late Archaic. For the modern sampling, hardhead catfishes were captured using seine and trawl nets, as well as hook-and-line fishing. Modern hardhead catfishes could have been taken in deeper areas of the estuaries, where older individuals are more likely found (Muncy and Wingo 1983). These

different fishing techniques could skew the modern age distribution towards an older population compared to the archaeological age distribution for the hardhead catfishes.

Given the current predation pressures on modern populations, the increased growth rates of both hardhead catfishes and Atlantic croakers suggest that modern populations are overfished and the modern data conform to the density-dependent model compared to the archaeological growth curves and growth rates. However, changes in the environmental condition of the Georgia estuaries between the Late Archaic and modern times also could be variables and need to be considered.

Environments and Fish Growth

Natural fluctuations in environmental conditions, unrelated to human fishing pressures, can drastically impact fish growth and must be ruled out as possible causal factors before the interpretation of overfishing is accepted (Attrill and Power 2002; Brunel and Boucher 2007; Hare and Able 2007; Marshall and McAdam 2007; Perry et al. 2005; Sandweiss et al. 2004; Ware and Thomson 2005). Environmental fluctuations are of particular concern because climatic changes occurred in the area while the shell rings were occupied (Anderson et al. 2007). These environmental fluctuations included sea level and salinity oscillations (Brooks and Colquhoun 1991; Colquhoun and Brooks 1986; DePratter 1977; Gayes et al. 1992; Thomas 2008a:42-47), and greater temperature and seasonality extremes compared to present-day conditions (Jones et al. 2005).

To evaluate the impacts of environmental fluctuations on modern and archaeological fish growth, $\delta^{18}O$ for both modern and archaeological otoliths are examined. The average temperature of all otoliths from the archaeological population is combined and compared to the

modern population. The averaged maximum and minimum temperature values are also compared.

Problems encountered when using $\delta^{18}O_{otolith}$ to determine temperature values are described in Chapter 8. By averaging the temperature estimations derived from $\delta^{18}O_{otolith}$, some of the variance in $\delta^{18}O_{otolith}$ caused by individual variation in fish behavior and other factors apart from temperature may be less significant.

The averaged $\delta^{18}O_{otolith}$ are similar in the archaeological and modern otoliths (Figure 9.5). There is little difference between the mean calculated temperatures experienced by both the modern and archaeological hardhead catfishes and Atlantic croakers. This suggests that there are few differences in the factors ($\delta^{18}O_{water}$, temperature, and salinity) that control $\delta^{18}O_{otolith}$ during the Late Archaic and today, despite periods of warming and cooling over the past 4,000 years (e.g., Medieval Warm and Little Ice Age although not examined here [Blanton and Thomas 2008]). Alternatively, there may be marked difference in the fractionation factors controlling $\delta^{18}O_{otolith}$ between the Late Archaic and present day, but hardhead catfishes and Atlantic croakers adjusted to these environmental changes by finding pockets of preferred environmental conditions and strictly residing in these specific environmental conditions. This behavior, known as thermoregulatory movement, is documented in other fish species and may be a behavior of these two species (Jones and Campana 2009). Regardless of which explanation is correct, it appears that changes in the fractionation factors of $\delta^{18}O_{otolith}$ between the Late Archaic period and present cannot account for the faster growth rates in modern fish populations.

Other Environmental Explanations

Fish growth is controlled by numerous environmental factors: temperature, salinity, hydrology, photic exposure, turbidity, sedimentation, dissolved oxygen, habitat availability,

nutrition, reproductive efforts, and pollution. Although temperature and salinity can be examined with $\delta^{18}O_{otolith}$, even if imprecisely, these other environmental factors cannot be explored using the archaeological proxies examined here. Additionally, evidence indicates that some of these environmental factors, specifically, the rate of sedimentation and the hydrological conditions, drastically changed over the last millennium (Hayes and Thomas 2008; Wilkinson 2005; Wilkinson and McElroy 2007). In order to clearly control for environmental factors as an explanation for the different growth curves and rates, pursuing other environmental variables is crucial.

Fish growth also is related to social interactions between fishes. Numerous studies suggest that behavioral interactions among fishes directly affect the rate fishes consume food, as well as the amount of energy fish apply to growth (Wootton 1998:127). For example, when a schooling fish is separated from its school, the separated fish does not eat, displays erratic behavior, and has limited growth (Stirling 1977). Fish species that display territorial behavior consume less food in the presence of dominant fishes, resulting in a slower growth rate (Wootton 1998:126). Social interactions within hardhead catfish populations and Atlantic croaker populations may have changed since the Late Archaic period, impacting growth. If social interactions changed drastically enough to increase growth rates in modern populations, it is likely that other factors, such as limited habitat availability or a radical reduction in the number of conspecifics would be related to the changes in social behavior. These other factors would more likely be related to major environmental changes, such as overfishing. It is impossible to fully understand any changes in social behavior experienced between the Late Archaic and present. Correlating fish growth rates and social interaction is extremely difficult for living fish populations, and is likely impossible for archaeological fish populations.

Other aspects of the biotic communities also correlate with fish growth rates and should be considered before concluding that overfishing is the primary explanation for the differences in archaeological and modern growth curves and growth rates. Biotic communities include all living organisms within the ecosystem, such as non-predators, interspecific competitors, predators, and prey as well as parasites. Any fluctuations in these organisms may impact fish growth rates.

Increases or decreases in the number of non-human predators could impact growth rates of both hardhead catfish and Atlantic croaker populations. Growth rate changes caused by increased, non-human predation would mirror that of increased human-predation and differentiating between the two is difficult. However, because hardhead catfishes and Atlantic croakers are relatively high trophic feeders, few other species, apart from humans, consume them. Non-human predators of hardhead catfishes and Atlantic croakers include sharks and larger fishes (Muncy and Wingo 1983). Heavy predation of sharks and large, predatory fishes is well documented over the past several decades (Myers and Worms 2003). It is estimated that the current biomass levels of sharks and large, predatory fishes is 90 percent lower than it was before industrialized fishing began (Myers and Worms 2003). With such low levels of predatory fishes in today's ocean, it is unlikely that increased predation by non-human predators is the cause of increased growth rates in hardhead catfish and Atlantic croaker populations.

Diseases that infect fishes also can contribute to the different growth rates between the modern and archaeological fish populations. Parasites deleteriously affect fish growth (Beamish et al. 1996) and, in some cases, parasites kill fish (Wootton 1998:191-192). Harmful algal blooms occur in coastal areas and estuaries. Algal blooms kill large numbers of fishes, which changes population structure and can impact growth rates (Anderson 1997). If disease rates and

harmful algal blooms have increased during modern times, as some researchers suggest (Anderson 1997), it is reasonable to hypothesize that death rates in fishes have increased in recent years unrelated to human predation. Large fish kills may eliminate density-dependent controls on fish populations, and increase fish growth rates in modern populations. Although an increase in diseases and harmful algal blooms is not overfishing, they could be related to anthropogenic environmental changes or may be part of a regular biological cycle.

Were Late Archaic People Overfishing?

The primary goal of this chapter is to determine whether Late Archaic populations overfished the Georgia estuaries. The growth curves and growth rates suggest that archaeological populations of hardhead catfishes and Atlantic croakers were not fished to the same extent as current populations. It appears that Late Archaic people did not overfish hardhead catfishes and Atlantic croakers, but they are being overfished today. Growth rates of fishes modern populations have increased compared to Late Archaic fishes. Further research is needed to establish a historical trajectory of fishing on the Georgia coast; but certainly today's populations are different from those in the Late Archaic. This interpretation is reflected in the recent decline of the hardhead catfish population of Georgia estuaries (Lambert 2007). Although the recent population decline may be part of a natural reproductive cycle (Lambert 2007); overfishing, disease, pollutants, and other environmental variations may be affecting sea catfishes. Similar population crashes are observed in Atlantic croakers and may be consequences of the same causal factors (Diamond et al. 1999).

Summary and Conclusions

When the archaeological population of hardhead catfishes is compared to the modern population, three observations are made: (1) age data suggest that individuals in archaeological

populations died at younger ages; (2) the growth curves indicate that the archaeological population of hardhead catfishes reached smaller body sizes at comparable ages when compared to the modern population sampled; and (3) the growth rates of archaeological hardhead catfishes are slower at all ages compared to the modern population. When the archaeological population of Atlantic croakers is compared to the modern population, similar observations are made: (1) the growth curve indicates that the archaeological population of Atlantic croakers reached smaller body sizes at comparable ages when compared to the sampled, modern populations, excluding the first year and a half of growth; and (2) the growth rates of archaeological Atlantic croakers are slower after the first year and a half of growth compared to the modern population. Unlike the hardhead catfish data, the archaeological population of Atlantic croakers tended to live longer than the modern Atlantic croaker population.

Some factor has affected the growth of these two species of fishes. Environmental data from modern and archaeological $\delta^{18}O_{otolith}$ suggest that there are few differences in the factors that control $\delta^{18}O_{otolith}$, such as temperature, in the Late Archaic and today. Other abiotic factors, such as sedimentation or pollutants, may contribute to the increased growth rates in the modern populations. Additionally, changes in the biotic community, such as changes in social interactions and an increase in non-human predation, may impact growth. Changes to the abiotic or biotic communities, as well as overfishing appear to be the mostly likely explanations. The growth curves and growth rates clearly suggest that Late Archaic populations did not fish hardhead catfishes and Atlantic croakers to the extent that modern human populations do.

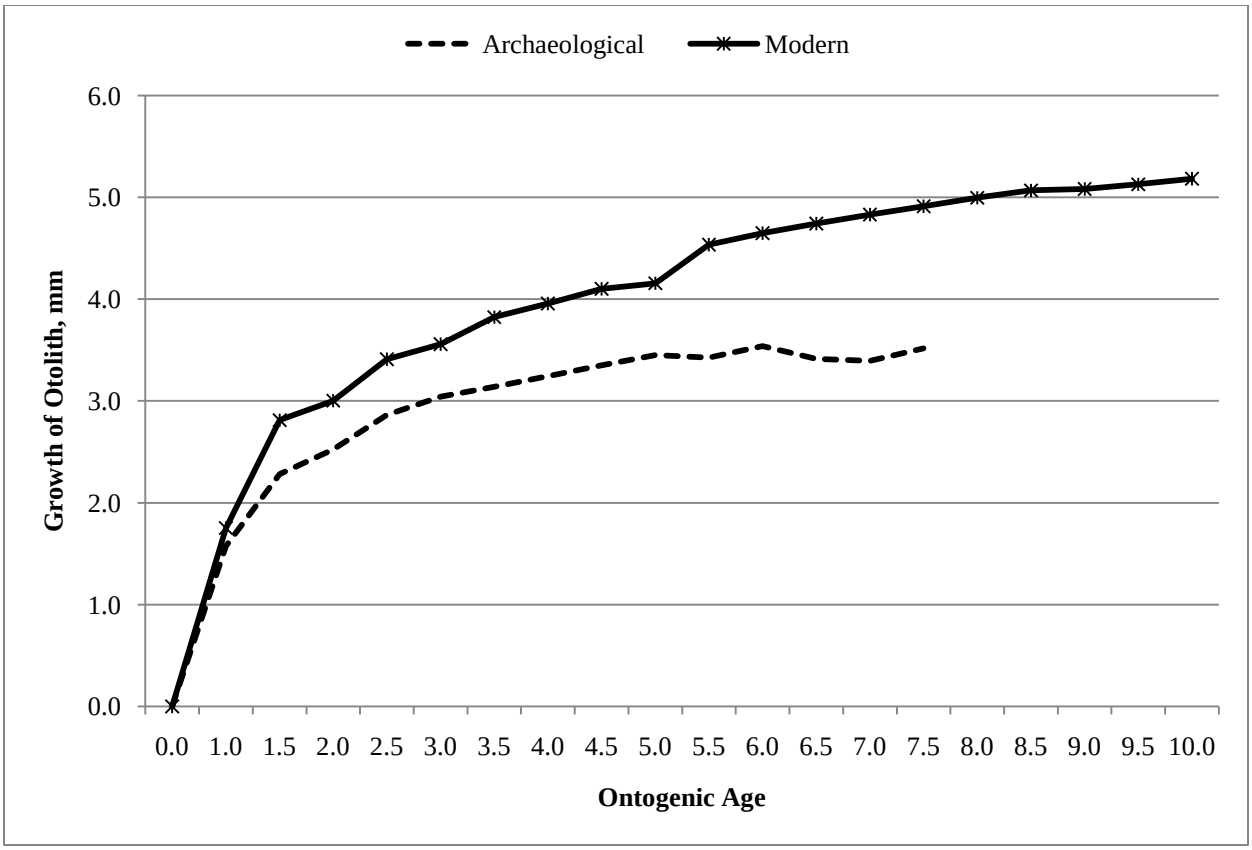


Figure 9.1: Growth curves of archaeological and modern hardhead catfishes.

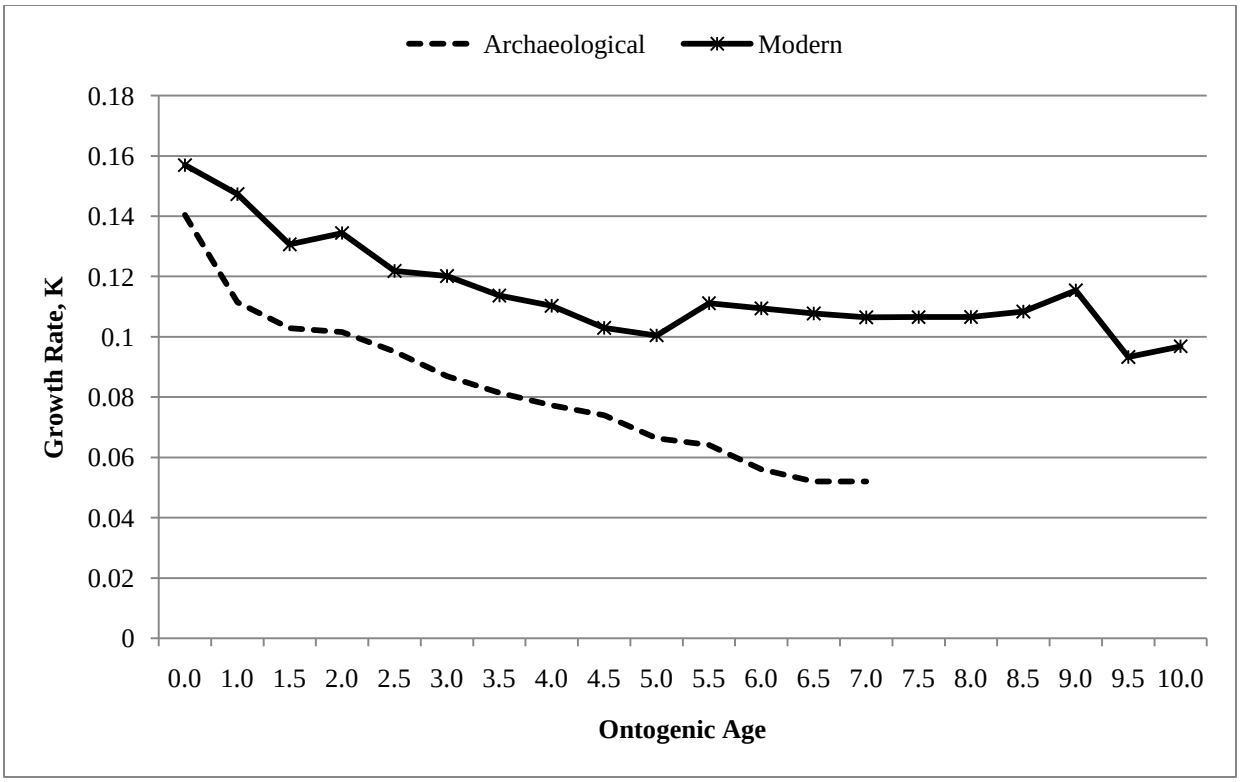


Figure 9.2: Growth rates of archaeological and modern hardhead catfishes.

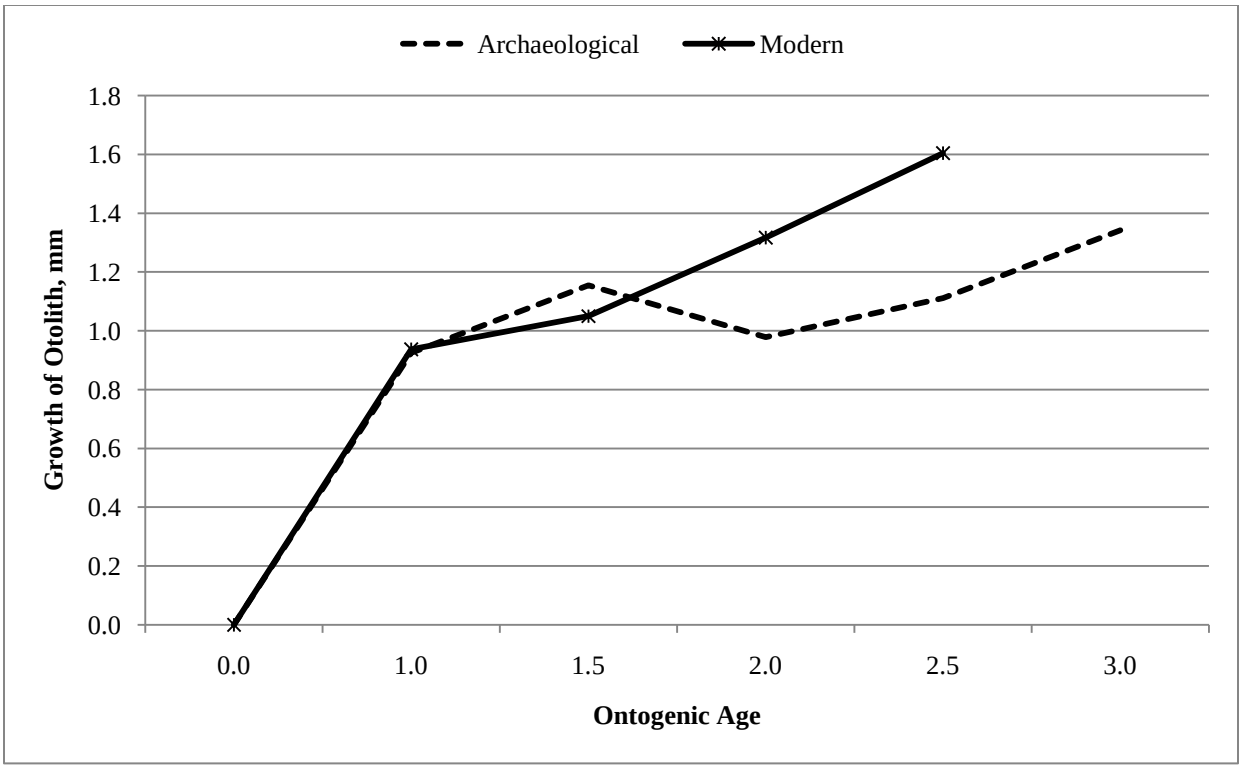


Figure 9.3: Growth curves of archaeological and modern Atlantic croakers.

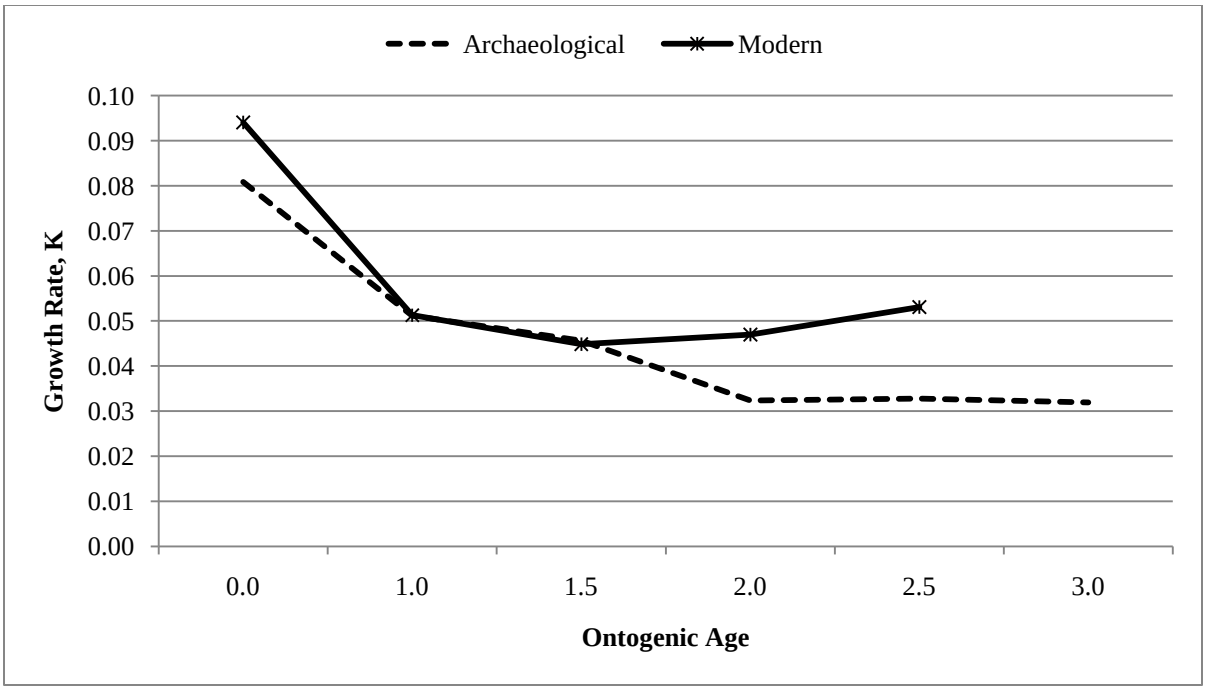


Figure 9.4: Growth rates of archaeological and modern Atlantic croakers.

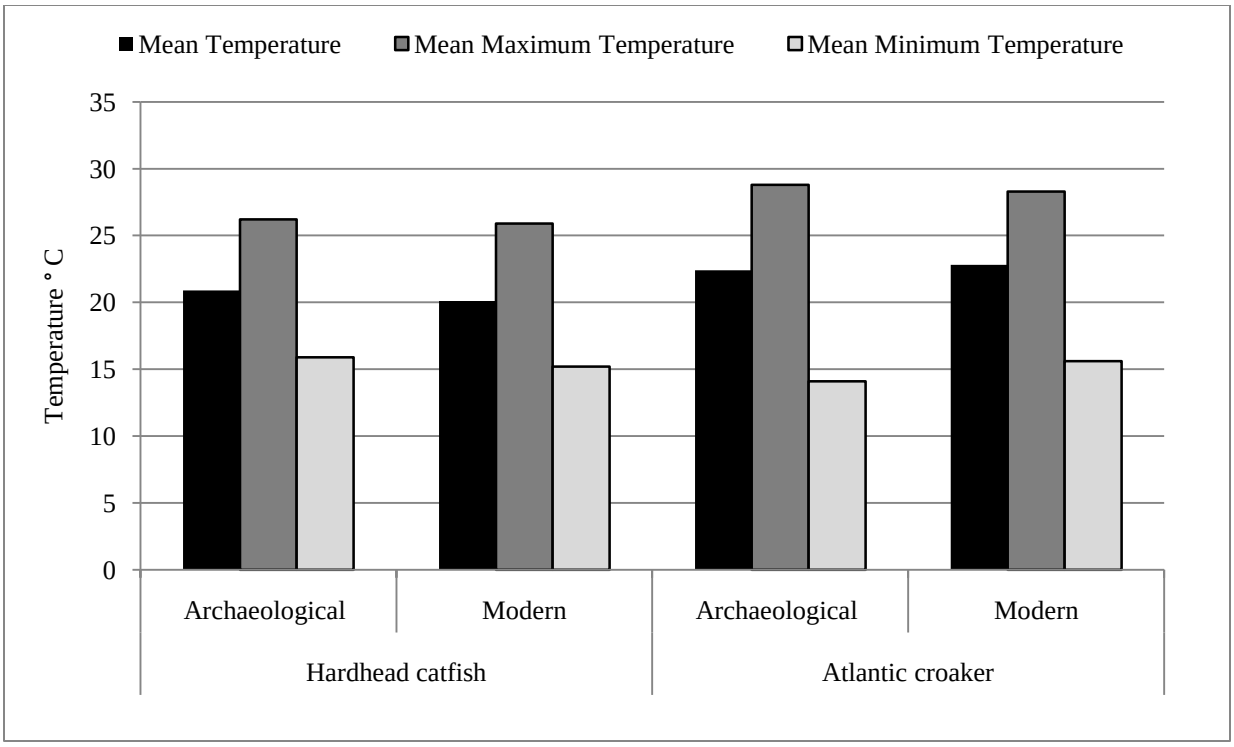


Figure 9.5: Estimated temperature values, including mean temperature, mean maximum temperature, and mean minimum temperature, from archaeological and modern samples of $\delta^{18}O_{otolith}$.

Table 9.1

Archaeological and Modern Growth Analysis Samples

Hardhead catfishes		Atlantic croakers	
Archaeological	Modern	Archaeological	Modern
FLMNH-EA 01551061	GMNH 2172	FLMNH-EA 01550585	GMNH 3762
FLMNH-EA 01610027	GMNH 1732	GMNH 02420187	GMNH 4462
FLMNH-EA 01610161	GMNH 4269	GMNH 02420057	FLMNH 11319
GMNH 02420216	FLMNH 11162	GMNH 02420100	FLMNH 11313
GMNH 02420047	FLMNH 11271	GMNH 02381348	GMNH 4473
GMNH 02380115	FLMNH 11341	GMNH 02381444	GMNH 4474
GMNH 02380115	GMNH 4472	GMNH 02381477	
GMNH 02380118	GMNH 4470	GMNH 02381554	
GMNH 02380118	GMNH 4295	GMNH 02380999	
GMNH 02380122	GMNH 4469	GMNH 02381886	
GMNH 02380120	GMNH 4468		
GMNH 02381373			
GMNH 02381373			
GMNH 02381373			
GMNH 02381373			
GMNH 02381437			
GMNH 02380989			
GMNH 02381037			

Table 9.2

Age Distribution of Archaeological and Modern Populations

	Hardhead catfishes		Atlantic croakers	
	Archaeological	Modern	Archaeological	Modern
Mean Age	5.2	6.3	2.9	1.5
Maximum	7.5	10.5	19.0	3.5
Minimum	3.0	2.5	1.0	1.0
N	18	11	16	6

CHAPTER 10:

SUMMARY, FUTURE RESEARCH, AND CONCLUSIONS

Researchers emphasize the need to document former human-environmental interactions in order to more fully understand contemporary environmental issues and human behavior (Erlandson and Rick 2008; Fisher and Feinman 2005; Jackson et al. 2001; Lyman 1996; Lyman and Cannon 2004; Redman et al. 2004b; van der Leeum and Redman 2002). Nowhere else is this documentation more pressing than in coastal environments (Erlandson and Rick 2008). Human population levels continue to rise in coastal regions around the world and stressors on coastal environments become greater as humans deplete coastal fisheries and resources, pollute coastal systems, and destroy coastal habitats. In areas of the world where earlier human-environmental interactions are documented, evidence indicates that human influences on coastal environments and biotic communities extend back thousands of years (Rick and Erlandson 2008). However, the scale and magnitude to which humans impacted coastal environments varies greatly, suggesting that more research is needed to record past human-environmental interactions and to understand the implications of these earlier interactions on current socio-environmental issues.

This dissertation adds to the understanding of former human-environmental interactions in coastal environments by examining several aspects of the socio-environmental relationship between Late Archaic human populations and Georgia coastal vertebrate communities. Specifically, five research questions are addressed that examine how Late Archaic populations interacted with vertebrate communities. (1) Did Late Archaic populations target taxa and habitats

that were high-ranking prey and high-ranking patches or hunt types under current diet-breadth and hunt-type models (Thomas 2008a, 2008c) and, if not, which taxa and hunt types were most heavily targeted? (2) Are there patterns in the fishing strategies of the Late Archaic shell ring collections and fishing technologies used by Late Archaic populations of the Georgia coast? (3) Are there similarities in the spatial distribution of animal remains among different Ring and Interior Areas of St. Catherines Shell Ring? (4) Can fish otoliths be used to determine seasonal fishing schedules and are those schedules consistent with the established model of shellfishing at other shell rings? and (5) Do the age distributions, growth curves, and growth rates of archaeological otoliths indicate that fish populations experienced environmental stress, of either anthropogenic or non-anthropogenic origins, during the Late Archaic period?

By investigating these research questions, additional information regarding the human-environmental interaction in coastal areas is generated. Understanding how humans interacted with the biotic communities of the Late Archaic Georgia coast and what impacts human actions had on these communities has important implications for today's socio-environmental issues of the Georgia coast and other coastal environments. This chapter provides a summary of the research presented in this volume, defines areas of future research, and provides conclusions of the human-environmental interaction of the Late Archaic Georgia coast.

Summary of the Late Archaic Shell Ring Archaeofaunal Analyses

Models of Human Behavioral Ecology and the Archaeofaunal Collections of the Shell Rings

Several diet-breadth models are proposed for coastal areas of North America (Broughton 1997, 1999; Kennett 2005), including the Georgia coast (Thomas 2008a, 2008c). Some of these models predict that large-bodied taxa, such as white-tailed deer, are the highest ranking prey because these taxa theoretically provide the highest post-encounter return rate (Thomas

2008a:195). The large archaeofaunal collections, recovered with fine-gauge mesh from the Late Archaic shell rings, were used to test several proposed diet-breadth models.

The archaeofaunal collections do not indicate that high-ranking, generally large-bodied, taxa were taken in abundance. Rather, these archaeofaunal collections are dominated by small-bodied, estuarine fishes that school or aggregate. As other researchers have shown (Lindström 1996; Losey et al. 2004; Madsen and Schmitt 1998; Schmitt et al. 2004), taxa forming schools and aggregates susceptible to mass capture may be ranked higher than large-bodied taxa that must be acquired individually. The pursuit and processing of large-bodied taxa may have been more costly than targeting smaller fishes that school and aggregate. Capturing small-bodied fishes en mass likely resulted in high post-encounter return rates and was a successful foraging strategy. This form of fishing was practiced by Late Archaic populations.

Although there is generally a highly positive correlation between body size and post-encounter return rate (Ugan 2005a), the constraints of the diet-breadth model may be over-simplified in the context of the complex estuarine systems of the Georgia coast, making the post-encounter return rate of small-bodied fishes higher than large-bodied taxa. This is because in the environmental context of the Georgia coast, the fine-grained search assumption, that prey are encountered randomly and sequentially, is violated for marine foraging. Once one fish that schools or aggregates is encountered when fishing in Georgia estuaries, the odds of encountering other individuals of that taxon increase. The accumulation of archaeological deposits involves numerous processes (e.g., the cultural filter [Reed 1963]) that are not controlled in the diet-breadth model and AI values (Bird et al. 2002; Grayson and Delpech 1998; Ugan and Bright 2001). Taphonomic processes, such as field processing (Thomas 2008a:211-233) and bone attrition (Ugan 2005b), are not accounted for in tests of the diet-breadth model on the Georgia

coast. Field-processing, specifically, could account for the lack of large-bodied specimens in these collections. Research regarding field processing on St. Catherines Island suggests that deer should rarely be field processed in this environment (Thomas 2008a:230-231).

A hunt-type model for foraging on the Georgia coast predicts that saltwater fishing would provide foragers with the highest potential post-encounter return rate of all available hunt-types (Thomas 2008c:974). The AI values for marine fishes are consistent with this hunt-type model. All AI values for NISP and MNI indicate that saltwater fishing was the primary hunting activity. The AI values for biomass are less consistent, but all, with the exclusion of the St. Catherines Shell Ring, have AI values over 0.50, confirming the effectiveness of saltwater fishing on the Georgia coast.

Fish Remains from the Late Archaic Shell Rings

Overall, human populations exploited fishes from nearby, shallow, estuarine waters. The ichthyofaunal collections demonstrate that several families of estuarine fishes, including herrings and shads, sea catfishes, mullets, and drums are ubiquitous to the shell ring collections. The relative abundance of these four fish families from the different shell ring collections suggests that the most abundant fishes in each collection reflect local environmental parameters of each estuarine system. Physical characteristics of the fishes and mortality profiles for sea catfishes, mullets, and drums indicate that mass-capture technologies, including weirs, fences, traps, and nets, were used by Late Archaic fisherfolk. Spearing devices likely were used in combination with stationary fishing facilities. Trotlines and other set lines also may have been used.

Intrasite Analysis of the St. Catherines Shell Ring

The relative abundance of animal classes, diversity, equitability, richness, the relative abundance of small-bodied and mass-captured fishes, and the mean trophic level of marine

organisms in archaeofaunal collections from four areas of the St. Catherines Shell Ring were compared. This analysis demonstrates that the North, East, and West sections of the Ring Area at the St. Catherines Shell Ring are very similar, while the Interior Area differs from the Ring Area collections. This suggests that formation processes associated with the St. Catherines Shell Ring were similar for the Ring Area. If the ring is interpreted as a village (Thompson 2006, 2007; Trinkley 1985; Waring and Larson 1968:273), the uniform distribution of vertebrate fauna in the ring itself indicates that individuals and groups occupying the ring had comparable access to hunting and fishing locations, technologies, processing, and disposal methods. Social inequalities are not reflected in the distribution of animal remains within the Ring Area.

The Interior Area collection of the St. Catherines Shell Ring is distinct from the Ring Area, suggesting that the activities related to animal use that formed the ring differed from those activities that occurred within the interior of the ring. The precise activities that formed the ring and the interior are unknown. Factors such as sample size, bone attrition due to the differential soil pH, and other taphonomic processes also can explain the differences between the Ring Area and the Interior Area. Further analysis at the St. Catherines Shell Ring is needed to fully understand if these similarities extend to other facets of the archaeological record.

Ichthyofaunal Proxies to Determine Seasonality for the Georgia Coast

Seasonal studies in coastal areas are the focus of much archaeological research. Such studies generally focus on seasonal use of molluscs (Andrus and Crowe 2000, 2008; Culleton et al. 2009; Deith 1986; Mannino et al. 2003; Quitmyer et al. 1997; Shackleton 1973). Few studies examine seasonal use of fishes and methods to determine the seasonality of fishing are limited (but see, Higham and Horn 2000; Hufthammer et al. 2010; Van Neer et al. 1999, 2004). In Chapter 8, methods were tested to determine the seasonality of fishes and address the seasonal

use of two fishes, hardhead catfishes and Atlantic croakers, at the shell rings. Two methods were applied: (1) the terminal increments of fish otoliths were characterized, and (2) the $\delta^{18}O_{otolith}$ of the terminal increment and those just prior to death were assessed to infer the temperature the fish experienced at death.

The characterization of the terminal increments in fish otoliths has been conducted using other archaeofaunal collections (Hales and Reitz 1992; Higham and Horn 2000; Van Neer et al. 1999, 2004), and this method could be a valuable tool for archaeologists working with other coastal collections. Visually inspecting the terminal increment in otoliths to determine season of capture was unsuccessful for hardhead catfishes and Atlantic croakers from the shell ring collections, however. The use of $\delta^{18}O_{otolith}$ to determine season of capture was more successful. The modern $\delta^{18}O_{otolith}$ profiles indicate that in most cases $\delta^{18}O_{otolith}$ can determine the temperature regime experienced by the fish at the time of capture. When the archaeological $\delta^{18}O_{otolith}$ profiles were examined, the temperature regime that the fish experienced at time of capture indicate that hardhead catfishes and Atlantic croakers were caught during multiple seasons, and probably throughout the year.

Human Impacts on Late Archaic Fisheries of the Georgia Coast

Calculations of age distribution, growth curves, and growth rates (defined as *K* in the von Bertalanffy growth equation) were examined using measures of the incremental bands in hardhead catfish and Atlantic croaker otoliths. Age data indicate that hardhead catfishes died at younger ages in the past than they do today. The growth curves show that hardhead catfishes reached smaller body sizes at comparable ages in the past compared to the modern populations. The growth rates of archaeological hardhead catfishes are slower at all ages compared to the modern hardhead catfishes. The growth curve for Atlantic croakers indicates that the

archaeological population reached smaller body sizes at comparable ages when compared to the modern populations, after the first year and a half of growth. The growth rates of archaeological Atlantic croakers are slower after the first year and a half of growth compared to the modern population. Unlike the hardhead catfish data, the archaeological population of Atlantic croakers tended to live to older ages in the past compared to the modern Atlantic croaker population.

These data suggest that some factors affected fish growth between the Late Archaic period and today, although estimated temperatures using $\delta^{18}O_{otolith}$ indicates that temperatures are not different between Late Archaic and today. These data suggest that either: (1) present-day fractionation factors were the same as during the Late Archaic; or (2) fish resolve environmental fluctuations through thermoregulatory movement. Combined, the environmental data and the increased growth rates of the modern hardhead catfish and Atlantic croaker populations are consistent with the density-dependent model and the increased growth patterns are similar to these observed in fish populations that are overfished. The growth curves and growth rates suggest that Late Archaic populations did not overfish hardhead catfishes and Atlantic croakers but that modern human populations may be doing so. Abiotic factors, such as sedimentation, dissolved oxygen, hydrology, turbidity, salinity, and pollution, may cause the increased growth rates in the modern populations, as well as changes in the biotic community. These factors cannot be assessed by the archaeological proxies used here.

Areas of Future Research

Future Research Regarding Human Impacts on Fish Populations of the Georgia Coast

The original research question proposed in Chapter 1 was: Did Late Archaic populations impact fish population through overexploitation? It appears they did not overfish hardhead catfish and Atlantic croaker populations. Although, the heavy, year-round exploitation of fishes

raises the possibility that Late Archaic people overfished or stressed the fish populations. The growth curves and growth rates indicate that Late Archaic populations did not impact fish populations to the same extent as current practices, which include commercial and recreational fishing (Coleman et al. 2004).

This research focuses on two temporal extremes for the Georgia coast: (1) the earliest evidence of fishing in this area during the Late Archaic, and (2) present-day fishing with high rates of fish mortality due to human fishing pressures. Approximately 4,000 years of human occupation on the Georgia coast separate these two extremes. Future archaeological research should establish growth curves and growth rates for the intervening time periods. The zooarchaeological record of the Georgia coast is rich with the data needed to test whether people impacted fisheries and when these impacts were most pronounced. Vertebrate fauna from the entire temporal sequence will offer the long-term framework needed to investigate the environmental changes fish experienced, whether of anthropogenic or non-anthropogenic origins. These data can inform current ecological views of the Georgia coast and fishery policies. Through such research, we may be able to document how fish growth and the health of fish populations and ecosystems responded to increases in human population size and density. Through such research, we may find oscillations in fish growth over time, either as a general trend towards today's parameters or a dramatic, recent shift in response to modern technologies and fisheries management. Further documentation of fish growth, temporal change in human populations, shifts in subsistence strategies (i.e., farming), and short term climatic fluctuations also must be considered (i.e., Medieval Warm and Little Ice Age). These factors impact the rate at which humans fish and the health of fish populations. Without more detailed temporal data, it

is difficult to interpret the full range of fish responses over time. This is a promising area of future research.

Future Research Regarding Otoliths and the Archaeological Implications

The study of otolith increments is not new to archaeology (Smith 1983). Despite this fact, few archaeologists work with growth rates and incremental structures in fish otoliths (but see, Hales and Reitz 1992; Van Neer et al. 1999, 2004). The results from the otolith analyses presented here provide data applicable not only to archaeologists, but also fisheries scientists and marine ecologists. Although this research documents a change in the growth rates between Late Archaic and modern fish populations, additional research is needed. More samples of both modern and archaeological otoliths are needed. The zooarchaeological assemblages from the Late Archaic shell rings have numerous, unstudied otoliths that can provide additional data to bolster the current data set.

Additionally, otoliths from other fish species and size changes in taxa with determinate growth can be studied (Purdue and Reitz 1993). Future research should establish if growth rates in other fish species were slower in the past compared to present-day populations and if these changes extend to non-fish taxa (Purdue and Reitz 1993). Such data provide evidence of changes in overall marine community structures and estuarine ecology, rather than just a couple of fish populations.

Although extensive $\delta^{18}O_{otolith}$ were taken, future research should focus on correlating $\delta^{18}O_{otolith}$ with incremental formation. That was an initial goal of this research, but the very small widths of incremental bands meant that efforts to sample these increments were unsuccessful. When increments were large enough to take multiple samples, incremental formation generally do not correlate with fluctuations in $\delta^{18}O_{otolith}$, although in some cases, fluctuations in $\delta^{18}O_{otolith}$

do correlate with incremental formations. More comprehensive sampling of modern $\delta^{18}O_{otolith}$ and more accurate sampling of very small increments is required. Incremental formation and $\delta^{18}O$ fluctuations are correlated in other species (Jones and Quitmyer 1996) and understanding incremental formation processes in fishes has significant archaeological and ecological implications. Future research should identify factors that are associated with incremental formation in fishes. As fisheries scientists show, otolith formation can correlate with reproductive efforts, as well as the age, sex, and habitat of the fish (Fowler 1995; Van Neer et al. 2004). Future modern $\delta^{18}O_{otolith}$ studies should consider these factors, in addition to temperature, both in sampling fishes and in the analysis of $\delta^{18}O_{otolith}$ profiles.

Future Research Regarding Zooarchaeology of the Georgia Coast

This study generated much information about Late Archaic economies and formation processes of the shell rings, but additional research is needed. Testing the diet-breadth and hunt-types models for the Georgia coast suggests that post-encounter return rates for small-bodied organisms captured en mass may be higher than large-bodied taxa taken individually. Invertebrates, such as oysters, clams, shrimps, crabs, and other arthropods may have been substantial contributors to the diet. Future research should focus on such organisms, as well as plants (including phytoliths, starches, and pollen grains). These analyses have the potential to generate a comprehensive interpretation of foraging behaviors and diets. Such data will generate a more complete picture of the Late Archaic environment and economy of the Georgia coast.

The intrasite analysis of St. Catherines Shell Ring provides results that have exciting social implications, suggesting that Late Archaic populations had similar access to fishing locations and technologies. Additional zooarchaeological analysis, beyond those reported here, is being conducted for the archaeofaunal collections from the McQueen Shell Ring and this may

identify distinctive activities areas at this site, particularly if shell ring contexts are found that were of ritual significance to Late Archaic populations. Intrasite analysis also can be expanded to include the horizontal and vertical stratigraphy of animal remains, invertebrate remains, lithics, ceramics, and radiocarbon dates. Such an analysis may generate further information regarding site formation processes and cultural institutions.

Conclusions

Historical ecology postulates that where humans are present, they impact the land and seascapes (Balée 1998). This impact is documented throughout the world (Grayson 2001; Redman et al. 2004b) and is notable in many coastal environments (Rick and Erlandson 2008). For the Late Archaic land and seascapes of the Georgia coast, the magnitude of this impact likely was not severe, although these people did use the estuaries of the Georgia coast extensively and altered them in doing so. With the construction of the shell rings, the landscape of the sea islands was changed. Beyond this, the Late Archaic populations changed the seascape by fishing the Georgia estuaries. The zooarchaeological data indicate that large numbers of fishes were taken from the estuaries. It is likely that the Late Archaic people deployed nets and weirs in many tidal creeks in addition to seining and harpooning fishes. Fish populations supported people during multiple seasons and possibly throughout the entire year. Late Archaic populations also hunted the terrestrial habitats of the sea islands. White-tailed deer, in addition to numerous other terrestrial taxa, were a component of the diet, although to a lesser extent than estuarine fishes. Through their actions, Late Archaic populations impacted the vertebrate communities of the sea islands and estuaries. The growth data from Late Archaic hardhead catfishes and Atlantic croakers suggest that these impacts were not as drastic as current fishing pressures, however.

Modern fisheries throughout the world recently have experienced population declines and changes in growth patterns (Hutchings and Reynolds 2004; Jackson et al. 2001; Morita and Fukuwaka 2007; Pauly et al. 1998; Rijnsdorp and van Leeuwen 1992). The fact that modern-day hardhead catfish and Atlantic croaker populations have increased growth rates compared to their Late Archaic counterparts is significant. This suggests that these modern populations may be part of a fisheries collapse and is a troubling sign for Georgia estuaries and the numerous fishes that depend on these estuaries. This is particularly true for hardhead catfishes. Modern Georgia fisherfolk recount the abundance of hardhead catfishes over the last several decades, even as the population levels of other fish species fluctuated. Over the past few years, however, hardhead catfishes have become nearly absent from Georgia estuaries. Hardhead catfishes are a catholic species that can survive under environmental stress (Muncy and Wingo 1983). The dramatic population decline of hardhead catfishes is an additional indication that Georgia estuaries and their inhabitants are facing ecological turmoil which may be caused by anthropogenic impacts.

There are no recreational fishing regulations for hardhead catfishes today, while 25 Atlantic croakers per day at a minimum of 20 cm total length can be captured in Georgia waters (http://www.georgiaoutdoors.com/fishing/length.asp?water=salt). Fisheries managers should consider establishing regulations for hardhead catfishes and lower the current daily total allowable catch for recreational and commercial Atlantic croaker fisheries. Regulation changes could possibly bring modern growth rates closer to the Late Archaic rates and increase population levels for these two species. These steps may be essential for reviving population levels of hardhead catfishes and sustaining the biotic communities of the Georgia coast.

This research has generated new evidence for human-environmental interactions both for the Late Archaic period and modern times. Clearly, additional work is needed to refine the

methods used in this study, bolster the sample sizes, and generate a complete, temporal data set to establish the full long-term trajectory of human impacts on the Georgia coast.

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APPENDIX A

FAUANL SAMPLES STUDIED

Bag/Field Number	Site	Unit	Level	Screen size
None	Sapelo Shell Ring	4	Level 1	0.64 cm
None	Sapelo Shell Ring	4	Level 2	0.64 cm
None	Sapelo Shell Ring	4	Level 3	0.64 cm
None	Sapelo Shell Ring	4	Level 4	0.64 cm
None	Sapelo Shell Ring	4	Level 5	0.64 cm
None	Sapelo Shell Ring	4	Level 6	0.64 cm
FL 18	Sapelo Shell Ring	9	0-5 cm	>0.4 cm
FL 19	Sapelo Shell Ring	9	5-10 cm	>0.4 cm
FL 24	Sapelo Shell Ring	9	10-15 cm	>0.4 cm
FL 17	Sapelo Shell Ring	9	15-20 cm	>0.4 cm
FL 17	Sapelo Shell Ring	9	15-20 cm	<0.6 cm
FL 5	Sapelo Shell Ring	9	20-25 cm	>0.4 cm
None	Sapelo Shell Ring	9	20-25 cm	<0.6 cm
FL 20	Sapelo Shell Ring	9	25-30 cm	>0.4 cm
FL 32	Sapelo Shell Ring	9	30-35 cm	>0.4 cm
FS 137	Sapelo Shell Ring	9	35-40 cm	>0.4 cm
FL 31	Sapelo Shell Ring	9	40-45 cm	>0.4 cm
FL 28	Sapelo Shell Ring	9	45-50 cm	>0.4 cm
FL 26	Sapelo Shell Ring	9	50-55 cm	>0.4 cm
FL 16	Sapelo Shell Ring	9	60-65 cm	>0.4 cm
FL 25	Sapelo Shell Ring	9	65-70 cm	>0.4 cm
FL 23	Sapelo Shell Ring	9	70-75 cm	>0.4 cm
FL 30	Sapelo Shell Ring	9	85-90 cm	>0.4 cm
FL 22	Sapelo Shell Ring	9	95-100 cm	>0.4 cm
311	St. Catherines Shell Ring	N779 E801	0-10 cm	0.32 cm
343	St. Catherines Shell Ring	N779 E801	10-20 cm	0.32 cm
345	St. Catherines Shell Ring	N779 E801	20-30 cm	0.32 cm
409	St. Catherines Shell Ring	N779 E801	30-40 cm	0.32 cm
414	St. Catherines Shell Ring	N779 E801	40-50 cm	0.32 cm
410	St. Catherines Shell Ring	N779 E801	50-60 cm	0.32 cm
404	St. Catherines Shell Ring	N779 E801	60-70 cm	0.32 cm
403	St. Catherines Shell Ring	N779 E801	70-80 cm	0.32 cm
486	St. Catherines Shell Ring	N779 E801	80-90 cm	0.32 cm
488	St. Catherines Shell Ring	N779 E801	90-100 cm	0.32 cm
489	St. Catherines Shell Ring	N779 E801	100-110 cm	0.32 cm
549	St. Catherines Shell Ring	N779 E801	110-120 cm	0.32 cm
552	St. Catherines Shell Ring	N779 E801	120-130 cm	0.32 cm
579	St. Catherines Shell Ring	N779 E801	130-140 cm	0.32 cm
581	St. Catherines Shell Ring	N779 E801	140-150 cm	0.32 cm
598	St. Catherines Shell Ring	N779 E801	150-160 cm	0.32 cm
319	St. Catherines Shell Ring	N782 E801	0-10 cm	0.32 cm

APPENDIX A—(*Continued*)

Bag/Field Number	Site	Unit	Level	Screen size
334	St. Catherines Shell Ring	N782 E801	10-20 cm	0.32 cm
450	St. Catherines Shell Ring	N782 E801	20-30 cm	0.32 cm
452	St. Catherines Shell Ring	N782 E801	30-40 cm	0.32 cm
454	St. Catherines Shell Ring	N782 E801	40-50 cm	0.32 cm
459	St. Catherines Shell Ring	N782 E801	50-60 cm	0.32 cm
463	St. Catherines Shell Ring	N782 E801	60-70 cm	0.32 cm
466	St. Catherines Shell Ring	N782 E801	70-80 cm	0.32 cm
467	St. Catherines Shell Ring	N782 E801	70-80 cm	0.32 cm
498	St. Catherines Shell Ring	N782 E801	80-90 cm	0.32 cm
502	St. Catherines Shell Ring	N782 E801	90-100 cm	0.32 cm
503	St. Catherines Shell Ring	N782 E801	100-110 cm	0.32 cm
603	St. Catherines Shell Ring	N782 E801	100-110 cm	0.32 cm
532	St. Catherines Shell Ring	N782 E801	110-120 cm	0.32 cm
533	St. Catherines Shell Ring	N782 E801	120-130 cm	0.32 cm
537	St. Catherines Shell Ring	N782 E801	130-140 cm	0.32 cm
313	St. Catherines Shell Ring	N784 E797	0-10 cm	0.32 cm
337	St. Catherines Shell Ring	N784 E797	10-20 cm	0.32 cm
663	St. Catherines Shell Ring	N784 E797	20-30 cm	0.32 cm
692	St. Catherines Shell Ring	N784 E797	30-40 cm	0.32 cm
690	St. Catherines Shell Ring	N784 E797	40-50 cm	0.32 cm
770	St. Catherines Shell Ring	N784 E797	50-60 cm	0.32 cm
820	St. Catherines Shell Ring	N784 E797	60-70 cm	0.32 cm
781	St. Catherines Shell Ring	N784 E797	60-70 cm	0.32 cm
784	St. Catherines Shell Ring	N784 E797	60-70 cm	0.32 cm
892	St. Catherines Shell Ring	N784 E797	70-75.5 cm	0.32 cm
894	St. Catherines Shell Ring	N784 E797	75.5-78 cm	0.32 cm
896	St. Catherines Shell Ring	N784 E797	75.5-78 cm	0.32 cm
906	St. Catherines Shell Ring	N784 E797	78-86 cm	0.32 cm
908	St. Catherines Shell Ring	N784 E797	86-96 cm	0.32 cm
936	St. Catherines Shell Ring	N784 E797	116-126 cm	0.32 cm
309	St. Catherines Shell Ring	N784 E801	0-10 cm	0.32 cm
432	St. Catherines Shell Ring	N784 E801	10-20 cm	0.32 cm
433	St. Catherines Shell Ring	N784 E801	20-30 cm	0.32 cm
439	St. Catherines Shell Ring	N784 E801	30-40 cm	0.32 cm
440	St. Catherines Shell Ring	N784 E801	40-50 cm	0.32 cm
438	St. Catherines Shell Ring	N784 E801	50-60 cm	0.32 cm
444	St. Catherines Shell Ring	N784 E801	50-60 cm	0.32 cm
445	St. Catherines Shell Ring	N784 E801	50-60 cm	0.32 cm
466	St. Catherines Shell Ring	N784 E801	50-60 cm	0.32 cm
491	St. Catherines Shell Ring	N784 E801	60-70 cm	0.32 cm
493	St. Catherines Shell Ring	N784 E801	60-70 cm	0.32 cm
494	St. Catherines Shell Ring	N784 E801	70-80 cm	0.32 cm

APPENDIX A—(*Continued*)

Bag/Field Number	Site	Unit	Level	Screen size
495	St. Catherines Shell Ring	N784 E801	70-80 cm	0.32 cm
542	St. Catherines Shell Ring	N784 E801	70-80 cm	0.32 cm
543	St. Catherines Shell Ring	N784 E801	70-80 cm	0.32 cm
544	St. Catherines Shell Ring	N784 E801	80-90 cm	0.32 cm
546	St. Catherines Shell Ring	N784 E801	80-90 cm	0.32 cm
547	St. Catherines Shell Ring	N784 E801	90-100 cm	0.32 cm
594	St. Catherines Shell Ring	N784 E801	100-110 cm	0.32 cm
595	St. Catherines Shell Ring	N784 E801	110-120 cm	0.32 cm
314	St. Catherines Shell Ring	N784 E811	0-10 cm	0.32 cm
340	St. Catherines Shell Ring	N784 E811	10-20 cm	0.32 cm
399	St. Catherines Shell Ring	N784 E811	20-30 cm	0.32 cm
651	St. Catherines Shell Ring	N784 E811	30-40 cm	0.32 cm
665	St. Catherines Shell Ring	N784 E811	40-50 cm	0.32 cm
682	St. Catherines Shell Ring	N784 E811	50-60 cm	0.32 cm
706	St. Catherines Shell Ring	N784 E811	60-70 cm	0.32 cm
778	St. Catherines Shell Ring	N784 E811	60-70 cm	0.32 cm
780	St. Catherines Shell Ring	N784 E811	60-70 cm	0.32 cm
783	St. Catherines Shell Ring	N784 E811	60-70 cm	0.32 cm
807	St. Catherines Shell Ring	N784 E811	70-80 cm	0.32 cm
806	St. Catherines Shell Ring	N784 E811	70-80 cm	0.32 cm
910	St. Catherines Shell Ring	N784 E811	80-90 cm	0.32 cm
911	St. Catherines Shell Ring	N784 E811	90-100 cm	0.32 cm
938	St. Catherines Shell Ring	N784 E811	100-110 cm	0.32 cm
310	St. Catherines Shell Ring	N789 E801	0-10 cm	0.32 cm
385	St. Catherines Shell Ring	N789 E801	10-20 cm	0.32 cm
381	St. Catherines Shell Ring	N789 E801	20-30 cm	0.32 cm
382	St. Catherines Shell Ring	N789 E801	30-40 cm	0.32 cm
387	St. Catherines Shell Ring	N789 E801	40-50 cm	0.32 cm
428	St. Catherines Shell Ring	N789 E801	40-50 cm	0.32 cm
496	St. Catherines Shell Ring	N789 E801	50-60 cm	0.32 cm
540	St. Catherines Shell Ring	N789 E801	50-60 cm	0.32 cm
539	St. Catherines Shell Ring	N789 E801	60-70 cm	0.32 cm
584	St. Catherines Shell Ring	N789 E801	70-80 cm	0.32 cm
585	St. Catherines Shell Ring	N789 E801	80-90 cm	0.32 cm
648	St. Catherines Shell Ring	N789 E801	90-100 cm	0.32 cm
645	St. Catherines Shell Ring	N789 E801	105-110 cm	0.32 cm
646	St. Catherines Shell Ring	N789 E801	110-120 cm	0.32 cm
668	St. Catherines Shell Ring	N789 E801	120-130 cm	0.32 cm
669	St. Catherines Shell Ring	N789 E801	130-140 cm	0.32 cm
695	St. Catherines Shell Ring	N789 E801	140-150 cm	0.32 cm
696	St. Catherines Shell Ring	N789 E801	150-160 cm	0.32 cm
697	St. Catherines Shell Ring	N789 E801	160-170 cm	0.32 cm

APPENDIX A—(*Continued*)

Bag/Field Number	Site	Unit	Level	Screen size
3988	St. Catherines Shell Ring	N771 E819	Open-2.2	0.32 cm
3976	St. Catherines Shell Ring	N771 E819	2.6-2.5	0.32 cm
3958	St. Catherines Shell Ring	N771 E819	2.5-2.4	0.32 cm
3973	St. Catherines Shell Ring	N771 E819	2.39-2.39	0.32 cm
3909	St. Catherines Shell Ring	N771 E819	2.39-2.3	0.32 cm
3993	St. Catherines Shell Ring	N771 E819	2.3-2.2	0.32 cm
3991	St. Catherines Shell Ring	N771 E819	2.2-2.1	0.32 cm
1244	St. Catherines Shell Ring	W82 S2	2.9-2.8	0.32 cm
1247	St. Catherines Shell Ring	W82 S2	2.9-2.8	0.32 cm
1252	St. Catherines Shell Ring	W82 S2	2.9-2.8	0.32 cm
1254	St. Catherines Shell Ring	W82 S2	2.8-2.7	0.32 cm
1257	St. Catherines Shell Ring	W82 S2	2.8-2.7	0.32 cm
1262	St. Catherines Shell Ring	W82 S2	2.7-2.6	0.32 cm
1262	St. Catherines Shell Ring	W82 S2	2.6-2.5	0.32 cm
1280	St. Catherines Shell Ring	W82 S2	2.6-2.5	0.32 cm
1390	St. Catherines Shell Ring	W82 S2	2.5-2.4	0.32 cm
1391	St. Catherines Shell Ring	W82 S2	2.5-2.4	0.32 cm
1401	St. Catherines Shell Ring	W82 S2	2.4-2.3	0.32 cm
1406	St. Catherines Shell Ring	W82 S2	2.3-2.2	0.32 cm
1452	St. Catherines Shell Ring	W82 S2	2.2-2.1	0.32 cm
1455	St. Catherines Shell Ring	W82 S2	2.1-2.0	0.32 cm
1464	St. Catherines Shell Ring	W82 S2	2.0-1.9	0.32 cm
1465	St. Catherines Shell Ring	W82 S2	2.0-1.9	0.32 cm
1468	St. Catherines Shell Ring	W82 S2	1.9-1.8	0.32 cm
1469	St. Catherines Shell Ring	W82 S2	1.9-1.8	0.32 cm
1472	St. Catherines Shell Ring	W82 S2	1.8-1.7	0.32 cm
1474	St. Catherines Shell Ring	W82 S2	1.8-1.7	0.32 cm
3058	St. Catherines Shell Ring	W84 S2	2.8-2.7	0.32 cm
3058	St. Catherines Shell Ring	W84 S2	2.8-2.7	0.32 cm
3057	St. Catherines Shell Ring	W84 S2	2.7-2.6	0.32 cm
3057	St. Catherines Shell Ring	W84 S2	2.7-2.6	0.32 cm
3043	St. Catherines Shell Ring	W84 S2	2.6-2.5	0.32 cm
3053	St. Catherines Shell Ring	W84 S2	2.5-2.4	0.32 cm
3048	St. Catherines Shell Ring	W84 S2	2.4-2.3	0.32 cm
3044	St. Catherines Shell Ring	W84 S2	2.4-2.3	0.32 cm
3041	St. Catherines Shell Ring	W84 S2	2.3-2.2	0.32 cm
2119	St. Catherines Shell Ring	Feature 5	2.1-2.0	0.32 cm
2293	St. Catherines Shell Ring	Feature 5	2.0-1.9	0.32 cm
2294	St. Catherines Shell Ring	Feature 5	2.0-1.9	0.32 cm
2321	St. Catherines Shell Ring	Feature 5	2.0-1.9	0.32 cm
2322	St. Catherines Shell Ring	Feature 5	2.0-1.9	0.32 cm

APPENDIX A—(*Continued*)

Bag/Field Number	Site	Unit	Level	Screen size
2295	St. Catherines Shell Ring	Feature 5	2.0-1.9	0.32 cm
2296	St. Catherines Shell Ring	Feature 5	2.0-1.9	0.32 cm
2298	St. Catherines Shell Ring	Feature 5	2.0-1.9	0.32 cm
2598	St. Catherines Shell Ring	Feature 5	1.9-1.8	0.32 cm
2588	St. Catherines Shell Ring	Feature 5	1.9-1.8	0.32 cm
2544	St. Catherines Shell Ring	Feature 5	1.9-1.8	0.32 cm
2816	St. Catherines Shell Ring	Feature 5	1.8-1.7	0.32 cm
2959	St. Catherines Shell Ring	Feature 5	1.5-1.4	0.32 cm
2960	St. Catherines Shell Ring	Feature 5	1.4-1.3	0.32 cm
2961	St. Catherines Shell Ring	Feature 5	1.3-1.2	0.32 cm
2089	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2213	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2107	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2232	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2233	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2235	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2237	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2238	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2239	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2240	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2241	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2243	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2244	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2245	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2246	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2247	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2248	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2249	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2251	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2252	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2253	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2254	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2255	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2256	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2257	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2258	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2259	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2260	St. Catherines Shell Ring	Feature 23	2.1-2.0	0.32 cm
2497	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2501	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm

APPENDIX A—(*Continued*)

Bag/Field Number	Site	Unit	Level	Screen size
2366	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2368	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2372	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2374	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2375	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2379	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2380	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2382	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2385	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2387	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2391	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2392	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2393	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2394	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2396	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2402	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2404	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2405	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2406	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2407	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2409	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2411	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2414	St. Catherines Shell Ring	Feature 23	2.0-1.9	0.32 cm
2500	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2475	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2476	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2476	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2479	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2480	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2482	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2483	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2485	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2487	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2488	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2490	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2492	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2493	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2494	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2495	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2548	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm

APPENDIX A—(*Continued*)

Bag/Field Number	Site	Unit	Level	Screen size
2521	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2522	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2523	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2524	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2481	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2528	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2529	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2530	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2531	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2532	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2537	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2538	St. Catherines Shell Ring	Feature 23	1.9-1.8	0.32 cm
2842	St. Catherines Shell Ring	Feature 23	1.8-1.7	0.32 cm
2818	St. Catherines Shell Ring	Feature 23	1.8-1.7	0.32 cm
2819	St. Catherines Shell Ring	Feature 23	1.8-1.7	0.32 cm
2820	St. Catherines Shell Ring	Feature 23	1.8-1.7	0.32 cm
2821	St. Catherines Shell Ring	Feature 23	1.8-1.7	0.32 cm
2823	St. Catherines Shell Ring	Feature 23	1.8-1.7	0.32 cm
2826	St. Catherines Shell Ring	Feature 23	1.8-1.7	0.32 cm
2827	St. Catherines Shell Ring	Feature 23	1.8-1.7	0.32 cm
2832	St. Catherines Shell Ring	Feature 23	1.8-1.7	0.32 cm
2834	St. Catherines Shell Ring	Feature 23	1.8-1.7	0.32 cm
2835	St. Catherines Shell Ring	Feature 23	1.8-1.7	0.32 cm
2837	St. Catherines Shell Ring	Feature 23	1.8-1.7	0.32 cm
2964	St. Catherines Shell Ring	Feature 23	1.7-1.6	0.32 cm
2966	St. Catherines Shell Ring	Feature 23	1.7-1.6	0.32 cm
2967	St. Catherines Shell Ring	Feature 23	1.6-1.5	0.32 cm
6668/6756	McQueen Shell Ring	N213 E198	Open-4.6	0.32 cm
6714/6757	McQueen Shell Ring	N213 E198	4.6-4.5	0.32 cm
6680/6758	McQueen Shell Ring	N213 E198	4.5-4.4	0.32 cm
6715	McQueen Shell Ring	N213 E198	4.4-4.3	0.32 cm
6682	McQueen Shell Ring	N213 E198	4.3-4.2	0.32 cm
6657/6774	McQueen Shell Ring	N263 E179	5.8-5.7	0.32 cm
6696/6775	McQueen Shell Ring	N263 E179	5.7-5.6	0.32 cm
6697/6776	McQueen Shell Ring	N263 E179	5.6-5.5	0.32 cm
6698/6777	McQueen Shell Ring	N263 E179	5.5-5.4	0.32 cm
6735/6778	McQueen Shell Ring	N263 E179	5.4-5.3	0.32 cm
6745/6779	McQueen Shell Ring	N263 E179	5.3-5.17	0.32 cm
6748/6780	McQueen Shell Ring	N263 E179	5.24-5.1	0.32 cm

APPENDIX B

IDENTIFIED TAXA AND CLASSIFICATIONS

Taxa	Common Name	Habitat Type	Body Size	Capture Type
Carcharhinidae	Requiem sharks	Estuarine	Large	Individual
Galeocerdo cuvieri	Tiger shark	Estuarine	Large	Individual
Sphyrna sp.	Bonnethead shark	Estuarine	Large	Individual
Raja eglanteria	Clearnose skate	Estuarine	Large	Individual
Myliobatiformes	Rays	Estuarine	Large	Individual
Myliobatidae	Eagle rays	Estuarine	Large	Individual
Dasyatidae	Stingrays	Estuarine	Large	Individual
Rhinoptera bonasus	Cownose ray	Estuarine	Large	Individual
Lepisosteus sp.	Gar	Aquatic	Large	Individual
Amia calva	Bowfin	Freshwater	Large	Individual
Elops saurus	Ladyfish	Estuarine	Small	Mass
Anguilla rostrata	American eel	Aquatic	Large	Individual
Clupeidae	Herrings and shads	Aquatic	Small	Mass
Ictaluridae	Freshwater catfish	Aquatic	Large	Individual
Ameiurus sp.	Bullhead catfish	Aquatic	Large	Individual
Ariidae	Sea catfish	Estuarine	Large	Mass
Ariopsis felis	Hardhead catfish	Estuarine	Large	Mass
Bagre marinus	Gafftopsail catfish	Estuarine	Large	Mass
Ophidiidae	Cusk-eels	Estuarine	Small	Individual
Opsanus sp.	Toadfish	Estuarine	Small	Individual
Mugil sp.	Mullet	Estuarine	Small	Mass
Belonidae	Needlefishes	Estuarine	Small	Individual
Cyprinodontidae	Killifishes	Estuarine	Small	Mass
Fundulus sp.	Killifish	Estuarine	Small	Mass
Chaenobryttus gulosus	Warmouth	Aquatic	Small	Individual
Lepomis sp.	Sunfish	Aquatic	Small	Individual
Pomatomus saltatrix	Bluefish	Estuarine	Large	Individual
Carangidae	Jacks and pompanos	Estuarine	Large	Individual
Orthopristis chrysoptera	Pigfish	Estuarine	Small	Mass
Archosargus probatocephalus	Sheepshead	Estuarine	Large	Individual
Lagodon rhomboides	Pinfish	Estuarine	Small	Mass
Bairdiella chrysoura	Silver perch	Estuarine	Small	Mass
Cynoscion sp.	Seatrout	Estuarine	Large	Individual
Larimus fasciatus	Banded drum	Estuarine	Small	Mass
Leiostomus xanthurus	Spot	Estuarine	Small	Mass
Menticirrhus sp.	Kingfish	Estuarine	Large	Individual
Menticirrhus americanus	Southern kingfish	Estuarine	Large	Individual
Micropogonias unduluatus	Atlantic croaker	Estuarine	Small	Mass
Pogonias cromis	Black drum	Estuarine	Large	Individual
Sciaenops ocellatus	Red drum	Estuarine	Large	Individual
Stellifer lanceolatus	Star drum	Estuarine	Small	Mass

APPENDIX B—(*Continued*)

Taxa	Common Name	Habitat Type	Body Size	Capture Type
Chaetodipterus faber	Atlantic spadefish	Estuarine	Small	Individual
Peprilus sp.	Harvest and butterfish	Estuarine	Small	Mass
Peprilus paru	Harvest fish	Estuarine	Small	Mass
Prionotus sp.	Searobin	Estuarine	Small	Mass
Paralichthyidae	Sand flounders	Estuarine	Large	Individual
Citharichthys sp.	Whiff	Estuarine	Small	Individual
Paralichthys sp.	Southern flounders	Estuarine	Large	Individual
Symphurus sp.	Tonguefish	Estuarine	Small	Individual
Amphibia	Indeterminate amphibians	Commensal		
Anura	Frogs and toads	Commensal		
Bufo sp.	Toad	Commensal		
Scaphiopus holbrookii	Eastern spadefoot toad	Commensal		
Rana spp.	Bullfrog	Commensal		
Caudata	Newts and salamanders	Commensal		
Alligator mississippiensis	American alligator	Terrestrial		
Testudines	Indeterminate turtles	Commensal		
Chelydra serpentina	Snapping turtle	Terrestrial		
Kinosternidae	Mud and musk turtles	Terrestrial		
Kinosternon sp.	Mud turtle	Terrestrial		
Sternotherus sp.	Musk turtle	Terrestrial		
Deirochelys reticularia	Chicken turtles	Terrestrial		
Malaclemys terrapin	Diamondback terrapin	Terrestrial		
Pseudemys sp.	Cooter	Terrestrial		
Trachemys sp.	Pond slider	Terrestrial		
Gopherus polyphemus	Gopher tortoise	Terrestrial		
Lacertilia	Indeterminate lizards	Commensal		
Anolis carolinensis	Green anole	Commensal		
Serpentes	Indeterminate snakes	Commensal		
Colubridae	Non-venomous snakes	Commensal		
Coluber constrictor	Black racer	Terrestrial		
Lampropeltis sp.	Kingsnake	Terrestrial		
Nerodia sp.	Water snake	Aquatic		
Viperidae	Venomous snakes	Terrestrial		
Aves	Indeterminate birds	Commensal		
Gavia sp.	Loon	Aquatic		
Ardeidae	Herons	Aquatic		
Ardea herodias	Great blue heron	Aquatic		
Anatidae	Ducks, geese, and swans	Aquatic		
Accipitridae	Eagles, hawks, and kites	Terrestrial		
Buteo lineatus	Red-shouldered hawk	Terrestrial		
Meleagris gallopavo	Turkey	Terrestrial		
Rallidae	Coots and rails	Aquatic		

APPENDIX B—(*Continued*)

Taxa	Common Name	Habitat Type	Body Size	Capture Type
Laridae	Gulls and terns	Aquatic		
Passeriformes	Perching birds	Terrestrial		
Didelphis virginiana	Opossum	Terrestrial		
Soricidae	Shrews	Commensal		
Blarina brevicauda	Short-tailed shrew	Commensal		
Cryptotis parva	Least shrew	Commensal		
Scalopus aquaticus	Eastern mole	Commensal		
Sylvilagus sp.	Cottontail rabbit	Terrestrial		
Glaucomys volan	Southern flying squirrel	Commensal		
Sciurus sp.	Squirrel	Terrestrial		
Sciurus carolinensis	Gray squirrel	Terrestrial		
Microtus pinetorum	Pine vole	Commensal		
Sigmodontinae	New World mice and rats	Commensal		
Neotoma floridana	Eastern woodrat	Terrestrial		
Orzomys sp.	Rice rat	Commensal		
Peromyscus sp.	New World mouse	Commensal		
Sigmodon hispidus	Hispid cotton rat	Commensal		
Canis familiaris	Dog	Terrestrial		
Procyon lotor	Raccoon	Terrestrial		
Lontra canadensis	Otter	Aquatic		
Neovison vison	Mink	Aquatic		
Odocoileus virginianus	White-tailed deer	Terrestrial		

APPENDIX C

LATE ARCHAIC SHELL RINGS: FISH MEASUREMENTS

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Clupeidae	St. Catherines	N784 E801	70-80 cm	Atlas				3.92	
Clupeidae	St. Catherines	N784 E801	80-90 cm	Atlas				3.88	
Clupeidae	St. Catherines	N789 E801	20-30 cm	Atlas				2.78	
Clupeidae	St. Catherines	N789 E801	80-90 cm	Atlas				3.92	
Clupeidae	St. Catherines	N784 E811	30-40 cm	Atlas				3.62	
Clupeidae	St. Catherines	N784 E811	50-60 cm	Atlas				4.97	
Clupeidae	St. Catherines	N784 E797	60-70 cm	Atlas				4.63	
Clupeidae	St. Catherines	W82 S2	2.1-2.0	Atlas				4.54	
Clupeidae	St. Catherines	N771 E819	2.2-2.1	Atlas				2.87	
Clupeidae	St. Catherines	N784 E801	40-50 cm	2nd Cervical				3.91	
Clupeidae	St. Catherines	N784 E801	60-70 cm	2nd Cervical				2.75	
Clupeidae	St. Catherines	N784 E811	20-30 cm	2nd Cervical				5.05	
Clupeidae	St. Catherines	N784 E811	20-30 cm	2nd Cervical				4.06	
Clupeidae	St. Catherines	N784 E811	30-40 cm	2nd Cervical				4.17	
Clupeidae	St. Catherines	N784 E811	50-60 cm	2nd Cervical				5.33	
Clupeidae	St. Catherines	N784 E797	0-10 cm	2nd Cervical				3.75	
Clupeidae	St. Catherines	N784 E797	20-30 cm	2nd Cervical				4.48	
Clupeidae	St. Catherines	N784 E797	50-60 cm	2nd Cervical				3.06	
Clupeidae	St. Catherines	W82 S2	2.1-2.0	2nd Cervical				4.22	
Ariidae	Cannon's Point	18N 0E	L1	Otolith	Right		14.68	12.91	7.07
Ariidae	Cannon's Point	18N 0E	L6	Otolith	Right		12.70	11.17	5.88
Ariidae	Cannon's Point	18N 0E	L13	Otolith	Right		7.53	7.05	3.35
Ariidae	Cannon's Point	18N 0E	L14	Otolith	Right		13.55	11.17	5.62
Ariidae	Cannon's Point	18N 0E	L16	Otolith	Right		12.66	10.96	5.76
Ariidae	Cannon's Point	18N 0E	L20	Otolith	Right		14.34	12.51	6.56
Ariidae	Cannon's Point	18N 0E	L21	Otolith	Right		12.55	10.25	5.41
Ariidae	Cannon's Point	18N 0E	L23	Otolith	Right		13.95	11.35	6.67
Ariidae	Cannon's Point	18N 0E	L24	Otolith	Right		12.42	10.28	5.36
Ariidae	Cannon's Point	18N 0E	L24	Otolith	Right		6.76	5.69	2.63
Ariidae	Cannon's Point	18N 0E	L26	Otolith	Right		13.45	11.34	5.69
Ariidae	Cannon's Point	18N 0E	L27	Otolith	Right		14.54	12.43	6.08
Ariidae	Cannon's Point	18N 0E	L30	Otolith	Right		14.63	12.37	6.68

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Ariidae	Cannon's Point	18N 0E	L33	Otolith	Right		11.15	9.53	4.83
Ariidae	Cannon's Point	18N 0E	L33	Otolith	Right		9.75	7.88	4.45
Ariidae	Cannon's Point	18N 0E	L33	Otolith	Right		8.56	8.27	4.09
Ariidae	Cannon's Point	18N 0E	L33	Otolith	Right		10.28	8.88	4.80
Ariidae	Cannon's Point	18N 0E	L33	Otolith	Right		8.08	7.56	4.62
Ariidae	Cannon's Point	18N 0E	L33	Otolith	Right		8.11	6.54	4.17
Ariidae	Cannon's Point	18N 0E	L33	Otolith	Right		9.76	7.99	4.23
Ariidae	Cannon's Point	18N 0E	L33	Otolith	Right		7.66	6.70	3.52
Ariidae	Cannon's Point	18N 0E	L33a	Otolith	Right		7.69	7.14	3.82
Ariidae	Cannon's Point	18N 0E	L34	Otolith	Right		12.81	10.79	6.13
Ariidae	Cannon's Point	18N 0E	L34	Otolith	Right		11.29	9.67	4.47
Ariidae	Cannon's Point	18N 0E	L34	Otolith	Right		9.89	8.83	4.26
Ariidae	Cannon's Point	18N 0E	L34	Otolith	Right		7.55	7.19	4.00
Ariidae	West	5S 30E	ZII L1	Otolith	Right		10.94	9.21	4.79
Ariidae	West	5S 30E	ZII L2	Otolith	Right		13.99	12.02	6.06
Ariidae	West	5S 30E	ZII L2	Otolith	Right		8.75	7.18	3.73
Ariidae	West	5S 30E	ZII L3	Otolith	Right		6.31	5.31	2.50
Ariidae	West	5S 30E	ZII L3	Otolith	Right		8.34	7.42	3.78
Ariidae	West	5S 30E	ZII L3	Otolith	Right		8.78	7.76	3.99
Ariidae	West	5S 30E	ZII L5	Otolith	Right		15.63	12.97	6.99
Ariidae	West	5S 30E	ZII L5	Otolith	Right		9.57	9.10	4.02
Ariidae	West	5S 30E	ZII L5	Otolith	Right		6.29	5.46	2.39
Ariidae	West	5S 30E	ZII L5	Otolith	Right		6.44	5.47	2.24
Ariidae	West	5S 30E	ZII L5	Otolith	Right		6.19	5.32	2.46
Ariidae	West	5S 30E	ZII L5	Otolith	Right		5.92	4.83	2.10
Ariidae	West	5S 30E	L6	Otolith	Right		10.03	9.37	4.76
Ariidae	West	5S 30E	L6	Otolith	Right		8.33	7.30	3.72
Ariidae	West	5S 30E	L6	Otolith	Right		8.59	7.69	3.84
Ariidae	West	5S 30E	L6	Otolith	Right		6.56	5.56	2.41
Ariidae	West	5S 30E	L6	Otolith	Right		5.96	5.12	2.43
Ariidae	West	5S 30E	L6	Otolith	Right		8.55	7.36	3.75
Ariidae	West	5S 30E	L7	Otolith	Right		8.76	7.35	3.80
Ariidae	West	5S 30E	L8	Otolith	Right		14.02	12.18	6.67
Ariidae	West	5S 30E	L9	Otolith	Right		11.67	10.10	5.31

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Ariidae	West	5S 30E	L9	Otolith	Right		7.96	6.88	3.86
Ariidae	West	5S 30E	L10	Otolith	Right		6.89	7.65	3.34
Ariidae	Sapelo	4	2	Otolith	Right		11.85	9.79	5.16
Ariidae	Sapelo	4	2	Otolith	Right	9.28	8.16	7.52	3.53
Ariidae	Sapelo	4	3	Otolith	Right	12.09	10.98	9.76	4.63
Ariidae	Sapelo	4	3	Otolith	Right	13.78	12.34	10.94	6.30
Ariidae	Sapelo	4	4	Otolith	Right	8.46	7.79	7.11	3.65
Ariidae	Sapelo	4	4	Otolith	Right	8.91	7.82	7.21	3.57
Ariidae	Sapelo	4	4	Otolith	Right	8.57	7.64	7.02	3.37
Ariidae	Sapelo	4	4	Otolith	Right	16.12	14.81	13.13	6.56
Ariidae	Sapelo	4	4	Otolith	Right	9.82	8.73	7.93	3.90
Ariidae	Sapelo	4	4	Otolith	Right	9.04	7.85	7.38	3.42
Ariidae	Sapelo	4	4	Otolith	Right	9.15	8.28	7.44	3.60
Ariidae	Sapelo	4	4	Otolith	Right	9.67	8.52	7.79	4.37
Ariidae	Sapelo	4	4	Otolith	Right	9.98	8.37	7.76	4.00
Ariidae	Sapelo	4	4	Otolith	Right	9.07	8.12	7.55	3.69
Ariidae	Sapelo	4	4	Otolith	Right	8.20	7.47	6.88	3.19
Ariidae	Sapelo	4	4	Otolith	Right	8.79	7.52	6.84	3.42
Ariidae	Sapelo	4	4	Otolith	Right	6.37	6.41	5.20	2.34
Ariidae	Sapelo	4	4	Otolith	Right	8.50	7.50	6.87	3.43
Ariidae	Sapelo	4	4	Otolith	Right	8.20	7.60	7.09	3.19
Ariidae	Sapelo	4	4	Otolith	Right	9.05	8.10	7.50	3.94
Ariidae	Sapelo	4	4	Otolith	Right	8.46	7.52	6.98	3.39
Ariidae	Sapelo	4	4	Otolith	Right	8.46	7.90	7.22	3.37
Ariidae	Sapelo	4	4	Otolith	Right	9.37	8.38	7.81	3.54
Ariidae	Sapelo	4	5	Otolith	Right	10.11	9.56	8.80	
Ariidae	Sapelo	4	5	Otolith	Right	10.08	9.07	8.29	4.16
Ariidae	Sapelo	4	6	Otolith	Right		9.14	8.81	4.05
Ariidae	Sapelo	4	6	Otolith	Right	10.92	9.50	8.75	4.65
Ariidae	Sapelo	9	10-15 cm	Otolith	Right	7.91	7.08	6.33	3.53
Ariidae	Sapelo	9	10-15 cm	Otolith	Right	7.35	6.53	6.06	3.16
Ariidae	Sapelo	9	15-20 cm	Otolith	Right	5.71	5.34	4.76	2.56
Ariidae	Sapelo	9	15-20 cm	Otolith	Right	7.53	6.82	6.23	3.07
Ariidae	Sapelo	9	15-20 cm	Otolith	Right	5.42	4.81	4.38	2.29

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Ariidae	Sapelo	9	20-25 cm	Otolith	Right	4.78	4.38	3.44	1.36
Ariidae	Sapelo	9	20-25 cm	Otolith	Right	5.32	4.73	4.33	1.96
Ariidae	Sapelo	9	20-25 cm	Otolith	Right	5.65	4.95	4.41	2.12
Ariidae	Sapelo	9	20-25 cm	Otolith	Right		5.36	4.85	2.06
Ariidae	Sapelo	9	20-25 cm	Otolith	Right	5.14	4.77	4.13	1.87
Ariidae	Sapelo	9	20-25 cm	Otolith	Right	8.59	7.65	7.15	3.50
Ariidae	Sapelo	9	20-25 cm	Otolith	Right	8.12	7.36	6.76	3.56
Ariidae	Sapelo	9	20-25 cm	Otolith	Right	9.09	7.90	7.31	3.66
Ariidae	Sapelo	9	20-25 cm	Otolith	Right	8.15	7.34	6.57	3.44
Ariidae	Sapelo	9	20-25 cm	Otolith	Right	8.34	7.18	6.60	3.98
Ariidae	Sapelo	9	20-25 cm	Otolith	Right	8.78	7.97	7.67	4.16
Ariidae	Sapelo	9	20-25 cm	Otolith	Right	7.35	6.70	6.10	3.43
Ariidae	Sapelo	9	25-30 cm	Otolith	Right	7.80	7.03	6.32	3.12
Ariidae	Sapelo	9	25-30 cm	Otolith	Right	9.57	8.31	7.70	3.91
Ariidae	Sapelo	9	40-45 cm	Otolith	Right	5.96	5.21	4.80	2.33
Ariidae	Sapelo	9	45-50 cm	Otolith	Right	8.55	7.72	7.08	3.51
Ariidae	Sapelo	9	45-50 cm	Otolith	Right	6.36	5.69	5.00	2.51
Ariidae	Sapelo	9	45-50 cm	Otolith	Right	5.89	5.05	4.63	2.19
Ariidae	Sapelo	9	45-50 cm	Otolith	Right	5.35	4.63	4.23	2.15
Ariidae	Sapelo	9	45-50 cm	Otolith	Right	5.95	5.22	4.79	2.05
Ariidae	Sapelo	9	65-70 cm	Otolith	Right	9.07	8.20	7.17	3.58
Ariidae	Sapelo	9	65-70 cm	Otolith	Right	8.24	7.71	7.18	3.74
Ariidae	St. Catherines	N784 E801	10-20 cm	Otolith	Right	8.76	7.70	7.16	3.44
Ariidae	St. Catherines	N784 E801	10-20 cm	Otolith	Right	7.10	6.48	5.80	2.95
Ariidae	St. Catherines	N784 E801	30-40 cm	Otolith	Right	7.45	6.83	6.09	2.99
Ariidae	St. Catherines	N784 E801	60-70 cm	Otolith	Right	7.28	6.46	5.78	2.84
Ariidae	St. Catherines	N784 E811	20-30 cm	Otolith	Right	12.23	11.22	9.87	4.89
Ariidae	St. Catherines	N784 E811	20-30 cm	Otolith	Right	7.58	6.75	6.03	2.98
Ariidae	St. Catherines	N789 E801	0-10 cm	Otolith	Right	13.63	12.31	10.89	5.47
Ariidae	St. Catherines	N789 E801	20-30 cm	Otolith	Right	10.65	9.50	8.73	5.32
Ariidae	St. Catherines	N789 E801	20-30 cm	Otolith	Right	9.71	8.70	8.31	3.85
Ariidae	St. Catherines	N789 E801	20-30 cm	Otolith	Right	7.90	7.04	6.54	3.13
Ariidae	St. Catherines	N789 E801	30-40 cm	Otolith	Right	8.17	7.13	6.31	3.34
Ariidae	St. Catherines	N784 E811	30-40 cm	Otolith	Right	13.68	12.67	11.16	5.44

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Ariidae	St. Catherines	N784 E797	40-50 cm	Otolith	Right	8.82	8.13	7.50	3.92
Ariidae	St. Catherines	N784 E797	86-96 cm	Otolith	Right	15.18	13.14	11.82	6.42
Ariidae	St. Catherines	W82 S2	2.9-2.8	Otolith	Right	9.68	8.63	7.61	4.01
Ariidae	St. Catherines	W82 S2	2.8-2.7	Otolith	Right		6.97	6.28	2.95
Ariidae	St. Catherines	W82 S2	2.7-2.6	Otolith	Right	6.00	5.67	4.61	1.89
Ariidae	St. Catherines	W82 S2	2.5-2.4	Otolith	Right	6.65	5.75	5.33	2.58
Ariidae	St. Catherines	W82 S2	2.5-2.4	Otolith	Right	7.48	6.82	6.32	3.30
Ariidae	St. Catherines	W82 S2	2.5-2.4	Otolith	Right	8.73	7.91	7.02	3.59
Ariidae	St. Catherines	W82 S2	2.4-2.3	Otolith	Right	14.56	13.08	11.67	6.34
Ariidae	St. Catherines	W82 S2	2.0-1.9	Otolith	Right	5.95	5.55	4.51	1.82
Ariidae	St. Catherines	W84 S2	2.8-2.7	Otolith	Right	14.27	13.20	11.55	5.93
Ariidae	St. Catherines	W84 S2	2.8-2.7	Otolith	Right	7.19	6.28	5.80	3.07
Ariidae	St. Catherines	W84 S2	2.7-2.6	Otolith	Right	8.47	7.57	7.03	3.71
Ariidae	St. Catherines	W84 S2	2.7-2.6	Otolith	Right		9.47	8.79	4.30
Ariidae	St. Catherines	W84 S2	2.6-2.5	Otolith	Right	10.06	9.16	8.07	4.30
Ariidae	St. Catherines	N771 E819	Surface-2.6	Otolith	Right		6.16	5.83	2.83
Ariidae	St. Catherines	N771 E819	Surface-2.6	Otolith	Right	6.53	5.89	4.93	2.20
Ariidae	St. Catherines	N771 E819	Surface-2.6	Otolith	Right		6.50	6.04	3.12
Ariidae	St. Catherines	N771 E819	2.6-2.5	Otolith	Right		10.07	8.19	5.16
Ariidae	St. Catherines	N771 E819	2.6-2.5	Otolith	Right	6.05	5.75	5.33	2.34
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Right	14.57	13.08	11.55	6.39
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Right	8.07	7.11	6.43	3.79
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Right				2.71
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Right	6.30	5.63	5.07	2.88
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Right	7.57	6.86	6.44	3.00
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Right	4.69	4.33	3.52	1.21
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Right	7.72	7.11	6.25	3.40
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Right	8.06	7.14	6.46	3.32
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Right	6.27	5.60	5.32	2.78
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Right			6.16	2.97
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Right	6.19	5.64	5.18	2.42
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Right	7.66	6.94	6.65	3.18
Ariidae	McQueen	N 213 E 198	4.6-4.5	Otolith	Right	9.04	8.40	7.55	4.00
Ariidae	McQueen	N 213 E 198	4.6-4.5	Otolith	Right	6.86	6.03	5.58	2.75

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Ariidae	McQueen	N 213 E 198	4.6-4.5	Otolith	Right	6.20	6.05	4.96	2.18
Ariidae	McQueen	N 213 E 198	4.6-4.5	Otolith	Right	6.95	6.22	5.57	3.10
Ariidae	McQueen	N 213 E 198	4.6-4.5	Otolith	Right	8.60	7.66	7.11	3.58
Ariidae	McQueen	N 213 E 198	4.5-4.4	Otolith	Right	8.97	8.50	8.16	4.11
Ariidae	McQueen	N 213 E 198	4.5-4.4	Otolith	Right	8.34	7.52	7.04	3.64
Ariidae	McQueen	N263 E179	5.8-5.7	Otolith	Right	6.08	5.94	5.61	2.57
Ariidae	McQueen	N263 E179	5.8-5.7	Otolith	Right	7.11	6.75	5.38	2.45
Ariidae	McQueen	N263 E179	5.8-5.7	Otolith	Right	8.30	7.70	7.00	3.40
Ariidae	McQueen	N263 E179	5.8-5.7	Otolith	Right	6.95	6.31	5.90	2.81
Ariidae	McQueen	N263 E179	5.8-5.7	Otolith	Right	5.96	5.24	4.70	2.31
Ariidae	McQueen	N263 E179	5.7-5.6	Otolith	Right	4.56	3.83	3.58	1.58
Ariidae	McQueen	N263 E179	5.7-5.6	Otolith	Right	9.19	8.23	7.71	3.70
Ariidae	McQueen	N263 E179	5.7-5.6	Otolith	Right		9.53	8.90	4.31
Ariidae	McQueen	N263 E179	5.7-5.6	Otolith	Right	5.96	5.41	4.84	2.36
Ariidae	McQueen	N263 E179	5.6-5.5	Otolith	Right	6.20	5.96	5.36	2.58
Ariidae	McQueen	N263 E179	5.6-5.5	Otolith	Right	7.36	6.44	5.89	2.64
Ariidae	McQueen	N263 E179	5.6-5.5	Otolith	Right	6.67	6.06	5.48	2.75
Ariidae	McQueen	N263 E179	5.6-5.5	Otolith	Right	7.68	6.87	6.80	3.20
Ariidae	McQueen	N263 E179	5.6-5.5	Otolith	Right	5.75	5.25	4.68	2.30
Ariidae	McQueen	N263 E179	5.5-5.4	Otolith	Right	6.83	6.22	5.50	2.79
Ariidae	McQueen	N263 E179	5.5-5.4	Otolith	Right	7.24	6.55	6.05	3.24
Ariidae	McQueen	N263 E179	5.5-5.4	Otolith	Right	7.99	7.01	6.40	3.33
Ariidae	McQueen	N263 E179	5.5-5.4	Otolith	Right	5.60	5.16	4.29	1.74
Ariidae	McQueen	N263 E179	5.4-5.3	Otolith	Right	8.52	7.51	6.81	3.75
Ariidae	McQueen	N263 E179	5.4-5.3	Otolith	Right	6.44	5.64	5.21	2.43
Ariidae	McQueen	N263 E179	5.4-5.3	Otolith	Right	5.13	4.71	4.44	2.13
Ariidae	McQueen	N263 E179	5.3-5.17	Otolith	Right	6.22	5.51	5.15	2.33
Ariidae	McQueen	N263 E179	5.3-5.17	Otolith	Right	8.04	7.04	6.47	3.37
Ariidae	McQueen	N263 E179	5.3-5.17	Otolith	Right	6.96	6.17	5.92	2.68
Ariidae	McQueen	N263 E179	5.3-5.17	Otolith	Right	9.16	8.06	7.50	4.18
Ariidae	McQueen	N263 E179	5.3-5.17	Otolith	Right	6.01	5.41	4.60	2.06
Ariidae	Cannon's Point	18N 0E	L18	Otolith	Left		12.66	10.80	5.43
Ariidae	Cannon's Point	18N 0E	L19	Otolith	Left		12.63	10.48	5.74
Ariidae	Cannon's Point	18N 0E	L21	Otolith	Left		12.41	10.45	5.57

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Ariidae	Cannon's Point	18N 0E	L21	Otolith	Left		7.42	6.14	3.08
Ariidae	Cannon's Point	18N 0E	L22	Otolith	Left		13.49	10.94	5.75
Ariidae	Cannon's Point	18N 0E	L22	Otolith	Left		6.71	5.75	2.54
Ariidae	Cannon's Point	18N 0E	L23	Otolith	Left		6.46	5.21	2.50
Ariidae	Cannon's Point	18N 0E	L25	Otolith	Left		8.80	8.20	3.66
Ariidae	Cannon's Point	18N 0E	L32	Otolith	Left		9.69	8.56	4.76
Ariidae	Cannon's Point	18N 0E	L33	Otolith	Left		14.09	12.60	7.05
Ariidae	Cannon's Point	18N 0E	L33	Otolith	Left		8.26	7.43	4.52
Ariidae	Cannon's Point	18N 0E	L33	Otolith	Left		10.17	8.45	4.48
Ariidae	Cannon's Point	18N 0E	L33	Otolith	Left		8.88	8.60	4.31
Ariidae	Cannon's Point	18N 0E	L33	Otolith	Left		7.20	7.03	3.78
Ariidae	Cannon's Point	18N 0E	L33	Otolith	Left		6.61	6.02	3.07
Ariidae	Cannon's Point	18N 0E	L34	Otolith	Left		10.40	9.54	3.97
Ariidae	Cannon's Point	18N 0E	L34	Otolith	Left		11.48	9.48	5.40
Ariidae	Cannon's Point	18N 0E	L34	Otolith	Left		8.89	7.92	3.71
Ariidae	West	5S 30E	ZII L1	Otolith	Left		9.32	8.78	4.49
Ariidae	West	5S 30E	ZII L1	Otolith	Left		10.90	9.23	4.81
Ariidae	West	5S 30E	ZII L2	Otolith	Left		8.42	7.52	3.68
Ariidae	West	5S 30E	ZII L5	Otolith	Left		6.58	5.76	2.38
Ariidae	West	5S 30E	ZII L5	Otolith	Left		6.52	5.29	2.33
Ariidae	West	5S 30E	L6	Otolith	Left		13.78	11.58	6.33
Ariidae	West	5S 30E	L6	Otolith	Left		6.54	5.53	2.64
Ariidae	West	5S 30E	L6	Otolith	Left		6.30	5.42	2.36
Ariidae	West	5S 30E	L6	Otolith	Left		9.50	8.86	4.04
Ariidae	West	5S 30E	L6	Otolith	Left		8.56	7.30	3.79
Ariidae	West	5S 30E	L6	Otolith	Left		8.96	7.70	3.82
Ariidae	West	5S 30E	L6	Otolith	Left		6.52	5.43	2.37
Ariidae	West	5S 30E	L6	Otolith	Left		6.73	5.59	2.38
Ariidae	West	5S 30E	L6	Otolith	Left		6.73	5.66	2.48
Ariidae	West	5S 30E	L6	Otolith	Left		6.63	5.40	2.43
Ariidae	West	5S 30E	L6	Otolith	Left		6.53	5.69	2.70
Ariidae	West	5S 30E	L7	Otolith	Left		6.68	5.48	2.41
Ariidae	West	5S 30E	L8	Otolith	Left		14.08	12.44	6.54
Ariidae	West	5S 30E	L8	Otolith	Left		14.75	12.68	6.91

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Ariidae	West	5S 30E	L8	Otolith	Left		8.58	7.33	3.48
Ariidae	West	5S 30E	L9	Otolith	Left		6.08	5.41	5.42
Ariidae	West	5S 30E	L9	Otolith	Left		8.79	7.17	4.07
Ariidae	Sapelo	4	2	Otolith	Left	9.32	8.43	7.47	3.64
Ariidae	Sapelo	4	2	Otolith	Left	11.95	11.42	10.23	5.72
Ariidae	Sapelo	4	3	Otolith	Left	10.58	9.67	8.45	4.29
Ariidae	Sapelo	4	3	Otolith	Left	11.95	10.78	9.33	4.53
Ariidae	Sapelo	4	3	Otolith	Left	8.56	7.67	7.13	3.40
Ariidae	Sapelo	4	3	Otolith	Left	9.87	8.42	7.77	3.88
Ariidae	Sapelo	4	3	Otolith	Left	8.08	7.66	6.98	3.31
Ariidae	Sapelo	4	3	Otolith	Left	8.21	8.13	7.41	3.49
Ariidae	Sapelo	4	4	Otolith	Left	8.59	7.74	7.04	3.39
Ariidae	Sapelo	4	4	Otolith	Left	8.26	7.70	7.17	3.74
Ariidae	Sapelo	4	4	Otolith	Left	5.49	5.08	4.72	2.09
Ariidae	Sapelo	4	4	Otolith	Left	8.68	7.82	7.15	3.78
Ariidae	Sapelo	4	4	Otolith	Left	8.78	7.69	6.99	3.43
Ariidae	Sapelo	4	4	Otolith	Left	9.09	8.04	7.48	4.06
Ariidae	Sapelo	4	4	Otolith	Left	7.41	6.79	6.13	3.38
Ariidae	Sapelo	4	4	Otolith	Left	7.94	6.89	6.23	3.37
Ariidae	Sapelo	4	4	Otolith	Left	9.90	8.45	7.71	3.99
Ariidae	Sapelo	4	4	Otolith	Left	8.81	8.06	7.34	3.95
Ariidae	Sapelo	4	4	Otolith	Left	9.75	8.46	7.73	4.42
Ariidae	Sapelo	4	4	Otolith	Left	9.60	8.35	8.27	4.32
Ariidae	Sapelo	4	4	Otolith	Left	9.91	8.47	7.71	3.45
Ariidae	Sapelo	4	4	Otolith	Left	9.39	8.46	7.73	4.00
Ariidae	Sapelo	4	4	Otolith	Left	9.51	8.55	7.71	4.00
Ariidae	Sapelo	4	4	Otolith	Left	9.00	8.21	7.43	3.78
Ariidae	Sapelo	4	4	Otolith	Left	8.91	8.02	7.47	3.99
Ariidae	Sapelo	4	4	Otolith	Left	9.73	8.67	7.91	4.01
Ariidae	Sapelo	4	5	Otolith	Left	8.72	7.89	7.35	3.41
Ariidae	Sapelo	4	5	Otolith	Left	9.23	8.09	7.53	3.73
Ariidae	Sapelo	4	5	Otolith	Left	8.37	7.49	6.89	3.78
Ariidae	Sapelo	4	5	Otolith	Left	7.84	7.11	6.47	3.23
Ariidae	Sapelo	4	5	Otolith	Left	9.55	8.65	8.08	3.76

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Ariidae	Sapelo	4	5	Otolith	Left	9.36	8.12	7.52	3.91
Ariidae	Sapelo	4	5	Otolith	Left	9.38	8.13	7.48	3.95
Ariidae	Sapelo	4	6	Otolith	Left	9.11	8.12	7.43	4.22
Ariidae	Sapelo	9	10-15 cm	Otolith	Left	7.47	7.36	6.66	3.26
Ariidae	Sapelo	9	10-15 cm	Otolith	Left	8.62	7.37	6.62	3.19
Ariidae	Sapelo	9	15-20 cm	Otolith	Left	5.32	4.82	4.40	2.28
Ariidae	Sapelo	9	15-20 cm	Otolith	Left	4.98	4.59	4.21	1.89
Ariidae	Sapelo	9	15-20 cm	Otolith	Left	8.06	7.02	6.41	3.04
Ariidae	Sapelo	9	15-20 cm	Otolith	Left	8.68	7.91	6.86	3.87
Ariidae	Sapelo	9	15-20 cm	Otolith	Left	7.57	6.88	6.19	3.25
Ariidae	Sapelo	9	15-20 cm	Otolith	Left	9.03	8.21	7.25	3.75
Ariidae	Sapelo	9	15-20 cm	Otolith	Left	6.97	6.25	5.78	3.01
Ariidae	Sapelo	9	15-20 cm	Otolith	Left	5.84	5.20	4.71	2.02
Ariidae	Sapelo	9	15-20 cm	Otolith	Left	8.71	7.87	7.18	3.33
Ariidae	Sapelo	9	20-25 cm	Otolith	Left	5.19	4.95	4.47	1.96
Ariidae	Sapelo	9	20-25 cm	Otolith	Left	5.66	4.97	4.48	2.00
Ariidae	Sapelo	9	20-25 cm	Otolith	Left	6.47	5.79	5.34	2.57
Ariidae	Sapelo	9	20-25 cm	Otolith	Left		4.42	3.57	1.37
Ariidae	Sapelo	9	20-25 cm	Otolith	Left	7.70	6.82	6.36	3.08
Ariidae	Sapelo	9	20-25 cm	Otolith	Left	8.37	7.47	6.57	3.82
Ariidae	Sapelo	9	20-25 cm	Otolith	Left		6.85	6.36	3.48
Ariidae	Sapelo	9	25-30 cm	Otolith	Left	9.41	8.25	7.54	3.98
Ariidae	Sapelo	9	25-30 cm	Otolith	Left	7.24	6.21	5.82	2.88
Ariidae	Sapelo	9	25-30 cm	Otolith	Left	8.81	7.96	7.41	3.92
Ariidae	Sapelo	9	25-30 cm	Otolith	Left	8.31	7.35	6.56	3.46
Ariidae	Sapelo	9	25-30 cm	Otolith	Left	8.08	7.24	6.46	3.55
Ariidae	Sapelo	9	40-45 cm	Otolith	Left	6.13	5.66	5.27	2.57
Ariidae	Sapelo	9	45-50 cm	Otolith	Left	8.57	7.44	6.87	3.27
Ariidae	Sapelo	9	45-50 cm	Otolith	Left	8.25	7.33	6.69	3.36
Ariidae	Sapelo	9	45-50 cm	Otolith	Left	5.79	5.09	4.58	2.23
Ariidae	Sapelo	9	45-50 cm	Otolith	Left	6.40	5.65	5.04	2.45
Ariidae	Sapelo	9	45-50 cm	Otolith	Left	6.02	5.39	4.98	2.21
Ariidae	St. Catherines	N784 E811	20-30 cm	Otolith	Left	7.41	6.86	5.98	3.10
					Left				

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Ariidae	St. Catherines	N784 E811	20-30 cm	Otolith	Left	7.95	7.16	6.59	3.39
Ariidae	St. Catherines	N784 E801	10-20 cm	Otolith	Left	9.38	8.28	7.68	3.89
Ariidae	St. Catherines	N784 E801	10-20 cm	Otolith	Left	5.07	4.49	4.10	1.91
Ariidae	St. Catherines	N784 E801	30-40 cm	Otolith	Left	8.28	7.57	6.98	3.80
Ariidae	St. Catherines	N784 E801	30-40 cm	Otolith	Left	8.58	7.83	7.05	3.56
Ariidae	St. Catherines	N784 E801	50-60 cm	Otolith	Left	7.16	6.55	5.95	3.02
Ariidae	St. Catherines	N789 E801	0-10 cm	Otolith	Left	7.91	7.36	6.72	3.66
Ariidae	St. Catherines	N789 E801	10-20 cm	Otolith	Left	9.76	8.73	7.86	4.02
Ariidae	St. Catherines	N789 E801	20-30 cm	Otolith	Left	9.52	8.70	7.99	3.83
Ariidae	St. Catherines	N789 E801	20-30 cm	Otolith	Left	8.09	7.53	6.87	3.58
Ariidae	St. Catherines	N789 E801	20-30 cm	Otolith	Left	10.72	9.41	8.64	4.99
Ariidae	St. Catherines	N789 E801	20-30 cm	Otolith	Left	9.32	8.38	7.79	4.39
Ariidae	St. Catherines	N789 E801	30-40 cm	Otolith	Left		9.17	7.62	3.77
Ariidae	St. Catherines	N789 E801	30-40 cm	Otolith	Left	9.85	8.73	8.09	4.40
Ariidae	St. Catherines	N789 E801	30-40 cm	Otolith	Left	8.71	7.70	7.19	3.50
Ariidae	St. Catherines	N784 E797	0-10 cm	Otolith	Left	7.39	6.48	6.02	3.21
Ariidae	St. Catherines	N784 E797	10-20 cm	Otolith	Left	5.00	4.71	3.83	1.49
Ariidae	St. Catherines	N784 E797	10-20 cm	Otolith	Left	5.78	5.35	4.85	2.34
Ariidae	St. Catherines	N784 E797	10-20 cm	Otolith	Left	5.62	4.99	4.41	2.12
Ariidae	St. Catherines	N784 E797	20-30 cm	Otolith	Left	8.08	7.61	6.24	3.40
Ariidae	St. Catherines	N784 E797	20-30 cm	Otolith	Left	5.14	5.15	4.01	1.67
Ariidae	St. Catherines	N784 E797	40-50 cm	Otolith	Left	9.22	8.09	7.14	3.62
Ariidae	St. Catherines	N784 E797	50-60 cm	Otolith	Left	13.38	12.71	11.26	5.82
Ariidae	St. Catherines	W82 S2	2.9-2.8	Otolith	Left	5.96	5.69	4.57	2.03
Ariidae	St. Catherines	W82 S2	2.7-2.6	Otolith	Left	8.50	7.66	6.97	3.42
Ariidae	St. Catherines	N771 E819	Surface-2.6	Otolith	Left	8.99	8.24	7.72	3.96
Ariidae	St. Catherines	N771 E819	Surface-2.6	Otolith	Left	8.60	7.80	7.16	3.59
Ariidae	St. Catherines	N771 E819	Surface-2.6	Otolith	Left		7.99	7.53	3.76
Ariidae	St. Catherines	N771 E819	2.6-2.5	Otolith	Left	7.62	7.01	6.35	3.52
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Left	6.10	5.36	4.94	2.41
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Left	6.96	6.09	6.16	3.01
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Left	8.41	7.76	8.19	4.07
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Left	8.13	7.01	6.21	3.50
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Left	7.72	6.86	5.98	3.16

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Left	6.59	6.18	5.58	2.68
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Left	8.98	8.25	7.31	3.47
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Left	8.82	7.88	7.38	3.61
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Left	8.55	7.69	7.11	3.63
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Left	7.68	7.26	6.75	3.63
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Left		6.35	5.82	2.84
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Left	6.44	6.28	5.14	2.32
Ariidae	McQueen	N 213 E 198	Open-4.6	Otolith	Left	6.41	5.70	5.25	2.62
Ariidae	McQueen	N 213 E 198	4.6-4.5	Otolith	Left	9.60	8.48	7.76	3.99
Ariidae	McQueen	N 213 E 198	4.6-4.5	Otolith	Left	6.93	6.35	6.07	2.84
Ariidae	McQueen	N 213 E 198	4.6-4.5	Otolith	Left	7.30	6.81	6.27	3.06
Ariidae	McQueen	N 213 E 198	4.6-4.5	Otolith	Left	8.48	7.62	6.72	3.36
Ariidae	McQueen	N 213 E 198	4.6-4.5	Otolith	Left	9.30	8.33	7.77	3.88
Ariidae	McQueen	N 213 E 198	4.6-4.5	Otolith	Left	6.55	6.02	5.32	2.75
Ariidae	McQueen	N 213 E 198	4.5-4.4	Otolith	Left	6.15	5.34	4.82	2.51
Ariidae	McQueen	N 213 E 198	4.5-4.4	Otolith	Left	7.63	6.88	6.18	2.98
Ariidae	McQueen	N 213 E 198	4.5-4.4	Otolith	Left	4.93	4.28	3.83	1.58
Ariidae	McQueen	N263 E179	5.8-5.7	Otolith	Left	5.13	4.55	4.11	1.84
Ariidae	McQueen	N263 E179	5.8-5.7	Otolith	Left	7.40	6.87	5.85	2.68
Ariidae	McQueen	N263 E179	5.8-5.7	Otolith	Left	5.08	4.47	4.04	1.97
Ariidae	McQueen	N263 E179	5.7-5.6	Otolith	Left		13.77	11.83	6.35
Ariidae	McQueen	N263 E179	5.7-5.6	Otolith	Left	7.31	6.55	6.12	3.17
Ariidae	McQueen	N263 E179	5.7-5.6	Otolith	Left	5.89	5.23	4.82	2.25
Ariidae	McQueen	N263 E179	5.6-5.5	Otolith	Left	6.93	6.17	5.57	2.90
Ariidae	McQueen	N263 E179	5.6-5.5	Otolith	Left	6.13	5.72	4.63	2.07
Ariidae	McQueen	N263 E179	5.6-5.5	Otolith	Left	5.52	5.03	3.99	1.61
Ariidae	McQueen	N263 E179	5.5-5.4	Otolith	Left	12.79	11.63	10.50	6.09
Ariidae	McQueen	N263 E179	5.5-5.4	Otolith	Left	5.77	5.08	4.60	2.05
Ariidae	McQueen	N263 E179	5.5-5.4	Otolith	Left	5.59	4.88	4.41	1.98
Ariidae	McQueen	N263 E179	5.4-5.3	Otolith	Left	15.60	14.23	12.62	6.53
Ariidae	McQueen	N263 E179	5.4-5.3	Otolith	Left	7.39	6.47	5.94	2.93
Ariidae	McQueen	N263 E179	5.4-5.3	Otolith	Left	9.11	8.25	7.46	3.91
Ariidae	McQueen	N263 E179	5.4-5.3	Otolith	Left	8.18	7.24	6.49	3.32
Ariidae	McQueen	N263 E179	5.4-5.3	Otolith	Left	6.49	5.72	5.21	2.58

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Ariidae	McQueen	N263 E179	5.4-5.3	Otolith	Left	6.85	6.37	5.60	3.03
Ariidae	McQueen	N263 E179	5.3-5.17	Otolith	Left	9.25	8.11	7.45	4.11
Ariidae	McQueen	N263 E179	5.3-5.17	Otolith	Left	7.05	6.55	5.85	3.09
Ariidae	McQueen	N263 E179	5.3-5.17	Otolith	Left	6.29	5.51	5.00	2.25
Ariidae	McQueen	N263 E179	5.3-5.17	Otolith	Left	5.21	5.16	4.02	1.84
Ariidae	McQueen	N263 E179	5.3-5.17	Otolith	Left	5.63	5.15	4.26	1.81
Ariidae	McQueen	N263 E179	5.3-5.17	Otolith	Left	7.87	7.08	6.48	3.20
Ariopsis felis	Sapelo	4	2	Otolith	Right	9.39	8.41	8.01	3.92
Ariopsis felis	Sapelo	4	2	Otolith	Right	8.89	8.09	7.75	4.01
Ariopsis felis	Sapelo	4	3	Otolith	Right	9.08	7.89	7.43	3.52
Ariopsis felis	Sapelo	4	4	Otolith	Right	11.29	9.61	9.01	5.39
Ariopsis felis	Sapelo	4	4	Otolith	Right	10.48	9.12	9.00	4.40
Ariopsis felis	Sapelo	4	4	Otolith	Right	9.19	8.04	7.79	3.87
Ariopsis felis	Sapelo	4	4	Otolith	Right	8.32	7.56	7.20	3.39
Ariopsis felis	Sapelo	4	4	Otolith	Right	9.21	8.13	7.62	4.00
Ariopsis felis	Sapelo	4	4	Otolith	Right	9.15	7.69	7.42	4.12
Ariopsis felis	Sapelo	4	4	Otolith	Right	9.87	8.17	7.87	3.89
Ariopsis felis	Sapelo	4	4	Otolith	Right	9.63	8.59	8.07	3.79
Ariopsis felis	Sapelo	4	4	Otolith	Right	10.12	8.75	8.32	4.02
Ariopsis felis	Sapelo	4	4	Otolith	Right	10.03	8.56	8.65	4.39
Ariopsis felis	Sapelo	4	4	Otolith	Right	8.75	7.91	7.47	3.48
Ariopsis felis	Sapelo	4	4	Otolith	Right	10.34	9.42	8.92	4.51
Ariopsis felis	Sapelo	4	4	Otolith	Right	10.01	8.81	8.30	4.09
Ariopsis felis	Sapelo	4	4	Otolith	Right	9.58	8.21	8.12	4.55
Ariopsis felis	Sapelo	4	5	Otolith	Right	9.20	8.20	7.80	4.18
Ariopsis felis	Sapelo	4	5	Otolith	Right	8.26	7.55	7.22	3.59
Ariopsis felis	Sapelo	4	5	Otolith	Right	8.74	8.17	7.80	4.09
Ariopsis felis	Sapelo	4	5	Otolith	Right	8.58	7.70	7.45	4.12
Ariopsis felis	Sapelo	4	5	Otolith	Right	9.09	7.98	7.49	4.20
Ariopsis felis	Sapelo	4	5	Otolith	Right	9.55	8.45	7.92	3.99
Ariopsis felis	Sapelo	4	5	Otolith	Right	9.17	8.52	8.05	3.73
Ariopsis felis	Sapelo	4	5	Otolith	Right	8.89	7.86	7.38	4.11
Ariopsis felis	Sapelo	4	6	Otolith	Right	8.87	7.78	7.55	4.03
Ariopsis felis	Sapelo	9	15-20 cm	Otolith	Right	7.41	6.82	6.38	3.13

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Ariopsis felis	Sapelo	9	20-25 cm	Otolith	Right	5.54	4.80	4.51	1.95
Ariopsis felis	Sapelo	9	20-25 cm	Otolith	Right	7.85	7.14	7.00	3.43
Ariopsis felis	Sapelo	9	20-25 cm	Otolith	Right	7.51	6.67	6.54	3.44
Ariopsis felis	Sapelo	9	20-25 cm	Otolith	Right	8.80	7.96	7.49	3.90
Ariopsis felis	Sapelo	9	20-25 cm	Otolith	Right	10.35	9.11	8.86	4.06
Ariopsis felis	Sapelo	9	25-30 cm	Otolith	Right	7.01	6.19	5.83	2.81
Ariopsis felis	Sapelo	9	25-30 cm	Otolith	Right	7.24	6.21	5.76	2.89
Ariopsis felis	Sapelo	9	25-30 cm	Otolith	Right	7.05	6.41	5.98	2.91
Ariopsis felis	Sapelo	9	40-45 cm	Otolith	Right	10.71	9.36	9.02	4.31
Ariopsis felis	Sapelo	9	45-50 cm	Otolith	Right	9.12	8.05	7.80	3.54
Ariopsis felis	Sapelo	9	45-50 cm	Otolith	Right	8.45	7.20	6.80	3.47
Ariopsis felis	Sapelo	9	45-50 cm	Otolith	Right	8.07	7.00	6.60	3.29
Ariopsis felis	Sapelo	9	45-50 cm	Otolith	Right	6.06	5.35	5.03	2.19
Ariopsis felis	Sapelo	9	45-50 cm	Otolith	Right	11.47	10.02	9.98	5.24
Ariopsis felis	Sapelo	9	45-50 cm	Otolith	Right	8.59	7.37	6.90	3.34
Ariopsis felis	Sapelo	9	45-50 cm	Otolith	Right	6.20	5.60	5.25	2.25
Ariopsis felis	Sapelo	9	45-50 cm	Otolith	Right	5.83	4.81	4.71	2.24
Ariopsis felis	Sapelo	9	45-50 cm	Otolith	Right	8.30	7.42	6.85	3.36
Ariopsis felis	Sapelo	9	50-55 cm	Otolith	Right	10.47	9.05	8.69	4.48
Ariopsis felis	Sapelo	9	50-55 cm	Otolith	Right	8.55	7.62	7.48	3.74
Ariopsis felis	St. Catherines	N784 E801	30-40 cm	Otolith	Right	9.24	8.19	7.91	3.74
Ariopsis felis	St. Catherines	N784 E801	60-70 cm	Otolith	Right	6.83	6.47	6.26	2.80
Ariopsis felis	St. Catherines	N789 E801	20-30 cm	Otolith	Right	9.35	8.44	7.92	5.05
Ariopsis felis	St. Catherines	N789 E801	20-30 cm	Otolith	Right	8.88	7.94	7.90	3.85
Ariopsis felis	St. Catherines	N789 E801	20-30 cm	Otolith	Right	8.84	7.94	7.69	3.94
Ariopsis felis	St. Catherines	N789 E801	20-30 cm	Otolith	Right	9.98	8.94	8.70	4.46
Ariopsis felis	St. Catherines	N789 E801	20-30 cm	Otolith	Right	13.37	11.15	10.98	4.87
Ariopsis felis	St. Catherines	N789 E801	20-30 cm	Otolith	Right	9.11	8.13	7.85	4.46
Ariopsis felis	St. Catherines	N789 E801	20-30 cm	Otolith	Right	8.80	7.90	7.75	4.46
Ariopsis felis	St. Catherines	N789 E801	30-40 cm	Otolith	Right	9.95	8.74	8.22	4.26
Ariopsis felis	St. Catherines	N789 E801	30-40 cm	Otolith	Right	8.62	7.69	7.34	3.49
Ariopsis felis	St. Catherines	N784 E811	20-30 cm	Otolith	Right	9.41	8.42	8.05	3.60
Ariopsis felis	St. Catherines	N784 E811	30-40 cm	Otolith	Right	9.64	8.17	7.92	4.07
Ariopsis felis	St. Catherines	N784 E811	30-40 cm	Otolith	Right	11.32	10.22	9.74	5.38

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Ariopsis felis	St. Catherines	N784 E811	50-60 cm	Otolith	Right	7.82	7.49	7.02	3.41
Ariopsis felis	St. Catherines	N784 E797	10-20 cm	Otolith	Right	6.19	5.29	5.37	2.30
Ariopsis felis	St. Catherines	N784 E797	20-30 cm	Otolith	Right	10.35	8.99	8.60	4.07
Ariopsis felis	St. Catherines	N784 E797	20-30 cm	Otolith	Right	9.96	8.80	8.42	4.05
Ariopsis felis	St. Catherines	N784 E797	30-40 cm	Otolith	Right	9.75	8.50	8.27	4.15
Ariopsis felis	St. Catherines	N784 E797	40-50 cm	Otolith	Right	9.76	8.15	7.96	3.82
Ariopsis felis	St. Catherines	N784 E797	60-70 cm	Otolith	Right	10.46	9.22	8.81	5.02
Ariopsis felis	St. Catherines	N784 E797	70-75.5 cm	Otolith	Right	7.71	6.89	6.66	3.11
Ariopsis felis	St. Catherines	W82 S2	2.4-2.3	Otolith	Right	10.44	9.18	9.09	4.35
Ariopsis felis	St. Catherines	W84 S2	2.8-2.7	Otolith	Right	8.95	8.32	7.88	4.30
Ariopsis felis	St. Catherines	N771 E819	Surface-2.6	Otolith	Right	8.59	7.83	7.15	3.69
Ariopsis felis	St. Catherines	N771 E819	Surface-2.6	Otolith	Right	9.13	8.15	7.56	3.66
Ariopsis felis	St. Catherines	N771 E819	Surface-2.6	Otolith	Right	8.29	7.65	7.66	3.54
Ariopsis felis	St. Catherines	N771 E819	Surface-2.6	Otolith	Right	7.06	6.38	5.82	2.89
Ariopsis felis	St. Catherines	Feature 23	2.0-1.9	Otolith	Right	9.41	8.12	7.72	3.62
Ariopsis felis	McQueen	N 213 E 198	Open-4.6	Otolith	Right	6.56	5.93	5.49	2.78
Ariopsis felis	McQueen	N 213 E 198	Open-4.6	Otolith	Right	7.70	6.68	6.62	3.30
Ariopsis felis	McQueen	N 213 E 198	Open-4.6	Otolith	Right	7.99	7.36	6.91	3.57
Ariopsis felis	McQueen	N 213 E 198	Open-4.6	Otolith	Right	7.88	7.01	6.60	3.17
Ariopsis felis	McQueen	N 213 E 198	Open-4.6	Otolith	Right	11.52	9.60	9.36	4.72
Ariopsis felis	McQueen	N 213 E 198	Open-4.6	Otolith	Right	8.57	7.75	7.39	3.23
Ariopsis felis	McQueen	N 213 E 198	Open-4.6	Otolith	Right	9.90	8.73	8.78	3.85
Ariopsis felis	McQueen	N 213 E 198	Open-4.6	Otolith	Right	10.61	9.65	9.26	4.52
Ariopsis felis	McQueen	N 213 E 198	4.6-4.5	Otolith	Right	9.10	8.02	7.73	4.21
Ariopsis felis	McQueen	N 213 E 198	4.6-4.5	Otolith	Right	9.75	8.48	8.17	3.97
Ariopsis felis	McQueen	N 213 E 198	4.6-4.5	Otolith	Right	7.16	6.16	5.95	2.95
Ariopsis felis	McQueen	N263 E179	5.7-5.6	Otolith	Right	7.74	6.92	6.46	3.02
Ariopsis felis	McQueen	N263 E179	5.3-5.17	Otolith	Right	8.61	8.07	7.46	4.08
Ariopsis felis	McQueen	N263 E179	5.3-5.17	Otolith	Right	8.46	7.41	6.99	3.58
Ariopsis felis	Sapelo	4	1	Otolith	Left	8.79	8.06	7.64	3.60
Ariopsis felis	Sapelo	4	4	Otolith	Left	8.79	7.64	7.23	3.48
Ariopsis felis	Sapelo	4	4	Otolith	Left	9.88	8.27	7.82	3.90
Ariopsis felis	Sapelo	4	4	Otolith	Left	8.50	8.04	7.53	3.99
Ariopsis felis	Sapelo	4	4	Otolith	Left	9.28	7.90	7.41	4.02

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Ariopsis felis	Sapelo	4	4	Otolith	Left	8.24	7.47	7.14	4.10
Ariopsis felis	Sapelo	4	4	Otolith	Left	10.05	8.73	8.17	4.08
Ariopsis felis	Sapelo	4	4	Otolith	Left	9.30	8.43	7.89	4.04
Ariopsis felis	Sapelo	4	4	Otolith	Left	8.14	7.47	7.05	3.60
Ariopsis felis	Sapelo	4	4	Otolith	Left	8.29	7.37	6.91	3.44
Ariopsis felis	Sapelo	4	4	Otolith	Left	8.92	7.90	7.50	3.61
Ariopsis felis	Sapelo	4	4	Otolith	Left	9.45	8.53	8.11	3.87
Ariopsis felis	Sapelo	4	4	Otolith	Left	10.22	9.13	8.91	4.67
Ariopsis felis	Sapelo	4	4	Otolith	Left	8.89	7.90	7.52	3.74
Ariopsis felis	Sapelo	4	4	Otolith	Left	10.26	9.00	8.72	4.70
Ariopsis felis	Sapelo	4	4	Otolith	Left	8.13	7.32	6.87	3.55
Ariopsis felis	Sapelo	4	4	Otolith	Left	9.35	8.41	7.93	3.82
Ariopsis felis	Sapelo	4	4	Otolith	Left	8.56	7.52	7.13	3.27
Ariopsis felis	Sapelo	4	5	Otolith	Left	9.01	7.99	7.57	3.98
Ariopsis felis	Sapelo	4	5	Otolith	Left	8.68	8.09	7.78	4.03
Ariopsis felis	Sapelo	4	5	Otolith	Left	10.04	8.66	8.64	4.70
Ariopsis felis	Sapelo	4	5	Otolith	Left	8.24	7.26	6.85	3.53
Ariopsis felis	Sapelo	4	5	Otolith	Left	9.27	8.22	7.83	4.17
Ariopsis felis	Sapelo	4	5	Otolith	Left	9.18	8.11	7.70	3.79
Ariopsis felis	Sapelo	4	5	Otolith	Left	9.29	8.27	7.97	4.02
Ariopsis felis	Sapelo	4	6	Otolith	Left	9.06	8.10	7.61	3.58
Ariopsis felis	Sapelo	9	15-20 cm	Otolith	Left	9.11	8.07	7.49	3.64
Ariopsis felis	Sapelo	9	15-20 cm	Otolith	Left	8.70	7.69	7.14	3.67
Ariopsis felis	Sapelo	9	20-25 cm	Otolith	Left	5.84	5.10	4.85	2.04
Ariopsis felis	Sapelo	9	20-25 cm	Otolith	Left	6.73	6.01	5.62	2.88
Ariopsis felis	Sapelo	9	20-25 cm	Otolith	Left	9.03	7.95	7.50	4.20
Ariopsis felis	Sapelo	9	20-25 cm	Otolith	Left	9.51	9.09	8.65	3.96
Ariopsis felis	Sapelo	9	40-45 cm	Otolith	Left	10.56	9.14	9.19	4.55
Ariopsis felis	Sapelo	9	40-45 cm	Otolith	Left	7.70	6.73	6.38	3.10
Ariopsis felis	Sapelo	9	45-50 cm	Otolith	Left	5.87	5.07	4.75	2.39
Ariopsis felis	Sapelo	9	45-50 cm	Otolith	Left	8.07	6.97	6.68	3.45
Ariopsis felis	Sapelo	9	45-50 cm	Otolith	Left	9.17	8.09	7.80	3.59
Ariopsis felis	Sapelo	9	45-50 cm	Otolith	Left	8.45	7.61	7.25	3.36
Ariopsis felis	Sapelo	9	45-50 cm	Otolith	Left	11.66	10.20	9.88	5.47

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Ariopsis felis	Sapelo	9	50-55 cm	Otolith	Left	8.78	7.73	7.50	3.72
Ariopsis felis	Sapelo	9	50-55 cm	Otolith	Left	10.41	8.99	8.39	4.18
Ariopsis felis	St. Catherines	N784 E801	10-20 cm	Otolith	Left	8.39	7.62	7.27	3.53
Ariopsis felis	St. Catherines	N784 E801	20-30 cm	Otolith	Left	5.81	5.43	5.14	2.36
Ariopsis felis	St. Catherines	N784 E801	30-40 cm	Otolith	Left	8.31	7.23	6.77	3.84
Ariopsis felis	St. Catherines	N784 E801	30-40 cm	Otolith	Left	8.74	7.60	7.13	3.75
Ariopsis felis	St. Catherines	N789 E801	0-10 cm	Otolith	Left	8.44	7.35	7.08	3.79
Ariopsis felis	St. Catherines	N789 E801	10-20 cm	Otolith	Left	9.36	8.29	7.82	3.56
Ariopsis felis	St. Catherines	N789 E801	10-20 cm	Otolith	Left	9.73	8.87	8.41	4.33
Ariopsis felis	St. Catherines	N789 E801	20-30 cm	Otolith	Left	7.99	6.87	6.49	3.38
Ariopsis felis	St. Catherines	N789 E801	20-30 cm	Otolith	Left	9.42	8.10	7.79	3.90
Ariopsis felis	St. Catherines	N789 E801	20-30 cm	Otolith	Left	8.53	7.32	6.85	3.64
Ariopsis felis	St. Catherines	N789 E801	20-30 cm	Otolith	Left	9.27	7.79	7.43	4.39
Ariopsis felis	St. Catherines	N789 E801	30-40 cm	Otolith	Left	8.87	8.08	7.78	4.13
Ariopsis felis	St. Catherines	N789 E801	40-50 cm	Otolith	Left	8.49	7.39	6.93	3.69
Ariopsis felis	St. Catherines	N784 E811	20-30 cm	Otolith	Left	9.36	8.39	8.06	3.55
Ariopsis felis	St. Catherines	N784 E811	30-40 cm	Otolith	Left	10.06	8.89	8.30	4.18
Ariopsis felis	St. Catherines	N784 E811	30-40 cm	Otolith	Left	9.29	8.28	7.85	3.84
Ariopsis felis	St. Catherines	N784 E797	20-30 cm	Otolith	Left	10.29	8.95	8.52	4.09
Ariopsis felis	St. Catherines	N784 E797	20-30 cm	Otolith	Left	9.64	8.56	8.21	4.11
Ariopsis felis	St. Catherines	N784 E797	20-30 cm	Otolith	Left	9.70	8.17	7.92	3.77
Ariopsis felis	St. Catherines	N784 E797	20-30 cm	Otolith	Left	10.13	8.73	8.38	4.02
Ariopsis felis	St. Catherines	N784 E797	20-30 cm	Otolith	Left	7.94	7.11	6.71	3.41
Ariopsis felis	St. Catherines	N784 E797	40-50 cm	Otolith	Left	8.76	8.07	7.55	3.83
Ariopsis felis	St. Catherines	W82 S2	2.5-2.4	Otolith	Left	9.24	8.38	7.93	4.07
Ariopsis felis	St. Catherines	N771 E819	Surface-2.6	Otolith	Left	8.23	7.35	6.80	3.12
Ariopsis felis	St. Catherines	N771 E819	Surface-2.6	Otolith	Left	7.55	7.09	6.32	3.37
Ariopsis felis	McQueen	N 213 E 198	Open-4.6	Otolith	Left	8.02	7.54	7.30	3.96
Ariopsis felis	McQueen	N 213 E 198	Open-4.6	Otolith	Left	8.39	7.78	7.53	3.90
Ariopsis felis	McQueen	N 213 E 198	Open-4.6	Otolith	Left	8.20	7.28	6.91	3.61
Ariopsis felis	McQueen	N 213 E 198	4.6-4.5	Otolith	Left	9.93	9.11	8.48	3.65
Ariopsis felis	McQueen	N 213 E 198	4.6-4.5	Otolith	Left	9.39	8.47	7.94	4.20
Ariopsis felis	McQueen	N263 E179	5.6-5.5	Otolith	Left	8.85	7.93	7.50	3.52
Ariopsis felis	McQueen	N263 E179	5.5-5.4	Otolith	Left	9.44	8.16	7.69	3.75

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Ariopsis felis	McQueen	N263 E179	5.5-5.4	Otolith	Left	9.04	8.10	7.62	4.07
Ariopsis felis	McQueen	N263 E179	5.5-5.4	Otolith	Left	8.07	7.26	6.77	3.72
Ariopsis felis	McQueen	N263 E179	5.3-5.17	Otolith	Left	8.12	7.52	7.20	3.52
Ariopsis felis	McQueen	N263 E179	5.3-5.17	Otolith	Left	7.93	7.04	6.58	3.02
Bagre marinus	Sapelo	4	3	Otolith	Right	16.53	15.40	12.66	7.62
Bagre marinus	Sapelo	4	3	Otolith	Right	13.39	12.48	10.46	5.59
Bagre marinus	Sapelo	4	3	Otolith	Right	15.07	13.95	11.85	5.63
Bagre marinus	Sapelo	4	3	Otolith	Right	10.99	10.01	8.57	4.52
Bagre marinus	Sapelo	4	4	Otolith	Right	12.75	11.93	10.05	4.95
Bagre marinus	Sapelo	4	4	Otolith	Right	10.07	9.34	8.17	4.65
Bagre marinus	Sapelo	4	4	Otolith	Right	11.33	10.45	8.81	4.61
Bagre marinus	Sapelo	4	5	Otolith	Right	10.26	10.14	8.46	4.88
Bagre marinus	Sapelo	4	6	Otolith	Right	8.96	8.41	7.00	3.51
Bagre marinus	Sapelo	9	10-15 cm	Otolith	Right	4.64	4.41	3.82	1.72
Bagre marinus	St. Catherines	N784 E801	0-10 cm	Otolith	Right	6.24	5.78	4.75	2.04
Bagre marinus	St. Catherines	N784 E801	20-30 cm	Otolith	Right	5.11	5.14	4.26	1.71
Bagre marinus	St. Catherines	N789 E801	10-20 cm	Otolith	Right	6.94	6.43	5.35	2.33
Bagre marinus	St. Catherines	N789 E801	10-20 cm	Otolith	Right	6.61	6.02	4.78	2.35
Bagre marinus	St. Catherines	N789 E801	10-20 cm	Otolith	Right	5.33	4.99	4.01	1.50
Bagre marinus	St. Catherines	N782 E801	20-30 cm	Otolith	Right	5.88	5.57	4.26	1.81
Bagre marinus	St. Catherines	N782 E801	30-40 cm	Otolith	Right	5.60	5.20	4.18	1.74
Bagre marinus	St. Catherines	N784 E811	30-40 cm	Otolith	Right	10.76	9.91	8.30	4.81
Bagre marinus	St. Catherines	N784 E811	30-40 cm	Otolith	Right	11.68	11.14	9.64	5.12
Bagre marinus	St. Catherines	N784 E811	50-60 cm	Otolith	Right	8.52	7.71	6.41	2.72
Bagre marinus	St. Catherines	N784 E797	10-20 cm	Otolith	Right	7.65	7.08	5.78	2.72
Bagre marinus	St. Catherines	N784 E797	20-30 cm	Otolith	Right	15.32	14.30	12.54	6.19
Bagre marinus	St. Catherines	N784 E797	20-30 cm	Otolith	Right	14.22	12.28	10.60	5.68
Bagre marinus	St. Catherines	N784 E797	40-50 cm	Otolith	Right	11.38	10.21	9.05	4.94
Bagre marinus	St. Catherines	N784 E797	40-50 cm	Otolith	Right	10.22	9.49	8.28	4.08
Bagre marinus	St. Catherines	N784 E797	70-75.5 cm	Otolith	Right	14.90	13.53	12.21	6.34
Bagre marinus	St. Catherines	N784 E797	78-86 cm	Otolith	Right	14.97	13.78	11.73	6.13
Bagre marinus	St. Catherines	W82 S2	2.3-2.2	Otolith	Right	7.78	7.53	6.16	3.32
Bagre marinus	St. Catherines	W84 S2	2.7-2.6	Otolith	Right	8.12	7.55	6.17	3.02
Bagre marinus	St. Catherines	N771 E819	2.5-2.4 m	Otolith	Right	12.86	12.11	10.54	5.42

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bagre marinus	St. Catherines	N771 E819	2.3-2.2 m	Otolith	Right	12.79	11.51	9.86	5.35
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Right	15.92	14.45	11.84	6.67
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Right	13.68	12.84	11.03	5.08
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Right	12.86	12.11	10.55	4.99
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Right	11.32	10.52	9.21	4.56
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Right	10.52	9.51	8.13	3.83
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Right	9.18	8.58	7.15	3.49
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Right	9.16	8.30	6.98	3.29
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Right	9.30	8.63	7.17	3.58
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Right	7.35	6.99	5.82	2.86
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Right	7.12	6.74	5.52	2.53
Bagre marinus	McQueen	N 213 E 198	4.6-4.5	Otolith	Right	8.45	7.87	6.88	3.39
Bagre marinus	McQueen	N 213 E 198	4.6-4.5	Otolith	Right	10.87	10.00	8.58	4.19
Bagre marinus	McQueen	N 213 E 198	4.6-4.5	Otolith	Right	7.74	7.32	6.07	3.03
Bagre marinus	McQueen	N 213 E 198	4.6-4.5	Otolith	Right	8.32	7.76	6.62	3.22
Bagre marinus	McQueen	N 213 E 198	4.5-4.4	Otolith	Right	8.75	8.53	7.04	3.32
Bagre marinus	McQueen	N263 E179	5.7-5.6	Otolith	Right	7.52	6.98	5.65	2.45
Bagre marinus	McQueen	N263 E179	5.7-5.6	Otolith	Right	6.23	5.87	4.71	2.04
Bagre marinus	McQueen	N263 E179	5.6-5.5	Otolith	Right	11.54	10.31	8.74	4.37
Bagre marinus	McQueen	N263 E179	5.6-5.5	Otolith	Right	13.07	12.12	10.18	5.32
Bagre marinus	McQueen	N263 E179	5.6-5.5	Otolith	Right	10.86	9.94	8.32	4.56
Bagre marinus	McQueen	N263 E179	5.5-5.4	Otolith	Right	7.83	7.33	6.45	3.42
Bagre marinus	McQueen	N263 E179	5.5-5.4	Otolith	Right	16.16	14.98	12.70	7.23
Bagre marinus	McQueen	N263 E179	5.5-5.4	Otolith	Right	14.90	13.80	11.93	6.32
Bagre marinus	McQueen	N263 E179	5.4-5.3	Otolith	Right	4.84	4.51	3.53	1.38
Bagre marinus	McQueen	N263 E179	5.4-5.3	Otolith	Right	7.24	6.58	5.27	2.67
Bagre marinus	McQueen	N263 E179	5.4-5.3	Otolith	Right	5.97	5.74	4.81	2.24
Bagre marinus	McQueen	N263 E179	5.4-5.3	Otolith	Right	14.37	13.24	11.46	6.01
Bagre marinus	McQueen	N263 E179	5.4-5.3	Otolith	Right	7.49	6.99	5.67	2.81
Bagre marinus	McQueen	N263 E179	5.4-5.3	Otolith	Right	7.55	7.01	5.67	2.61
Bagre marinus	McQueen	N263 E179	5.3-5.17	Otolith	Right	6.80	6.37	5.43	2.48
Bagre marinus	McQueen	N263 E179	5.3-5.17	Otolith	Right	7.08	6.68	5.45	2.52
Bagre marinus	McQueen	N263 E179	5.3-5.17	Otolith	Right	7.38	6.67	5.74	2.43
Bagre marinus	McQueen	N263 E179	5.3-5.17	Otolith	Right	6.32	5.84	5.06	2.10

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bagre marinus	Sapelo	4	2	Otolith	Left	15.43	14.26	12.39	6.07
Bagre marinus	Sapelo	4	2	Otolith	Left	10.08	9.86	8.40	4.51
Bagre marinus	Sapelo	4	3	Otolith	Left	12.21	10.82	9.30	4.87
Bagre marinus	Sapelo	4	3	Otolith	Left	11.77	11.10	9.18	4.38
Bagre marinus	Sapelo	4	3	Otolith	Left	11.12	10.15	8.57	4.47
Bagre marinus	Sapelo	4	3	Otolith	Left	12.67	11.92	9.90	4.95
Bagre marinus	Sapelo	4	3	Otolith	Left	12.10	11.00	9.41	4.68
Bagre marinus	Sapelo	4	3	Otolith	Left	14.86	13.45	11.60	6.20
Bagre marinus	Sapelo	4	4	Otolith	Left	14.74	13.32	11.24	5.92
Bagre marinus	Sapelo	4	4	Otolith	Left	12.24	11.11	9.17	5.10
Bagre marinus	Sapelo	4	4	Otolith	Left	12.84	11.85	9.82	5.84
Bagre marinus	Sapelo	4	4	Otolith	Left	15.56	14.18	12.23	6.58
Bagre marinus	Sapelo	4	4	Otolith	Left	9.72	8.88	7.71	3.79
Bagre marinus	Sapelo	4	5	Otolith	Left	9.08	8.40	7.25	3.93
Bagre marinus	Sapelo	4	5	Otolith	Left	9.12	8.65	7.16	3.99
Bagre marinus	St. Catherines	N784 E801	20-30 cm	Otolith	Left	4.43	4.35	3.60	1.32
Bagre marinus	St. Catherines	N789 E801	10-20 cm	Otolith	Left	7.31	6.65	5.59	2.76
Bagre marinus	St. Catherines	N789 E801	10-20 cm	Otolith	Left	4.45	4.43	3.59	1.26
Bagre marinus	St. Catherines	N789 E801	30-40 cm	Otolith	Left	8.63	8.08	6.85	3.24
Bagre marinus	St. Catherines	N782 E801	30-40 cm	Otolith	Left	13.33	12.77	10.83	5.45
Bagre marinus	St. Catherines	N784 E811	20-30 cm	Otolith	Left	5.33	4.95	4.12	1.68
Bagre marinus	St. Catherines	N784 E811	20-30 cm	Otolith	Left	8.15	7.77	6.32	2.85
Bagre marinus	St. Catherines	N784 E797	0-10 cm	Otolith	Left	13.13	12.25	10.40	5.46
Bagre marinus	St. Catherines	N784 E797	0-10 cm	Otolith	Left	10.67	10.71	8.76	4.84
Bagre marinus	St. Catherines	N784 E797	20-30 cm	Otolith	Left	12.88	11.73	10.25	5.31
Bagre marinus	St. Catherines	N784 E797	20-30 cm	Otolith	Left	14.10	12.49	10.41	5.69
Bagre marinus	St. Catherines	N784 E797	20-30 cm	Otolith	Left	7.35	6.94	5.67	2.60
Bagre marinus	St. Catherines	N784 E797	30-40 cm	Otolith	Left	11.11	10.17	8.98	4.84
Bagre marinus	St. Catherines	N784 E797	75.5-78 cm	Otolith	Left	15.39	14.27	12.67	7.14
Bagre marinus	St. Catherines	N784 E797	78-86 cm	Otolith	Left	16.98	15.19	12.54	6.87
Bagre marinus	St. Catherines	N784 E797	86-96 cm	Otolith	Left	16.03	15.06	12.68	6.35
Bagre marinus	St. Catherines	W82 S2	2.7-2.6	Otolith	Left	12.32	11.40	9.53	5.06
Bagre marinus	St. Catherines	W84 S2	2.8-2.7	Otolith	Left	6.04	5.72	4.64	1.89
Bagre marinus	St. Catherines	N771 E819	2.5-2.4	Otolith	Left	9.85	9.28	7.76	4.08

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bagre marinus	St. Catherines	N771 E819	2.3-2.2	Otolith	Left		11.56	9.84	5.46
Bagre marinus	St. Catherines	Feature 23	2.0-1.9	Otolith	Left	13.84	12.63	11.03	5.95
Bagre marinus	St. Catherines	Feature 23	2.0-1.9	Otolith	Left	7.75	7.35	6.18	3.11
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	6.89	6.70	5.64	2.62
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	7.15	6.67	5.76	2.63
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	7.18	6.68	5.69	2.58
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	7.18	6.85	5.75	2.65
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	9.68	9.01	7.43	3.64
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	8.80	8.61	7.19	3.82
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	9.89	9.17	8.16	4.35
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	10.44	9.60	8.36	4.45
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	10.76	10.09	8.19	4.38
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	11.03	10.25	8.68	4.13
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	10.78	10.70	8.57	4.45
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	11.73	11.41	9.64	4.86
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	12.76	11.47	9.88	5.59
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	13.34	12.54	10.78	5.45
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	13.17	12.57	11.17	5.62
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	14.66	13.24	11.50	5.95
Bagre marinus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	14.86	13.91	12.33	5.80
Bagre marinus	McQueen	N 213 E 198	4.6-4.5	Otolith	Left	7.37	7.27	5.91	2.90
Bagre marinus	McQueen	N 213 E 198	4.6-4.5	Otolith	Left	12.60	11.56	9.72	5.34
Bagre marinus	McQueen	N263 E179	5.8-5.7	Otolith	Left	7.07	6.78	5.55	2.66
Bagre marinus	McQueen	N263 E179	5.7-5.6	Otolith	Left	13.22	12.64	9.98	5.64
Bagre marinus	McQueen	N263 E179	5.7-5.6	Otolith	Left	8.06	7.62	6.24	2.94
Bagre marinus	McQueen	N263 E179	5.5-5.4	Otolith	Left	7.85	7.47	6.19	2.93
Bagre marinus	McQueen	N263 E179	5.5-5.4	Otolith	Left	7.18	7.08	5.82	2.58
Bagre marinus	McQueen	N263 E179	5.5-5.4	Otolith	Left	7.34	6.93	5.60	2.68
Bagre marinus	McQueen	N263 E179	5.5-5.4	Otolith	Left	7.68	7.10	5.81	2.82
Bagre marinus	McQueen	N263 E179	5.5-5.4	Otolith	Left	7.73	7.34	6.12	2.86
Bagre marinus	McQueen	N263 E179	5.5-5.4	Otolith	Left	8.01	7.55	6.23	3.05
Bagre marinus	McQueen	N263 E179	5.5-5.4	Otolith	Left	15.42	14.35	12.35	6.46
Bagre marinus	McQueen	N263 E179	5.4-5.3	Otolith	Left	15.92	14.73	12.79	7.31
Bagre marinus	McQueen	N263 E179	5.4-5.3	Otolith	Left	7.05	6.48	5.39	2.40

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bagre marinus	McQueen	N263 E179	5.4-5.3	Otolith	Left	6.32	5.86	4.77	2.15
Bagre marinus	McQueen	N263 E179	5.4-5.3	Otolith	Left	6.91	6.27	5.34	2.62
Bagre marinus	McQueen	N263 E179	5.4-5.3	Otolith	Left	6.74	6.25	5.19	2.27
Bagre marinus	McQueen	N263 E179	5.3-5.17	Otolith	Left	7.03	6.50	5.43	2.51
Bagre marinus	McQueen	N263 E179	5.3-5.17	Otolith	Left	6.78	6.47	5.48	2.56
Bagre marinus	McQueen	N263 E179	5.3-5.17	Otolith	Left	6.23	5.78	4.63	1.88
Bagre marinus	McQueen	N263 E179	5.3-5.17	Otolith	Left	6.30	5.79	4.73	2.05
Bagre marinus	McQueen	N263 E179	5.3-5.17	Otolith	Left	6.35	5.73	4.61	1.91
Opsanus sp.	Sapelo	9	25-30 cm	Atlas				4.16	
Opsanus sp.	St. Catherines	N784 E801	50-60 cm	Atlas				2.77	
Opsanus sp.	St. Catherines	N789 E801	10-20 cm	Atlas				2.60	
Opsanus sp.	St. Catherines	N789 E801	10-20 cm	Atlas				2.80	
Opsanus sp.	St. Catherines	N789 E801	20-30 cm	Atlas				3.14	
Opsanus sp.	St. Catherines	N782 E801	110-120 cm	Atlas				3.32	
Opsanus sp.	St. Catherines	N779 E801	30-40 cm	Atlas				2.63	
Opsanus sp.	St. Catherines	N784 E811	20-30 cm	Atlas				3.45	
Opsanus sp.	St. Catherines	N784 E811	30-40 cm	Atlas				3.15	
Opsanus sp.	St. Catherines	N784 E811	30-40 cm	Atlas				2.56	
Opsanus sp.	St. Catherines	N771 E819	2.5-2.4	Atlas				2.60	
Opsanus sp.	McQueen	N 213 E 198	Open-4.6	Atlas				3.15	
Opsanus sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				6.66	
Opsanus sp.	McQueen	N263 E179	5.8-5.7	Atlas				3.49	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Otolith	Left	9.54		4.24	
Mugil sp.	Cannon's Point	18N 0E	L4	Atlas				3.48	
Mugil sp.	Cannon's Point	18N 0E	L4	Atlas				2.87	
Mugil sp.	Cannon's Point	18N 0E	L5	Atlas				2.04	
Mugil sp.	Cannon's Point	18N 0E	L5	Atlas				2.75	
Mugil sp.	Cannon's Point	18N 0E	L9	Atlas				2.13	
Mugil sp.	Cannon's Point	18N 0E	L10	Atlas				2.63	
Mugil sp.	Cannon's Point	18N 0E	L11	Atlas				2.80	
Mugil sp.	Cannon's Point	18N 0E	L11	Atlas				3.18	
Mugil sp.	Cannon's Point	18N 0E	L11	Atlas				3.50	
Mugil sp.	Cannon's Point	18N 0E	L11	Atlas				2.35	
Mugil sp.	Cannon's Point	18N 0E	L11	Atlas				2.37	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Mugil sp.	Cannon's Point	18N 0E	L11	Atlas				1.76	
Mugil sp.	Cannon's Point	18N 0E	L12	Atlas				3.02	
Mugil sp.	Cannon's Point	18N 0E	L12	Atlas				1.98	
Mugil sp.	Cannon's Point	18N 0E	L13	Atlas				2.73	
Mugil sp.	Cannon's Point	18N 0E	L13	Atlas				1.75	
Mugil sp.	Cannon's Point	18N 0E	L14	Atlas				4.27	
Mugil sp.	Cannon's Point	18N 0E	L14	Atlas				3.21	
Mugil sp.	Cannon's Point	18N 0E	L20	Atlas				3.70	
Mugil sp.	Cannon's Point	18N 0E	L20	Atlas				2.88	
Mugil sp.	Cannon's Point	18N 0E	L20	Atlas				2.67	
Mugil sp.	Cannon's Point	18N 0E	L21	Atlas				2.05	
Mugil sp.	Cannon's Point	18N 0E	L22	Atlas				2.04	
Mugil sp.	Cannon's Point	18N 0E	L23	Atlas				2.40	
Mugil sp.	Cannon's Point	18N 0E	L23	Atlas				2.22	
Mugil sp.	Cannon's Point	18N 0E	L23	Atlas				2.29	
Mugil sp.	Cannon's Point	18N 0E	L25	Atlas				2.44	
Mugil sp.	Cannon's Point	18N 0E	L27	Atlas				2.57	
Mugil sp.	Cannon's Point	18N 0E	L28	Atlas				3.31	
Mugil sp.	Cannon's Point	18N 0E	L28	Atlas				2.27	
Mugil sp.	Cannon's Point	18N 0E	L30	Atlas				2.49	
Mugil sp.	Cannon's Point	18N 0E	L30	Atlas				2.70	
Mugil sp.	Cannon's Point	18N 0E	L31	Atlas				2.84	
Mugil sp.	Cannon's Point	18N 0E	L33	Atlas				4.64	
Mugil sp.	Cannon's Point	18N 0E	L33	Atlas				2.49	
Mugil sp.	Cannon's Point	18N 0E	L33	Atlas				1.98	
Mugil sp.	Cannon's Point	18N 0E	L33	Atlas				1.64	
Mugil sp.	Cannon's Point	18N 0E	L35	Atlas				3.07	
Mugil sp.	West	5S 30E	ZII L1	Atlas				2.28	
Mugil sp.	West	5S 30E	ZII L2	Atlas				2.54	
Mugil sp.	West	5S 30E	ZII L2	Atlas				2.70	
Mugil sp.	West	5S 30E	ZII L3	Atlas				3.04	
Mugil sp.	West	5S 30E	ZII L5	Atlas				4.19	
Mugil sp.	West	5S 30E	ZII L5	Atlas				2.62	
Mugil sp.	West	5S 30E	ZII L5	Atlas				2.66	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Mugil sp.	West	5S 30E	ZII L5	Atlas				2.17	
Mugil sp.	West	5S 30E	L6	Atlas				2.50	
Mugil sp.	West	5S 30E	L6	Atlas				2.62	
Mugil sp.	West	5S 30E	L6	Atlas				2.71	
Mugil sp.	West	5S 30E	L6	Atlas				1.68	
Mugil sp.	West	5S 30E	L6	Atlas				2.60	
Mugil sp.	West	5S 30E	L6	Atlas				2.96	
Mugil sp.	West	5S 30E	L6	Atlas				2.82	
Mugil sp.	West	5S 30E	L7	Atlas				2.85	
Mugil sp.	West	5S 30E	L7	Atlas				2.91	
Mugil sp.	West	5S 30E	L7	Atlas				2.50	
Mugil sp.	West	5S 30E	L7	Atlas				2.37	
Mugil sp.	West	5S 30E	L7	Atlas				2.25	
Mugil sp.	West	5S 30E	L7	Atlas				2.61	
Mugil sp.	West	5S 30E	L7	Atlas				2.27	
Mugil sp.	West	5S 30E	L7	Atlas				2.48	
Mugil sp.	West	5S 30E	L8	Atlas				3.07	
Mugil sp.	West	5S 30E	L8	Atlas				3.56	
Mugil sp.	West	5S 30E	L8	Atlas				1.47	
Mugil sp.	West	5S 30E	L8	Atlas				1.43	
Mugil sp.	West	5S 30E	L9	Atlas				2.80	
Mugil sp.	West	5S 30E	L10	Atlas				2.37	
Mugil sp.	Sapelo	4	2	Atlas				4.97	
Mugil sp.	Sapelo	4	2	Atlas				4.39	
Mugil sp.	Sapelo	4	3	Atlas				4.32	
Mugil sp.	Sapelo	4	3	Atlas				4.89	
Mugil sp.	Sapelo	4	4	Atlas				4.28	
Mugil sp.	Sapelo	4	4	Atlas				5.34	
Mugil sp.	Sapelo	4	4	Atlas				4.83	
Mugil sp.	Sapelo	4	5	Atlas				3.35	
Mugil sp.	St. Catherines	N789 E801	0-10 cm	Atlas				2.45	
Mugil sp.	St. Catherines	N789 E801	0-10 cm	Atlas				2.45	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				3.38	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				2.49	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				2.85	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				3.10	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				2.51	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				2.15	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				3.00	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				3.12	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				1.85	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				2.58	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				3.13	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				1.57	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				2.41	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				1.53	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				2.53	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				2.55	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				2.87	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				2.17	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				1.50	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				2.39	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				1.55	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				1.81	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				2.17	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				1.25	
Mugil sp.	St. Catherines	N789 E801	10-20 cm	Atlas				2.19	
Mugil sp.	St. Catherines	N789 E801	20-30 cm	Atlas				1.40	
Mugil sp.	St. Catherines	N789 E801	20-30 cm	Atlas				2.44	
Mugil sp.	St. Catherines	N789 E801	20-30 cm	Atlas				1.96	
Mugil sp.	St. Catherines	N789 E801	20-30 cm	Atlas				1.67	
Mugil sp.	St. Catherines	N789 E801	20-30 cm	Atlas				1.61	
Mugil sp.	St. Catherines	N789 E801	20-30 cm	Atlas				2.72	
Mugil sp.	St. Catherines	N789 E801	20-30 cm	Atlas				2.66	
Mugil sp.	St. Catherines	N789 E801	20-30 cm	Atlas				2.50	
Mugil sp.	St. Catherines	N789 E801	20-30 cm	Atlas				2.34	
Mugil sp.	St. Catherines	N789 E801	20-30 cm	Atlas				2.10	
Mugil sp.	St. Catherines	N789 E801	20-30 cm	Atlas				1.93	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Mugil sp.	St. Catherines	N789 E801	20-30 cm	Atlas				2.03	
Mugil sp.	St. Catherines	N789 E801	20-30 cm	Atlas				2.47	
Mugil sp.	St. Catherines	N789 E801	20-30 cm	Atlas				2.06	
Mugil sp.	St. Catherines	N789 E801	20-30 cm	Atlas				2.63	
Mugil sp.	St. Catherines	N789 E801	20-30 cm	Atlas				2.67	
Mugil sp.	St. Catherines	N789 E801	20-30 cm	Atlas				3.41	
Mugil sp.	St. Catherines	N789 E801	20-30 cm	Atlas				2.69	
Mugil sp.	St. Catherines	N789 E801	20-30 cm	Atlas				2.28	
Mugil sp.	St. Catherines	N789 E801	20-30 cm	Atlas				1.46	
Mugil sp.	St. Catherines	N789 E801	20-30 cm	Atlas				1.37	
Mugil sp.	St. Catherines	N789 E801	30-40 cm	Atlas				2.75	
Mugil sp.	St. Catherines	N789 E801	30-40 cm	Atlas				1.78	
Mugil sp.	St. Catherines	N789 E801	30-40 cm	Atlas				2.11	
Mugil sp.	St. Catherines	N789 E801	30-40 cm	Atlas				2.69	
Mugil sp.	St. Catherines	N789 E801	30-40 cm	Atlas				1.38	
Mugil sp.	St. Catherines	N789 E801	30-40 cm	Atlas				1.58	
Mugil sp.	St. Catherines	N789 E801	30-40 cm	Atlas				2.36	
Mugil sp.	St. Catherines	N789 E801	30-40 cm	Atlas				2.24	
Mugil sp.	St. Catherines	N789 E801	30-40 cm	Atlas				2.48	
Mugil sp.	St. Catherines	N789 E801	30-40 cm	Atlas				2.63	
Mugil sp.	St. Catherines	N789 E801	30-40 cm	Atlas				2.06	
Mugil sp.	St. Catherines	N789 E801	30-40 cm	Atlas				3.10	
Mugil sp.	St. Catherines	N789 E801	40-50 cm	Atlas				1.81	
Mugil sp.	St. Catherines	N789 E801	40-50 cm	Atlas				2.84	
Mugil sp.	St. Catherines	N789 E801	40-50 cm	Atlas				2.72	
Mugil sp.	St. Catherines	N789 E801	40-50 cm	Atlas				2.61	
Mugil sp.	St. Catherines	N789 E801	40-50 cm	Atlas				3.66	
Mugil sp.	St. Catherines	N789 E801	40-50 cm	Atlas				2.64	
Mugil sp.	St. Catherines	N789 E801	40-50 cm	Atlas				2.56	
Mugil sp.	St. Catherines	N789 E801	40-50 cm	Atlas				2.21	
Mugil sp.	St. Catherines	N789 E801	40-50 cm	Atlas				2.52	
Mugil sp.	St. Catherines	N789 E801	40-50 cm	Atlas				2.69	
Mugil sp.	St. Catherines	N789 E801	40-50 cm	Atlas				2.44	
Mugil sp.	St. Catherines	N789 E801	40-50 cm	Atlas				2.07	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Mugil sp.	St. Catherines	N789 E801	40-50 cm	Atlas				2.57	
Mugil sp.	St. Catherines	N789 E801	40-50 cm	Atlas				2.19	
Mugil sp.	St. Catherines	N789 E801	40-50 cm	Atlas				2.13	
Mugil sp.	St. Catherines	N789 E801	40-50 cm	Atlas				2.31	
Mugil sp.	St. Catherines	N789 E801	40-50 cm	Atlas				2.02	
Mugil sp.	St. Catherines	N789 E801	40-50 cm	Atlas				1.72	
Mugil sp.	St. Catherines	N789 E801	40-50 cm	Atlas				2.13	
Mugil sp.	St. Catherines	N789 E801	40-50 cm	Atlas				2.14	
Mugil sp.	St. Catherines	N789 E801	40-50 cm	Atlas				2.19	
Mugil sp.	St. Catherines	N789 E801	40-50 cm	Atlas				2.43	
Mugil sp.	St. Catherines	N789 E801	40-50 cm	Atlas				1.27	
Mugil sp.	St. Catherines	N789 E801	50-60 cm	Atlas				2.13	
Mugil sp.	St. Catherines	N789 E801	50-60 cm	Atlas				2.70	
Mugil sp.	St. Catherines	N789 E801	50-60 cm	Atlas				3.74	
Mugil sp.	St. Catherines	N789 E801	50-60 cm	Atlas				2.11	
Mugil sp.	St. Catherines	N789 E801	50-60 cm	Atlas				2.63	
Mugil sp.	St. Catherines	N789 E801	50-60 cm	Atlas				2.35	
Mugil sp.	St. Catherines	N789 E801	50-60 cm	Atlas				2.50	
Mugil sp.	St. Catherines	N789 E801	50-60 cm	Atlas				1.61	
Mugil sp.	St. Catherines	N789 E801	50-60 cm	Atlas				2.42	
Mugil sp.	St. Catherines	N789 E801	50-60 cm	Atlas				2.59	
Mugil sp.	St. Catherines	N789 E801	50-60 cm	Atlas				1.46	
Mugil sp.	St. Catherines	N789 E801	50-60 cm	Atlas				2.17	
Mugil sp.	St. Catherines	N789 E801	60-70 cm	Atlas				6.29	
Mugil sp.	St. Catherines	N789 E801	60-70 cm	Atlas				1.68	
Mugil sp.	St. Catherines	N789 E801	60-70 cm	Atlas				1.39	
Mugil sp.	St. Catherines	N789 E801	60-70 cm	Atlas				1.66	
Mugil sp.	St. Catherines	N789 E801	70-80 cm	Atlas				2.44	
Mugil sp.	St. Catherines	N789 E801	70-80 cm	Atlas				2.24	
Mugil sp.	St. Catherines	N789 E801	70-80 cm	Atlas				2.10	
Mugil sp.	St. Catherines	N789 E801	80-90 cm	Atlas				2.52	
Mugil sp.	St. Catherines	N789 E801	80-90 cm	Atlas				2.51	
Mugil sp.	St. Catherines	N789 E801	80-90 cm	Atlas				3.51	
Mugil sp.	St. Catherines	N789 E801	80-90 cm	Atlas				2.40	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Mugil sp.	St. Catherines	N789 E801	105-110 cm	Atlas				2.65	
Mugil sp.	St. Catherines	N784 E811	20-30 cm	Atlas				3.92	
Mugil sp.	St. Catherines	N784 E811	20-30 cm	Atlas				2.43	
Mugil sp.	St. Catherines	N784 E811	20-30 cm	Atlas				2.83	
Mugil sp.	St. Catherines	N784 E811	20-30 cm	Atlas				2.53	
Mugil sp.	St. Catherines	N784 E811	20-30 cm	Atlas				2.05	
Mugil sp.	St. Catherines	N784 E811	20-30 cm	Atlas				2.35	
Mugil sp.	St. Catherines	N784 E811	20-30 cm	Atlas				3.66	
Mugil sp.	St. Catherines	N784 E811	20-30 cm	Atlas				2.03	
Mugil sp.	St. Catherines	N784 E811	20-30 cm	Atlas				1.65	
Mugil sp.	St. Catherines	N784 E811	30-40 cm	Atlas				2.28	
Mugil sp.	St. Catherines	N784 E811	30-40 cm	Atlas				2.53	
Mugil sp.	St. Catherines	N784 E811	30-40 cm	Atlas				2.43	
Mugil sp.	St. Catherines	N784 E811	30-40 cm	Atlas				1.73	
Mugil sp.	St. Catherines	N784 E811	30-40 cm	Atlas				2.16	
Mugil sp.	St. Catherines	N784 E811	30-40 cm	Atlas				2.00	
Mugil sp.	St. Catherines	N784 E811	30-40 cm	Atlas				2.49	
Mugil sp.	St. Catherines	N784 E811	30-40 cm	Atlas				1.79	
Mugil sp.	St. Catherines	N784 E811	30-40 cm	Atlas				2.29	
Mugil sp.	St. Catherines	N784 E811	40-50 cm	Atlas				1.61	
Mugil sp.	St. Catherines	N784 E811	40-50 cm	Atlas				2.27	
Mugil sp.	St. Catherines	N784 E811	40-50 cm	Atlas				1.56	
Mugil sp.	St. Catherines	N784 E811	40-50 cm	Atlas				2.76	
Mugil sp.	St. Catherines	N784 E811	40-50 cm	Atlas				2.65	
Mugil sp.	St. Catherines	N784 E811	40-50 cm	Atlas				1.80	
Mugil sp.	St. Catherines	N784 E811	40-50 cm	Atlas				1.78	
Mugil sp.	St. Catherines	N784 E811	40-50 cm	Atlas				1.67	
Mugil sp.	St. Catherines	N784 E811	40-50 cm	Atlas				1.79	
Mugil sp.	St. Catherines	N784 E811	40-50 cm	Atlas				1.33	
Mugil sp.	St. Catherines	N784 E811	50-60 cm	Atlas				2.06	
Mugil sp.	St. Catherines	N784 E811	50-60 cm	Atlas				2.67	
Mugil sp.	St. Catherines	N784 E811	50-60 cm	Atlas				2.88	
Mugil sp.	St. Catherines	N784 E811	50-60 cm	Atlas				3.07	
Mugil sp.	St. Catherines	N784 E811	50-60 cm	Atlas				2.02	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Mugil sp.	St. Catherines	N784 E811	50-60 cm	Atlas				2.18	
Mugil sp.	St. Catherines	N784 E811	50-60 cm	Atlas				2.24	
Mugil sp.	St. Catherines	N784 E811	50-60 cm	Atlas				1.67	
Mugil sp.	St. Catherines	N784 E811	50-60 cm	Atlas				2.39	
Mugil sp.	St. Catherines	N784 E811	50-60 cm	Atlas				2.03	
Mugil sp.	St. Catherines	N784 E811	50-60 cm	Atlas				1.87	
Mugil sp.	St. Catherines	N784 E811	50-60 cm	Atlas				2.23	
Mugil sp.	St. Catherines	N784 E811	50-60 cm	Atlas				2.29	
Mugil sp.	St. Catherines	N784 E811	50-60 cm	Atlas				1.45	
Mugil sp.	St. Catherines	N784 E811	50-60 cm	Atlas				1.87	
Mugil sp.	St. Catherines	N784 E811	50-60 cm	Atlas				3.20	
Mugil sp.	St. Catherines	N784 E811	50-60 cm	Atlas				1.78	
Mugil sp.	St. Catherines	N784 E811	50-60 cm	Atlas				1.35	
Mugil sp.	St. Catherines	N784 E811	50-60 cm	Atlas				1.57	
Mugil sp.	St. Catherines	N784 E811	50-60 cm	Atlas				1.93	
Mugil sp.	St. Catherines	N784 E811	50-60 cm	Atlas				2.11	
Mugil sp.	St. Catherines	N784 E811	50-60 cm	Atlas				1.68	
Mugil sp.	St. Catherines	N784 E811	50-60 cm	Atlas				1.44	
Mugil sp.	St. Catherines	N784 E811	60-70 cm	Atlas				2.10	
Mugil sp.	St. Catherines	N784 E811	60-70 cm	Atlas				2.18	
Mugil sp.	St. Catherines	N784 E811	60-70 cm	Atlas				2.32	
Mugil sp.	St. Catherines	N784 E811	60-70 cm	Atlas				3.64	
Mugil sp.	St. Catherines	N784 E811	60-70 cm	Atlas				2.21	
Mugil sp.	St. Catherines	N784 E811	60-70 cm	Atlas				2.31	
Mugil sp.	St. Catherines	N784 E811	60-70 cm	Atlas				2.43	
Mugil sp.	St. Catherines	N784 E811	60-70 cm	Atlas				2.34	
Mugil sp.	St. Catherines	N784 E811	60-70 cm	Atlas				2.00	
Mugil sp.	St. Catherines	N784 E811	60-70 cm	Atlas				2.26	
Mugil sp.	St. Catherines	N784 E811	60-70 cm	Atlas				1.86	
Mugil sp.	St. Catherines	N784 E811	60-70 cm	Atlas				3.23	
Mugil sp.	St. Catherines	N784 E811	60-70 cm	Atlas				2.97	
Mugil sp.	St. Catherines	N784 E811	60-70 cm	Atlas				3.26	
Mugil sp.	St. Catherines	N784 E811	60-70 cm	Atlas				3.23	
Mugil sp.	St. Catherines	N784 E811	60-70 cm	Atlas				2.84	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Mugil sp.	St. Catherines	N784 E811	70-80 cm	Atlas				2.15	
Mugil sp.	St. Catherines	N784 E797	0-10 cm	Atlas				2.62	
Mugil sp.	St. Catherines	N784 E797	10-20 cm	Atlas				2.86	
Mugil sp.	St. Catherines	N784 E797	10-20 cm	Atlas				2.34	
Mugil sp.	St. Catherines	N784 E797	10-20 cm	Atlas				2.21	
Mugil sp.	St. Catherines	N784 E797	10-20 cm	Atlas				2.93	
Mugil sp.	St. Catherines	N784 E797	10-20 cm	Atlas				1.46	
Mugil sp.	St. Catherines	N784 E797	20-30 cm	Atlas				2.93	
Mugil sp.	St. Catherines	N784 E797	20-30 cm	Atlas				1.71	
Mugil sp.	St. Catherines	N784 E797	20-30 cm	Atlas				2.13	
Mugil sp.	St. Catherines	N784 E797	20-30 cm	Atlas				1.62	
Mugil sp.	St. Catherines	N784 E797	20-30 cm	Atlas				2.46	
Mugil sp.	St. Catherines	N784 E797	20-30 cm	Atlas				2.08	
Mugil sp.	St. Catherines	N784 E797	20-30 cm	Atlas				1.71	
Mugil sp.	St. Catherines	N784 E797	20-30 cm	Atlas				1.69	
Mugil sp.	St. Catherines	N784 E797	20-30 cm	Atlas				2.32	
Mugil sp.	St. Catherines	N784 E797	20-30 cm	Atlas				1.48	
Mugil sp.	St. Catherines	N784 E797	20-30 cm	Atlas				2.17	
Mugil sp.	St. Catherines	N784 E797	30-40 cm	Atlas				2.56	
Mugil sp.	St. Catherines	N784 E797	30-40 cm	Atlas				1.67	
Mugil sp.	St. Catherines	N784 E797	30-40 cm	Atlas				3.01	
Mugil sp.	St. Catherines	N784 E797	30-40 cm	Atlas				1.95	
Mugil sp.	St. Catherines	N784 E797	30-40 cm	Atlas				2.07	
Mugil sp.	St. Catherines	N784 E797	30-40 cm	Atlas				1.98	
Mugil sp.	St. Catherines	N784 E797	30-40 cm	Atlas				1.71	
Mugil sp.	St. Catherines	N784 E797	40-50 cm	Atlas				1.32	
Mugil sp.	St. Catherines	N784 E797	40-50 cm	Atlas				2.55	
Mugil sp.	St. Catherines	N784 E797	40-50 cm	Atlas				2.73	
Mugil sp.	St. Catherines	N784 E797	50-60 cm	Atlas				2.68	
Mugil sp.	St. Catherines	N784 E797	50-60 cm	Atlas				1.43	
Mugil sp.	St. Catherines	N784 E797	50-60 cm	Atlas				1.86	
Mugil sp.	St. Catherines	N784 E797	50-60 cm	Atlas				1.98	
Mugil sp.	St. Catherines	N784 E797	60-70 cm	Atlas				2.37	
Mugil sp.	St. Catherines	N784 E797	60-70 cm	Atlas				1.86	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Mugil sp.	St. Catherines	N784 E797	60-70 cm	Atlas				3.42	
Mugil sp.	St. Catherines	N784 E797	60-70 cm	Atlas				1.18	
Mugil sp.	St. Catherines	N784 E797	60-70 cm	Atlas				2.87	
Mugil sp.	St. Catherines	N784 E797	60-70 cm	Atlas				2.21	
Mugil sp.	St. Catherines	N784 E797	60-70 cm	Atlas				2.08	
Mugil sp.	St. Catherines	N784 E797	60-70 cm	Atlas				2.43	
Mugil sp.	St. Catherines	N784 E797	60-70 cm	Atlas				2.95	
Mugil sp.	St. Catherines	N784 E797	60-70 cm	Atlas				1.91	
Mugil sp.	St. Catherines	N784 E797	60-70 cm	Atlas				2.33	
Mugil sp.	St. Catherines	N784 E797	60-70 cm	Atlas				2.37	
Mugil sp.	St. Catherines	N784 E797	60-70 cm	Atlas				2.59	
Mugil sp.	St. Catherines	N784 E797	60-70 cm	Atlas				2.40	
Mugil sp.	St. Catherines	N784 E797	60-70 cm	Atlas				2.04	
Mugil sp.	St. Catherines	N784 E797	70-75.5 cm	Atlas				2.61	
Mugil sp.	St. Catherines	N784 E797	70-75.5 cm	Atlas				2.47	
Mugil sp.	St. Catherines	N784 E797	70-75.5 cm	Atlas				3.43	
Mugil sp.	St. Catherines	N784 E797	70-75.5 cm	Atlas				3.22	
Mugil sp.	St. Catherines	N784 E797	70-75.5 cm	Atlas				2.23	
Mugil sp.	St. Catherines	N784 E797	78-86 cm	Atlas				2.07	
Mugil sp.	St. Catherines	N784 E797	78-86 cm	Atlas				2.64	
Mugil sp.	St. Catherines	N784 E797	78-86 cm	Atlas				3.45	
Mugil sp.	St. Catherines	N784 E797	78-86 cm	Atlas				1.47	
Mugil sp.	St. Catherines	N784 E797	78-86 cm	Atlas				2.37	
Mugil sp.	St. Catherines	N784 E797	78-86 cm	Atlas				1.89	
Mugil sp.	St. Catherines	W82 S2	2.9-2.8	Atlas				3.19	
Mugil sp.	St. Catherines	W82 S2	2.9-2.8	Atlas				3.11	
Mugil sp.	St. Catherines	W82 S2	2.9-2.8	Atlas				2.63	
Mugil sp.	St. Catherines	W82 S2	2.9-2.8	Atlas				2.36	
Mugil sp.	St. Catherines	W82 S2	2.8-2.7	Atlas				5.90	
Mugil sp.	St. Catherines	W82 S2	2.8-2.7	Atlas				2.46	
Mugil sp.	St. Catherines	W82 S2	2.8-2.7	Atlas				2.46	
Mugil sp.	St. Catherines	W82 S2	2.7-2.6	Atlas				2.13	
Mugil sp.	St. Catherines	W82 S2	2.7-2.6	Atlas				2.85	
Mugil sp.	St. Catherines	W82 S2	2.7-2.6	Atlas				2.51	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Mugil sp.	St. Catherines	W82 S2	2.7-2.6	Atlas				2.80	
Mugil sp.	St. Catherines	W82 S2	2.7-2.6	Atlas				2.34	
Mugil sp.	St. Catherines	W82 S2	2.7-2.6	Atlas				2.50	
Mugil sp.	St. Catherines	W82 S2	2.7-2.6	Atlas				1.81	
Mugil sp.	St. Catherines	W82 S2	2.6-2.5	Atlas				2.28	
Mugil sp.	St. Catherines	W82 S2	2.6-2.5	Atlas				1.67	
Mugil sp.	St. Catherines	W82 S2	2.6-2.5	Atlas				1.51	
Mugil sp.	St. Catherines	W82 S2	2.6-2.5	Atlas				2.54	
Mugil sp.	St. Catherines	W82 S2	2.6-2.5	Atlas				2.26	
Mugil sp.	St. Catherines	W82 S2	2.6-2.5	Atlas				3.04	
Mugil sp.	St. Catherines	W82 S2	2.6-2.5	Atlas				1.90	
Mugil sp.	St. Catherines	W82 S2	2.6-2.5	Atlas				2.13	
Mugil sp.	St. Catherines	W82 S2	2.6-2.5	Atlas				1.68	
Mugil sp.	St. Catherines	W82 S2	2.6-2.5	Atlas				2.07	
Mugil sp.	St. Catherines	W82 S2	2.6-2.5	Atlas				2.32	
Mugil sp.	St. Catherines	W82 S2	2.5-2.4	Atlas				2.56	
Mugil sp.	St. Catherines	W82 S2	2.5-2.4	Atlas				2.56	
Mugil sp.	St. Catherines	W82 S2	2.5-2.4	Atlas				3.00	
Mugil sp.	St. Catherines	W82 S2	2.5-2.4	Atlas				2.62	
Mugil sp.	St. Catherines	W82 S2	2.5-2.4	Atlas				2.26	
Mugil sp.	St. Catherines	W82 S2	2.5-2.4	Atlas				2.21	
Mugil sp.	St. Catherines	W82 S2	2.5-2.4	Atlas				2.31	
Mugil sp.	St. Catherines	W82 S2	2.5-2.4	Atlas				2.59	
Mugil sp.	St. Catherines	W82 S2	2.5-2.4	Atlas				2.58	
Mugil sp.	St. Catherines	W82 S2	2.5-2.4	Atlas				1.53	
Mugil sp.	St. Catherines	W82 S2	2.5-2.4	Atlas				2.30	
Mugil sp.	St. Catherines	W82 S2	2.5-2.4	Atlas				2.64	
Mugil sp.	St. Catherines	W82 S2	2.5-2.4	Atlas				2.15	
Mugil sp.	St. Catherines	W82 S2	2.5-2.4	Atlas				1.97	
Mugil sp.	St. Catherines	W82 S2	2.4-2.3	Atlas				2.49	
Mugil sp.	St. Catherines	W82 S2	2.4-2.3	Atlas				2.92	
Mugil sp.	St. Catherines	W82 S2	2.4-2.3	Atlas				2.39	
Mugil sp.	St. Catherines	W82 S2	2.4-2.3	Atlas				1.46	
Mugil sp.	St. Catherines	W82 S2	2.4-2.3	Atlas				3.16	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Mugil sp.	St. Catherines	W82 S2	2.4-2.3	Atlas				2.75	
Mugil sp.	St. Catherines	W82 S2	2.4-2.3	Atlas				2.22	
Mugil sp.	St. Catherines	W82 S2	2.3-2.2	Atlas				2.18	
Mugil sp.	St. Catherines	W82 S2	2.3-2.2	Atlas				2.00	
Mugil sp.	St. Catherines	W82 S2	2.3-2.2	Atlas				1.45	
Mugil sp.	St. Catherines	W82 S2	2.3-2.2	Atlas				2.23	
Mugil sp.	St. Catherines	W82 S2	2.3-2.2	Atlas				1.89	
Mugil sp.	St. Catherines	W82 S2	2.3-2.2	Atlas				2.16	
Mugil sp.	St. Catherines	W82 S2	2.3-2.2	Atlas				2.12	
Mugil sp.	St. Catherines	W82 S2	2.3-2.2	Atlas				2.20	
Mugil sp.	St. Catherines	W82 S2	2.3-2.2	Atlas				3.04	
Mugil sp.	St. Catherines	W82 S2	2.3-2.2	Atlas				2.20	
Mugil sp.	St. Catherines	W82 S2	2.3-2.2	Atlas				2.38	
Mugil sp.	St. Catherines	W82 S2	2.3-2.2	Atlas				2.85	
Mugil sp.	St. Catherines	W82 S2	2.3-2.2	Atlas				2.27	
Mugil sp.	St. Catherines	W82 S2	2.3-2.2	Atlas				2.55	
Mugil sp.	St. Catherines	W82 S2	2.3-2.2	Atlas				2.65	
Mugil sp.	St. Catherines	W82 S2	2.3-2.2	Atlas				2.27	
Mugil sp.	St. Catherines	W82 S2	2.3-2.2	Atlas				2.66	
Mugil sp.	St. Catherines	W82 S2	2.3-2.2	Atlas				2.71	
Mugil sp.	St. Catherines	W82 S2	2.3-2.2	Atlas				1.89	
Mugil sp.	St. Catherines	W82 S2	2.2-2.1	Atlas				2.26	
Mugil sp.	St. Catherines	W82 S2	2.2-2.1	Atlas				1.97	
Mugil sp.	St. Catherines	W82 S2	2.2-2.1	Atlas				1.99	
Mugil sp.	St. Catherines	W82 S2	2.1-2.0	Atlas				2.49	
Mugil sp.	St. Catherines	W82 S2	2.1-2.0	Atlas				2.58	
Mugil sp.	St. Catherines	W82 S2	2.1-2.0	Atlas				2.45	
Mugil sp.	St. Catherines	W82 S2	2.1-2.0	Atlas				1.27	
Mugil sp.	St. Catherines	W82 S2	2.1-2.0	Atlas				2.47	
Mugil sp.	St. Catherines	W82 S2	2.1-2.0	Atlas				2.14	
Mugil sp.	St. Catherines	W82 S2	2.0-1.9	Atlas				1.93	
Mugil sp.	St. Catherines	W84 S2	2.8-2.7	Atlas				1.75	
Mugil sp.	St. Catherines	W84 S2	2.8-2.7	Atlas				2.10	
Mugil sp.	St. Catherines	W84 S2	2.8-2.7	Atlas				2.82	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Mugil sp.	St. Catherines	W84 S2	2.8-2.7	Atlas				2.16	
Mugil sp.	St. Catherines	W84 S2	2.8-2.7	Atlas				2.31	
Mugil sp.	St. Catherines	W84 S2	2.8-2.7	Atlas				2.26	
Mugil sp.	St. Catherines	W84 S2	2.8-2.7	Atlas				2.35	
Mugil sp.	St. Catherines	W84 S2	2.8-2.7	Atlas				1.34	
Mugil sp.	St. Catherines	W84 S2	2.8-2.7	Atlas				1.97	
Mugil sp.	St. Catherines	W84 S2	2.8-2.7	Atlas				1.57	
Mugil sp.	St. Catherines	W84 S2	2.7-2.6	Atlas				2.18	
Mugil sp.	St. Catherines	W84 S2	2.7-2.6	Atlas				2.26	
Mugil sp.	St. Catherines	W84 S2	2.7-2.6	Atlas				1.29	
Mugil sp.	St. Catherines	W84 S2	2.7-2.6	Atlas				1.65	
Mugil sp.	St. Catherines	W84 S2	2.7-2.6	Atlas				1.88	
Mugil sp.	St. Catherines	W84 S2	2.7-2.6	Atlas				2.36	
Mugil sp.	St. Catherines	W84 S2	2.7-2.6	Atlas				2.85	
Mugil sp.	St. Catherines	W84 S2	2.7-2.6	Atlas				1.59	
Mugil sp.	St. Catherines	W84 S2	2.7-2.6	Atlas				2.17	
Mugil sp.	St. Catherines	W84 S2	2.7-2.6	Atlas				1.76	
Mugil sp.	St. Catherines	W84 S2	2.7-2.6	Atlas				2.53	
Mugil sp.	St. Catherines	W84 S2	2.7-2.6	Atlas				2.51	
Mugil sp.	St. Catherines	W84 S2	2.7-2.6	Atlas				2.23	
Mugil sp.	St. Catherines	W84 S2	2.7-2.6	Atlas				2.13	
Mugil sp.	St. Catherines	W84 S2	2.7-2.6	Atlas				2.82	
Mugil sp.	St. Catherines	W84 S2	2.7-2.6	Atlas				1.83	
Mugil sp.	St. Catherines	W84 S2	2.6-2.5	Atlas				2.30	
Mugil sp.	St. Catherines	W84 S2	2.6-2.5	Atlas				2.05	
Mugil sp.	St. Catherines	W84 S2	2.6-2.5	Atlas				1.36	
Mugil sp.	St. Catherines	N771 E819	Surface-2.6	Atlas				2.48	
Mugil sp.	St. Catherines	N771 E819	Surface-2.6	Atlas				2.19	
Mugil sp.	St. Catherines	N771 E819	2.6-2.5	Atlas				5.31	
Mugil sp.	St. Catherines	N771 E819	2.6-2.5	Atlas				2.66	
Mugil sp.	St. Catherines	N771 E819	2.6-2.5	Atlas				1.80	
Mugil sp.	St. Catherines	N771 E819	2.6-2.5	Atlas				1.92	
Mugil sp.	St. Catherines	N771 E819	2.6-2.5	Atlas				2.37	
Mugil sp.	St. Catherines	N771 E819	2.6-2.5	Atlas				1.66	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Mugil sp.	St. Catherines	N771 E819	2.6-2.5	Atlas				1.56	
Mugil sp.	St. Catherines	N771 E819	2.6-2.5	Atlas				1.93	
Mugil sp.	St. Catherines	N771 E819	2.6-2.5	Atlas				2.02	
Mugil sp.	St. Catherines	N771 E819	2.6-2.5	Atlas				1.89	
Mugil sp.	St. Catherines	N771 E819	2.6-2.5	Atlas				1.70	
Mugil sp.	St. Catherines	N771 E819	2.5-2.4	Atlas				2.25	
Mugil sp.	St. Catherines	N771 E819	2.5-2.4	Atlas				1.49	
Mugil sp.	St. Catherines	N771 E819	2.5-2.4	Atlas				2.65	
Mugil sp.	St. Catherines	N771 E819	2.5-2.4	Atlas				1.63	
Mugil sp.	St. Catherines	N771 E819	2.5-2.4	Atlas				2.22	
Mugil sp.	St. Catherines	N771 E819	2.5-2.4	Atlas				2.55	
Mugil sp.	St. Catherines	N771 E819	2.5-2.4	Atlas				2.06	
Mugil sp.	St. Catherines	N771 E819	2.5-2.4	Atlas				2.94	
Mugil sp.	St. Catherines	N771 E819	2.5-2.4	Atlas				2.20	
Mugil sp.	St. Catherines	N771 E819	2.39-2.3	Atlas				1.89	
Mugil sp.	St. Catherines	N771 E819	2.39-2.3	Atlas				1.88	
Mugil sp.	St. Catherines	N771 E819	2.3-2.2	Atlas				1.66	
Mugil sp.	St. Catherines	N771 E819	2.3-2.2	Atlas				2.19	
Mugil sp.	St. Catherines	Feature 23	1.8-1.7	Atlas				2.24	
Mugil sp.	St. Catherines	Feature 23	1.8-1.7	Atlas				2.37	
Mugil sp.	McQueen	N 213 E 198	Open-4.6	Atlas				4.04	
Mugil sp.	McQueen	N 213 E 198	Open-4.6	Atlas				3.15	
Mugil sp.	McQueen	N 213 E 198	Open-4.6	Atlas				2.31	
Mugil sp.	McQueen	N 213 E 198	Open-4.6	Atlas				2.03	
Mugil sp.	McQueen	N 213 E 198	Open-4.6	Atlas				1.95	
Mugil sp.	McQueen	N 213 E 198	Open-4.6	Atlas				2.09	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				3.00	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				2.87	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				2.10	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				2.57	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				2.11	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				1.89	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				2.70	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				2.70	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				2.01	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				3.58	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				2.29	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				2.07	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				1.67	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				1.97	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				3.94	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				2.36	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				2.25	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				3.60	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				2.55	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				1.40	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				1.92	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				2.82	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				2.77	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				3.13	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				3.36	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				5.88	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				2.96	
Mugil sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				4.81	
Mugil sp.	McQueen	N 213 E 198	4.5-4.4	Atlas				2.73	
Mugil sp.	McQueen	N 213 E 198	4.5-4.4	Atlas				1.60	
Mugil sp.	McQueen	N 213 E 198	4.5-4.4	Atlas				2.92	
Mugil sp.	McQueen	N 213 E 198	4.5-4.4	Atlas				1.52	
Mugil sp.	McQueen	N 213 E 198	4.5-4.4	Atlas				2.60	
Mugil sp.	McQueen	N 213 E 198	4.5-4.4	Atlas				1.59	
Mugil sp.	McQueen	N 213 E 198	4.5-4.4	Atlas				2.56	
Mugil sp.	McQueen	N 213 E 198	4.5-4.4	Atlas				1.50	
Mugil sp.	McQueen	N 213 E 198	4.5-4.4	Atlas				1.88	
Mugil sp.	McQueen	N 213 E 198	4.5-4.4	Atlas				2.39	
Mugil sp.	McQueen	N 213 E 198	4.5-4.4	Atlas				2.35	
Mugil sp.	McQueen	N 213 E 198	4.5-4.4	Atlas				3.08	
Mugil sp.	McQueen	N 213 E 198	4.5-4.4	Atlas				3.13	
Mugil sp.	McQueen	N 213 E 198	4.5-4.4	Atlas				1.47	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Mugil sp.	McQueen	N 213 E 198	4.5-4.4	Atlas				1.81	
Mugil sp.	McQueen	N 213 E 198	4.5-4.4	Atlas				1.31	
Mugil sp.	McQueen	N 213 E 198	4.5-4.4	Atlas				2.58	
Mugil sp.	McQueen	N 213 E 198	4.5-4.4	Atlas				2.49	
Mugil sp.	McQueen	N263 E179	5.8-5.7	Atlas				2.57	
Mugil sp.	McQueen	N263 E179	5.7-5.6	Atlas				2.66	
Mugil sp.	McQueen	N263 E179	5.7-5.6	Atlas				2.50	
Mugil sp.	McQueen	N263 E179	5.7-5.6	Atlas				2.47	
Mugil sp.	McQueen	N263 E179	5.7-5.6	Atlas				2.21	
Mugil sp.	McQueen	N263 E179	5.7-5.6	Atlas				1.53	
Mugil sp.	McQueen	N263 E179	5.7-5.6	Atlas				1.57	
Mugil sp.	McQueen	N263 E179	5.7-5.6	Atlas				2.38	
Mugil sp.	McQueen	N263 E179	5.7-5.6	Atlas				1.42	
Mugil sp.	McQueen	N263 E179	5.7-5.6	Atlas				2.41	
Mugil sp.	McQueen	N263 E179	5.7-5.6	Atlas				2.30	
Mugil sp.	McQueen	N263 E179	5.7-5.6	Atlas				2.29	
Mugil sp.	McQueen	N263 E179	5.7-5.6	Atlas				2.48	
Mugil sp.	McQueen	N263 E179	5.7-5.6	Atlas				2.03	
Mugil sp.	McQueen	N263 E179	5.6-5.5	Atlas				2.90	
Mugil sp.	McQueen	N263 E179	5.6-5.5	Atlas				2.08	
Mugil sp.	McQueen	N263 E179	5.6-5.5	Atlas				1.31	
Mugil sp.	McQueen	N263 E179	5.6-5.5	Atlas				2.77	
Mugil sp.	McQueen	N263 E179	5.6-5.5	Atlas				1.67	
Mugil sp.	McQueen	N263 E179	5.6-5.5	Atlas				1.87	
Mugil sp.	McQueen	N263 E179	5.6-5.5	Atlas				2.26	
Mugil sp.	McQueen	N263 E179	5.6-5.5	Atlas				1.85	
Mugil sp.	McQueen	N263 E179	5.6-5.5	Atlas				2.86	
Mugil sp.	McQueen	N263 E179	5.6-5.5	Atlas				1.99	
Mugil sp.	McQueen	N263 E179	5.6-5.5	Atlas				2.73	
Mugil sp.	McQueen	N263 E179	5.6-5.5	Atlas				1.86	
Mugil sp.	McQueen	N263 E179	5.6-5.5	Atlas				2.19	
Mugil sp.	McQueen	N263 E179	5.6-5.5	Atlas				1.46	
Mugil sp.	McQueen	N263 E179	5.6-5.5	Atlas				2.36	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				2.28	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				4.87	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				2.37	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				2.32	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				2.75	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				3.20	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				2.19	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				1.70	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				3.16	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				2.27	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				2.05	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				1.42	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				1.70	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				2.30	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				1.73	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				2.33	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				3.17	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				1.41	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				2.35	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				2.78	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				2.01	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				1.88	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				2.12	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				1.25	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				1.81	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				1.37	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				1.28	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				2.10	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				1.65	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				1.42	
Mugil sp.	McQueen	N263 E179	5.5-5.4	Atlas				1.43	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.24	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.30	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.87	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.10	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.48	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.30	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.74	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.49	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.30	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.81	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.35	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.28	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.24	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.42	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.98	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.24	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.81	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.33	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.40	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.95	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.98	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.20	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.58	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.08	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.06	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.80	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				3.37	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.33	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.56	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.28	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				3.19	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.39	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.15	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.71	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.26	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.42	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.13	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.64	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.02	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.33	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				3.00	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.92	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.45	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.27	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.89	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.46	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.16	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.02	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.60	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.29	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.63	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.83	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.71	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.02	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.18	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.35	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.10	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.52	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.60	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.35	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.39	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.58	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				4.20	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.69	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.30	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.38	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.88	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				3.20	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.10	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.75	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.90	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.42	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.84	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				4.01	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.91	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.46	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.02	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.27	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.06	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.16	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				4.07	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				5.11	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.48	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.75	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.18	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.72	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				3.04	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.36	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.23	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.22	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.00	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.90	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.28	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.19	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.66	
Mugil sp.	McQueen	N263 E179	5.4-5.3	Atlas				1.52	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				3.06	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				3.20	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.15	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.79	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				3.18	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.70	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.82	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.53	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.31	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.26	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				3.01	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.50	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.32	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.59	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.61	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				3.31	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.66	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.81	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.29	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				4.00	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.62	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				3.34	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.73	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.34	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.53	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.15	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.19	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.10	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.18	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.39	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.73	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.07	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.68	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.49	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				3.00	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.63	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.55	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.35	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.19	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.71	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.27	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.67	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.37	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.80	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.26	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.61	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.16	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.27	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.19	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.23	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.29	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.03	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.50	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.85	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.97	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.79	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.52	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.94	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.72	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				3.53	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.52	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.55	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.06	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.96	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.38	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.57	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				3.17	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.34	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.25	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.50	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.93	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.33	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.26	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.55	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.55	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.73	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.34	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.35	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.50	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.64	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.34	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.35	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.47	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.21	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.76	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.93	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.76	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.21	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.02	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.37	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.25	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.16	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.46	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.73	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.69	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.25	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.36	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.14	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.23	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.18	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.31	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.57	
Mugil sp.	McQueen	N263 E179	5.3-5.17	Atlas				1.72	
Mugil sp.	McQueen	N263 E179	5.24-5.1	Atlas				1.40	
Mugil sp.	McQueen	N263 E179	5.24-5.1	Atlas				1.93	
Mugil sp.	McQueen	N263 E179	5.24-5.1	Atlas				1.11	
Mugil sp.	McQueen	N263 E179	5.24-5.1	Atlas				1.79	
Cyprinodontidae	Cannon's Point	18N 0E	L5	Atlas				2.19	
Cyprinodontidae	Cannon's Point	18N 0E	L9	Atlas				2.33	
Cyprinodontidae	Cannon's Point	18N 0E	L22	Atlas				2.45	
Cyprinodontidae	Cannon's Point	18N 0E	L33	Atlas				1.88	
Cyprinodontidae	Sapelo	9	20-25 cm	Atlas				1.82	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Cyprinodontidae	St. Catherines	N782 E801	20-30 cm	Atlas				2.65	
Cyprinodontidae	St. Catherines	N784 E801	10-20 cm	Atlas				2.35	
Cyprinodontidae	St. Catherines	N784 E801	20-30 cm	Atlas				2.41	
Cyprinodontidae	St. Catherines	N784 E801	50-60 cm	Atlas				1.97	
Cyprinodontidae	St. Catherines	N784 E801	50-60 cm	Atlas				2.40	
Cyprinodontidae	St. Catherines	N784 E801	50-60 cm	Atlas				1.53	
Cyprinodontidae	St. Catherines	N784 E801	60-70 cm	Atlas				2.04	
Cyprinodontidae	St. Catherines	N789 E801	10-20 cm	Atlas				2.47	
Cyprinodontidae	St. Catherines	N789 E801	20-30 cm	Atlas				2.36	
Cyprinodontidae	St. Catherines	N789 E801	10-20 cm	Atlas				2.05	
Cyprinodontidae	St. Catherines	N789 E801	30-40 cm	Atlas				1.71	
Cyprinodontidae	St. Catherines	N789 E801	30-40 cm	Atlas				2.11	
Cyprinodontidae	St. Catherines	N789 E801	40-50 cm	Atlas				2.29	
Cyprinodontidae	St. Catherines	N789 E801	40-50 cm	Atlas				2.28	
Cyprinodontidae	St. Catherines	N789 E801	40-50 cm	Atlas				2.33	
Cyprinodontidae	St. Catherines	N789 E801	40-50 cm	Atlas				2.13	
Cyprinodontidae	St. Catherines	N789 E801	70-80 cm	Atlas				2.47	
Cyprinodontidae	St. Catherines	N789 E801	70-80 cm	Atlas				2.34	
Cyprinodontidae	St. Catherines	N784 E811	20-30 cm	Atlas				1.73	
Cyprinodontidae	St. Catherines	N784 E811	20-30 cm	Atlas				1.81	
Cyprinodontidae	St. Catherines	N784 E811	20-30 cm	Atlas				1.55	
Cyprinodontidae	St. Catherines	N784 E811	30-40 cm	Atlas				2.00	
Cyprinodontidae	St. Catherines	N784 E811	30-40 cm	Atlas				2.37	
Cyprinodontidae	St. Catherines	N784 E811	30-40 cm	Atlas				1.71	
Cyprinodontidae	St. Catherines	N784 E811	50-60 cm	Atlas				2.30	
Cyprinodontidae	St. Catherines	N784 E811	50-60 cm	Atlas				2.05	
Cyprinodontidae	St. Catherines	W82 S2	2.7-2.6	Atlas				2.07	
Cyprinodontidae	St. Catherines	W82 S2	2.6-2.5	Atlas				2.49	
Cyprinodontidae	St. Catherines	W82 S2	2.4-2.3	Atlas				2.20	
Cyprinodontidae	St. Catherines	W82 S2	2.3-2.2	Atlas				2.01	
Cyprinodontidae	St. Catherines	W84 S2	2.8-2.7	Atlas				1.91	
Cyprinodontidae	St. Catherines	W84 S2	2.7-2.6	Atlas				1.63	
Cyprinodontidae	St. Catherines	W84 S2	2.7-2.6	Atlas				1.86	
Cyprinodontidae	St. Catherines	N771 E819	2.6-2.5	Atlas				2.59	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Cyprinodontidae	St. Catherines	N771 E819	2.6-2.5	Atlas				1.78	
Cyprinodontidae	St. Catherines	N771 E819	2.5-2.4	Atlas				2.24	
Cyprinodontidae	McQueen	N263 E179	5.7-5.6	Atlas				2.55	
Cyprinodontidae	McQueen	N263 E179	5.6-5.5	Atlas				1.98	
Cyprinodontidae	McQueen	N263 E179	5.5-5.4	Atlas				1.98	
Cyprinodontidae	McQueen	N263 E179	5.4-5.3	Atlas				1.78	
Lepomis sp.	St. Catherines	N789 E801	70-80 cm	Atlas				2.16	
Pomatomus saltatrix	McQueen	N263 E179	5.8-5.7	Atlas				3.46	
Pomatomus saltatrix	McQueen	N263 E179	5.6-5.5	Atlas				2.50	
Pomatomus saltatrix	McQueen	N263 E179	5.6-5.5	Atlas				2.73	
Pomatomus saltatrix	McQueen	N263 E179	5.3-5.17	Atlas				1.57	
Orthopristis chrysoptera	McQueen	N 213 E 198	4.5-4.4	Atlas				2.74	
Sparidae	Cannon's Point	18N 0E	L15	Atlas				2.61	
Lagodon rhomboides	St. Catherines	N784 E797	78-86 cm	Atlas				3.25	
Lagodon rhomboides	McQueen	N263 E179	5.4-5.3	Atlas				2.58	
Bairdiella chrysoura	Cannon's Point	18N 0E	L11	Sagitta otolith	Right	4.09		4.96	2.06
Bairdiella chrysoura	Cannon's Point	18N 0E	L11	Sagitta otolith	Right	5.06		5.59	2.44
Bairdiella chrysoura	Cannon's Point	18N 0E	L24	Sagitta otolith	Right	4.70		4.91	2.29
Bairdiella chrysoura	West	5S 30E	ZII L2	Sagitta otolith	Right	5.77		6.69	2.83
Bairdiella chrysoura	West	5S 30E	ZII L3	Sagitta otolith	Right	3.69		4.22	1.98
Bairdiella chrysoura	West	5S 30E	ZII L3	Sagitta otolith	Right	4.15		5.01	2.21
Bairdiella chrysoura	West	5S 30E	ZII L5	Sagitta otolith	Right	3.93		4.40	1.88
Bairdiella chrysoura	West	5S 30E	L6	Sagitta otolith	Right	5.37		6.02	2.76
Bairdiella chrysoura	West	5S 30E	L6	Sagitta otolith	Right	3.57		4.37	1.89
Bairdiella chrysoura	West	5S 30E	L7	Sagitta otolith	Right	4.56		4.72	2.18
Bairdiella chrysoura	West	5S 30E	L9	Sagitta otolith	Right	5.82		6.25	2.92
Bairdiella chrysoura	West	5S 30E	L9	Sagitta otolith	Right	4.20		5.07	2.13
Bairdiella chrysoura	West	5S 30E	L9	Sagitta otolith	Right	3.74		3.54	1.74
Bairdiella chrysoura	West	5S 30E	L9	Sagitta otolith	Right	4.58		5.11	2.26
Bairdiella chrysoura	West	5S 30E	L10	Sagitta otolith	Right	5.23		6.05	2.47
Bairdiella chrysoura	West	5S 30E	L10	Sagitta otolith	Right	4.46		5.03	2.24
Bairdiella chrysoura	Sapelo	9	10-15 cm	Sagitta otolith	Right	7.41		6.14	3.19
Bairdiella chrysoura	Sapelo	9	15-20 cm	Sagitta otolith	Right	3.34		3.26	1.67
Bairdiella chrysoura	Sapelo	9	15-20 cm	Sagitta otolith	Right	5.57		4.72	2.63

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bairdiella chrysoura	Sapelo	9	20-25 cm	Sagitta otolith	Right	4.93		4.58	2.15
Bairdiella chrysoura	Sapelo	9	35-40 cm	Sagitta otolith	Right	4.69		4.03	2.10
Bairdiella chrysoura	St. Catherines	N784 E801	10-20 cm	Sagitta otolith	Right	5.54		4.83	2.63
Bairdiella chrysoura	St. Catherines	N784 E801	30-40 cm	Sagitta otolith	Right	5.75		4.87	2.46
Bairdiella chrysoura	St. Catherines	N784 E801	40-50 cm	Sagitta otolith	Right	4.61		4.12	2.00
Bairdiella chrysoura	St. Catherines	N789 E801	0-10 cm	Sagitta otolith	Right	5.39		4.35	2.45
Bairdiella chrysoura	St. Catherines	N789 E801	0-10 cm	Sagitta otolith	Right	6.04		5.21	2.93
Bairdiella chrysoura	St. Catherines	N789 E801	10-20 cm	Sagitta otolith	Right	7.32		5.76	3.14
Bairdiella chrysoura	St. Catherines	N789 E801	10-20 cm	Sagitta otolith	Right	6.47		5.22	2.81
Bairdiella chrysoura	St. Catherines	N789 E801	20-30 cm	Sagitta otolith	Right	5.36		4.61	2.35
Bairdiella chrysoura	St. Catherines	N789 E801	20-30 cm	Sagitta otolith	Right	5.46		4.90	2.50
Bairdiella chrysoura	St. Catherines	N789 E801	20-30 cm	Sagitta otolith	Right	4.36		3.93	2.02
Bairdiella chrysoura	St. Catherines	N789 E801	20-30 cm	Sagitta otolith	Right	6.61		5.52	2.88
Bairdiella chrysoura	St. Catherines	N789 E801	20-30 cm	Sagitta otolith	Right	4.70		3.96	2.09
Bairdiella chrysoura	St. Catherines	N789 E801	30-40 cm	Sagitta otolith	Right	5.75		4.81	2.57
Bairdiella chrysoura	St. Catherines	N789 E801	30-40 cm	Sagitta otolith	Right	6.27		5.14	2.70
Bairdiella chrysoura	St. Catherines	N789 E801	30-40 cm	Sagitta otolith	Right	5.42		4.42	2.42
Bairdiella chrysoura	St. Catherines	N789 E801	30-40 cm	Sagitta otolith	Right	6.02		5.19	2.54
Bairdiella chrysoura	St. Catherines	N789 E801	30-40 cm	Sagitta otolith	Right	4.89		4.04	1.95
Bairdiella chrysoura	St. Catherines	N789 E801	40-50 cm	Sagitta otolith	Right	4.48		3.86	1.96
Bairdiella chrysoura	St. Catherines	N789 E801	40-50 cm	Sagitta otolith	Right	4.68		3.96	1.91
Bairdiella chrysoura	St. Catherines	N789 E801	40-50 cm	Sagitta otolith	Right	5.00		4.14	2.15
Bairdiella chrysoura	St. Catherines	N789 E801	40-50 cm	Sagitta otolith	Right	4.69		3.74	2.03
Bairdiella chrysoura	St. Catherines	N789 E801	50-60 cm	Sagitta otolith	Right	5.26		4.57	2.24
Bairdiella chrysoura	St. Catherines	N789 E801	50-60 cm	Sagitta otolith	Right	4.84		4.26	2.09
Bairdiella chrysoura	St. Catherines	N789 E801	80-90 cm	Sagitta otolith	Right	4.42		3.81	1.93
Bairdiella chrysoura	St. Catherines	N784 E811	20-30 cm	Sagitta otolith	Right	6.39		5.13	2.86
Bairdiella chrysoura	St. Catherines	N784 E811	20-30 cm	Sagitta otolith	Right	5.35		4.21	2.41
Bairdiella chrysoura	St. Catherines	N784 E811	20-30 cm	Sagitta otolith	Right	5.88		4.98	2.74
Bairdiella chrysoura	St. Catherines	N784 E811	20-30 cm	Sagitta otolith	Right	5.47		4.79	2.38
Bairdiella chrysoura	St. Catherines	N784 E811	20-30 cm	Sagitta otolith	Right	5.04		4.66	2.11
Bairdiella chrysoura	St. Catherines	N784 E811	30-40 cm	Sagitta otolith	Right	6.19		4.93	2.59
Bairdiella chrysoura	St. Catherines	N784 E811	30-40 cm	Sagitta otolith	Right	6.51		5.22	2.79
Bairdiella chrysoura	St. Catherines	N784 E811	30-40 cm	Sagitta otolith	Right	6.25		4.99	2.76

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bairdiella chrysoura	St. Catherines	N784 E811	30-40 cm	Sagitta otolith	Right	4.78		4.24	1.99
Bairdiella chrysoura	St. Catherines	N784 E811	40-50 cm	Sagitta otolith	Right	6.14		5.17	2.75
Bairdiella chrysoura	St. Catherines	N784 E811	40-50 cm	Sagitta otolith	Right	5.23		4.42	2.29
Bairdiella chrysoura	St. Catherines	N784 E811	40-50 cm	Sagitta otolith	Right	5.81		5.15	2.59
Bairdiella chrysoura	St. Catherines	N784 E811	40-50 cm	Sagitta otolith	Right	6.96		5.95	3.18
Bairdiella chrysoura	St. Catherines	N784 E811	50-60 cm	Sagitta otolith	Right	5.12		4.17	2.14
Bairdiella chrysoura	St. Catherines	N784 E811	60-70 cm	Sagitta otolith	Right	5.28		4.79	2.36
Bairdiella chrysoura	St. Catherines	N784 E797	10-20 cm	Sagitta otolith	Right	4.89		4.11	2.08
Bairdiella chrysoura	St. Catherines	N784 E797	10-20 cm	Sagitta otolith	Right	5.69		4.93	2.41
Bairdiella chrysoura	St. Catherines	N784 E797	10-20 cm	Sagitta otolith	Right	6.18		5.72	2.66
Bairdiella chrysoura	St. Catherines	N784 E797	10-20 cm	Sagitta otolith	Right	5.47		4.82	2.27
Bairdiella chrysoura	St. Catherines	N784 E797	10-20 cm	Sagitta otolith	Right	6.28		4.98	2.63
Bairdiella chrysoura	St. Catherines	N784 E797	10-20 cm	Sagitta otolith	Right	5.87		4.98	2.67
Bairdiella chrysoura	St. Catherines	N784 E797	10-20 cm	Sagitta otolith	Right	6.23		5.28	2.81
Bairdiella chrysoura	St. Catherines	N784 E797	10-20 cm	Sagitta otolith	Right	4.40		4.00	2.12
Bairdiella chrysoura	St. Catherines	N784 E797	20-30 cm	Sagitta otolith	Right	5.08		4.31	2.17
Bairdiella chrysoura	St. Catherines	N784 E797	20-30 cm	Sagitta otolith	Right	5.66		4.57	2.44
Bairdiella chrysoura	St. Catherines	N784 E797	20-30 cm	Sagitta otolith	Right	7.43		5.88	3.14
Bairdiella chrysoura	St. Catherines	N784 E797	20-30 cm	Sagitta otolith	Right	5.44		4.39	2.24
Bairdiella chrysoura	St. Catherines	N784 E797	20-30 cm	Sagitta otolith	Right	6.81		5.41	2.92
Bairdiella chrysoura	St. Catherines	N784 E797	20-30 cm	Sagitta otolith	Right	4.67		3.96	1.90
Bairdiella chrysoura	St. Catherines	N784 E797	30-40 cm	Sagitta otolith	Right	5.04		4.41	2.12
Bairdiella chrysoura	St. Catherines	N784 E797	30-40 cm	Sagitta otolith	Right	5.62		4.55	2.20
Bairdiella chrysoura	St. Catherines	N784 E797	30-40 cm	Sagitta otolith	Right	5.38		4.20	2.31
Bairdiella chrysoura	St. Catherines	N784 E797	30-40 cm	Sagitta otolith	Right	4.66		4.02	2.05
Bairdiella chrysoura	St. Catherines	N784 E797	30-40 cm	Sagitta otolith	Right	5.42		4.53	2.30
Bairdiella chrysoura	St. Catherines	N784 E797	30-40 cm	Sagitta otolith	Right	4.79		4.50	2.14
Bairdiella chrysoura	St. Catherines	N784 E797	40-50 cm	Sagitta otolith	Right	5.04		4.34	2.17
Bairdiella chrysoura	St. Catherines	N784 E797	40-50 cm	Sagitta otolith	Right	4.15		3.52	1.86
Bairdiella chrysoura	St. Catherines	N784 E797	40-50 cm	Sagitta otolith	Right	4.41		4.15	1.95
Bairdiella chrysoura	St. Catherines	N784 E797	40-50 cm	Sagitta otolith	Right	4.38		3.79	1.86
Bairdiella chrysoura	St. Catherines	N784 E797	50-60 cm	Sagitta otolith	Right	4.73		4.07	2.07
Bairdiella chrysoura	St. Catherines	W82 S2	2.7-2.6	Sagitta otolith	Right	6.86		5.65	3.14
Bairdiella chrysoura	St. Catherines	W82 S2	2.7-2.6	Sagitta otolith	Right	6.77		5.26	2.90

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bairdiella chrysoura	St. Catherines	W82 S2	2.7-2.6	Sagitta otolith	Right	5.15		4.49	2.24
Bairdiella chrysoura	St. Catherines	W82 S2	2.7-2.6	Sagitta otolith	Right	4.87		3.69	2.05
Bairdiella chrysoura	St. Catherines	W82 S2	2.7-2.6	Sagitta otolith	Right	5.11		4.76	2.18
Bairdiella chrysoura	St. Catherines	W82 S2	2.6-2.5	Sagitta otolith	Right	6.12		5.22	2.71
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Sagitta otolith	Right	3.85		3.60	1.60
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Sagitta otolith	Right	6.18		5.01	2.49
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Sagitta otolith	Right	6.97		5.77	3.04
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Sagitta otolith	Right	4.98		3.92	2.10
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Sagitta otolith	Right	5.65		4.68	2.61
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Sagitta otolith	Right	4.17		3.48	1.83
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Sagitta otolith	Right	4.55		4.04	1.95
Bairdiella chrysoura	St. Catherines	W84 S2	2.6-2.5	Sagitta otolith	Right	4.48		3.77	1.91
Bairdiella chrysoura	St. Catherines	N771 E819	2.6-2.5	Sagitta otolith	Right	3.83		3.82	1.77
Bairdiella chrysoura	St. Catherines	N771 E819	2.6-2.5	Sagitta otolith	Right	4.37		4.02	1.74
Bairdiella chrysoura	St. Catherines	N771 E819	2.6-2.5	Sagitta otolith	Right	3.70		3.43	1.55
Bairdiella chrysoura	St. Catherines	N771 E819	2.6-2.5	Sagitta otolith	Right	6.70		5.96	2.93
Bairdiella chrysoura	St. Catherines	N771 E819	2.6-2.5	Sagitta otolith	Right	6.20		5.23	2.61
Bairdiella chrysoura	St. Catherines	N771 E819	2.6-2.5	Sagitta otolith	Right	5.45		4.50	2.49
Bairdiella chrysoura	St. Catherines	N771 E819	2.3-2.2	Sagitta otolith	Right	5.69		5.38	2.74
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	5.62		4.81	2.31
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	5.23		4.77	2.28
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.83		4.54	2.11
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.27		4.02	1.97
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	5.52		4.72	2.37
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.36		5.00	2.14
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	5.07		4.31	2.11
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	5.30		4.56	2.38
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.74		4.62	2.23
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.42		4.14	1.98
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	6.54		5.96	2.92
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	6.19		5.39	2.65
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	5.54		4.81	2.31
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	5.48		4.97	2.35
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.62		4.49	2.30

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	5.90		4.96	2.57
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	5.06		4.32	2.16
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.62		4.47	2.16
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	5.54		5.11	2.50
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	6.04		5.49	2.52
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.42		4.19	2.11
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	6.73		6.57	3.01
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.78		4.38	2.10
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Right	4.13		3.95	1.90
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Right	5.63		5.47	2.50
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Right	6.26		6.25	2.92
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Right	5.43		4.96	2.48
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Right	5.41		5.62	2.46
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Right	6.14		5.61	2.69
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Right	4.94		5.17	2.55
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Right	4.72		4.38	2.03
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Right	5.90		5.78	2.66
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Right	6.30		6.37	3.06
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Right	5.90		5.86	2.83
Bairdiella chrysoura	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Right	5.07		4.58	2.24
Bairdiella chrysoura	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Right	4.38		3.82	1.82
Bairdiella chrysoura	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Right	4.80		4.37	2.15
Bairdiella chrysoura	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Right	5.62		4.51	2.30
Bairdiella chrysoura	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Right	4.18		3.47	1.72
Bairdiella chrysoura	McQueen	N263 E179	5.8-5.7	Sagitta otolith	Right	4.79		4.45	2.12
Bairdiella chrysoura	McQueen	N263 E179	5.8-5.7	Sagitta otolith	Right	4.79		4.13	2.02
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Right	5.69		5.34	2.84
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Right	4.82		4.09	2.08
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Right	3.83		3.40	1.68
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Right	5.42		4.42	2.28
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Right	5.39		4.46	2.30
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Right	4.49		4.05	2.04
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Right	4.68		3.87	1.97
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Right	4.87		3.93	1.93

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Right	6.29		5.18	2.71
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Right	6.68		5.38	2.73
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Right	7.51		5.88	3.30
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Right	5.19		4.43	2.25
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Right	5.00		4.23	2.15
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Right	4.98		4.39	2.13
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Right	4.79		4.24	2.02
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Right	4.87		4.18	2.14
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Right	4.67		3.95	1.89
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Right	6.86		5.42	2.90
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Right	4.83		4.17	2.11
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Right	5.37		4.63	2.31
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Right	3.78		3.21	1.56
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Right	4.92		4.19	2.07
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Right	6.26		5.25	2.74
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Right	4.95		4.57	2.12
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Right	4.41		3.57	1.97
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Right	5.37		4.34	2.33
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Right	6.20		5.18	2.67
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Right	5.64		4.84	2.37
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Right	5.19		4.21	2.15
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Right	5.85		5.22	2.65
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Right	4.17		3.58	1.76
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Right	4.12		3.27	1.70
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Right	6.11		5.17	2.67
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Right	6.55		5.07	2.82
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Right	4.51		3.93	1.87
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Right	4.26		3.72	1.85
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	4.33		3.46	1.72
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	5.45		4.54	2.38
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	5.86		4.74	2.36
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	4.37		3.72	1.84
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	5.23		4.72	2.16
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	5.40		4.84	2.22

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	5.76		5.02	2.41
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	5.38		4.93	2.24
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	4.83		4.02	2.06
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	5.18		4.60	2.35
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	4.28		3.89	1.77
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Right	6.65		5.84	2.82
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Right	4.33		3.88	1.84
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Right	4.35		3.63	1.81
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Right	5.60		4.92	2.43
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Right	4.54		3.66	1.94
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Right	4.37		4.12	2.05
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Right	4.87		4.36	2.11
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Right	4.00		3.66	1.68
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Right	4.49		3.99	1.92
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Right	5.23		4.38	2.14
Bairdiella chrysoura	Cannon's Point	18N 0E	L5	Sagitta otolith	Left	5.83		5.99	2.91
Bairdiella chrysoura	Cannon's Point	18N 0E	L8	Sagitta otolith	Left	4.35		5.72	2.11
Bairdiella chrysoura	Cannon's Point	18N 0E	L8	Sagitta otolith	Left	5.85		7.08	2.93
Bairdiella chrysoura	Cannon's Point	18N 0E	L13	Sagitta otolith	Left	4.27		5.24	2.14
Bairdiella chrysoura	Cannon's Point	18N 0E	L17	Sagitta otolith	Left	5.31		5.93	2.50
Bairdiella chrysoura	Cannon's Point	18N 0E	L23	Sagitta otolith	Left	4.40		4.99	2.14
Bairdiella chrysoura	Cannon's Point	18N 0E	L24	Sagitta otolith	Left	4.96		5.69	2.54
Bairdiella chrysoura	Cannon's Point	18N 0E	L28	Sagitta otolith	Left	4.83		5.09	2.30
Bairdiella chrysoura	Cannon's Point	18N 0E	L33	Sagitta otolith	Left	4.15		4.32	1.90
Bairdiella chrysoura	West	5S 30E	ZII L3	Sagitta otolith	Left	5.44		5.39	2.46
Bairdiella chrysoura	West	5S 30E	ZII L3	Sagitta otolith	Left	4.87		5.15	2.34
Bairdiella chrysoura	West	5S 30E	L6	Sagitta otolith	Left	4.57		4.81	2.22
Bairdiella chrysoura	West	5S 30E	L8	Sagitta otolith	Left	5.12		5.83	2.65
Bairdiella chrysoura	West	5S 30E	L9	Sagitta otolith	Left	4.29		4.52	2.18
Bairdiella chrysoura	West	5S 30E	L9	Sagitta otolith	Left	5.60		6.06	2.97
Bairdiella chrysoura	West	5S 30E	L9	Sagitta otolith	Left	5.07		5.83	2.79
Bairdiella chrysoura	West	5S 30E	L9	Sagitta otolith	Left	4.83		5.53	2.33
Bairdiella chrysoura	West	5S 30E	L9	Sagitta otolith	Left	4.13		4.55	1.94
Bairdiella chrysoura	West	5S 30E	L9	Sagitta otolith	Left	4.81		4.76	2.36

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bairdiella chrysoura	Sapelo	9	15-20 cm	Sagitta otolith	Left	3.39		2.94	1.36
Bairdiella chrysoura	Sapelo	9	15-20 cm	Sagitta otolith	Left	6.53		5.48	2.93
Bairdiella chrysoura	Sapelo	9	20-25 cm	Sagitta otolith	Left	5.17		4.72	2.36
Bairdiella chrysoura	Sapelo	9	25-30 cm	Sagitta otolith	Left	6.51		5.47	2.74
Bairdiella chrysoura	St. Catherines	N784 E801	10-20 cm	Sagitta otolith	Left	6.35		5.29	2.49
Bairdiella chrysoura	St. Catherines	N784 E801	30-40 cm	Sagitta otolith	Left	4.28		3.74	1.86
Bairdiella chrysoura	St. Catherines	N784 E801	30-40 cm	Sagitta otolith	Left	5.11		4.79	2.13
Bairdiella chrysoura	St. Catherines	N784 E801	50-60 cm	Sagitta otolith	Left	4.08		3.48	1.75
Bairdiella chrysoura	St. Catherines	N784 E801	50-60 cm	Sagitta otolith	Left	6.11		5.11	2.62
Bairdiella chrysoura	St. Catherines	N784 E801	70-80 cm	Sagitta otolith	Left	6.11		5.28	2.61
Bairdiella chrysoura	St. Catherines	N784 E801	70-80 cm	Sagitta otolith	Left	6.13		5.27	2.70
Bairdiella chrysoura	St. Catherines	N789 E801	20-30 cm	Sagitta otolith	Left	5.55		4.49	2.21
Bairdiella chrysoura	St. Catherines	N789 E801	0-10 cm	Sagitta otolith	Left	5.30		4.32	2.25
Bairdiella chrysoura	St. Catherines	N789 E801	0-10 cm	Sagitta otolith	Left	5.58		4.48	2.49
Bairdiella chrysoura	St. Catherines	N789 E801	10-20 cm	Sagitta otolith	Left	6.33		4.89	2.46
Bairdiella chrysoura	St. Catherines	N789 E801	20-30 cm	Sagitta otolith	Left	5.13		4.49	2.17
Bairdiella chrysoura	St. Catherines	N789 E801	20-30 cm	Sagitta otolith	Left	6.66		4.92	2.41
Bairdiella chrysoura	St. Catherines	N789 E801	20-30 cm	Sagitta otolith	Left	4.66		4.02	2.00
Bairdiella chrysoura	St. Catherines	N789 E801	30-40 cm	Sagitta otolith	Left	4.76		4.43	2.08
Bairdiella chrysoura	St. Catherines	N789 E801	30-40 cm	Sagitta otolith	Left	5.84		5.04	2.27
Bairdiella chrysoura	St. Catherines	N789 E801	30-40 cm	Sagitta otolith	Left	5.60		4.22	2.10
Bairdiella chrysoura	St. Catherines	N789 E801	30-40 cm	Sagitta otolith	Left	6.13		4.31	2.23
Bairdiella chrysoura	St. Catherines	N789 E801	30-40 cm	Sagitta otolith	Left	7.01		4.94	2.55
Bairdiella chrysoura	St. Catherines	N789 E801	30-40 cm	Sagitta otolith	Left	8.18		5.73	2.96
Bairdiella chrysoura	St. Catherines	N789 E801	30-40 cm	Sagitta otolith	Left	6.23		4.55	2.31
Bairdiella chrysoura	St. Catherines	N789 E801	40-50 cm	Sagitta otolith	Left	5.69		4.95	2.34
Bairdiella chrysoura	St. Catherines	N789 E801	50-60 cm	Sagitta otolith	Left	5.56		4.31	2.23
Bairdiella chrysoura	St. Catherines	N789 E801	50-60 cm	Sagitta otolith	Left	6.56		4.81	2.39
Bairdiella chrysoura	St. Catherines	N789 E801	80-90 cm	Sagitta otolith	Left	4.63		4.13	1.91
Bairdiella chrysoura	St. Catherines	N784 E811	20-30 cm	Sagitta otolith	Left	6.77		5.86	2.86
Bairdiella chrysoura	St. Catherines	N784 E811	20-30 cm	Sagitta otolith	Left	5.11		4.39	2.20
Bairdiella chrysoura	St. Catherines	N784 E811	20-30 cm	Sagitta otolith	Left	5.58		4.60	2.31
Bairdiella chrysoura	St. Catherines	N784 E811	20-30 cm	Sagitta otolith	Left	6.54		5.39	2.90
Bairdiella chrysoura	St. Catherines	N784 E811	20-30 cm	Sagitta otolith	Left	5.22		4.52	2.19

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bairdiella chrysoura	St. Catherines	N784 E811	20-30 cm	Sagitta otolith	Left	4.33		3.81	1.88
Bairdiella chrysoura	St. Catherines	N784 E811	30-40 cm	Sagitta otolith	Left	4.33		3.60	1.94
Bairdiella chrysoura	St. Catherines	N784 E811	30-40 cm	Sagitta otolith	Left	4.69		4.00	2.02
Bairdiella chrysoura	St. Catherines	N784 E811	30-40 cm	Sagitta otolith	Left	7.34		6.02	3.09
Bairdiella chrysoura	St. Catherines	N784 E811	30-40 cm	Sagitta otolith	Left	5.43		4.77	2.25
Bairdiella chrysoura	St. Catherines	N784 E811	30-40 cm	Sagitta otolith	Left	5.84		4.53	2.27
Bairdiella chrysoura	St. Catherines	N784 E811	30-40 cm	Sagitta otolith	Left	6.20		4.69	2.24
Bairdiella chrysoura	St. Catherines	N784 E811	40-50 cm	Sagitta otolith	Left	4.71		3.94	1.99
Bairdiella chrysoura	St. Catherines	N784 E811	40-50 cm	Sagitta otolith	Left	5.63		4.70	2.50
Bairdiella chrysoura	St. Catherines	N784 E811	40-50 cm	Sagitta otolith	Left	5.40		4.60	2.22
Bairdiella chrysoura	St. Catherines	N784 E811	40-50 cm	Sagitta otolith	Left	5.24		5.03	2.29
Bairdiella chrysoura	St. Catherines	N784 E811	40-50 cm	Sagitta otolith	Left	6.00		5.04	2.48
Bairdiella chrysoura	St. Catherines	N784 E811	50-60 cm	Sagitta otolith	Left	5.62		4.69	2.48
Bairdiella chrysoura	St. Catherines	N784 E797	0-10 cm	Sagitta otolith	Left	6.22		5.36	2.63
Bairdiella chrysoura	St. Catherines	N784 E797	10-20 cm	Sagitta otolith	Left	4.36		3.95	1.87
Bairdiella chrysoura	St. Catherines	N784 E797	10-20 cm	Sagitta otolith	Left	5.44		4.85	2.33
Bairdiella chrysoura	St. Catherines	N784 E797	10-20 cm	Sagitta otolith	Left	6.48		5.33	2.74
Bairdiella chrysoura	St. Catherines	N784 E797	10-20 cm	Sagitta otolith	Left	3.48		3.10	1.52
Bairdiella chrysoura	St. Catherines	N784 E797	10-20 cm	Sagitta otolith	Left	4.41		4.23	2.08
Bairdiella chrysoura	St. Catherines	N784 E797	20-30 cm	Sagitta otolith	Left	5.64		4.93	2.44
Bairdiella chrysoura	St. Catherines	N784 E797	20-30 cm	Sagitta otolith	Left	5.41		4.75	2.36
Bairdiella chrysoura	St. Catherines	N784 E797	20-30 cm	Sagitta otolith	Left	5.81		4.88	2.29
Bairdiella chrysoura	St. Catherines	N784 E797	20-30 cm	Sagitta otolith	Left	3.68		3.28	1.71
Bairdiella chrysoura	St. Catherines	N784 E797	30-40 cm	Sagitta otolith	Left	5.48		4.39	2.26
Bairdiella chrysoura	St. Catherines	N784 E797	30-40 cm	Sagitta otolith	Left	4.77		4.03	1.98
Bairdiella chrysoura	St. Catherines	N784 E797	30-40 cm	Sagitta otolith	Left	3.88		3.53	1.77
Bairdiella chrysoura	St. Catherines	N784 E797	40-50 cm	Sagitta otolith	Left	5.02		4.60	2.15
Bairdiella chrysoura	St. Catherines	N784 E797	40-50 cm	Sagitta otolith	Left	4.91		4.36	2.07
Bairdiella chrysoura	St. Catherines	N784 E797	40-50 cm	Sagitta otolith	Left	5.21		4.50	2.22
Bairdiella chrysoura	St. Catherines	N784 E797	40-50 cm	Sagitta otolith	Left	4.82		4.26	2.08
Bairdiella chrysoura	St. Catherines	N784 E797	50-60 cm	Sagitta otolith	Left	6.72		5.80	3.00
Bairdiella chrysoura	St. Catherines	N784 E797	70-75.5 cm	Sagitta otolith	Left	5.44		5.14	2.50
Bairdiella chrysoura	St. Catherines	W82 S2	2.5-2.4	Sagitta otolith	Left	6.07		5.57	2.75
Bairdiella chrysoura	St. Catherines	W82 S2	2.4-2.3	Sagitta otolith	Left	6.69		5.75	3.02

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bairdiella chrysoura	St. Catherines	W82 S2	2.1-2.0	Sagitta otolith	Left	4.88		4.15	2.01
Bairdiella chrysoura	St. Catherines	W82 S2	2.0-1.9	Sagitta otolith	Left	4.64		4.55	2.30
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Sagitta otolith	Left	5.30		4.10	1.90
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Sagitta otolith	Left	6.27		5.13	2.48
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Sagitta otolith	Left	7.28		5.33	2.66
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Sagitta otolith	Left	7.31		5.76	2.75
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Sagitta otolith	Left	4.68		3.75	1.76
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Sagitta otolith	Left	5.13		4.29	2.22
Bairdiella chrysoura	St. Catherines	W84 S2	2.7-2.6	Sagitta otolith	Left	5.16		4.34	2.19
Bairdiella chrysoura	St. Catherines	W84 S2	2.7-2.6	Sagitta otolith	Left	7.07		5.44	2.80
Bairdiella chrysoura	St. Catherines	W84 S2	2.7-2.6	Sagitta otolith	Left	5.97		5.39	2.58
Bairdiella chrysoura	St. Catherines	N771 E819	2.6-2.5	Sagitta otolith	Left	6.84		5.73	2.99
Bairdiella chrysoura	St. Catherines	N771 E819	2.6-2.5	Sagitta otolith	Left	3.86		3.57	1.71
Bairdiella chrysoura	St. Catherines	N771 E819	2.5-2.4	Sagitta otolith	Left	5.63		4.97	2.65
Bairdiella chrysoura	St. Catherines	N771 E819	2.5-2.4	Sagitta otolith	Left	6.01		5.16	2.47
Bairdiella chrysoura	St. Catherines	N771 E819	2.5-2.4	Sagitta otolith	Left	3.87		3.56	1.65
Bairdiella chrysoura	St. Catherines	N771 E819	2.5-2.4	Sagitta otolith	Left	3.87		3.66	1.77
Bairdiella chrysoura	St. Catherines	N771 E819	2.5-2.4	Sagitta otolith	Left	5.42		5.21	2.37
Bairdiella chrysoura	St. Catherines	N771 E819	2.39-2.39	Sagitta otolith	Left	4.60		4.29	2.09
Bairdiella chrysoura	St. Catherines	N771 E819	2.39-2.3	Sagitta otolith	Left	5.88		5.37	2.52
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	5.17		4.74	2.31
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	5.25		5.03	2.37
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	5.26		4.50	2.25
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	5.23		4.43	2.16
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	4.51		4.80	2.26
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	4.49		4.62	2.19
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	5.76		5.75	2.56
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	4.93		4.48	2.17
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	4.12		4.58	2.21
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	5.71		5.43	2.69
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	3.98		4.20	2.12
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	5.07		4.89	2.20
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	5.83		5.68	2.70
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	4.91		4.63	2.26

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	4.88		4.42	2.23
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	6.22		6.16	2.54
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	5.65		5.88	2.77
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	4.55		4.27	2.16
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	4.76		4.58	2.14
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	5.92		5.77	2.52
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	4.39		4.50	2.17
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	4.06		4.16	2.17
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	5.07		4.81	2.31
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	4.25		4.65	2.26
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	6.49		6.64	2.99
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	4.62		3.73	2.11
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	5.14		4.74	2.23
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	6.14		5.71	2.57
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	5.15		4.61	2.31
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	4.21		4.01	1.94
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	5.69		5.42	2.71
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	4.09		4.16	1.99
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	4.67		4.32	2.03
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	3.54		3.22	1.49
Bairdiella chrysoura	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Left	5.10		4.63	2.20
Bairdiella chrysoura	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Left	6.82		5.69	2.97
Bairdiella chrysoura	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Left	4.43		3.86	1.85
Bairdiella chrysoura	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Left	4.89		4.26	2.12
Bairdiella chrysoura	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Left	3.88		3.56	1.89
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	5.62		4.66	2.43
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	6.48		5.35	2.67
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	4.94		4.45	2.12
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	5.67		4.62	2.44
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	4.63		4.31	2.15
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	5.08		4.47	2.12
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	5.05		4.29	2.00
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	4.80		4.24	2.10
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	5.23		4.46	2.15

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	6.97		5.07	2.86
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	5.69		5.02	2.53
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	5.26		4.54	2.20
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	5.17		4.57	2.35
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	5.08		4.78	2.26
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	5.33		4.67	2.23
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	4.03		3.47	1.71
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	4.67		4.36	2.02
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	5.38		4.92	2.30
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	5.40		4.99	2.17
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	6.46		5.70	2.76
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	3.72		3.21	1.65
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	7.16		5.27	2.60
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	4.97		4.62	2.10
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	6.39		5.39	2.72
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	5.93		5.02	2.65
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	6.37		5.66	2.93
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	4.62		4.05	1.99
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	6.85		5.27	2.60
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	7.59		6.12	3.10
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	7.23		6.01	3.03
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	3.86		3.50	1.69
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	5.51		4.86	2.36
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	6.63		5.14	2.51
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	4.02		3.64	1.91
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	6.13		5.00	2.56
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	4.93		4.51	2.20
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	5.02		4.46	2.20
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	4.94		4.93	2.13
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	4.99		4.36	2.22
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	6.44		5.41	2.77
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	4.93		4.43	1.93
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	5.93		5.31	2.69
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	5.80		5.34	2.52

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	5.09		4.33	2.12
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	5.43		4.71	2.34
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	5.14		4.40	2.22
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	5.41		4.87	2.41
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	6.46		5.36	2.88
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	4.63		4.45	2.13
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	5.46		4.76	2.33
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	4.90		4.32	2.24
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	4.93		4.58	2.22
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	4.84		4.57	2.30
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	5.98		5.04	2.38
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	5.72		5.06	2.37
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	4.21		3.90	1.91
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	5.70		5.05	2.47
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Left	5.92		4.97	2.55
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Left	5.35		4.52	2.26
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Left	5.47		4.92	2.49
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Left	4.98		4.35	2.03
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Left	3.95		3.56	1.81
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Left	5.80		4.30	2.17
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Left	5.78		4.21	2.11
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Left	4.66		3.85	2.04
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Left	4.69		4.03	2.10
Bairdiella chrysoura	Sapelo	9	15-20 cm	Lapillus otolith	Right	4.53		2.85	
Bairdiella chrysoura	Sapelo	9	15-20 cm	Lapillus otolith	Right	4.83		3.04	1.55
Bairdiella chrysoura	St. Catherines	N784 E801	20-30 cm	Lapillus otolith	Right	5.32		3.31	1.54
Bairdiella chrysoura	St. Catherines	N784 E801	60-70 cm	Lapillus otolith	Right	4.20		2.79	1.33
Bairdiella chrysoura	St. Catherines	N784 E797	10-20 cm	Lapillus otolith	Right	5.22		3.24	1.63
Bairdiella chrysoura	St. Catherines	N784 E797	10-20 cm	Lapillus otolith	Right	5.43		3.32	1.66
Bairdiella chrysoura	St. Catherines	W84 S2	2.7-2.6	Lapillus otolith	Right	6.10		3.69	1.89
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Right	5.31		3.39	1.79
Bairdiella chrysoura	McQueen	N 213 E 198	4.5-4.4	Lapillus otolith	Right	5.67		3.62	1.97
Bairdiella chrysoura	McQueen	N 213 E 198	4.5-4.4	Lapillus otolith	Right	5.87		3.62	1.91
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Lapillus otolith	Right	6.01		3.72	1.98

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Lapillus otolith	Right	4.18		2.76	1.25
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Lapillus otolith	Right	4.30		2.66	1.29
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Lapillus otolith	Right	4.98		3.14	1.62
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Lapillus otolith	Right	5.23		3.25	1.73
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Lapillus otolith	Right	6.42		3.96	2.05
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Lapillus otolith	Right	4.24		2.64	1.32
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Lapillus otolith	Right	5.46		3.22	1.67
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Lapillus otolith	Right	5.04		3.19	1.52
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Right	5.73		3.64	1.92
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Right	4.47		2.72	1.29
Bairdiella chrysoura	St. Catherines	N784 E811	20-30 cm	Lapillus otolith	Left	4.52		2.93	1.46
Bairdiella chrysoura	St. Catherines	N784 E801	10-20 cm	Lapillus otolith	Left	4.73		2.74	1.45
Bairdiella chrysoura	St. Catherines	N782 E801	20-30 cm	Lapillus otolith	Left	4.36		3.32	1.79
Bairdiella chrysoura	St. Catherines	N784 E811	30-40 cm	Lapillus otolith	Left	4.49		2.71	1.29
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Lapillus otolith	Left	5.53		3.45	1.74
Bairdiella chrysoura	St. Catherines	W84 S2	2.7-2.6	Lapillus otolith	Left	5.33		3.36	1.71
Bairdiella chrysoura	McQueen	N 213 E 198	4.5-4.4	Lapillus otolith	Left	5.88		3.43	1.88
Bairdiella chrysoura	McQueen	N 213 E 198	4.5-4.4	Lapillus otolith	Left	4.26		2.67	1.28
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Left	5.75		3.79	1.75
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Left	4.84		3.20	1.66
Bairdiella chrysoura	McQueen	N 213 E 198	4.4-4.3	Lapillus otolith	Left	5.08		3.23	1.77
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Lapillus otolith	Left	4.40		3.07	1.40
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Lapillus otolith	Left	5.77		3.55	1.84
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Lapillus otolith	Left	5.85		3.53	1.84
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Lapillus otolith	Left	6.62		4.01	2.33
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Lapillus otolith	Left	5.84		3.63	1.96
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Lapillus otolith	Left	5.76		3.63	1.75
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Lapillus otolith	Left	4.96		3.22	1.67
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Left	6.28		3.84	2.02
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Left	4.99		3.14	1.58
Bairdiella chrysoura	Cannon's Point	18N 0E	L5	Atlas				2.89	
Bairdiella chrysoura	Cannon's Point	18N 0E	L5	Atlas				2.29	
Bairdiella chrysoura	Cannon's Point	18N 0E	L7	Atlas				3.39	
Bairdiella chrysoura	Cannon's Point	18N 0E	L7	Atlas				2.06	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bairdiella chrysoura	Cannon's Point	18N 0E	L10	Atlas				2.73	
Bairdiella chrysoura	Cannon's Point	18N 0E	L11	Atlas				3.00	
Bairdiella chrysoura	Cannon's Point	18N 0E	L11	Atlas				2.30	
Bairdiella chrysoura	Cannon's Point	18N 0E	L15	Atlas				2.26	
Bairdiella chrysoura	Cannon's Point	18N 0E	L15	Atlas				2.55	
Bairdiella chrysoura	Cannon's Point	18N 0E	L16	Atlas				3.86	
Bairdiella chrysoura	Cannon's Point	18N 0E	L16	Atlas				3.06	
Bairdiella chrysoura	Cannon's Point	18N 0E	L19	Atlas				2.13	
Bairdiella chrysoura	Cannon's Point	18N 0E	L20	Atlas				2.47	
Bairdiella chrysoura	Cannon's Point	18N 0E	L21	Atlas				2.17	
Bairdiella chrysoura	Cannon's Point	18N 0E	L22	Atlas				2.39	
Bairdiella chrysoura	Cannon's Point	18N 0E	L23	Atlas				2.86	
Bairdiella chrysoura	Cannon's Point	18N 0E	L24	Atlas				3.20	
Bairdiella chrysoura	Cannon's Point	18N 0E	L25	Atlas				2.48	
Bairdiella chrysoura	Cannon's Point	18N 0E	L29	Atlas				3.05	
Bairdiella chrysoura	Cannon's Point	18N 0E	L30	Atlas				2.07	
Bairdiella chrysoura	Cannon's Point	18N 0E	L33	Atlas				3.23	
Bairdiella chrysoura	Cannon's Point	18N 0E	L33	Atlas				2.85	
Bairdiella chrysoura	Cannon's Point	18N 0E	L33	Atlas				2.31	
Bairdiella chrysoura	Cannon's Point	18N 0E	L33	Atlas				1.95	
Bairdiella chrysoura	Cannon's Point	18N 0E	L33	Atlas				2.70	
Bairdiella chrysoura	Cannon's Point	18N 0E	L33	Atlas				2.47	
Bairdiella chrysoura	Cannon's Point	18N 0E	L33	Atlas				2.70	
Bairdiella chrysoura	Cannon's Point	18N 0E	L33	Atlas				2.35	
Bairdiella chrysoura	Cannon's Point	18N 0E	L33a	Atlas				2.54	
Bairdiella chrysoura	West	5S 30E	ZII L1	Atlas				3.22	
Bairdiella chrysoura	West	5S 30E	ZII L2	Atlas				2.37	
Bairdiella chrysoura	West	5S 30E	ZII L3	Atlas				2.87	
Bairdiella chrysoura	West	5S 30E	ZII L3	Atlas				2.29	
Bairdiella chrysoura	West	5S 30E	ZII L5	Atlas				3.14	
Bairdiella chrysoura	West	5S 30E	ZII L5	Atlas				3.01	
Bairdiella chrysoura	West	5S 30E	ZII L5	Atlas				3.36	
Bairdiella chrysoura	West	5S 30E	ZII L5	Atlas				2.56	
Bairdiella chrysoura	West	5S 30E	ZII L5	Atlas				2.44	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bairdiella chrysoura	West	5S 30E	L6	Atlas				2.58	
Bairdiella chrysoura	West	5S 30E	L6	Atlas				2.14	
Bairdiella chrysoura	West	5S 30E	L6	Atlas				2.26	
Bairdiella chrysoura	West	5S 30E	L6	Atlas				2.13	
Bairdiella chrysoura	West	5S 30E	L7	Atlas				2.39	
Bairdiella chrysoura	West	5S 30E	L7	Atlas				2.71	
Bairdiella chrysoura	West	5S 30E	L7	Atlas				2.26	
Bairdiella chrysoura	West	5S 30E	L8	Atlas				3.36	
Bairdiella chrysoura	West	5S 30E	L8	Atlas				2.77	
Bairdiella chrysoura	West	5S 30E	L9	Atlas				2.40	
Bairdiella chrysoura	West	5S 30E	L9	Atlas				2.65	
Bairdiella chrysoura	West	5S 30E	L9	Atlas				3.13	
Bairdiella chrysoura	West	5S 30E	L9	Atlas				2.40	
Bairdiella chrysoura	Sapelo	9	10-15 cm	Atlas				3.24	
Bairdiella chrysoura	Sapelo	9	15-20 cm	Atlas				2.29	
Bairdiella chrysoura	Sapelo	9	20-25 cm	Atlas				3.38	
Bairdiella chrysoura	St. Catherines	N782 E801	100-110 cm	Atlas				2.26	
Bairdiella chrysoura	St. Catherines	N784 E801	10-20 cm	Atlas				2.70	
Bairdiella chrysoura	St. Catherines	N784 E801	10-20 cm	Atlas				2.95	
Bairdiella chrysoura	St. Catherines	N784 E801	20-30 cm	Atlas				2.33	
Bairdiella chrysoura	St. Catherines	N784 E801	20-30 cm	Atlas				2.52	
Bairdiella chrysoura	St. Catherines	N784 E801	40-50 cm	Atlas				2.52	
Bairdiella chrysoura	St. Catherines	N784 E801	40-50 cm	Atlas				3.19	
Bairdiella chrysoura	St. Catherines	N784 E801	40-50 cm	Atlas				1.59	
Bairdiella chrysoura	St. Catherines	N784 E801	60-70 cm	Atlas				2.23	
Bairdiella chrysoura	St. Catherines	N784 E801	60-70 cm	Atlas				2.39	
Bairdiella chrysoura	St. Catherines	N784 E801	60-70 cm	Atlas				2.16	
Bairdiella chrysoura	St. Catherines	N784 E801	70-80 cm	Atlas				2.48	
Bairdiella chrysoura	St. Catherines	N784 E801	70-80 cm	Atlas				2.59	
Bairdiella chrysoura	St. Catherines	N784 E801	70-80 cm	Atlas				2.46	
Bairdiella chrysoura	St. Catherines	N789 E801	20-30 cm	Atlas				2.03	
Bairdiella chrysoura	St. Catherines	N789 E801	20-30 cm	Atlas				2.89	
Bairdiella chrysoura	St. Catherines	N789 E801	20-30 cm	Atlas				2.32	
Bairdiella chrysoura	St. Catherines	N789 E801	30-40 cm	Atlas				3.30	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bairdiella chrysoura	St. Catherines	N789 E801	30-40 cm	Atlas				2.57	
Bairdiella chrysoura	St. Catherines	N789 E801	30-40 cm	Atlas				1.91	
Bairdiella chrysoura	St. Catherines	N789 E801	30-40 cm	Atlas				2.18	
Bairdiella chrysoura	St. Catherines	N789 E801	40-50 cm	Atlas				2.04	
Bairdiella chrysoura	St. Catherines	N789 E801	40-50 cm	Atlas				1.97	
Bairdiella chrysoura	St. Catherines	N789 E801	40-50 cm	Atlas				2.43	
Bairdiella chrysoura	St. Catherines	N789 E801	40-50 cm	Atlas				1.97	
Bairdiella chrysoura	St. Catherines	N789 E801	40-50 cm	Atlas				2.85	
Bairdiella chrysoura	St. Catherines	N789 E801	40-50 cm	Atlas				2.23	
Bairdiella chrysoura	St. Catherines	N789 E801	40-50 cm	Atlas				2.93	
Bairdiella chrysoura	St. Catherines	N789 E801	50-60 cm	Atlas				2.22	
Bairdiella chrysoura	St. Catherines	N789 E801	50-60 cm	Atlas				3.16	
Bairdiella chrysoura	St. Catherines	N789 E801	50-60 cm	Atlas				2.05	
Bairdiella chrysoura	St. Catherines	N789 E801	50-60 cm	Atlas				2.91	
Bairdiella chrysoura	St. Catherines	N789 E801	70-80 cm	Atlas				2.09	
Bairdiella chrysoura	St. Catherines	N789 E801	80-90 cm	Atlas				2.31	
Bairdiella chrysoura	St. Catherines	N789 E801	90-100 cm	Atlas				2.32	
Bairdiella chrysoura	St. Catherines	N784 E811	20-30 cm	Atlas				3.19	
Bairdiella chrysoura	St. Catherines	N784 E811	20-30 cm	Atlas				2.57	
Bairdiella chrysoura	St. Catherines	N784 E811	20-30 cm	Atlas				2.41	
Bairdiella chrysoura	St. Catherines	N784 E811	20-30 cm	Atlas				2.53	
Bairdiella chrysoura	St. Catherines	N784 E811	20-30 cm	Atlas				2.50	
Bairdiella chrysoura	St. Catherines	N784 E811	20-30 cm	Atlas				2.43	
Bairdiella chrysoura	St. Catherines	N784 E811	20-30 cm	Atlas				2.29	
Bairdiella chrysoura	St. Catherines	N784 E811	20-30 cm	Atlas				2.06	
Bairdiella chrysoura	St. Catherines	N784 E811	30-40 cm	Atlas				2.89	
Bairdiella chrysoura	St. Catherines	N784 E811	30-40 cm	Atlas				2.36	
Bairdiella chrysoura	St. Catherines	N784 E811	30-40 cm	Atlas				2.46	
Bairdiella chrysoura	St. Catherines	N784 E811	30-40 cm	Atlas				2.72	
Bairdiella chrysoura	St. Catherines	N784 E811	30-40 cm	Atlas				2.21	
Bairdiella chrysoura	St. Catherines	N784 E811	40-50 cm	Atlas				2.44	
Bairdiella chrysoura	St. Catherines	N784 E811	40-50 cm	Atlas				2.32	
Bairdiella chrysoura	St. Catherines	N784 E811	40-50 cm	Atlas				2.66	
Bairdiella chrysoura	St. Catherines	N784 E811	40-50 cm	Atlas				2.62	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bairdiella chrysoura	St. Catherines	N784 E811	40-50 cm	Atlas				2.66	
Bairdiella chrysoura	St. Catherines	N784 E811	40-50 cm	Atlas				2.20	
Bairdiella chrysoura	St. Catherines	N784 E797	0-10 cm	Atlas				2.70	
Bairdiella chrysoura	St. Catherines	N784 E797	0-10 cm	Atlas				2.52	
Bairdiella chrysoura	St. Catherines	N784 E797	10-20 cm	Atlas				2.63	
Bairdiella chrysoura	St. Catherines	N784 E797	10-20 cm	Atlas				2.73	
Bairdiella chrysoura	St. Catherines	N784 E797	20-30 cm	Atlas				3.20	
Bairdiella chrysoura	St. Catherines	N784 E797	20-30 cm	Atlas				2.93	
Bairdiella chrysoura	St. Catherines	N784 E797	20-30 cm	Atlas				2.42	
Bairdiella chrysoura	St. Catherines	N784 E797	20-30 cm	Atlas				2.40	
Bairdiella chrysoura	St. Catherines	N784 E797	20-30 cm	Atlas				2.68	
Bairdiella chrysoura	St. Catherines	N784 E797	30-40 cm	Atlas				2.36	
Bairdiella chrysoura	St. Catherines	N784 E797	30-40 cm	Atlas				2.65	
Bairdiella chrysoura	St. Catherines	N784 E797	30-40 cm	Atlas				2.45	
Bairdiella chrysoura	St. Catherines	N784 E797	30-40 cm	Atlas				2.17	
Bairdiella chrysoura	St. Catherines	N784 E797	30-40 cm	Atlas				2.58	
Bairdiella chrysoura	St. Catherines	N784 E797	30-40 cm	Atlas				2.20	
Bairdiella chrysoura	St. Catherines	N784 E797	40-50 cm	Atlas				2.64	
Bairdiella chrysoura	St. Catherines	N784 E797	40-50 cm	Atlas				2.94	
Bairdiella chrysoura	St. Catherines	W82 S2	2.9-2.8	Atlas				2.29	
Bairdiella chrysoura	St. Catherines	W82 S2	2.7-2.6	Atlas				2.84	
Bairdiella chrysoura	St. Catherines	W82 S2	2.7-2.6	Atlas				3.11	
Bairdiella chrysoura	St. Catherines	W82 S2	2.5-2.4	Atlas				2.76	
Bairdiella chrysoura	St. Catherines	W82 S2	2.5-2.4	Atlas				2.27	
Bairdiella chrysoura	St. Catherines	W82 S2	2.5-2.4	Atlas				3.28	
Bairdiella chrysoura	St. Catherines	W82 S2	2.5-2.4	Atlas				2.43	
Bairdiella chrysoura	St. Catherines	W82 S2	2.5-2.4	Atlas				2.13	
Bairdiella chrysoura	St. Catherines	W82 S2	2.4-2.3	Atlas				2.68	
Bairdiella chrysoura	St. Catherines	W82 S2	2.3-2.2	Atlas				2.20	
Bairdiella chrysoura	St. Catherines	W82 S2	2.3-2.2	Atlas				2.09	
Bairdiella chrysoura	St. Catherines	W82 S2	2.3-2.2	Atlas				2.63	
Bairdiella chrysoura	St. Catherines	W82 S2	2.3-2.2	Atlas				2.30	
Bairdiella chrysoura	St. Catherines	W82 S2	2.2-2.1	Atlas				2.34	
Bairdiella chrysoura	St. Catherines	W82 S2	2.2-2.1	Atlas				2.74	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bairdiella chrysoura	St. Catherines	W82 S2	2.2-2.1	Atlas				2.32	
Bairdiella chrysoura	St. Catherines	W82 S2	2.1-2.0	Atlas				2.80	
Bairdiella chrysoura	St. Catherines	W82 S2	2.1-2.0	Atlas				2.38	
Bairdiella chrysoura	St. Catherines	W82 S2	2.1-2.0	Atlas				2.07	
Bairdiella chrysoura	St. Catherines	W82 S2	2.1-2.0	Atlas				2.04	
Bairdiella chrysoura	St. Catherines	W82 S2	2.0-1.9	Atlas				2.42	
Bairdiella chrysoura	St. Catherines	W82 S2	2.0-1.9	Atlas				2.72	
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Atlas				2.60	
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Atlas				2.94	
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Atlas				3.54	
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Atlas				2.98	
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Atlas				1.98	
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Atlas				2.70	
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Atlas				2.54	
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Atlas				2.37	
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Atlas				2.32	
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Atlas				2.74	
Bairdiella chrysoura	St. Catherines	W84 S2	2.8-2.7	Atlas				2.84	
Bairdiella chrysoura	St. Catherines	W84 S2	2.7-2.6	Atlas				2.62	
Bairdiella chrysoura	St. Catherines	W84 S2	2.7-2.6	Atlas				3.12	
Bairdiella chrysoura	St. Catherines	W84 S2	2.7-2.6	Atlas				2.36	
Bairdiella chrysoura	St. Catherines	N771 E819	2.6-2.5	Atlas				2.47	
Bairdiella chrysoura	St. Catherines	N771 E819	2.6-2.5	Atlas				2.98	
Bairdiella chrysoura	St. Catherines	N771 E819	2.6-2.5	Atlas				2.53	
Bairdiella chrysoura	St. Catherines	N771 E819	2.6-2.5	Atlas				2.41	
Bairdiella chrysoura	St. Catherines	N771 E819	2.6-2.5	Atlas				2.58	
Bairdiella chrysoura	St. Catherines	N771 E819	2.6-2.5	Atlas				2.47	
Bairdiella chrysoura	St. Catherines	N771 E819	2.5-2.4	Atlas				2.70	
Bairdiella chrysoura	St. Catherines	N771 E819	2.3-2.2	Atlas				2.87	
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Atlas				2.42	
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Atlas				2.65	
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Atlas				3.23	
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Atlas				3.68	
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Atlas				2.16	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Atlas				2.52	
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Atlas				2.38	
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Atlas				2.35	
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Atlas				2.54	
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Atlas				3.00	
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Atlas				2.16	
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Atlas				2.33	
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Atlas				2.69	
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Atlas				2.84	
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Atlas				2.22	
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Atlas				2.85	
Bairdiella chrysoura	McQueen	N 213 E 198	Open-4.6	Atlas				2.97	
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Atlas				3.09	
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Atlas				2.70	
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Atlas				2.88	
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Atlas				2.76	
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Atlas				2.18	
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Atlas				2.43	
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Atlas				3.47	
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Atlas				2.46	
Bairdiella chrysoura	McQueen	N 213 E 198	4.6-4.5	Atlas				2.61	
Bairdiella chrysoura	McQueen	N 213 E 198	4.5-4.4	Atlas				2.29	
Bairdiella chrysoura	McQueen	N 213 E 198	4.5-4.4	Atlas				2.27	
Bairdiella chrysoura	McQueen	N 213 E 198	4.5-4.4	Atlas				3.00	
Bairdiella chrysoura	McQueen	N 213 E 198	4.5-4.4	Atlas				2.83	
Bairdiella chrysoura	McQueen	N 213 E 198	4.5-4.4	Atlas				3.37	
Bairdiella chrysoura	McQueen	N 213 E 198	4.5-4.4	Atlas				3.46	
Bairdiella chrysoura	McQueen	N 213 E 198	4.5-4.4	Atlas				3.47	
Bairdiella chrysoura	McQueen	N 213 E 198	4.5-4.4	Atlas				3.60	
Bairdiella chrysoura	McQueen	N263 E179	5.8-5.7	Atlas				2.70	
Bairdiella chrysoura	McQueen	N263 E179	5.8-5.7	Atlas				2.67	
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Atlas				3.04	
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Atlas				2.73	
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Atlas				2.92	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Atlas				2.81	
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Atlas				2.86	
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Atlas				2.37	
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Atlas				2.62	
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Atlas				2.93	
Bairdiella chrysoura	McQueen	N263 E179	5.7-5.6	Atlas				2.55	
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Atlas				3.20	
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Atlas				3.23	
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Atlas				2.95	
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Atlas				2.61	
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Atlas				1.88	
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Atlas				2.71	
Bairdiella chrysoura	McQueen	N263 E179	5.6-5.5	Atlas				2.38	
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Atlas				2.96	
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Atlas				2.23	
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Atlas				2.48	
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Atlas				3.30	
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Atlas				2.09	
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Atlas				2.22	
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Atlas				2.14	
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Atlas				2.46	
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Atlas				2.05	
Bairdiella chrysoura	McQueen	N263 E179	5.5-5.4	Atlas				2.49	
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Atlas				3.27	
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Atlas				2.79	
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Atlas				2.51	
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Atlas				2.73	
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Atlas				2.26	
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Atlas				2.10	
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Atlas				2.79	
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Atlas				2.68	
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Atlas				2.35	
Bairdiella chrysoura	McQueen	N263 E179	5.4-5.3	Atlas				2.61	
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Atlas				2.07	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Atlas				1.79	
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Atlas				2.38	
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Atlas				2.86	
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Atlas				3.27	
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Atlas				2.15	
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Atlas				2.33	
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Atlas				2.50	
Bairdiella chrysoura	McQueen	N263 E179	5.3-5.17	Atlas				2.74	
Cynoscion nebulosus	Cannon's Point	18N 0E	L4	Otolith	Right	17.78		7.14	4.03
Cynoscion nebulosus	Cannon's Point	18N 0E	L6	Otolith	Right	13.65		5.64	2.81
Cynoscion nebulosus	Cannon's Point	18N 0E	L14	Otolith	Right	9.68		4.62	1.92
Cynoscion nebulosus	Cannon's Point	18N 0E	L2	Otolith	Left	16.15		6.56	3.62
Cynoscion nebulosus	Cannon's Point	18N 0E	L10	Otolith	Left	10.12		4.55	2.00
Cynoscion nebulosus	Cannon's Point	18N 0E	L14	Otolith	Left	9.52		4.50	1.79
Cynoscion sp.	Cannon's Point	18N 0E	L1	Otolith	Right	21.66		8.70	5.22
Cynoscion sp.	Cannon's Point	18N 0E	L23	Otolith	Right	16.44		6.99	3.47
Cynoscion sp.	Cannon's Point	18N 0E	L24	Otolith	Right	8.97		4.16	1.81
Cynoscion sp.	Cannon's Point	18N 0E	L27	Otolith	Right	6.22		3.46	1.32
Cynoscion sp.	West	5S 30E	ZII L5	Otolith	Right	18.25		7.08	4.07
Cynoscion sp.	West	5S 30E	L6	Otolith	Right	5.98		3.14	1.20
Cynoscion sp.	West	5S 30E	L6	Otolith	Right	7.17		3.72	1.33
Cynoscion sp.	West	5S 30E	L7	Otolith	Right	21.34		7.84	4.51
Cynoscion sp.	West	5S 30E	L7	Otolith	Right	8.82		4.41	1.91
Cynoscion sp.	West	5S 30E	L7	Otolith	Right	9.78		4.77	2.09
Cynoscion sp.	West	5S 30E	L9	Otolith	Right	18.17		7.18	4.45
Cynoscion sp.	West	5S 30E	L9	Otolith	Right	11.19		5.38	2.61
Cynoscion sp.	West	5S 30E	L9	Otolith	Right	6.47		3.43	1.29
Cynoscion sp.	West	5S 30E	L9	Otolith	Right	5.95		3.64	1.20
Cynoscion sp.	West	5S 30E	L9	Otolith	Right	7.96		4.00	1.68
Cynoscion sp.	West	5S 30E	L9	Otolith	Right	5.80		3.57	1.21
Cynoscion sp.	West	5S 30E	L10	Otolith	Right	8.38		4.01	1.95
Cynoscion sp.	West	5S 30E	L11	Otolith	Right	11.03		4.99	3.01
Cynoscion sp.	Sapelo	4	3	Otolith	Right	14.70		5.84	2.85
Cynoscion sp.	Sapelo	9	20-25 cm	Otolith	Right	6.68		3.28	1.36

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Cynoscion sp.	St. Catherines	N784 E801	0-10 cm	Otolith	Right	13.56		5.83	3.28
Cynoscion sp.	St. Catherines	N784 E801	40-50 cm	Otolith	Right			6.40	3.41
Cynoscion sp.	St. Catherines	N784 E801	50-60 cm	Otolith	Right	17.79		6.95	3.88
Cynoscion sp.	St. Catherines	N789 E801	10-20 cm	Otolith	Right			6.69	3.28
Cynoscion sp.	St. Catherines	N789 E801	10-20 cm	Otolith	Right	5.24		3.00	1.13
Cynoscion sp.	St. Catherines	N789 E801	20-30 cm	Otolith	Right	17.70		6.59	3.81
Cynoscion sp.	St. Catherines	N789 E801	80-90 cm	Otolith	Right	15.84		6.70	3.56
Cynoscion sp.	St. Catherines	N784 E797	10-20 cm	Otolith	Right	7.11		3.73	1.38
Cynoscion sp.	St. Catherines	N784 E797	30-40 cm	Otolith	Right	15.97		6.31	3.72
Cynoscion sp.	St. Catherines	N784 E797	40-50 cm	Otolith	Right	8.01		3.80	1.66
Cynoscion sp.	St. Catherines	W82 S2	2.3-2.2	Otolith	Right			7.15	3.86
Cynoscion sp.	St. Catherines	W82 S2	2.3-2.2	Otolith	Right	16.91		6.91	3.87
Cynoscion sp.	St. Catherines	W84 S2	2.8-2.7	Otolith	Right	13.33		5.75	2.92
Cynoscion sp.	St. Catherines	N771 E819	Surface-2.6	Otolith	Right			4.90	2.53
Cynoscion sp.	St. Catherines	N771 E819	2.6-2.5	Otolith	Right	7.32		3.93	1.68
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Right			5.27	2.76
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Right	13.94		5.49	2.69
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Right	9.09		4.23	1.90
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Right	11.09		4.74	2.18
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Right	7.63		3.90	1.61
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Right			4.19	1.95
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Right	11.62		4.76	2.39
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Right	7.96		4.27	1.57
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Right	10.38		4.78	1.99
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Right	10.92		4.55	2.04
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Right	4.82		3.16	1.08
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Right	5.27		3.34	1.16
Cynoscion sp.	McQueen	N 213 E 198	5.5-5.4	Otolith	Right	16.85		6.79	3.84
Cynoscion sp.	McQueen	N 213 E 198	4.6-4.5	Otolith	Right	12.96		5.59	2.68
Cynoscion sp.	McQueen	N 213 E 198	4.6-4.5	Otolith	Right	8.13		3.84	1.50
Cynoscion sp.	McQueen	N 213 E 198	4.6-4.5	Otolith	Right	19.75		7.54	4.16
Cynoscion sp.	McQueen	N 213 E 198	4.6-4.5	Otolith	Right	9.02		4.51	2.26
Cynoscion sp.	McQueen	N 213 E 198	4.6-4.5	Otolith	Right	11.07		4.97	2.17
Cynoscion sp.	McQueen	N 213 E 198	4.6-4.5	Otolith	Right			4.83	1.91

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Cynoscion sp.	McQueen	N 213 E 198	4.6-4.5	Otolith	Right	16.32		6.51	3.65
Cynoscion sp.	McQueen	N263 E179	5.7-5.6	Otolith	Right	10.09		5.28	1.99
Cynoscion sp.	McQueen	N263 E179	5.7-5.6	Otolith	Right	7.21		3.61	1.55
Cynoscion sp.	McQueen	N263 E179	5.6-5.5	Otolith	Right	16.36		6.59	2.92
Cynoscion sp.	McQueen	N263 E179	5.6-5.5	Otolith	Right	11.03		4.87	2.41
Cynoscion sp.	McQueen	N263 E179	5.5-5.4	Otolith	Right	17.32		7.01	4.13
Cynoscion sp.	McQueen	N263 E179	5.5-5.4	Otolith	Right	17.91		6.53	4.26
Cynoscion sp.	McQueen	N263 E179	5.5-5.4	Otolith	Right	15.46		6.13	3.30
Cynoscion sp.	McQueen	N263 E179	5.4-5.3	Otolith	Right	14.30		5.79	2.78
Cynoscion sp.	McQueen	N263 E179	5.4-5.3	Otolith	Right	13.04		5.18	2.56
Cynoscion sp.	McQueen	N263 E179	5.3-5.17	Otolith	Right	5.65		3.10	1.24
Cynoscion sp.	Cannon's Point	18N 0E	L24	Otolith	Left	14.14		6.63	3.49
Cynoscion sp.	Cannon's Point	18N 0E	L26	Otolith	Left	8.35		3.98	1.50
Cynoscion sp.	Cannon's Point	18N 0E	L33	Otolith	Left	8.92		4.20	1.72
Cynoscion sp.	West	5S 30E	ZII L1	Otolith	Left	17.67		7.53	3.61
Cynoscion sp.	West	5S 30E	ZII L3	Otolith	Left	15.20		6.21	3.49
Cynoscion sp.	West	5S 30E	L6	Otolith	Left	4.78		2.91	0.94
Cynoscion sp.	West	5S 30E	L9	Otolith	Left	5.97		3.31	1.17
Cynoscion sp.	West	5S 30E	L9	Otolith	Left	17.94		7.29	4.37
Cynoscion sp.	West	5S 30E	L9	Otolith	Left			6.57	3.74
Cynoscion sp.	West	5S 30E	L9	Otolith	Left	6.15		3.61	1.32
Cynoscion sp.	West	5S 30E	L9	Otolith	Left	5.19		2.87	1.20
Cynoscion sp.	West	5S 30E	L9	Otolith	Left	8.04		3.94	1.32
Cynoscion sp.	Sapelo	4	2	Otolith	Left			7.88	4.62
Cynoscion sp.	Sapelo	4	2	Otolith	Left	16.31		6.23	3.62
Cynoscion sp.	Sapelo	4	2	Otolith	Left			6.37	2.69
Cynoscion sp.	Sapelo	4	4	Otolith	Left	12.87		5.36	2.53
Cynoscion sp.	Sapelo	4	5	Otolith	Left	21.26		7.71	5.09
Cynoscion sp.	Sapelo	9	15-20 cm	Otolith	Left	9.97		4.33	1.88
Cynoscion sp.	Sapelo	9	15-20 cm	Otolith	Left	10.47		4.70	2.14
Cynoscion sp.	St. Catherines	N789 E801	10-20 cm	Otolith	Left	17.34		6.77	3.81
Cynoscion sp.	St. Catherines	N789 E801	10-20 cm	Otolith	Left	17.74		7.16	3.66
Cynoscion sp.	St. Catherines	N789 E801	30-40 cm	Otolith	Left	7.80		3.82	1.65
Cynoscion sp.	St. Catherines	N784 E811	20-30 cm	Otolith	Left	17.40		6.96	3.52

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Cynoscion sp.	St. Catherines	N784 E811	40-50 cm	Otolith	Left	10.02		4.26	1.93
Cynoscion sp.	St. Catherines	N784 E797	0-10 cm	Otolith	Left	17.88		7.16	4.01
Cynoscion sp.	St. Catherines	N784 E797	10-20 cm	Otolith	Left	16.51		6.81	3.72
Cynoscion sp.	St. Catherines	N784 E797	20-30 cm	Otolith	Left			7.17	4.00
Cynoscion sp.	St. Catherines	N784 E797	30-40 cm	Otolith	Left	14.30		5.86	3.39
Cynoscion sp.	St. Catherines	N784 E797	78-86 cm	Otolith	Left	12.80		5.27	2.57
Cynoscion sp.	St. Catherines	W82 S2	2.2-2.1	Otolith	Left			6.61	4.00
Cynoscion sp.	St. Catherines	W82 S2	2.1-2.0	Otolith	Left			5.21	2.58
Cynoscion sp.	St. Catherines	N771 E819	Surface-2.6	Otolith	Left			6.21	3.06
Cynoscion sp.	St. Catherines	N771 E819	2.6-2.5	Otolith	Left	9.93		4.60	1.92
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Left	18.62		8.03	4.23
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Left	11.61		5.29	2.44
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Left			4.24	1.86
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Left	9.00		4.46	1.71
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Left	10.05		4.76	2.20
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Left	10.09		4.69	2.05
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Left	10.39		4.79	1.95
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Left	5.32		3.13	1.19
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Left	5.07		3.35	1.20
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Left	5.46		3.36	1.10
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Left	7.72		3.77	1.74
Cynoscion sp.	McQueen	N 213 E 198	4.5-4.4	Otolith	Left	15.25		6.39	2.98
Cynoscion sp.	McQueen	N 213 E 198	4.5-4.4	Otolith	Left	14.39		6.15	3.31
Cynoscion sp.	McQueen	N 213 E 198	4.5-4.4	Otolith	Left	15.77		6.35	3.44
Cynoscion sp.	McQueen	N 213 E 198	4.5-4.4	Otolith	Left	14.47		6.13	3.11
Cynoscion sp.	McQueen	N 213 E 198	4.6-4.5	Otolith	Left	12.47		5.24	2.47
Cynoscion sp.	McQueen	N 213 E 198	4.6-4.5	Otolith	Left	16.33		6.99	3.63
Cynoscion sp.	McQueen	N 213 E 198	4.6-4.5	Otolith	Left	15.27		6.13	3.36
Cynoscion sp.	McQueen	N263 E179	5.7-5.6	Otolith	Left	12.21		5.09	2.04
Cynoscion sp.	McQueen	N263 E179	5.5-5.4	Otolith	Left	14.11		5.66	3.07
Cynoscion sp.	McQueen	N263 E179	5.5-5.4	Otolith	Left	11.06		4.96	2.19
Cynoscion sp.	McQueen	N263 E179	5.4-5.3	Otolith	Left	10.84		4.75	1.93
Cynoscion sp.	McQueen	N263 E179	5.4-5.3	Otolith	Left	15.15		5.84	2.98
Cynoscion sp.	Cannon's Point	18N 0E	L5	Atlas				4.75	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Cynoscion sp.	Cannon's Point	18N 0E	L9	Atlas				4.33	
Cynoscion sp.	Cannon's Point	18N 0E	L11	Atlas				1.94	
Cynoscion sp.	Cannon's Point	18N 0E	L11	Atlas				2.11	
Cynoscion sp.	Cannon's Point	18N 0E	L19	Atlas				2.66	
Cynoscion sp.	Cannon's Point	18N 0E	L20	Atlas				2.39	
Cynoscion sp.	Cannon's Point	18N 0E	L24	Atlas				3.22	
Cynoscion sp.	Cannon's Point	18N 0E	L25	Atlas				3.58	
Cynoscion sp.	Cannon's Point	18N 0E	L25	Atlas				2.76	
Cynoscion sp.	Cannon's Point	18N 0E	L33	Atlas				2.57	
Cynoscion sp.	West	5S 30E	ZII L1	Atlas				2.60	
Cynoscion sp.	West	5S 30E	ZII L5	Atlas				2.73	
Cynoscion sp.	West	5S 30E	L6	Atlas				4.52	
Cynoscion sp.	West	5S 30E	L7	Atlas				4.05	
Cynoscion sp.	West	5S 30E	L6	Atlas				3.49	
Cynoscion sp.	Sapelo	4	3	Atlas				5.13	
Cynoscion sp.	Sapelo	4	3	Atlas				3.66	
Cynoscion sp.	Sapelo	4	5	Atlas				4.35	
Cynoscion sp.	Sapelo	4	5	Atlas				3.60	
Cynoscion sp.	Sapelo	4	6	Atlas				5.61	
Cynoscion sp.	St. Catherines	N784 E811	10-20 cm	Atlas				10.85	
Cynoscion sp.	St. Catherines	N784 E797	40-50 cm	Atlas				5.07	
Cynoscion sp.	St. Catherines	N784 E797	78-86 cm	Atlas				4.61	
Cynoscion sp.	St. Catherines	W82 S2	2.7-2.6	Atlas				3.75	
Cynoscion sp.	St. Catherines	W82 S2	2.3-2.2	Atlas				2.14	
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Atlas				3.00	
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Atlas				2.99	
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Atlas				2.74	
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Atlas				2.58	
Cynoscion sp.	McQueen	N 213 E 198	Open-4.6	Atlas				2.34	
Cynoscion sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				8.94	
Cynoscion sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				7.17	
Cynoscion sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				2.75	
Cynoscion sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				2.63	
Cynoscion sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				2.75	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Cynoscion sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				2.15	
Cynoscion sp.	McQueen	N263 E179	5.8-5.7	Atlas				2.61	
Cynoscion sp.	McQueen	N263 E179	5.6-5.5	Atlas				2.13	
Cynoscion sp.	McQueen	N263 E179	5.6-5.5	Atlas				3.56	
Cynoscion sp.	McQueen	N263 E179	5.6-5.5	Atlas				1.95	
Cynoscion sp.	McQueen	N263 E179	5.5-5.4	Atlas				5.62	
Cynoscion sp.	McQueen	N263 E179	5.4-5.3	Atlas				3.56	
Cynoscion sp.	McQueen	N263 E179	5.4-5.3	Atlas				3.02	
Cynoscion sp.	McQueen	N263 E179	5.4-5.3	Atlas				2.36	
Cynoscion sp.	McQueen	N263 E179	5.3-5.17	Atlas				5.42	
Cynoscion sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.76	
Cynoscion sp.	McQueen	N263 E179	5.3-5.17	Atlas				3.03	
Cynoscion sp.	McQueen	N263 E179	5.3-5.17	Atlas				2.53	
Leiostomus xanthurus	Sapelo	9	15-20 cm	Otolith	Right	4.96		3.12	1.05
Leiostomus xanthurus	Sapelo	9	15-20 cm	Otolith	Right	4.23		2.76	0.87
Leiostomus xanthurus	Sapelo	9	20-25 cm	Otolith	Right	4.74		3.19	1.07
Leiostomus xanthurus	St. Catherines	W82 S2	1.9-1.8	Otolith	Right	4.92		3.17	1.65
Leiostomus xanthurus	McQueen	N 213 E 198	4.6-4.5	Otolith	Right	6.60		3.53	1.30
Leiostomus xanthurus	McQueen	N 213 E 198	4.6-4.5	Otolith	Right	6.53		3.62	1.37
Leiostomus xanthurus	McQueen	N 213 E 198	4.5-4.4	Otolith	Right	5.48		3.12	1.22
Leiostomus xanthurus	McQueen	N263 E179	5.6-5.5	Otolith	Right	5.74		3.15	1.16
Leiostomus xanthurus	McQueen	N263 E179	5.6-5.5	Otolith	Right	5.68		3.16	1.22
Leiostomus xanthurus	McQueen	N263 E179	5.5-5.4	Otolith	Right	5.68		3.34	1.21
Leiostomus xanthurus	McQueen	N263 E179	5.5-5.4	Otolith	Right	4.99		2.90	1.05
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Otolith	Right	6.04		3.34	1.55
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Otolith	Right	7.05		3.73	1.47
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Otolith	Right	6.17		3.37	1.22
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Otolith	Right	6.14		3.38	1.26
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Otolith	Right	6.18		3.50	1.33
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Otolith	Right	5.53		3.28	1.18
Leiostomus xanthurus	Sapelo	9	10-15 cm	Otolith	Left	5.51		3.61	1.26
Leiostomus xanthurus	St. Catherines	N784 E797	30-40 cm	Otolith	Left	5.33		2.94	1.09
Leiostomus xanthurus	McQueen	N 213 E 198	4.6-4.5	Otolith	Left	5.59		3.17	1.22
Leiostomus xanthurus	McQueen	N263 E179	5.7-5.6	Otolith	Left	5.44		3.24	1.20

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Leiostomus xanthurus	McQueen	N263 E179	5.7-5.6	Otolith	Left	5.68		3.26	1.20
Leiostomus xanthurus	McQueen	N263 E179	5.6-5.5	Otolith	Left	6.02		3.65	1.49
Leiostomus xanthurus	McQueen	N263 E179	5.6-5.5	Otolith	Left	3.87		2.57	0.81
Leiostomus xanthurus	McQueen	N263 E179	5.6-5.5	Otolith	Left	6.29		3.90	1.50
Leiostomus xanthurus	McQueen	N263 E179	5.6-5.5	Otolith	Left	5.08		3.10	1.03
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Otolith	Left	5.49		3.60	1.34
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Otolith	Left	6.16		3.29	1.28
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Otolith	Left	5.51		3.33	1.34
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Otolith	Left	6.05		3.53	1.31
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Otolith	Left	4.78		3.01	1.07
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Otolith	Left	5.99		3.17	1.17
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Otolith	Left	6.39		3.93	1.39
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Otolith	Left	6.17		3.49	1.29
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Otolith	Left	4.86		3.18	1.02
Leiostomus xanthurus	McQueen	N263 E179	5.24-5.1	Otolith	Left	5.02		2.95	1.11
Leiostomus xanthurus	Cannon's Point	18N 0E	L11	Atlas				2.80	
Leiostomus xanthurus	Cannon's Point	18N 0E	L11	Atlas				2.96	
Leiostomus xanthurus	Cannon's Point	18N 0E	L12	Atlas				2.35	
Leiostomus xanthurus	Cannon's Point	18N 0E	L15	Atlas				2.57	
Leiostomus xanthurus	Cannon's Point	18N 0E	L20	Atlas				2.21	
Leiostomus xanthurus	Cannon's Point	18N 0E	L21	Atlas				2.78	
Leiostomus xanthurus	Cannon's Point	18N 0E	L21	Atlas				2.10	
Leiostomus xanthurus	Cannon's Point	18N 0E	L23	Atlas				2.82	
Leiostomus xanthurus	Cannon's Point	18N 0E	L24	Atlas				3.34	
Leiostomus xanthurus	Cannon's Point	18N 0E	L24	Atlas				2.72	
Leiostomus xanthurus	Cannon's Point	18N 0E	L24	Atlas				2.55	
Leiostomus xanthurus	Cannon's Point	18N 0E	L24	Atlas				2.36	
Leiostomus xanthurus	Cannon's Point	18N 0E	L25	Atlas				2.21	
Leiostomus xanthurus	Cannon's Point	18N 0E	L25	Atlas				2.29	
Leiostomus xanthurus	Cannon's Point	18N 0E	L27	Atlas				3.36	
Leiostomus xanthurus	Cannon's Point	18N 0E	L27	Atlas				2.23	
Leiostomus xanthurus	Cannon's Point	18N 0E	L27	Atlas				2.32	
Leiostomus xanthurus	Cannon's Point	18N 0E	L28	Atlas				2.42	
Leiostomus xanthurus	Cannon's Point	18N 0E	L29	Atlas				1.94	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Leiostomus xanthurus	Cannon's Point	18N 0E	L33	Atlas				2.94	
Leiostomus xanthurus	Cannon's Point	18N 0E	L33	Atlas				1.95	
Leiostomus xanthurus	Cannon's Point	18N 0E	L33	Atlas				2.92	
Leiostomus xanthurus	Cannon's Point	18N 0E	L33	Atlas				3.25	
Leiostomus xanthurus	Cannon's Point	18N 0E	L33	Atlas				2.49	
Leiostomus xanthurus	Cannon's Point	18N 0E	L33	Atlas				2.21	
Leiostomus xanthurus	West	5S 30E	ZII L4	Atlas				2.26	
Leiostomus xanthurus	West	5S 30E	ZII L5	Atlas				2.45	
Leiostomus xanthurus	West	5S 30E	ZII L5	Atlas				2.20	
Leiostomus xanthurus	West	5S 30E	L6	Atlas				3.19	
Leiostomus xanthurus	West	5S 30E	L7	Atlas				2.90	
Leiostomus xanthurus	West	5S 30E	L7	Atlas				2.82	
Leiostomus xanthurus	West	5S 30E	L7	Atlas				2.41	
Leiostomus xanthurus	West	5S 30E	L9	Atlas				2.21	
Leiostomus xanthurus	Sapelo	9	15-20 cm	Atlas				2.59	
Leiostomus xanthurus	Sapelo	9	20-25 cm	Atlas				2.12	
Leiostomus xanthurus	St. Catherines	N789 E801	70-80 cm	Atlas				2.21	
Leiostomus xanthurus	St. Catherines	N789 E801	70-80 cm	Atlas				2.06	
Leiostomus xanthurus	St. Catherines	N789 E801	80-90 cm	Atlas				2.71	
Leiostomus xanthurus	St. Catherines	N789 E801	90-100 cm	Atlas				2.38	
Leiostomus xanthurus	St. Catherines	N784 E811	20-30 cm	Atlas				2.63	
Leiostomus xanthurus	St. Catherines	N784 E811	20-30 cm	Atlas				2.60	
Leiostomus xanthurus	St. Catherines	N784 E811	30-40 cm	Atlas				2.16	
Leiostomus xanthurus	St. Catherines	N784 E811	40-50 cm	Atlas				3.86	
Leiostomus xanthurus	St. Catherines	N784 E811	50-60 cm	Atlas				2.60	
Leiostomus xanthurus	St. Catherines	N784 E811	60-70 cm	Atlas				2.24	
Leiostomus xanthurus	St. Catherines	N784 E797	10-20 cm	Atlas				2.35	
Leiostomus xanthurus	St. Catherines	N784 E797	10-20 cm	Atlas				2.31	
Leiostomus xanthurus	St. Catherines	N784 E797	20-30 cm	Atlas				2.29	
Leiostomus xanthurus	St. Catherines	N784 E797	60-70 cm	Atlas				2.99	
Leiostomus xanthurus	St. Catherines	N784 E797	75.5-78 cm	Atlas				2.16	
Leiostomus xanthurus	St. Catherines	W82 S2	2.8-2.7	Atlas				3.44	
Leiostomus xanthurus	St. Catherines	W82 S2	2.7-2.6	Atlas				2.12	
Leiostomus xanthurus	St. Catherines	W82 S2	2.7-2.6	Atlas				2.23	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Leiostomus xanthurus	St. Catherines	W82 S2	2.6-2.5	Atlas				2.28	
Leiostomus xanthurus	St. Catherines	W82 S2	2.6-2.5	Atlas				2.34	
Leiostomus xanthurus	St. Catherines	W82 S2	2.4-2.3	Atlas				2.68	
Leiostomus xanthurus	St. Catherines	W82 S2	2.3-2.2	Atlas				2.36	
Leiostomus xanthurus	St. Catherines	W84 S2	2.8-2.7	Atlas				2.31	
Leiostomus xanthurus	St. Catherines	N771 E819	2.6-2.5	Atlas				2.46	
Leiostomus xanthurus	St. Catherines	N771 E819	2.6-2.5	Atlas				3.23	
Leiostomus xanthurus	St. Catherines	N771 E819	2.6-2.5	Atlas				2.38	
Leiostomus xanthurus	St. Catherines	N771 E819	2.6-2.5	Atlas				2.21	
Leiostomus xanthurus	St. Catherines	N771 E819	2.5-2.4	Atlas				2.44	
Leiostomus xanthurus	St. Catherines	N771 E819	2.5-2.4	Atlas				2.38	
Leiostomus xanthurus	St. Catherines	N771 E819	2.5-2.4	Atlas				2.80	
Leiostomus xanthurus	St. Catherines	N771 E819	2.39-2.3	Atlas				1.87	
Leiostomus xanthurus	St. Catherines	Feature 23	1.8-1.7	Atlas				3.01	
Leiostomus xanthurus	McQueen	N 213 E 198	Open-4.6	Atlas				1.99	
Leiostomus xanthurus	McQueen	N 213 E 198	Open-4.6	Atlas				2.35	
Leiostomus xanthurus	McQueen	N 213 E 198	Open-4.6	Atlas				1.69	
Leiostomus xanthurus	McQueen	N 213 E 198	Open-4.6	Atlas				2.35	
Leiostomus xanthurus	McQueen	N 213 E 198	Open-4.6	Atlas				2.70	
Leiostomus xanthurus	McQueen	N 213 E 198	Open-4.6	Atlas				2.39	
Leiostomus xanthurus	McQueen	N 213 E 198	Open-4.6	Atlas				2.98	
Leiostomus xanthurus	McQueen	N 213 E 198	Open-4.6	Atlas				3.47	
Leiostomus xanthurus	McQueen	N 213 E 198	Open-4.6	Atlas				3.57	
Leiostomus xanthurus	McQueen	N 213 E 198	Open-4.6	Atlas				3.13	
Leiostomus xanthurus	McQueen	N 213 E 198	4.6-4.5	Atlas				6.21	
Leiostomus xanthurus	McQueen	N 213 E 198	4.6-4.5	Atlas				3.47	
Leiostomus xanthurus	McQueen	N 213 E 198	4.6-4.5	Atlas				2.80	
Leiostomus xanthurus	McQueen	N 213 E 198	4.6-4.5	Atlas				2.51	
Leiostomus xanthurus	McQueen	N 213 E 198	4.6-4.5	Atlas				2.49	
Leiostomus xanthurus	McQueen	N 213 E 198	4.6-4.5	Atlas				2.09	
Leiostomus xanthurus	McQueen	N 213 E 198	4.6-4.5	Atlas				2.78	
Leiostomus xanthurus	McQueen	N 213 E 198	4.6-4.5	Atlas				2.67	
Leiostomus xanthurus	McQueen	N 213 E 198	4.5-4.4	Atlas				2.24	
Leiostomus xanthurus	McQueen	N 213 E 198	4.5-4.4	Atlas				2.30	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Leiostomus xanthurus	McQueen	N 213 E 198	4.5-4.4	Atlas				3.15	
Leiostomus xanthurus	McQueen	N 213 E 198	4.5-4.4	Atlas				3.03	
Leiostomus xanthurus	McQueen	N 213 E 198	4.5-4.4	Atlas				2.40	
Leiostomus xanthurus	McQueen	N 213 E 198	4.5-4.4	Atlas				2.28	
Leiostomus xanthurus	McQueen	N 213 E 198	4.4-4.3	Atlas				2.87	
Leiostomus xanthurus	McQueen	N263 E179	5.8-5.7	Atlas				2.55	
Leiostomus xanthurus	McQueen	N263 E179	5.7-5.6	Atlas				2.29	
Leiostomus xanthurus	McQueen	N263 E179	5.7-5.6	Atlas				3.00	
Leiostomus xanthurus	McQueen	N263 E179	5.7-5.6	Atlas				2.31	
Leiostomus xanthurus	McQueen	N263 E179	5.6-5.5	Atlas				1.96	
Leiostomus xanthurus	McQueen	N263 E179	5.6-5.5	Atlas				2.93	
Leiostomus xanthurus	McQueen	N263 E179	5.6-5.5	Atlas				2.05	
Leiostomus xanthurus	McQueen	N263 E179	5.6-5.5	Atlas				2.49	
Leiostomus xanthurus	McQueen	N263 E179	5.6-5.5	Atlas				2.83	
Leiostomus xanthurus	McQueen	N263 E179	5.6-5.5	Atlas				2.54	
Leiostomus xanthurus	McQueen	N263 E179	5.6-5.5	Atlas				2.21	
Leiostomus xanthurus	McQueen	N263 E179	5.5-5.4	Atlas				2.76	
Leiostomus xanthurus	McQueen	N263 E179	5.5-5.4	Atlas				2.48	
Leiostomus xanthurus	McQueen	N263 E179	5.5-5.4	Atlas				2.27	
Leiostomus xanthurus	McQueen	N263 E179	5.5-5.4	Atlas				2.72	
Leiostomus xanthurus	McQueen	N263 E179	5.5-5.4	Atlas				2.25	
Leiostomus xanthurus	McQueen	N263 E179	5.5-5.4	Atlas				2.26	
Leiostomus xanthurus	McQueen	N263 E179	5.5-5.4	Atlas				2.72	
Leiostomus xanthurus	McQueen	N263 E179	5.5-5.4	Atlas				2.86	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				2.46	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				2.47	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				2.52	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				2.92	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				2.45	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				2.94	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				2.47	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				2.39	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				2.77	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				2.03	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				2.38	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				2.10	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				2.65	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				3.06	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				2.67	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				2.88	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				3.00	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				2.33	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				2.89	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				2.61	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				3.15	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				2.45	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				2.93	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				2.31	
Leiostomus xanthurus	McQueen	N263 E179	5.4-5.3	Atlas				2.96	
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				2.74	
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				2.12	
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				2.71	
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				3.33	
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				2.26	
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				2.50	
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				2.81	
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				2.33	
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				2.88	
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				2.79	
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				2.21	
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				2.46	
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				2.75	
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				2.57	
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				2.75	
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				2.51	
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				2.48	
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				3.41	
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				2.13	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				2.68	
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				2.70	
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				2.56	
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				2.81	
Leiostomus xanthurus	McQueen	N263 E179	5.3-5.17	Atlas				2.83	
Menticirrhus americanus	St. Catherines	N771 E819	2.6-2.5	Otolith	Left	10.94		3.67	2.41
Menticirrhus sp.	McQueen	N263 E179	5.6-5.5	Otolith	Right	9.41		3.44	2.15
Menticirrhus sp.	McQueen	N263 E179	5.5-5.4	Otolith	Right	9.62		3.35	2.41
Menticirrhus sp.	McQueen	N263 E179	5.3-5.17	Otolith	Right	9.58		3.71	2.25
Menticirrhus sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Left	9.93		3.31	2.17
Menticirrhus sp.	McQueen	N 213 E 198	Open-4.6	Otolith	Left			3.36	2.78
Menticirrhus sp.	McQueen	N 213 E 198	4.5-4.4	Otolith	Left	11.33		4.04	2.70
Menticirrhus sp.	McQueen	N263 E179	5.7-5.6	Otolith	Left	8.50		2.92	1.83
Menticirrhus sp.	McQueen	N263 E179	5.5-5.4	Otolith	Left	8.93		3.31	1.88
Menticirrhus sp.	McQueen	N263 E179	5.4-5.3	Otolith	Left	8.07		3.00	1.93
Menticirrhus sp.	McQueen	N263 E179	5.3-5.17	Otolith	Left	6.33		2.53	1.25
Menticirrhus sp.	Sapelo	4	2	Atlas				5.33	
Menticirrhus sp.	St. Catherines	N789 E801	0-10 cm	Atlas				7.75	
Menticirrhus sp.	St. Catherines	N789 E801	20-30 cm	Atlas				2.71	
Menticirrhus sp.	St. Catherines	W82 S2	2.1-2.0	Atlas				5.36	
Menticirrhus sp.	McQueen	N 213 E 198	Open-4.6	Atlas				4.21	
Menticirrhus sp.	McQueen	N 213 E 198	4.6-4.5	Atlas				5.29	
Menticirrhus sp.	McQueen	N263 E179	5.5-5.4	Atlas				3.28	
Menticirrhus sp.	McQueen	N263 E179	5.5-5.4	Atlas				2.30	
Micropogonias undulatus	Cannon's Point	18N 0E	L24	Otolith	Right	6.87		5.19	3.02
Micropogonias undulatus	Cannon's Point	18N 0E	L24	Otolith	Right	5.56		4.30	2.25
Micropogonias undulatus	Cannon's Point	18N 0E	L24	Otolith	Right			6.06	3.38
Micropogonias undulatus	Cannon's Point	18N 0E	L24	Otolith	Right	5.66		4.40	2.35
Micropogonias undulatus	Cannon's Point	18N 0E	L24	Otolith	Right	5.39		3.80	2.50
Micropogonias undulatus	Cannon's Point	18N 0E	L24	Otolith	Right	5.89		4.45	2.43
Micropogonias undulatus	Cannon's Point	18N 0E	L24	Otolith	Right	5.39		3.72	2.08
Micropogonias undulatus	Cannon's Point	18N 0E	L25	Otolith	Right	4.99		3.81	2.44
Micropogonias undulatus	Cannon's Point	18N 0E	L26	Otolith	Right	5.24		3.99	2.33
Micropogonias undulatus	Cannon's Point	18N 0E	L26	Otolith	Right	6.62		5.13	2.93

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Micropogonias undulatus	Cannon's Point	18N 0E	L26	Otolith	Right	6.08		4.65	2.76
Micropogonias undulatus	Cannon's Point	18N 0E	L27	Otolith	Right	7.32		5.46	3.32
Micropogonias undulatus	Cannon's Point	18N 0E	L27	Otolith	Right	6.19		4.81	2.53
Micropogonias undulatus	Cannon's Point	18N 0E	L28	Otolith	Right	7.94		5.94	3.39
Micropogonias undulatus	Cannon's Point	18N 0E	L29	Otolith	Right	9.40		7.36	4.13
Micropogonias undulatus	Cannon's Point	18N 0E	L29	Otolith	Right	7.62		5.47	2.93
Micropogonias undulatus	Cannon's Point	18N 0E	L29	Otolith	Right	9.28		6.99	3.61
Micropogonias undulatus	Cannon's Point	18N 0E	L30	Otolith	Right	5.23		3.83	2.03
Micropogonias undulatus	Cannon's Point	18N 0E	L31	Otolith	Right	5.26		4.06	2.18
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Otolith	Right	8.66		6.87	3.64
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Otolith	Right	7.05		5.18	2.90
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Otolith	Right	8.18		6.23	3.53
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Otolith	Right	8.29		6.74	3.41
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Otolith	Right	8.02		6.27	3.60
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Otolith	Right	7.94		5.94	3.18
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Otolith	Right	6.27		4.62	2.63
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Otolith	Right			5.22	3.17
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Otolith	Right	8.48		6.44	3.48
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Otolith	Right	7.34		5.72	3.17
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Otolith	Right	4.25		3.46	1.60
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Otolith	Right	7.58		5.83	3.24
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Otolith	Right			6.00	3.35
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Otolith	Right	5.15		3.79	2.26
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Otolith	Right	6.19		4.82	2.85
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Otolith	Right	5.56		4.44	2.30
Micropogonias undulatus	Cannon's Point	18N 0E	L33a	Otolith	Right	7.52		5.76	3.42
Micropogonias undulatus	West	5S 30E	L6	Otolith	Right	7.04		4.88	2.56
Micropogonias undulatus	West	5S 30E	L7	Otolith	Right	16.21		11.26	7.77
Micropogonias undulatus	West	5S 30E	L7	Otolith	Right	7.31		5.43	3.41
Micropogonias undulatus	West	5S 30E	L7	Otolith	Right	7.25		5.57	3.38
Micropogonias undulatus	West	5S 30E	L7	Otolith	Right	7.46		5.71	3.05
Micropogonias undulatus	West	5S 30E	L7	Otolith	Right	7.56		5.30	3.20
Micropogonias undulatus	West	5S 30E	L7	Otolith	Right	6.03		4.45	2.48
Micropogonias undulatus	West	5S 30E	L7	Otolith	Right	7.73		6.01	3.38

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Micropogonias undulatus	West	5S 30E	L7	Otolith	Right	4.95		3.67	1.96
Micropogonias undulatus	West	5S 30E	L8	Otolith	Right	9.31		6.56	4.34
Micropogonias undulatus	West	5S 30E	L8	Otolith	Right	8.85		6.37	4.07
Micropogonias undulatus	West	5S 30E	L8	Otolith	Right	5.72		3.95	2.10
Micropogonias undulatus	West	5S 30E	L8	Otolith	Right	8.32		5.85	3.49
Micropogonias undulatus	West	5S 30E	L8	Otolith	Right	8.41		6.39	3.70
Micropogonias undulatus	West	5S 30E	L8	Otolith	Right	5.18		3.59	1.98
Micropogonias undulatus	West	5S 30E	L8	Otolith	Right	8.09		6.44	4.15
Micropogonias undulatus	West	5S 30E	L8	Otolith	Right	7.83		5.38	3.37
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	9.62		8.16	4.24
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	9.35		7.02	4.03
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	8.13		6.00	3.39
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right			5.86	3.49
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	7.64		6.01	3.26
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	9.15		6.67	3.63
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	4.37		3.33	1.86
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	8.05		6.34	3.40
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	8.53		6.51	3.72
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	8.10		6.27	3.88
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	8.60		6.30	3.87
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	7.59		5.74	3.22
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	7.98		6.20	3.20
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	8.03		6.23	3.01
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	8.28		6.53	4.09
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	7.42		5.67	3.55
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	7.26		5.64	3.39
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	8.76		6.81	3.49
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	8.93		6.42	3.91
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	6.27		4.57	2.58
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	7.34		5.39	2.94
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	8.24		6.09	3.70
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	7.46		5.55	3.28
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	7.75		5.97	3.33
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	10.50		8.73	4.74

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	8.83		6.99	3.57
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	8.52		6.60	3.71
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	8.28		6.01	3.51
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	6.75		4.91	2.19
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	7.45		5.91	3.34
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	8.27		6.66	3.83
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	8.16		6.03	3.56
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	7.52		5.76	3.39
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	7.70		5.64	3.51
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right			5.98	3.30
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right			6.44	3.35
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	8.03		6.30	3.61
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	7.98		6.28	3.20
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right			6.52	3.59
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	7.20		5.78	2.73
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right				3.18
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	7.62		5.36	3.46
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	7.89		6.21	3.55
Micropogonias undulatus	West	5S 30E	L9	Otolith	Right	6.88		5.06	2.94
Micropogonias undulatus	West	5S 30E	L10	Otolith	Right	5.41		4.36	2.30
Micropogonias undulatus	West	5S 30E	L10	Otolith	Right	7.53		5.88	3.32
Micropogonias undulatus	West	5S 30E	L10	Otolith	Right	7.74		6.22	3.32
Micropogonias undulatus	West	5S 30E	L10	Otolith	Right	7.36		5.70	2.97
Micropogonias undulatus	West	5S 30E	L11	Otolith	Right	8.47		6.75	3.76
Micropogonias undulatus	West	5S 30E	L11	Otolith	Right	6.59		5.64	3.17
Micropogonias undulatus	West	5S 30E	L11	Otolith	Right	7.76		5.82	3.49
Micropogonias undulatus	West	5S 30E	L11	Otolith	Right	7.17		5.33	3.01
Micropogonias undulatus	Sapelo	4	4	Otolith	Right	8.31		6.40	3.60
Micropogonias undulatus	Sapelo	9	15-20 cm	Otolith	Right	9.93		6.98	4.27
Micropogonias undulatus	Sapelo	9	20-25 cm	Otolith	Right	11.68		9.05	5.73
Micropogonias undulatus	Sapelo	9	45-50 cm	Otolith	Right	6.70		5.25	2.87
Micropogonias undulatus	St. Catherines	N784 E801	20-30 cm	Otolith	Right	8.28		6.04	3.48
Micropogonias undulatus	St. Catherines	N784 E801	30-40 cm	Otolith	Right	4.75		3.52	1.70
Micropogonias undulatus	St. Catherines	N784 E801	40-50 cm	Otolith	Right	7.59		5.47	3.46

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Micropogonias undulatus	St. Catherines	N784 E801	80-90 cm	Otolith	Right	7.31		5.81	3.46
Micropogonias undulatus	St. Catherines	N789 E801	10-20 cm	Otolith	Right	5.44		4.07	1.98
Micropogonias undulatus	St. Catherines	N789 E801	10-20 cm	Otolith	Right	3.95		2.88	1.41
Micropogonias undulatus	St. Catherines	N789 E801	20-30 cm	Otolith	Right	5.44		4.19	2.16
Micropogonias undulatus	St. Catherines	N789 E801	30-40 cm	Otolith	Right	6.01		4.18	2.61
Micropogonias undulatus	St. Catherines	N784 E811	20-30 cm	Otolith	Right	8.05		6.02	3.70
Micropogonias undulatus	St. Catherines	N784 E811	20-30 cm	Otolith	Right	5.98		4.44	2.31
Micropogonias undulatus	St. Catherines	N784 E811	20-30 cm	Otolith	Right	5.37		4.24	2.13
Micropogonias undulatus	St. Catherines	N784 E811	20-30 cm	Otolith	Right	7.64		5.71	3.00
Micropogonias undulatus	St. Catherines	N784 E811	20-30 cm	Otolith	Right	3.74		2.80	1.42
Micropogonias undulatus	St. Catherines	N784 E811	30-40 cm	Otolith	Right	7.23		5.70	2.96
Micropogonias undulatus	St. Catherines	N784 E811	30-40 cm	Otolith	Right	5.67		4.33	1.99
Micropogonias undulatus	St. Catherines	N784 E811	40-50 cm	Otolith	Right	5.42		4.17	2.04
Micropogonias undulatus	St. Catherines	N784 E811	50-60 cm	Otolith	Right	4.42		3.16	1.53
Micropogonias undulatus	St. Catherines	N784 E811	50-60 cm	Otolith	Right	4.23		3.07	1.71
Micropogonias undulatus	St. Catherines	N784 E797	20-30 cm	Otolith	Right	8.98		6.74	3.26
Micropogonias undulatus	St. Catherines	N784 E797	20-30 cm	Otolith	Right	5.83		4.55	2.32
Micropogonias undulatus	St. Catherines	N784 E797	30-40 cm	Otolith	Right	8.43		6.32	3.73
Micropogonias undulatus	St. Catherines	N784 E797	50-60 cm	Otolith	Right	9.03		7.12	4.04
Micropogonias undulatus	St. Catherines	N784 E797	70-75.5 cm	Otolith	Right	5.07		3.87	1.81
Micropogonias undulatus	St. Catherines	N784 E797	70-75.5 cm	Otolith	Right	9.41		7.75	4.51
Micropogonias undulatus	St. Catherines	W82 S2	2.8-2.7	Otolith	Right	8.14		6.17	3.55
Micropogonias undulatus	St. Catherines	W82 S2	2.7-2.6	Otolith	Right	8.26		5.89	3.45
Micropogonias undulatus	St. Catherines	W82 S2	2.4-2.3	Otolith	Right	5.25		4.13	1.91
Micropogonias undulatus	St. Catherines	W82 S2	2.3-2.2	Otolith	Right	7.45		5.46	3.20
Micropogonias undulatus	St. Catherines	W82 S2	2.1-2.0	Otolith	Right	7.91		5.80	3.50
Micropogonias undulatus	St. Catherines	W82 S2	2.0-1.9	Otolith	Right	6.71		4.93	3.05
Micropogonias undulatus	St. Catherines	W84 S2	2.8-2.7	Otolith	Right	10.79		8.41	4.73
Micropogonias undulatus	St. Catherines	W84 S2	2.8-2.7	Otolith	Right	8.96		6.72	4.09
Micropogonias undulatus	St. Catherines	W84 S2	2.8-2.7	Otolith	Right	8.31		6.24	3.32
Micropogonias undulatus	St. Catherines	N771 E819	2.6-2.5	Otolith	Right	10.06		7.22	3.68
Micropogonias undulatus	St. Catherines	N771 E819	2.6-2.5	Otolith	Right	8.39		6.46	3.57
Micropogonias undulatus	St. Catherines	N771 E819	2.6-2.5	Otolith	Right	9.34		7.00	4.08
Micropogonias undulatus	St. Catherines	N771 E819	2.5-2.4	Otolith	Right	9.54		6.97	3.74

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Micropogonias undulatus	St. Catherines	N771 E819	2.5-2.4	Otolith	Right	6.45		4.93	2.60
Micropogonias undulatus	St. Catherines	N771 E819	2.39-2.39	Otolith	Right	7.70		5.57	3.21
Micropogonias undulatus	McQueen	N 213 E 198	Open-4.6	Otolith	Right	9.35		7.04	3.87
Micropogonias undulatus	McQueen	N 213 E 198	Open-4.6	Otolith	Right	6.82		5.26	2.78
Micropogonias undulatus	McQueen	N 213 E 198	Open-4.6	Otolith	Right	6.41		5.10	2.85
Micropogonias undulatus	McQueen	N 213 E 198	Open-4.6	Otolith	Right	7.08		5.24	2.91
Micropogonias undulatus	McQueen	N 213 E 198	Open-4.6	Otolith	Right	7.03		5.35	2.86
Micropogonias undulatus	McQueen	N 213 E 198	4.6-4.5	Otolith	Right	8.07		5.94	3.26
Micropogonias undulatus	McQueen	N 213 E 198	4.6-4.5	Otolith	Right	5.35		3.76	1.87
Micropogonias undulatus	McQueen	N 213 E 198	4.6-4.5	Otolith	Right	7.02		5.19	2.67
Micropogonias undulatus	McQueen	N 213 E 198	4.5-4.4	Otolith	Right	8.41		6.60	3.62
Micropogonias undulatus	McQueen	N 213 E 198	4.5-4.4	Otolith	Right	8.49		6.47	3.74
Micropogonias undulatus	McQueen	N263 E179	5.7-5.6	Otolith	Right	9.00		7.14	4.25
Micropogonias undulatus	McQueen	N263 E179	5.7-5.6	Otolith	Right	7.34		5.43	2.89
Micropogonias undulatus	McQueen	N263 E179	5.6-5.5	Otolith	Right	6.65		5.33	2.62
Micropogonias undulatus	McQueen	N263 E179	5.6-5.5	Otolith	Right	7.68		6.18	3.14
Micropogonias undulatus	McQueen	N263 E179	5.6-5.5	Otolith	Right	5.51		4.57	2.23
Micropogonias undulatus	McQueen	N263 E179	5.6-5.5	Otolith	Right	5.47		3.99	2.21
Micropogonias undulatus	McQueen	N263 E179	5.5-5.4	Otolith	Right	4.60		3.31	1.71
Micropogonias undulatus	McQueen	N263 E179	5.5-5.4	Otolith	Right	7.54		5.66	3.41
Micropogonias undulatus	McQueen	N263 E179	5.5-5.4	Otolith	Right	9.25		7.30	3.87
Micropogonias undulatus	McQueen	N263 E179	5.5-5.4	Otolith	Right	6.05		4.88	2.44
Micropogonias undulatus	McQueen	N263 E179	5.4-5.3	Otolith	Right	9.48		7.39	3.88
Micropogonias undulatus	McQueen	N263 E179	5.3-5.17	Otolith	Right	6.06		4.65	2.47
Micropogonias undulatus	McQueen	N263 E179	5.3-5.17	Otolith	Right	5.78		4.36	2.19
Micropogonias undulatus	McQueen	N263 E179	5.3-5.17	Otolith	Right	6.25		4.48	2.36
Micropogonias undulatus	McQueen	N263 E179	5.24-5.1	Otolith	Right	4.22		3.07	1.68
Micropogonias undulatus	Cannon's Point	18N 0E	L4	Otolith	Left	9.11		6.52	4.04
Micropogonias undulatus	Cannon's Point	18N 0E	L11	Otolith	Left	8.12		5.85	3.36
Micropogonias undulatus	Cannon's Point	18N 0E	L12	Otolith	Left	9.36		7.21	4.45
Micropogonias undulatus	Cannon's Point	18N 0E	L24	Otolith	Left	4.84		3.53	1.75
Micropogonias undulatus	Cannon's Point	18N 0E	L24	Otolith	Left	5.98		4.27	2.74
Micropogonias undulatus	Cannon's Point	18N 0E	L25	Otolith	Left	5.34		3.97	2.33
Micropogonias undulatus	Cannon's Point	18N 0E	L25	Otolith	Left	8.44		6.17	3.66

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Micropogonias undulatus	Cannon's Point	18N 0E	L25	Otolith	Left	5.56		4.10	2.39
Micropogonias undulatus	Cannon's Point	18N 0E	L27	Otolith	Left	6.02		4.56	2.88
Micropogonias undulatus	Cannon's Point	18N 0E	L27	Otolith	Left	7.25		5.57	3.30
Micropogonias undulatus	Cannon's Point	18N 0E	L27	Otolith	Left	8.57		6.41	3.15
Micropogonias undulatus	Cannon's Point	18N 0E	L27	Otolith	Left	6.03		4.57	2.56
Micropogonias undulatus	Cannon's Point	18N 0E	L28	Otolith	Left	9.48		6.58	3.95
Micropogonias undulatus	Cannon's Point	18N 0E	L29	Otolith	Left	5.33		4.26	2.39
Micropogonias undulatus	Cannon's Point	18N 0E	L30	Otolith	Left	5.84		4.27	2.45
Micropogonias undulatus	Cannon's Point	18N 0E	L30	Otolith	Left	4.87		3.83	2.21
Micropogonias undulatus	Cannon's Point	18N 0E	L31	Otolith	Left	10.27		7.95	5.07
Micropogonias undulatus	Cannon's Point	18N 0E	L31	Otolith	Left	6.78		4.88	2.86
Micropogonias undulatus	Cannon's Point	18N 0E	L31	Otolith	Left	7.14		5.50	3.04
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Otolith	Left	7.94		5.76	3.09
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Otolith	Left	8.07		6.04	3.51
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Otolith	Left	8.65		6.42	3.44
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Otolith	Left	7.39		5.74	3.11
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Otolith	Left	5.28		4.16	2.31
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Otolith	Left	8.09		6.13	3.19
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Otolith	Left	8.08		6.12	3.47
Micropogonias undulatus	West	5S 30E	ZII L5	Otolith	Left	8.66		6.66	4.20
Micropogonias undulatus	West	5S 30E	ZII L5	Otolith	Left	7.53		5.56	3.02
Micropogonias undulatus	West	5S 30E	L6	Otolith	Left	8.53		6.57	4.01
Micropogonias undulatus	West	5S 30E	L6	Otolith	Left	7.70		5.74	3.77
Micropogonias undulatus	West	5S 30E	L6	Otolith	Left	7.99		6.51	3.17
Micropogonias undulatus	West	5S 30E	L6	Otolith	Left	7.36		5.36	3.36
Micropogonias undulatus	West	5S 30E	L6	Otolith	Left	8.03		6.17	3.43
Micropogonias undulatus	West	5S 30E	L6	Otolith	Left	8.06		6.25	3.38
Micropogonias undulatus	West	5S 30E	L7	Otolith	Left	7.69		5.79	3.25
Micropogonias undulatus	West	5S 30E	L7	Otolith	Left	8.53		6.21	3.36
Micropogonias undulatus	West	5S 30E	L8	Otolith	Left	13.12		9.21	4.94
Micropogonias undulatus	West	5S 30E	L8	Otolith	Left	9.21		7.06	4.53
Micropogonias undulatus	West	5S 30E	L8	Otolith	Left	6.61		4.91	2.73
Micropogonias undulatus	West	5S 30E	L8	Otolith	Left	5.06		3.95	1.92
Micropogonias undulatus	West	5S 30E	L8	Otolith	Left	9.01		6.69	3.67

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Micropogonias undulatus	West	5S 30E	L8	Otolith	Left	8.94		6.51	4.02
Micropogonias undulatus	West	5S 30E	L8	Otolith	Left	7.87		5.74	3.40
Micropogonias undulatus	West	5S 30E	L8	Otolith	Left	7.34		5.37	2.90
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	7.19		5.28	2.93
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	8.37		6.08	3.38
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	19.98		14.35	8.29
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	7.18		5.65	3.20
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	8.33		6.14	3.60
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left			5.58	3.27
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	7.94		5.70	
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	8.43		6.04	3.44
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	7.51		5.64	3.08
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left			5.82	3.46
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left			5.31	3.21
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	7.49		5.69	3.07
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	7.36		5.30	3.39
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	8.42		6.03	3.43
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	8.00		5.90	3.31
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left			5.82	3.51
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	7.54		5.79	3.37
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	8.64		6.23	3.60
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	7.04		5.60	3.21
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	7.77		5.62	2.97
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	8.25		6.13	3.59
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	5.47		4.39	2.38
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	7.30		5.62	3.34
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	7.00		5.24	2.56
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	7.90		5.74	3.43
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	7.26		5.07	2.74
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	8.36		6.17	3.46
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	6.28		5.01	2.70
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	5.30		4.07	2.11
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	7.40		5.48	3.16
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	7.71		5.59	3.29

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Micropogonias undulatus	West	5S 30E	L9	Otolith	Left	9.50		7.81	4.35
Micropogonias undulatus	West	5S 30E	L10	Otolith	Left	8.02		5.88	3.28
Micropogonias undulatus	West	5S 30E	L10	Otolith	Left	7.00		5.27	3.17
Micropogonias undulatus	West	5S 30E	L10	Otolith	Left	8.93		6.78	4.19
Micropogonias undulatus	West	5S 30E	L10	Otolith	Left	7.19		5.19	2.90
Micropogonias undulatus	West	5S 30E	L10	Otolith	Left	8.32		6.14	3.64
Micropogonias undulatus	West	5S 30E	L10	Otolith	Left	7.22		5.23	3.07
Micropogonias undulatus	West	5S 30E	L11	Otolith	Left	7.38		5.51	3.17
Micropogonias undulatus	West	5S 30E	L11	Otolith	Left	7.90		6.09	3.46
Micropogonias undulatus	West	5S 30E	L11	Otolith	Left	7.53		5.70	3.45
Micropogonias undulatus	Sapelo	4	4	Otolith	Left	8.24		6.35	3.50
Micropogonias undulatus	Sapelo	4	5	Otolith	Left	8.97		6.48	3.86
Micropogonias undulatus	Sapelo	9	10-15 cm	Otolith	Left	8.94		7.07	3.95
Micropogonias undulatus	Sapelo	9	15-20 cm	Otolith	Left	3.58		2.57	1.37
Micropogonias undulatus	Sapelo	9	15-20 cm	Otolith	Left	9.77		6.96	4.23
Micropogonias undulatus	St. Catherines	N784 E797	20-30 cm	Otolith	Left	5.63		4.58	2.17
Micropogonias undulatus	St. Catherines	N784 E801	10-20 cm	Otolith	Left	5.22		4.12	2.01
Micropogonias undulatus	St. Catherines	N784 E801	70-80 cm	Otolith	Left	5.25		3.67	2.11
Micropogonias undulatus	St. Catherines	N789 E801	0-10 cm	Otolith	Left	12.59		9.98	5.73
Micropogonias undulatus	St. Catherines	N789 E801	20-30 cm	Otolith	Left	7.69		5.32	3.10
Micropogonias undulatus	St. Catherines	N789 E801	20-30 cm	Otolith	Left	6.93		5.20	2.93
Micropogonias undulatus	St. Catherines	N784 E811	20-30 cm	Otolith	Left	7.47		5.47	3.33
Micropogonias undulatus	St. Catherines	N784 E811	20-30 cm	Otolith	Left	8.93		6.44	3.93
Micropogonias undulatus	St. Catherines	N784 E811	20-30 cm	Otolith	Left	5.33		4.30	2.15
Micropogonias undulatus	St. Catherines	N784 E811	20-30 cm	Otolith	Left	7.78		5.90	3.27
Micropogonias undulatus	St. Catherines	N784 E811	20-30 cm	Otolith	Left	4.81		3.39	1.81
Micropogonias undulatus	St. Catherines	N784 E811	30-40 cm	Otolith	Left	7.34		5.35	3.07
Micropogonias undulatus	St. Catherines	N784 E811	30-40 cm	Otolith	Left	5.46		4.20	2.14
Micropogonias undulatus	St. Catherines	N784 E811	30-40 cm	Otolith	Left	6.34		4.78	2.75
Micropogonias undulatus	St. Catherines	N784 E811	30-40 cm	Otolith	Left	5.95		4.42	2.73
Micropogonias undulatus	St. Catherines	N784 E811	30-40 cm	Otolith	Left	6.68		5.06	2.62
Micropogonias undulatus	St. Catherines	N784 E811	50-60 cm	Otolith	Left	5.27		3.98	1.91
Micropogonias undulatus	St. Catherines	N784 E811	60-70 cm	Otolith	Left	8.15		6.16	3.56
Micropogonias undulatus	St. Catherines	N784 E797	10-20 cm	Otolith	Left	9.00		6.50	3.64

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Micropogonias undulatus	St. Catherines	N784 E797	10-20 cm	Otolith	Left	5.39		3.96	1.85
Micropogonias undulatus	St. Catherines	N784 E797	10-20 cm	Otolith	Left	8.70		6.82	3.69
Micropogonias undulatus	St. Catherines	N784 E797	40-50 cm	Otolith	Left	9.17		7.03	3.96
Micropogonias undulatus	St. Catherines	N784 E797	40-50 cm	Otolith	Left	8.66		6.33	3.41
Micropogonias undulatus	St. Catherines	N784 E797	50-60 cm	Otolith	Left	9.64		7.62	4.05
Micropogonias undulatus	St. Catherines	N784 E797	60-70 cm	Otolith	Left	7.67		5.16	3.17
Micropogonias undulatus	St. Catherines	N784 E797	70-75.5 cm	Otolith	Left	10.32		7.62	4.35
Micropogonias undulatus	St. Catherines	W82 S2	2.7-2.6	Otolith	Left	7.13		5.24	3.11
Micropogonias undulatus	St. Catherines	W82 S2	2.7-2.6	Otolith	Left	10.67		8.14	4.85
Micropogonias undulatus	St. Catherines	W82 S2	2.7-2.6	Otolith	Left	7.66		5.82	3.22
Micropogonias undulatus	St. Catherines	W82 S2	2.7-2.6	Otolith	Left	5.06		3.67	1.84
Micropogonias undulatus	St. Catherines	W82 S2	2.6-2.5	Otolith	Left	12.05		9.36	5.57
Micropogonias undulatus	St. Catherines	W82 S2	2.4-2.3	Otolith	Left	4.49		3.26	1.57
Micropogonias undulatus	St. Catherines	W82 S2	2.1-2.0	Otolith	Left	6.00		4.41	2.48
Micropogonias undulatus	St. Catherines	W84 S2	2.8-2.7	Otolith	Left	7.26		5.19	2.48
Micropogonias undulatus	St. Catherines	W84 S2	2.8-2.7	Otolith	Left	6.54		5.07	2.92
Micropogonias undulatus	St. Catherines	W84 S2	2.8-2.7	Otolith	Left	5.72		4.20	2.26
Micropogonias undulatus	St. Catherines	W84 S2	2.7-2.6	Otolith	Left	8.35		6.12	3.62
Micropogonias undulatus	St. Catherines	N771 E819	2.6-2.5	Otolith	Left	4.10		3.05	1.36
Micropogonias undulatus	St. Catherines	N771 E819	2.6-2.5	Otolith	Left	4.35		3.15	1.45
Micropogonias undulatus	St. Catherines	N771 E819	2.5-2.4	Otolith	Left	9.24		7.06	4.24
Micropogonias undulatus	St. Catherines	N771 E819	2.5-2.4	Otolith	Left	7.81		5.81	3.56
Micropogonias undulatus	St. Catherines	N771 E819	2.5-2.4	Otolith	Left	7.72		5.64	3.42
Micropogonias undulatus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	7.72		5.53	3.02
Micropogonias undulatus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	5.14		3.73	1.86
Micropogonias undulatus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	6.42		4.97	2.91
Micropogonias undulatus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	7.19		5.53	3.29
Micropogonias undulatus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	7.35		5.74	3.05
Micropogonias undulatus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	5.28		4.02	2.11
Micropogonias undulatus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	7.68		5.77	2.96
Micropogonias undulatus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	5.84		4.59	2.07
Micropogonias undulatus	McQueen	N 213 E 198	Open-4.6	Otolith	Left	7.30		5.72	3.44
Micropogonias undulatus	McQueen	N 213 E 198	4.6-4.5	Otolith	Left	11.37		8.45	4.65
Micropogonias undulatus	McQueen	N 213 E 198	4.6-4.5	Otolith	Left	7.71		5.65	3.01

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Micropogonias undulatus	McQueen	N 213 E 198	4.6-4.5	Otolith	Left	7.56		5.82	3.54
Micropogonias undulatus	McQueen	N 213 E 198	4.5-4.4	Otolith	Left	5.54		4.23	2.24
Micropogonias undulatus	McQueen	N 213 E 198	4.5-4.4	Otolith	Left	10.38		7.41	4.42
Micropogonias undulatus	McQueen	N263 E179	5.8-5.7	Otolith	Left	7.91		5.97	2.96
Micropogonias undulatus	McQueen	N263 E179	5.7-5.6	Otolith	Left	8.87		6.68	3.24
Micropogonias undulatus	McQueen	N263 E179	5.7-5.6	Otolith	Left	5.22		4.03	1.87
Micropogonias undulatus	McQueen	N263 E179	5.7-5.6	Otolith	Left	6.79		4.86	2.62
Micropogonias undulatus	McQueen	N263 E179	5.7-5.6	Otolith	Left	6.05		4.39	2.47
Micropogonias undulatus	McQueen	N263 E179	5.7-5.6	Otolith	Left	10.85		9.22	4.84
Micropogonias undulatus	McQueen	N263 E179	5.6-5.5	Otolith	Left	6.76		5.42	2.61
Micropogonias undulatus	McQueen	N263 E179	5.6-5.5	Otolith	Left	6.86		5.37	3.13
Micropogonias undulatus	McQueen	N263 E179	5.6-5.5	Otolith	Left	5.55		4.03	2.06
Micropogonias undulatus	McQueen	N263 E179	5.6-5.5	Otolith	Left	3.87		3.09	1.49
Micropogonias undulatus	McQueen	N263 E179	5.6-5.5	Otolith	Left	5.14		3.99	2.29
Micropogonias undulatus	McQueen	N263 E179	5.6-5.5	Otolith	Left	3.84		2.89	1.41
Micropogonias undulatus	McQueen	N263 E179	5.6-5.5	Otolith	Left	8.14		5.98	3.33
Micropogonias undulatus	McQueen	N263 E179	5.5-5.4	Otolith	Left	5.01		3.73	2.08
Micropogonias undulatus	McQueen	N263 E179	5.5-5.4	Otolith	Left	5.88		4.50	2.40
Micropogonias undulatus	McQueen	N263 E179	5.5-5.4	Otolith	Left	7.93		5.94	3.12
Micropogonias undulatus	McQueen	N263 E179	5.5-5.4	Otolith	Left	7.61		5.70	2.88
Micropogonias undulatus	McQueen	N263 E179	5.5-5.4	Otolith	Left	7.53		5.63	3.18
Micropogonias undulatus	McQueen	N263 E179	5.5-5.4	Otolith	Left	7.33		5.41	2.62
Micropogonias undulatus	McQueen	N263 E179	5.5-5.4	Otolith	Left	5.12		3.76	1.95
Micropogonias undulatus	McQueen	N263 E179	5.5-5.4	Otolith	Left	10.90		8.13	4.72
Micropogonias undulatus	McQueen	N263 E179	5.5-5.4	Otolith	Left	7.61		5.83	3.00
Micropogonias undulatus	McQueen	N263 E179	5.4-5.3	Otolith	Left	4.95		3.62	2.09
Micropogonias undulatus	McQueen	N263 E179	5.4-5.3	Otolith	Left	4.47		3.18	1.59
Micropogonias undulatus	McQueen	N263 E179	5.3-5.17	Otolith	Left	6.45		5.02	2.83
Micropogonias undulatus	McQueen	N263 E179	5.3-5.17	Otolith	Left	6.24		4.59	2.42
Micropogonias undulatus	Cannon's Point	18N 0E	L7	Atlas				2.97	
Micropogonias undulatus	Cannon's Point	18N 0E	L23	Atlas				2.84	
Micropogonias undulatus	Cannon's Point	18N 0E	L24	Atlas				2.65	
Micropogonias undulatus	Cannon's Point	18N 0E	L27	Atlas				3.77	
Micropogonias undulatus	Cannon's Point	18N 0E	L29	Atlas				4.20	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Micropogonias undulatus	Cannon's Point	18N 0E	L32	Atlas				3.13	
Micropogonias undulatus	Cannon's Point	18N 0E	L32	Atlas				2.95	
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Atlas				2.49	
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Atlas				3.13	
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Atlas				4.08	
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Atlas				3.09	
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Atlas				2.56	
Micropogonias undulatus	Cannon's Point	18N 0E	L33	Atlas				3.62	
Micropogonias undulatus	Cannon's Point	18N 0E	L34	Atlas				3.22	
Micropogonias undulatus	West	5S 30E	L7	Atlas				3.21	
Micropogonias undulatus	West	5S 30E	L7	Atlas				4.21	
Micropogonias undulatus	West	5S 30E	L8	Atlas				3.69	
Micropogonias undulatus	West	5S 30E	L8	Atlas				2.75	
Micropogonias undulatus	West	5S 30E	L8	Atlas				3.00	
Micropogonias undulatus	West	5S 30E	L8	Atlas				2.98	
Micropogonias undulatus	West	5S 30E	L9	Atlas				2.70	
Micropogonias undulatus	West	5S 30E	L9	Atlas				2.44	
Micropogonias undulatus	West	5S 30E	L9	Atlas				2.98	
Micropogonias undulatus	West	5S 30E	L10	Atlas				3.10	
Micropogonias undulatus	West	5S 30E	L10	Atlas				2.66	
Micropogonias undulatus	West	5S 30E	L10	Atlas				2.74	
Micropogonias undulatus	Sapelo	9	45-50 cm	Atlas				3.17	
Micropogonias undulatus	Sapelo	9	45-50 cm	Atlas				3.47	
Micropogonias undulatus	Sapelo	9	45-50 cm	Atlas				3.92	
Micropogonias undulatus	St. Catherines	N784 E801	10-20 cm	Atlas				3.10	
Micropogonias undulatus	St. Catherines	N784 E801	40-50 cm	Atlas				1.90	
Micropogonias undulatus	St. Catherines	N789 E801	20-30 cm	Atlas				4.55	
Micropogonias undulatus	St. Catherines	N789 E801	20-30 cm	Atlas				2.61	
Micropogonias undulatus	St. Catherines	N789 E801	20-30 cm	Atlas				2.34	
Micropogonias undulatus	St. Catherines	N784 E811	30-40 cm	Atlas				4.11	
Micropogonias undulatus	St. Catherines	N784 E811	30-40 cm	Atlas				1.79	
Micropogonias undulatus	St. Catherines	N784 E811	40-50 cm	Atlas				3.04	
Micropogonias undulatus	St. Catherines	N784 E797	30-40 cm	Atlas				1.76	
Micropogonias undulatus	St. Catherines	N784 E797	75.5-78 cm	Atlas				2.36	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Micropogonias undulatus	St. Catherines	W82 S2	2.7-2.6	Atlas				3.37	
Micropogonias undulatus	St. Catherines	W82 S2	2.2-2.1	Atlas				1.90	
Micropogonias undulatus	St. Catherines	W84 S2	2.6-2.5	Atlas				1.77	
Micropogonias undulatus	St. Catherines	N771 E819	2.5-2.4	Atlas				4.09	
Micropogonias undulatus	St. Catherines	N771 E819	2.5-2.4	Atlas				4.27	
Micropogonias undulatus	St. Catherines	N771 E819	2.5-2.4	Atlas				2.79	
Micropogonias undulatus	St. Catherines	N771 E819	2.5-2.4	Atlas				3.90	
Micropogonias undulatus	McQueen	N 213 E 198	4.6-4.5	Atlas				2.97	
Micropogonias undulatus	McQueen	N 213 E 198	4.6-4.5	Atlas				3.25	
Micropogonias undulatus	McQueen	N 213 E 198	4.5-4.4	Atlas				3.10	
Micropogonias undulatus	McQueen	N 213 E 198	4.5-4.4	Atlas				2.99	
Micropogonias undulatus	McQueen	N263 E179	5.7-5.6	Atlas				2.89	
Micropogonias undulatus	McQueen	N263 E179	5.7-5.6	Atlas				3.35	
Micropogonias undulatus	McQueen	N263 E179	5.6-5.5	Atlas				2.51	
Micropogonias undulatus	McQueen	N263 E179	5.6-5.5	Atlas				3.57	
Micropogonias undulatus	McQueen	N263 E179	5.6-5.5	Atlas				1.64	
Micropogonias undulatus	McQueen	N263 E179	5.5-5.4	Atlas				4.45	
Micropogonias undulatus	McQueen	N263 E179	5.4-5.3	Atlas				1.66	
Micropogonias undulatus	McQueen	N263 E179	5.4-5.3	Atlas				3.14	
Micropogonias undulatus	McQueen	N263 E179	5.4-5.3	Atlas				3.07	
Micropogonias undulatus	McQueen	N263 E179	5.4-5.3	Atlas				1.45	
Micropogonias undulatus	McQueen	N263 E179	5.4-5.3	Atlas				3.03	
Micropogonias undulatus	McQueen	N263 E179	5.3-5.17	Atlas				3.91	
Micropogonias undulatus	McQueen	N263 E179	5.3-5.17	Atlas				3.95	
Micropogonias undulatus	McQueen	N263 E179	5.3-5.17	Atlas				3.11	
Micropogonias undulatus	McQueen	N263 E179	5.3-5.17	Atlas				2.83	
Micropogonias undulatus	McQueen	N263 E179	5.3-5.17	Atlas				2.26	
Pogonias cromis	St. Catherines	W82 S2	2.4-2.3	Otolith	Right	12.20		9.80	4.07
Pogonias cromis	McQueen	N263 E179	5.6-5.5	Otolith	Right	9.06		7.64	2.50
Pogonias cromis	St. Catherines	N784 E801	0-10 cm	Otolith	Left	7.13		6.37	2.03
Pogonias cromis	St. Catherines	W84 S2	2.7-2.6	Otolith	Left	7.69		6.88	1.98
Pogonias cromis	McQueen	N263 E179	5.6-5.5	Otolith	Left	10.11		8.62	3.39
Pogonias cromis	McQueen	N263 E179	5.6-5.5	Otolith	Left	10.00		8.16	2.92
Pogonias cromis	Cannon's Point	18N 0E	L14	Atlas				3.56	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Pogonias cromis	Cannon's Point	18N 0E	L16	Atlas				1.88	
Pogonias cromis	Cannon's Point	18N 0E	L16	Atlas				2.55	
Pogonias cromis	Cannon's Point	18N 0E	L16	Atlas				2.74	
Pogonias cromis	Cannon's Point	18N 0E	L27	Atlas				2.46	
Pogonias cromis	West	5S 30E	L8	Atlas				2.65	
Pogonias cromis	St. Catherines	N784 E811	30-40 cm	Atlas				8.55	
Pogonias cromis	St. Catherines	N784 E801	20-30 cm	Atlas				11.14	
Pogonias cromis	St. Catherines	W82 S2	2.0-1.9	Atlas				4.54	
Sciaenops ocellatus	Cannon's Point	18N 0E	L2	Otolith	Right	15.79		8.61	3.97
Sciaenops ocellatus	Cannon's Point	18N 0E	L2	Otolith	Right	14.74		9.01	4.89
Sciaenops ocellatus	Cannon's Point	18N 0E	L25	Otolith	Right	12.23		8.06	3.18
Sciaenops ocellatus	St. Catherines	N784 E797	10-20 cm	Otolith	Right	10.10		6.75	2.72
Sciaenops ocellatus	St. Catherines	N784 E797	20-30 cm	Otolith	Right	13.96		7.61	4.97
Sciaenops ocellatus	St. Catherines	N784 E797	20-30 cm	Otolith	Right	15.31		9.32	5.41
Sciaenops ocellatus	St. Catherines	W84 S2	2.8-2.7	Otolith	Right	9.40		6.24	2.93
Sciaenops ocellatus	Cannon's Point	18N 0E	L3	Otolith	Left			7.97	
Sciaenops ocellatus	Cannon's Point	18N 0E	L26	Otolith	Left	11.77		7.77	3.64
Sciaenops ocellatus	Sapelo	4	2	Otolith	Left	14.30		8.73	3.85
Sciaenops ocellatus	St. Catherines	N784 E801	10-20 cm	Otolith	Left	12.67		8.29	3.72
Sciaenops ocellatus	St. Catherines	N784 E801	20-30 cm	Otolith	Left	16.77		9.31	5.03
Stellifer lanceolatus	Cannon's Point	18N 0E	L11	Sagitta otolith	Right	4.78		3.35	2.22
Stellifer lanceolatus	Cannon's Point	18N 0E	L11	Sagitta otolith	Rigth	4.02		2.75	1.87
Stellifer lanceolatus	West	5S 30E	ZII L3	Sagitta otolith	Right	4.05		3.17	2.04
Stellifer lanceolatus	West	5S 30E	L9	Sagitta otolith	Right	3.97		2.70	1.84
Stellifer lanceolatus	West	5S 30E	L9	Sagitta otolith	Right	3.94		2.62	1.66
Stellifer lanceolatus	West	5S 30E	L9	Sagitta otolith	Right	4.55		3.27	2.02
Stellifer lanceolatus	Sapelo	4	4	Sagitta otolith	Right	6.03		3.80	2.35
Stellifer lanceolatus	Sapelo	9	10-15 cm	Sagitta otolith	Right	5.38		3.62	2.23
Stellifer lanceolatus	Sapelo	9	10-15 cm	Sagitta otolith	Right	3.71		2.59	1.50
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Right	4.49		3.05	2.01
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Right	5.28		3.52	2.18
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Right	4.67		3.17	1.89
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Right	4.79		3.50	2.21
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Right	4.60		3.35	2.01

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Right	4.19		2.83	1.72
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Right	3.29		2.51	1.48
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Right	3.91		2.84	1.68
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Right	4.80		3.55	2.26
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Right	5.20		3.41	2.09
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Right	5.27		3.79	2.41
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Right	3.13		2.44	1.34
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Right	4.66		3.31	2.00
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Right	5.03		3.63	2.24
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Right	3.96		2.79	1.69
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Right	4.01		2.71	1.59
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Right	4.39		2.99	1.82
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	4.12		2.81	1.70
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	3.89		2.88	1.71
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	3.76		2.72	1.60
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	5.94		3.77	2.58
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	3.15		2.28	1.33
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	4.87		3.48	2.09
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	5.23		3.53	2.35
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	4.33		2.98	1.77
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	4.87		3.59	2.18
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	3.79		2.70	1.64
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	5.48		4.06	2.50
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	6.11		3.99	2.44
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	3.82		2.67	1.59
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	4.42		3.05	1.76
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	6.00		3.99	2.54
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	3.50		2.34	1.39
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	5.48		3.68	2.46
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	4.68		3.34	2.15
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	4.61		3.36	2.08
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	4.72		3.49	2.23
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	5.37		3.62	2.42
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	4.88		3.43	2.18

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	5.62		3.69	2.45
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Right	3.69		2.56	1.47
Stellifer lanceolatus	Sapelo	9	30-35 cm	Sagitta otolith	Right	5.03		3.71	2.40
Stellifer lanceolatus	Sapelo	9	30-35 cm	Sagitta otolith	Right	5.17		3.52	2.17
Stellifer lanceolatus	Sapelo	9	25-30 cm	Sagitta otolith	Right	4.52		3.25	2.08
Stellifer lanceolatus	Sapelo	9	35-40 cm	Sagitta otolith	Right	4.38		3.24	1.93
Stellifer lanceolatus	Sapelo	9	35-40 cm	Sagitta otolith	Right	3.66		2.67	1.59
Stellifer lanceolatus	Sapelo	9	35-40 cm	Sagitta otolith	Right	5.08		3.92	2.33
Stellifer lanceolatus	Sapelo	9	35-40 cm	Sagitta otolith	Right	4.67		3.55	2.29
Stellifer lanceolatus	St. Catherines	N784 E801	10-20 cm	Sagitta otolith	Right	4.89		3.34	2.01
Stellifer lanceolatus	St. Catherines	N784 E801	30-40 cm	Sagitta otolith	Right	4.53		3.00	1.95
Stellifer lanceolatus	St. Catherines	N784 E801	50-60 cm	Sagitta otolith	Right	5.20		3.76	2.44
Stellifer lanceolatus	St. Catherines	N789 E801	20-30 cm	Sagitta otolith	Right	6.77		4.55	2.83
Stellifer lanceolatus	St. Catherines	N789 E801	40-50 cm	Sagitta otolith	Right	2.66		1.87	1.20
Stellifer lanceolatus	St. Catherines	N784 E811	30-40 cm	Sagitta otolith	Right	5.85		3.78	2.58
Stellifer lanceolatus	St. Catherines	N784 E811	50-60 cm	Sagitta otolith	Right	5.39		4.23	2.67
Stellifer lanceolatus	St. Catherines	N784 E811	50-60 cm	Sagitta otolith	Right	5.35		3.61	2.35
Stellifer lanceolatus	St. Catherines	N784 E797	0-10 cm	Sagitta otolith	Right	4.24		3.24	1.97
Stellifer lanceolatus	St. Catherines	N771 E819	Surface-2.6 m	Sagitta otolith	Right	4.94		3.66	2.31
Stellifer lanceolatus	St. Catherines	N771 E819	Surface-2.6 m	Sagitta otolith	Right	5.76		3.93	2.55
Stellifer lanceolatus	St. Catherines	W82 S2	2.6-2.5	Sagitta otolith	Right	5.49		3.80	2.39
Stellifer lanceolatus	St. Catherines	W82 S2	2.3-2.2	Sagitta otolith	Right	4.59		3.31	2.11
Stellifer lanceolatus	St. Catherines	W84 S2	2.8-2.7	Sagitta otolith	Right	5.75		4.25	2.71
Stellifer lanceolatus	St. Catherines	N771 E819	Surface-2.6	Sagitta otolith	Right	4.94		3.66	2.31
Stellifer lanceolatus	St. Catherines	N771 E819	Surface-2.6	Sagitta otolith	Right	5.76		3.93	2.55
Stellifer lanceolatus	St. Catherines	N771 E819	Surface-2.6	Sagitta otolith	Right	5.27		3.87	2.37
Stellifer lanceolatus	St. Catherines	N771 E819	Surface-2.6	Sagitta otolith	Right	4.66		3.56	2.15
Stellifer lanceolatus	St. Catherines	N771 E819	Surface-2.6	Sagitta otolith	Right	5.49		3.90	2.45
Stellifer lanceolatus	St. Catherines	N771 E819	Surface-2.6	Sagitta otolith	Right	5.92		3.96	2.55
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	5.91		4.35	2.91
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	5.07		3.60	2.35
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	5.20		3.40	2.25
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.61		3.24	2.06
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	5.05		3.48	2.23

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	5.00		3.86	2.40
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.11		3.19	1.96
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.95		3.55	2.25
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.82		3.42	2.17
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	5.67		3.89	2.49
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	3.88		2.98	1.92
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	3.24		2.51	1.38
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	5.72		3.78	2.47
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.86		3.07	2.05
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.80		3.08	1.79
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	3.29		2.56	1.48
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.36		2.98	1.79
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	5.10		3.71	2.31
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	5.13		3.71	2.44
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	3.90		2.68	1.58
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.47		3.16	1.94
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.17		3.22	1.96
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	5.34		3.53	2.16
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.24		3.28	2.03
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.80		3.18	2.00
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.83		3.39	2.16
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	3.77		2.86	1.61
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.85		3.63	2.40
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.35		2.66	1.83
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	5.46		3.70	2.27
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	4.63		3.36	2.18
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Right	6.04		3.86	2.72
Stellifer lanceolatus	McQueen	N 213 E 198	4.4-4.3	Sagitta otolith	Right	5.16		3.42	2.19
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Right	5.65		3.79	2.42
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Right	4.46		3.14	1.90
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Right	5.21		3.76	2.31
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Right	5.72		4.35	2.71
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Right	5.45		3.97	2.60
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Right	6.13		3.92	2.65

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Right	5.61		4.09	2.55
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Right	5.23		3.66	2.44
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Right	5.03		3.42	2.12
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Right	4.73		3.28	2.03
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Right	5.47		3.79	2.29
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Right	5.33		3.86	2.52
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Right	5.43		4.00	2.63
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Right	5.80		3.87	2.44
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Right	5.92		3.87	2.58
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Right	5.04		3.66	2.42
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Right	5.01		3.28	2.02
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Right	3.87		2.61	1.53
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Right	4.66		3.43	2.15
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Right	5.10		3.78	2.35
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Right	3.81		2.54	1.52
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Right	5.18		3.40	2.09
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Right	6.19		4.17	2.62
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Right	4.91		3.52	2.26
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Right	4.10		3.10	1.86
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Right	4.67		3.34	2.14
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Right	3.87		2.56	1.50
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Right	3.98		2.67	1.59
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Right	5.91		3.89	2.40
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Right	6.03		3.99	2.59
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Right	5.91		4.26	2.62
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Right	5.34		3.45	2.14
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Right	6.29		4.12	2.63
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Right	5.31		3.71	2.46
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Right	5.81		3.93	2.54
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Right	4.45		3.05	1.85
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Right	3.64		2.47	1.49
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Right	5.49		3.81	2.55
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Right	5.52		3.77	2.33
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Right	5.12		3.18	1.98

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Right	3.88		2.71	1.68
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Right	3.61		2.38	1.47
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	5.97		3.79	2.55
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	5.20		3.78	2.53
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	5.22		3.62	2.16
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	5.35		3.64	2.32
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	5.35		3.89	2.30
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	4.88		3.23	2.07
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	5.03		3.68	2.25
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	5.41		3.67	2.29
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	4.99		3.56	2.23
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	5.47		3.50	2.30
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	5.01		3.38	2.13
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	5.56		3.95	2.62
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	5.12		3.58	2.28
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	5.35		3.30	2.14
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	3.81		2.73	1.68
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Right	5.43		3.66	2.31
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Right	4.94		3.46	2.14
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Right	5.33		3.56	2.31
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Right	3.04		2.33	1.33
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Right	3.62		2.49	1.44
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Right	5.99		4.24	2.52
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Right	5.12		3.41	2.10
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Right	5.38		3.65	2.27
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Right	3.52		2.46	1.49
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Right	3.37		2.36	1.43
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Right	5.42		3.52	2.13
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Right	5.73		3.73	2.43
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Right	4.31		2.85	1.78
Stellifer lanceolatus	Cannon's Point	18N 0E	L7	Sagitta otolith	Left	5.20		3.36	2.11
Stellifer lanceolatus	Cannon's Point	18N 0E	L26	Sagitta otolith	Left	4.51		3.38	2.06
Stellifer lanceolatus	West	5S 30E	L6	Sagitta otolith	Left	5.66		3.66	2.28
Stellifer lanceolatus	West	5S 30E	L6	Sagitta otolith	Left	5.22		3.71	2.31

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Stellifer lanceolatus	West	5S 30E	L7	Sagitta otolith	Left	4.11		2.85	1.90
Stellifer lanceolatus	West	5S 30E	L9	Sagitta otolith	Left	4.47		3.10	1.98
Stellifer lanceolatus	West	5S 30E	L9	Sagitta otolith	Left	5.07		3.38	2.32
Stellifer lanceolatus	West	5S 30E	L9	Sagitta otolith	Left	3.65		2.92	2.02
Stellifer lanceolatus	West	5S 30E	L9	Sagitta otolith	Left	4.92		3.39	2.14
Stellifer lanceolatus	West	5S 30E	L9	Sagitta otolith	Left	5.03		3.70	2.25
Stellifer lanceolatus	West	5S 30E	L9	Sagitta otolith	Left	4.69		2.99	1.93
Stellifer lanceolatus	West	5S 30E	L9	Sagitta otolith	Left	4.90		3.54	2.25
Stellifer lanceolatus	West	5S 30E	L9	Sagitta otolith	Left	4.71		3.27	2.02
Stellifer lanceolatus	West	5S 30E	L9	Sagitta otolith	Left	5.06		3.45	2.20
Stellifer lanceolatus	West	5S 30E	L9	Sagitta otolith	Left	4.64		3.17	2.01
Stellifer lanceolatus	West	5S 30E	ZII L5	Sagitta otolith	Left	5.26		3.40	2.09
Stellifer lanceolatus	Sapelo	4	4	Sagitta otolith	Left	5.44		3.95	2.42
Stellifer lanceolatus	Sapelo	4	5	Sagitta otolith	Left	4.17		2.85	1.71
Stellifer lanceolatus	Sapelo	4	5	Sagitta otolith	Left	5.05		3.54	2.30
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Left	4.61		3.40	2.14
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Left	4.80		3.52	2.24
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Left	4.66		3.30	2.01
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Left	5.09		3.24	2.06
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Left	5.67		3.55	2.16
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Left	4.42		2.94	1.81
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Left	4.61		2.96	1.85
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Left	5.13		3.87	2.46
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Left	3.60		2.40	1.41
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Left	3.83		2.85	1.69
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Left	3.40		2.25	1.45
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Left	3.98		2.66	1.63
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Left	4.13		2.88	1.64
Stellifer lanceolatus	Sapelo	9	10-15 cm	Sagitta otolith	Left	4.26		2.90	1.69
Stellifer lanceolatus	Sapelo	9	10-15 cm	Sagitta otolith	Left	5.17		3.45	2.20
Stellifer lanceolatus	Sapelo	9	10-15 cm	Sagitta otolith	Left	5.57		3.53	2.31
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Left	5.81		3.88	2.38
Stellifer lanceolatus	Sapelo	9	15-20 cm	Sagitta otolith	Left	5.20		3.70	2.24
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Left	3.91		2.69	1.64

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Left	3.49		2.35	1.34
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Left	5.29		3.56	2.16
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Left	4.86		3.38	2.14
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Left	5.29		3.35	2.13
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Left	4.57		3.40	2.16
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Left	4.08		3.18	1.93
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Left	5.65		3.64	2.39
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Left	4.46		3.10	1.98
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Left	5.62		3.76	2.36
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Left	4.10		2.67	1.65
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Left	6.07		3.96	2.59
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Left	4.98		3.29	2.04
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Left	4.35		2.96	1.85
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Left	4.15		2.66	1.57
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Left	4.00		2.80	1.65
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Left	3.94		2.54	1.59
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Left	3.57		2.53	1.42
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Left	3.79		3.11	1.68
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Left	4.23		2.82	1.64
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Left	6.02		4.08	2.57
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Left	5.88		3.79	2.56
Stellifer lanceolatus	Sapelo	9	20-25 cm	Sagitta otolith	Left	3.61		2.45	1.41
Stellifer lanceolatus	Sapelo	9	35-40 cm	Sagitta otolith	Left	4.60		3.51	2.18
Stellifer lanceolatus	Sapelo	9	35-40 cm	Sagitta otolith	Left	3.90		2.86	1.75
Stellifer lanceolatus	Sapelo	9	35-40 cm	Sagitta otolith	Left	4.86		3.40	2.17
Stellifer lanceolatus	St. Catherines	N784 E801	30-40 cm	Sagitta otolith	Left	4.29		3.14	1.93
Stellifer lanceolatus	St. Catherines	N782 E801	20-30 cm	Sagitta otolith	Left	5.64		3.66	2.39
Stellifer lanceolatus	St. Catherines	N789 E801	10-20 cm	Sagitta otolith	Left	5.87		4.19	2.83
Stellifer lanceolatus	St. Catherines	N789 E801	20-30 cm	Sagitta otolith	Left	6.73		4.54	2.91
Stellifer lanceolatus	St. Catherines	N789 E801	30-40 cm	Sagitta otolith	Left	5.61		4.08	2.62
Stellifer lanceolatus	St. Catherines	N789 E801	30-40 cm	Sagitta otolith	Left	4.45		2.90	1.86
Stellifer lanceolatus	St. Catherines	N789 E801	40-50 cm	Sagitta otolith	Left	5.50		3.67	2.25
Stellifer lanceolatus	St. Catherines	N784 E811	20-30 cm	Sagitta otolith	Left	4.70		3.09	1.82
Stellifer lanceolatus	St. Catherines	N784 E811	20-30 cm	Sagitta otolith	Left	5.45		3.87	2.57

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Stellifer lanceolatus	St. Catherines	N784 E811	30-40 cm	Sagitta otolith	Left	5.89		4.25	2.65
Stellifer lanceolatus	St. Catherines	N784 E811	30-40 cm	Sagitta otolith	Left	4.81		3.37	2.39
Stellifer lanceolatus	St. Catherines	W82 S2	2.3-2.2	Sagitta otolith	Left	4.77		3.17	2.03
Stellifer lanceolatus	St. Catherines	N771 E819	Surface-2.6 m	Sagitta otolith	Left	5.07		3.56	2.19
Stellifer lanceolatus	St. Catherines	N771 E819	Surface-2.6 m	Sagitta otolith	Left	5.08		3.61	2.42
Stellifer lanceolatus	St. Catherines	N771 E819	Surface-2.6 m	Sagitta otolith	Left	5.19		3.86	2.29
Stellifer lanceolatus	St. Catherines	N771 E819	Surface-2.6 m	Sagitta otolith	Left	5.73		4.06	2.57
Stellifer lanceolatus	St. Catherines	N771 E819	2.6-2.5 m	Sagitta otolith	Left	6.04		3.92	2.54
Stellifer lanceolatus	St. Catherines	N771 E819	2.6-2.5 m	Sagitta otolith	Left	5.34		3.52	2.25
Stellifer lanceolatus	St. Catherines	Feature 23	1.8-1.7	Sagitta otolith	Left	4.74		3.19	1.92
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	5.21		3.54	2.25
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	4.18		3.05	1.91
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	4.11		2.93	1.71
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	4.86		3.58	2.19
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	3.97		2.80	1.59
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	4.69		3.08	1.92
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	5.10		3.49	2.15
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	3.21		2.62	1.58
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	4.96		3.36	2.19
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	4.88		3.11	2.06
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	4.52		3.31	2.24
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	5.47		3.62	2.35
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	3.52		2.58	1.50
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	4.87		3.25	2.08
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	5.35		3.46	2.23
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	5.13		3.32	2.02
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	4.79		3.53	2.22
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	6.25		4.33	2.66
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	5.55		3.80	2.58
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	4.72		3.40	2.02
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	5.50		3.49	2.35
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	5.18		3.37	2.37
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	5.40		3.71	2.32
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	5.21		3.70	2.50

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	5.76		3.65	2.61
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	5.32		3.75	2.53
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Sagitta otolith	Left	6.14		4.08	2.58
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	5.40		3.77	2.36
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	5.50		3.87	2.57
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	5.09		3.64	2.40
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	5.97		4.09	2.63
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	6.18		4.40	2.76
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	5.67		3.87	2.70
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	6.04		4.48	2.72
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	4.85		3.44	2.29
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	5.34		3.86	2.59
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	4.94		3.36	2.14
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	5.29		3.80	2.45
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	5.41		3.91	2.50
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	3.80		2.77	1.69
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	4.18		2.95	1.83
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Sagitta otolith	Left	5.22		4.02	
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Left	5.10		3.39	2.16
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Left	5.91		4.11	2.57
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Left	5.82		3.79	2.37
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Left	5.04		3.56	2.31
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Left	5.06		3.69	2.39
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Left	5.67		3.75	2.38
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Left	4.36		2.89	1.85
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Left	5.09		3.41	2.07
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Sagitta otolith	Left	4.58		3.15	1.97
Stellifer lanceolatus	McQueen	N263 E179	5.8-5.7	Sagitta otolith	Left	5.26		3.31	2.11
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	4.72		3.53	2.22
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	5.23		3.67	2.30
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	5.93		4.13	2.55
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	4.82		3.44	2.05
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	4.14		3.01	2.20
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	6.56		4.29	2.68

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	5.04		3.58	2.19
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	5.29		3.34	2.09
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Sagitta otolith	Left	5.73		3.90	2.50
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	4.42		2.97	1.78
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	3.82		2.82	1.62
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	4.74		3.33	2.05
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	5.33		3.54	2.16
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	3.58		2.45	1.47
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	5.20		3.43	2.16
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	5.39		3.67	2.26
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	5.14		3.60	2.32
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	3.65		2.52	1.51
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	5.47		3.74	2.34
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Sagitta otolith	Left	5.17		3.78	2.38
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	5.79		4.23	2.90
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	5.22		3.65	2.26
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	5.58		3.91	2.54
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	4.23		3.05	1.80
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	5.22		3.52	2.25
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	5.12		3.43	2.11
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	4.90		3.35	2.05
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	4.93		3.39	2.06
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Sagitta otolith	Left	4.76		3.39	2.06
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	4.48		2.88	1.70
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	4.60		3.38	2.17
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	4.64		3.42	2.13
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	3.79		2.58	1.50
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	5.82		3.99	2.60
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	3.91		2.59	1.52
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	4.98		3.39	2.08
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	4.72		3.40	2.08
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	5.44		3.69	2.27
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	6.12		4.17	2.63
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	5.90		4.00	2.56

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	5.26		3.81	2.30
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	5.56		3.69	2.33
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	5.45		3.61	2.21
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	5.70		3.90	2.50
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	5.43		3.60	2.26
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	5.37		3.24	2.13
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	4.95		3.45	2.02
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	5.63		3.69	2.34
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	5.11		3.55	2.14
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	4.75		3.20	1.91
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	5.35		3.60	2.27
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	5.52		3.55	2.20
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	5.38		3.53	2.23
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Sagitta otolith	Left	4.84		3.05	1.80
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Left	5.97		3.78	2.52
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Left	5.60		4.06	2.72
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Left	5.49		3.62	2.44
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Left	4.70		3.28	2.04
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Left	5.59		3.78	2.42
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Left	4.70		3.28	2.08
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Sagitta otolith	Left	5.14		3.49	2.12
Stellifer lanceolatus	McQueen	N263 E179	5.24-5.1	Sagitta otolith	Left	4.21		2.65	1.68
Stellifer lanceolatus	Sapelo	9	10-15 cm	Lapillus otolith	Right	5.70		4.87	1.97
Stellifer lanceolatus	Sapelo	9	10-15 cm	Lapillus otolith	Right	5.37		4.51	1.72
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Right	3.32		3.06	1.15
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Right	4.90		3.83	1.59
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Right	5.79		4.45	2.02
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Right	5.39		4.39	1.87
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Right	4.57		4.02	1.62
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Right	3.93		3.55	1.73
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Right	5.31		4.36	1.73
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Right	4.26		3.76	1.54
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Right	5.11		4.08	1.68
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Right	3.31		2.87	1.13

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Right	5.25		4.22	1.77
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Right	5.63		4.69	1.88
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Right	3.58		3.13	1.29
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Right	4.54		3.78	1.57
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Right	5.47		4.49	1.85
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Right	4.92		4.12	1.76
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Right	3.45		3.03	1.25
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Right	5.62		4.50	1.88
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Right	3.71		3.09	1.32
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Right	5.83		4.65	1.98
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Right	5.51		4.60	1.95
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Right	3.60		3.08	1.34
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Right	4.51		3.81	1.61
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Right	3.13		2.54	
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Right	4.24		3.64	1.46
Stellifer lanceolatus	Sapelo	9	25-30 cm	Lapillus otolith	Right	6.63		5.48	2.29
Stellifer lanceolatus	St. Catherines	N784 E801	0-10 cm	Lapillus otolith	Right	5.85		4.94	2.04
Stellifer lanceolatus	St. Catherines	N784 E801	20-30 cm	Lapillus otolith	Right			4.45	1.76
Stellifer lanceolatus	St. Catherines	N789 E801	40-50 cm	Lapillus otolith	Right	6.37		5.21	2.23
Stellifer lanceolatus	St. Catherines	N784 E797	20-30 cm	Lapillus otolith	Right	5.03		4.47	1.83
Stellifer lanceolatus	St. Catherines	W82 S2	2.0-1.9	Lapillus otolith	Right	4.68		3.74	1.67
Stellifer lanceolatus	St. Catherines	W84 S2	2.8-2.7	Lapillus otolith	Right	5.49		4.62	1.86
Stellifer lanceolatus	St. Catherines	W84 S2	2.7-2.6	Lapillus otolith	Right	3.98		3.31	1.44
Stellifer lanceolatus	St. Catherines	N771 E819	Surface-2.6	Lapillus otolith	Right	6.19		5.01	2.09
Stellifer lanceolatus	St. Catherines	N771 E819	2.6-2.5	Lapillus otolith	Right	5.32		4.20	1.73
Stellifer lanceolatus	St. Catherines	N771 E819	2.6-2.5	Lapillus otolith	Right	5.48		4.53	2.03
Stellifer lanceolatus	St. Catherines	N771 E819	2.6-2.5	Lapillus otolith	Right	4.26		3.51	1.42
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Right	5.84		4.59	1.86
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Right	4.00		3.40	1.48
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Right	5.63		4.58	2.00
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Right	4.07		3.29	1.47
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Right	3.51		3.14	1.29
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Right	4.32		4.03	1.53
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Right	5.45		4.53	1.93

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Right	4.84		4.17	1.90
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Right	5.84		4.77	2.03
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Right	4.52		4.03	1.58
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Right	5.69		4.56	2.06
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Right	5.58		4.58	1.97
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Right	5.74		4.39	2.09
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Lapillus otolith	Right	5.49		4.74	1.98
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Lapillus otolith	Right	5.28		3.96	2.05
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Lapillus otolith	Right			4.27	1.73
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Lapillus otolith	Right			3.85	1.51
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Lapillus otolith	Right	6.06		5.13	2.14
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Lapillus otolith	Right	5.18		4.39	1.74
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Lapillus otolith	Right	5.39		4.70	1.90
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Lapillus otolith	Right	4.97		4.14	1.72
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Lapillus otolith	Right	4.07		3.48	1.44
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Lapillus otolith	Right	5.54		4.35	1.79
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Lapillus otolith	Right	4.60		3.90	1.57
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Lapillus otolith	Right	4.88		4.01	1.70
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Lapillus otolith	Right	3.94		3.14	1.39
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Lapillus otolith	Right	6.03		5.25	2.20
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Lapillus otolith	Right	7.00		5.68	2.37
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Lapillus otolith	Right	5.07		4.31	1.80
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Lapillus otolith	Right	3.99		3.61	1.48
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Lapillus otolith	Right	5.14		4.05	1.77
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Lapillus otolith	Right	5.47		4.32	1.86
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Lapillus otolith	Right	4.91		4.01	1.50
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Lapillus otolith	Right	5.71		4.39	1.87
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Lapillus otolith	Right	5.44		4.45	1.91
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Lapillus otolith	Right	6.25		5.06	1.87
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Lapillus otolith	Right	5.26		4.16	1.82
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Lapillus otolith	Right	3.77		3.19	1.31
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Lapillus otolith	Right	5.71		4.80	1.89
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Lapillus otolith	Right	5.73		4.64	1.92
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Lapillus otolith	Right	5.22		4.53	2.08

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Right	5.88		4.70	1.90
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Right	4.06		3.44	1.45
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Right	5.87		4.63	2.01
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Right	5.52		4.31	1.75
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Right	4.17		3.41	1.40
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Right	3.92		3.15	1.31
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Right	5.48		4.53	2.03
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Right	3.66		3.18	1.39
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Right	3.63		3.18	1.36
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Right	3.34		3.22	1.33
Stellifer lanceolatus	McQueen	N263 E179	5.24-5.1	Lapillus otolith	Right	4.91		4.26	1.71
Stellifer lanceolatus	Sapelo	9	10-15 cm	Lapillus otolith	Left	5.34		4.34	1.90
Stellifer lanceolatus	Sapelo	9	10-15 cm	Lapillus otolith	Left	5.82		5.01	2.07
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Left	3.70		3.05	1.35
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Left	5.41		4.44	1.60
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Left	6.03		4.77	1.95
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Left	5.87		4.60	1.97
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Left	5.01		4.04	1.67
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Left	4.33		3.83	1.61
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Left	3.81		3.23	1.32
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Left	5.36		4.42	1.70
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Left	3.32		3.06	1.28
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Left	3.55		3.04	1.09
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Left	5.17		4.20	1.70
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Left	3.65		3.22	1.29
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Left	4.17		3.56	
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Left	5.68		4.60	1.90
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Left	5.74		4.77	2.12
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Left	5.76		5.02	2.05
Stellifer lanceolatus	Sapelo	9	15-20 cm	Lapillus otolith	Left	6.19		2.01	4.90
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Left	4.56		3.95	1.65
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Left	6.07		4.71	2.02
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Left	3.27		2.77	1.08
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Left	6.11		4.76	2.12

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Left	4.93		4.12	1.80
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Left	5.00		4.19	1.70
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Left	4.52		3.88	1.54
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Left	5.39		4.17	1.86
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Left	5.02		4.29	1.71
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Left	4.28		3.62	1.48
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Left	5.12		4.10	1.68
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Left	2.76		2.23	1.13
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Left	4.97		4.00	1.73
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Left	3.19		3.03	1.22
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Left	3.68		3.20	1.30
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Left	4.15		3.59	1.35
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Left	4.80		3.95	1.60
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Left	3.19		2.64	1.09
Stellifer lanceolatus	Sapelo	9	20-25 cm	Lapillus otolith	Left	6.08		4.71	1.91
Stellifer lanceolatus	Sapelo	9	45-50 cm	Lapillus otolith	Left	5.67		4.46	1.80
Stellifer lanceolatus	St. Catherines	N784 E801	10-20 cm	Lapillus otolith	Left	5.24		4.19	1.76
Stellifer lanceolatus	St. Catherines	N784 E801	20-30 cm	Lapillus otolith	Left	5.80		4.65	2.11
Stellifer lanceolatus	St. Catherines	N784 E811	30-40 cm	Lapillus otolith	Left	6.55		5.31	2.11
Stellifer lanceolatus	St. Catherines	N784 E811	50-60 cm	Lapillus otolith	Left	6.26		5.15	2.12
Stellifer lanceolatus	St. Catherines	N784 E797	10-20 cm	Lapillus otolith	Left	5.41		4.27	1.70
Stellifer lanceolatus	St. Catherines	W84 S2	2.8-2.7	Lapillus otolith	Left	4.79		3.80	1.60
Stellifer lanceolatus	St. Catherines	N771 E819	Surface-2.6	Lapillus otolith	Left	5.64		4.65	1.89
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Left	3.82		3.27	1.36
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Left	4.80		4.03	1.63
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Left	4.85		3.87	1.65
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Left	4.65		3.84	1.65
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Left	4.81		4.01	1.84
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Left	5.21		4.42	1.88
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Left	4.72		4.35	1.71
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Left	5.27		4.45	1.86
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Left	5.80		4.56	2.10
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Lapillus otolith	Left	5.91		4.66	2.00
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Lapillus otolith	Left	6.74		5.29	2.34

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Lapillus otolith	Left			5.13	2.02
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Lapillus otolith	Left	6.21		4.96	2.01
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Lapillus otolith	Left	5.86		4.63	2.02
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Lapillus otolith	Left			4.05	1.59
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Lapillus otolith	Left	5.03		4.23	1.74
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Lapillus otolith	Left	4.56		3.84	1.49
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Lapillus otolith	Left	5.24		4.25	1.77
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Lapillus otolith	Left	4.59		3.93	1.47
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Lapillus otolith	Left	5.80		5.02	2.10
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Lapillus otolith	Left	4.78		4.01	1.58
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Lapillus otolith	Left	6.16		5.14	2.13
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Lapillus otolith	Left	5.10		4.44	1.87
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Lapillus otolith	Left	5.21		4.39	1.82
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Lapillus otolith	Left	5.73		4.72	1.95
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Lapillus otolith	Left	4.89		4.39	1.92
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Lapillus otolith	Left	4.87		4.24	1.79
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Lapillus otolith	Left	6.14		4.56	1.98
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Lapillus otolith	Left	5.46		4.26	1.86
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Lapillus otolith	Left	5.48		4.76	1.82
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Lapillus otolith	Left	3.83		3.39	1.40
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Lapillus otolith	Left	3.14		2.73	1.16
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Lapillus otolith	Left	5.73		4.57	2.07
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Lapillus otolith	Left	5.09		4.16	1.95
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Lapillus otolith	Left	5.62		4.79	1.94
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Lapillus otolith	Left	5.25		4.23	1.83
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Lapillus otolith	Left	5.19		4.34	2.20
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Lapillus otolith	Left	4.99		4.02	1.69
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Lapillus otolith	Left	5.47		4.45	1.86
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Lapillus otolith	Left	4.97		4.20	1.72
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Lapillus otolith	Left	6.15		5.02	2.06
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Left	5.38		4.74	1.91
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Left	5.40		4.62	1.85
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Left	5.74		4.90	2.04
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Left	5.26		4.27	1.75

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Left	5.79		4.62	2.01
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Left	5.25		4.46	1.80
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Left	4.44		3.70	1.61
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Left	4.97		4.13	1.83
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Left	5.59		4.60	1.80
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Left	4.98		4.18	1.81
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Left	4.03		3.52	1.57
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Lapillus otolith	Left	4.26		3.75	1.54
Stellifer lanceolatus	West	5S 30E	ZII L5	Atlas				2.42	
Stellifer lanceolatus	Sapelo	4	4	Atlas				2.55	
Stellifer lanceolatus	Sapelo	4	4	Atlas				2.65	
Stellifer lanceolatus	Sapelo	4	4	Atlas				2.16	
Stellifer lanceolatus	Sapelo	9	10-15 cm	Atlas				2.58	
Stellifer lanceolatus	Sapelo	9	10-15 cm	Atlas				2.79	
Stellifer lanceolatus	Sapelo	9	10-15 cm	Atlas				2.51	
Stellifer lanceolatus	Sapelo	9	10-15 cm	Atlas				2.69	
Stellifer lanceolatus	Sapelo	9	10-15 cm	Atlas				2.47	
Stellifer lanceolatus	Sapelo	9	15-20 cm	Atlas				2.92	
Stellifer lanceolatus	Sapelo	9	15-20 cm	Atlas				1.97	
Stellifer lanceolatus	Sapelo	9	15-20 cm	Atlas				2.40	
Stellifer lanceolatus	Sapelo	9	15-20 cm	Atlas				2.72	
Stellifer lanceolatus	Sapelo	9	15-20 cm	Atlas				2.79	
Stellifer lanceolatus	Sapelo	9	15-20 cm	Atlas				1.92	
Stellifer lanceolatus	Sapelo	9	15-20 cm	Atlas				2.70	
Stellifer lanceolatus	Sapelo	9	15-20 cm	Atlas				2.40	
Stellifer lanceolatus	Sapelo	9	15-20 cm	Atlas				2.05	
Stellifer lanceolatus	Sapelo	9	15-20 cm	Atlas				2.88	
Stellifer lanceolatus	Sapelo	9	20-25 cm	Atlas				2.49	
Stellifer lanceolatus	Sapelo	9	20-25 cm	Atlas				2.36	
Stellifer lanceolatus	Sapelo	9	20-25 cm	Atlas				2.66	
Stellifer lanceolatus	Sapelo	9	20-25 cm	Atlas				2.34	
Stellifer lanceolatus	Sapelo	9	20-25 cm	Atlas				2.71	
Stellifer lanceolatus	Sapelo	9	20-25 cm	Atlas				3.11	
Stellifer lanceolatus	Sapelo	9	20-25 cm	Atlas				2.41	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Stellifer lanceolatus	Sapelo	9	25-30 cm	Atlas				2.63	
Stellifer lanceolatus	Sapelo	9	30-35 cm	Atlas				3.06	
Stellifer lanceolatus	Sapelo	9	35-40 cm	Atlas				2.92	
Stellifer lanceolatus	Sapelo	9	35-40 cm	Atlas				2.58	
Stellifer lanceolatus	Sapelo	9	35-40 cm	Atlas				2.68	
Stellifer lanceolatus	Sapelo	9	35-40 cm	Atlas				1.87	
Stellifer lanceolatus	Sapelo	9	40-45 cm	Atlas				2.45	
Stellifer lanceolatus	Sapelo	9	85-90 cm	Atlas				3.05	
Stellifer lanceolatus	St. Catherines	N784 E801	20-30 cm	Atlas				2.38	
Stellifer lanceolatus	St. Catherines	N784 E801	30-40 cm	Atlas				3.00	
Stellifer lanceolatus	St. Catherines	N789 E801	110-120 cm	Atlas				3.48	
Stellifer lanceolatus	St. Catherines	N784 E797	0-10 cm	Atlas				2.77	
Stellifer lanceolatus	St. Catherines	N784 E797	40-50 cm	Atlas				3.16	
Stellifer lanceolatus	St. Catherines	W82 S2	2.3-2.2	Atlas				2.64	
Stellifer lanceolatus	St. Catherines	W84 S2	2.8-2.7	Atlas				3.13	
Stellifer lanceolatus	St. Catherines	N771 E819	Surface-2.6	Atlas				2.39	
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Atlas				3.19	
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Atlas				3.01	
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Atlas				2.76	
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Atlas				2.29	
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Atlas				2.59	
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Atlas				3.21	
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Atlas				2.64	
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Atlas				2.68	
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Atlas				2.61	
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Atlas				2.74	
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Atlas				2.98	
Stellifer lanceolatus	McQueen	N 213 E 198	Open-4.6	Atlas				3.06	
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Atlas				3.45	
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Atlas				2.85	
Stellifer lanceolatus	McQueen	N 213 E 198	4.6-4.5	Atlas				2.66	
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Atlas				2.86	
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Atlas				2.53	
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Atlas				3.31	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Atlas				3.07	
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Atlas				3.11	
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Atlas				3.30	
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Atlas				2.93	
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Atlas				2.68	
Stellifer lanceolatus	McQueen	N 213 E 198	4.5-4.4	Atlas				3.08	
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Atlas				2.86	
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Atlas				3.16	
Stellifer lanceolatus	McQueen	N263 E179	5.7-5.6	Atlas				3.00	
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Atlas				2.65	
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Atlas				2.84	
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Atlas				2.58	
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Atlas				2.81	
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Atlas				2.52	
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Atlas				1.99	
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Atlas				2.75	
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Atlas				2.30	
Stellifer lanceolatus	McQueen	N263 E179	5.6-5.5	Atlas				2.21	
Stellifer lanceolatus	McQueen	N263 E179	5.5-5.4	Atlas				2.64	
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Atlas				2.80	
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Atlas				3.18	
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Atlas				2.44	
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Atlas				2.48	
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Atlas				2.52	
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Atlas				2.56	
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Atlas				2.49	
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Atlas				2.52	
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Atlas				2.33	
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Atlas				2.70	
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Atlas				3.34	
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Atlas				2.57	
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Atlas				3.49	
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Atlas				2.48	
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Atlas				2.69	

APPENDIX C—(*Continued*)

Taxa	Collection	Unit	Level	Element	Side	Len, mm	Brt, mm	Wdh, mm	Th, mm
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Atlas				2.77	
Stellifer lanceolatus	McQueen	N263 E179	5.4-5.3	Atlas				3.16	
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Atlas				1.86	
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Atlas				2.68	
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Atlas				2.85	
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Atlas				2.93	
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Atlas				2.63	
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Atlas				3.00	
Stellifer lanceolatus	McQueen	N263 E179	5.3-5.17	Atlas				2.46	
Peprilus sp.	Sapelo	9	20-25 cm	Otolith	Right	4.86		3.23	0.64
Paralichthys sp.	McQueen	N263 E179	5.6-5.5	Otolith	Right	7.91		4.94	1.34

APPENDIX D

LATE ARCHAIC SHELL RINGS: BIRD AND MAMMAL MEASUREMENTS

Taxa	Unit	Level	Element	Side	Dim.	mm	Dim.	mm	Dim.	mm	Dim.
Ardea herodias	N784 E811	20-30 cm	Ulna	Right	Did	13.89					
Rallidae	N263 E179	5.5-5.4	Humerus	Right	Bd	7.37					
Rallidae	N263 E179	5.3-5.17	Humerus	Right	Bd	8.02					
Rallidae	N263 E179	5.5-5.4	Humerus	Left	Bp	11.07					
Rallidae	N784 E797	20-30 cm	Humerus	Left	Bd	7.40					
Rallidae	N789 E801	60-70 cm	Ulna	Right	Bp	5.49	Dip	5.78	Did	4.77	
Rallidae	N263 E179	5.4-5.3	Ulna	Right	GL	47.99	Bp	6.29	Did	5.25	
Rallidae	N263 E179	5.4-5.3	Ulna	Right	Bp	5.77					
Rallidae	N263 E179	5.4-5.3	Ulna	Right	Did	4.62					
Rallidae	N263 E179	5.3-5.17	Ulna	Right	Bp	5.22	Did	4.43			
Rallidae	N263 E179	5.4-5.3	Ulna	Left	Did	4.33					
Rallidae	N263 E179	5.3-5.17	Ulna	Left	Bp	5.55					
Rallidae	N263 E179	5.3-5.17	Ulna	Left	Bp	5.46					
Rallidae	N789 E801	30-40 cm	Carpometacarpus	Right	Dip	4.13					
Rallidae	N771 E819	2.6-2.5	Carpometacarpus	Right	Bp	5.4					
Rallidae	N263 E179	5.6-5.5	Carpometacarpus	Right	Bp	6.51	GL	29.32	Did	4.37	
Rallidae	N263 E179	5.5-5.4	Carpometacarpus	Right	Bp	6.10					
Rallidae	N263 E179	5.4-5.3	Carpometacarpus	Right	GL	31.19	Bp	6.69	Did	3.73	
Rallidae	N263 E179	5.4-5.3	Carpometacarpus	Right	Bp	6.17					
Rallidae	N263 E179	5.4-5.3	Carpometacarpus	Right	Bp	6.19					
Rallidae	N263 E179	5.4-5.3	Carpometacarpus	Right	Did	3.16					
Rallidae	N789 E801	20-30 cm	Carpometacarpus	Left	Dip	2.89					
Rallidae	N789 E801	20-30 cm	Carpometacarpus	Left	Bp	6.64					
Rallidae	N784 E797	60-70 cm	Carpometacarpus	Left	Bp	6.45					
Rallidae	N263 E179	5.5-5.4	Scapula	Right	Dic	6.36					
Rallidae	N263 E179	5.6-5.5	Scapula	Left	Dic	4.93					
Rallidae	N263 E179	5.3-5.17	Coracoid	Right	GL	25.75					
Rallidae	N789 E801	20-30 cm	Coracoid	Left	Bb	6.49					
Rallidae	N263 E179	5.3-5.17	Femur	Right	Bp	9.90	Bd	8.96			
Rallidae	N263 E179	5.5-5.4	Femur	Left	Bp	8.73					
Rallidae	N784 E797	0-10 cm	Tibiotarsus	Right	Dp	7.04	Bp	6.50			
Rallidae	N784 E797	10-20 cm	Tibiotarsus	Right	Db	6.87	Bd	6.87			

APPENDIX D—(*Continued*)

Taxa	Unit	Level	Element	Side	Dim.	mm	Dim.	mm	Dim.	mm	Dim.
Rallidae	N771 E819	2.6-2.5	Tibiotarsus	Right	Bd	7.2					
Rallidae	N771 E819	2.5-2.4	Tibiotarsus	Right	Bd	6.26					
Rallidae	N789 E801	20-30 cm	Tibiotarsus	Left	Dd	7.41	Dip	7.00			
Rallidae	N789 E801	20-30 cm	Tibiotarsus	Left	Dip	10.06					
Rallidae	N784 E797	50-60 cm	Tibiotarsus	Left	Bd	7.04					
Rallidae	N263 E179	5.4-5.3	Tarsometatarus	Right	Bp	6.69					
Rallidae	N263 E179	5.3-5.17	Tarsometatarus	Left	GL	47.72	Bp	6.39	Bd	7.30	
Didelphis virginiana	N789 E801	40-50 cm	Atlas	Ind.	GL	11.81	GB	29.63	Lad	8.51	BFcr
Didelphis virginiana	Feature 23	1.9-1.8	Axis	Ind.	LCDe	13.85					
Didelphis virginiana	N771 E819	2.3-2.2	3rd Premolar, lower	Right	L	5.25	B	2.14			
Didelphis virginiana	W84 S2	2.8-2.7	1st Molar, lower	Left	L	4.54	B	2.47			
Didelphis virginiana	W84 S2	2.8-2.7	2nd Molar, lower	Left	L	6.12	B	3.62			
Didelphis virginiana	N784 E797	30-40 cm	3rd Molar, lower	Right	L	5.50	B	3.12			
Didelphis virginiana	W82 S2	2.4-2.3	3rd Molar, lower	Left	L	6.79	B	3.72			
Didelphis virginiana	N784 E797	30-40 cm	4th Molar, lower	Right	L	6.08	B	3.58			
Didelphis virginiana	W82 S2	2.4-2.3	4th Molar, lower	Left	L	6.29	B	3.74			
Didelphis virginiana	N784 E797	0-10 cm	1st Molar, upper	Left	L	5.02	B	3.32			
Didelphis virginiana	W84 S2	2.7-2.6	2nd Molar, upper	Right	L	7.30	B	5.26			
Didelphis virginiana	N784 E797	0-10 cm	3rd Premolar, upper	Left	L	4.57	B	2.58			
Didelphis virginiana	N784 E797	10-20 cm	Humerus, prox. unf.	Right	Bp	13.05					
Didelphis virginiana	N789 E801	50-60 cm	Radius	Left	Bp	5.45					
Didelphis virginiana	N784 E797	20-30 cm	Femur unf.	Left	Bp	18.28					
Didelphis virginiana	N784 E797	20-30 cm	Astragalus	Right	GL	8.74					
Canis familiaris	N784 E811	20-30 cm	1st Molar, upper	Left	L	11.50	B	13.09			
Canis familiaris	N263 E179	5.3-5.17	Ulna	Left	BPC	14.76					
Procyon lotor	Feature 23	1.9-1.8	Axis	Ind.	LCDe	19.80					
Procyon lotor	N771 E819	2.6-2.5	2nd Premolar, lower	Right	L	4.26	B	2.57			
Procyon lotor	N771 E819	2.6-2.5	3rd Premolar, lower	Right	L	5.25	B	3.45			
Procyon lotor	N784 E801	80-90 cm	4th Premolar, lower	Right	L	7.59	B	4.48			
Procyon lotor	N771 E819	2.6-2.5	4th Premolar, lower	Right	L	7.53	B	5.16			
Procyon lotor	N771 E819	2.6-2.5	1st Molar, lower	Right	L	10.81	B	6.66			
Procyon lotor	N771 E819	2.6-2.5	2nd Molar, lower	Right	L	10.18	B	6.09			
Procyon lotor	W84 S2	2.6-2.5	2nd Premolar, upper	Left	L	4.38	B	2.74			

Taxa	Unit	Level	Element	Side	Dim.	mm	Dim.	mm	Dim.	mm	Dim.
Procyon lotor	W84 S2	2.6-2.5	3rd Premolar, upper	Left	L	5.63	B	4.08			
Procyon lotor	N771 E819	2.5-2.4	4th Premolar, upper	Right	L	7.49	B	8.26			
Procyon lotor	W84 S2	2.6-2.5	4th Premolar, upper	Left	L	8.06	B	7.75			
Procyon lotor	Feature 23	1.9-1.8	1st Molar, upper	Right	L	10.81	B	7.70			
Procyon lotor	N784 E811	50-60 cm	2nd Molar, upper	Left	L	6.73	B	7.92			
Procyon lotor	N784 E797	10-20 cm	Humerus	Right	Bd	25.79					
Procyon lotor	N789 E801	60-70 cm	Humerus	Left	Bd	24.07	BT	17.75			
Procyon lotor	N789 E801	50-60 cm	Radius	Left	Bp	10.29					
Procyon lotor	N771 E819	2.6-2.5	Femur	Right	Bp	26.72	DC	13.09			
Procyon lotor	N263 E179	5.5-5.4	Femur	Left	Bp	27.48					
Procyon lotor	N263 E179	5.6-5.5	Femur	Left	Bd	23.65					
Procyon lotor	W82 S2	2.5-2.4	Tibia ephysis	Left	Bp	23.53					
Procyon lotor	N784 E801	110-120 cm	Astragalus	Left	GL	17.92					
Procyon lotor	N789 E801	40-50 cm	Astragalus	Right	GL	17.93					
Procyon lotor	N789 E801	30-40 cm	Calcaneus	Right	GL	29.00	GB	13.18			
Procyon lotor	N784 E801	0-10 cm	2nd Metatrsal	Left	Bp	5.30					
Odocoileus virginianus	N789 E801	105-110 cm	Atlas	Ind.	GB	99.28	GL	76.87	H	47.97	LAd
Odocoileus virginianus	W82 S2	2.7-2.6	Axis	Ind.	BFcr	55.34					
Odocoileus virginianus	N784 E797	40-50 cm	1st Molar, lower	Right	L	14.39	B	9.12			
Odocoileus virginianus	N779 E801	110-120 cm	2nd Molar, lower	Right	L	16.12	B	10.35			
Odocoileus virginianus	N771 E819	2.5-2.4 m	2nd Molar, lower	Right	L	14.48	B	10.44			
Odocoileus virginianus	N784 E801	80-90 cm	3rd Molar, lower	Right	L	24.03	B	10.69			
Odocoileus virginianus	Feature 23	2.0-1.9	1st Premolar, upper	Right	L	12.31	B	11.03			
Odocoileus virginianus	Feature 23	2.0-1.9	2nd Premolar, upper	Right	L	11.83	B	12.34			
Odocoileus virginianus	Feature 23	2.0-1.9	3rd Premolar, upper	Right	L	13.39	B	11.98			
Odocoileus virginianus	N789 E801	20-30 cm	3rd Premolar, upper	Left	L	10.76	B	11.80			
Odocoileus virginianus	Feature 23	2.0-1.9	4th Premolar, upper	Right	L	13.85	B	10.86			
Odocoileus virginianus	Feature 23	2.0-19.	1st Molar, upper	Right	L	16.68	B	16.52			
Odocoileus virginianus	Feature 23	2.1-2.0	3rd Molar, upper	Right	L	15.31	B	15.49			
Odocoileus virginianus	N771 E819	2.5-2.4 m	3rd Molar, upper	Left	L	14.57	B	16.09			
Odocoileus virginianus	N771 E819	2.6-2.5 m	Scapula	Left	GLP	44.12	LG	32.93	BG	31.26	
Odocoileus virginianus	W82 S2	2.5-2.4	Humerus	Left	Bd	39.90					
Odocoileus virginianus	N213 E198	4.5-4.4	Humerus	Lt	Bd	42.28					

APPENDIX D—(*Continued*)

Taxa	Unit	Level	Element	Side	Dim.	mm	Dim.	mm	Dim.	mm	Dim.
Odocoileus virginianus	N789 E801	0-10 cm	Ulna	Right	ULC	20.14					
Odocoileus virginianus	Feature 23	2.1-2.0	Ulna	Left	BPC	22.13					
Odocoileus virginianus	Feature 23	2.0-1.9	Radius	Right	Bp	40.84					
Odocoileus virginianus	Feature 23	1.9-1.8	Radius	Right	Bp	34.51					
Odocoileus virginianus	N771 E819	2.6-2.5 m	Radius	Right	BFp	36.3	Bp	38.27			
Odocoileus virginianus	Feature 23	1.9-1.8	Radius	Left	Bd	36.28					
Odocoileus virginianus	N784 E797	0-10 cm	Intermediate carpal	Left	GB	21.72					
Odocoileus virginianus	Feature 23	2.0-1.9	Metacarpal	Left	Bp	29.54					
Odocoileus virginianus	N771 E819	2.6-2.5 m	Metacarpal	Left	Bp	31.46					
Odocoileus virginianus	N789 E801	40-50 cm	Scarum	Ind.	BFcr	39.15	HFcr	16.33			
Odocoileus virginianus	N263 E179	5.3-5.17	Tibia	Right	Bp	55.67					
Odocoileus virginianus	Feature 23	2.0-1.9	Tibia	Left	Bp	51.88					
Odocoileus virginianus	Feature 23	2.0-1.9	Tibia	Left	Bp	45.77					
Odocoileus virginianus	N771 E819	2.6-2.5 m	Tibia	Left	Bp	57.49					
Odocoileus virginianus	N263 E179	5.6-5.5	Astragalus	Right	GL	43.22	Bd	27.90	GLm	40.82	
Odocoileus virginianus	N263 E179	5.3-5.17	Astragalus	Right	GL	38.29	Bd	24.06	GLm	34.56	
Odocoileus virginianus	N789 E801	10-20 cm	Calcaneus	Right	GL	63.14	GB	20.26			
Odocoileus virginianus	W84 S2	2.6-2.5	Calcaneus	Right	GB	27.20					
Odocoileus virginianus	Feature 23	2.1-2.0	Calcaneus	Right	GL	85.65	GB	26.28			
Odocoileus virginianus	Feature 23	2.1-2.0	Calcaneus	Right	GB	24.70					
Odocoileus virginianus	Feature 23	1.9-1.8	Calcaneus	Left	GB	23.71					
Odocoileus virginianus	N789 E801	60-70 cm	Os malleolare	Left	GD	17.86					
Odocoileus virginianus	N784 E797	70-75.5 cm	1st Phalanx	Ind.	Bd	12.05					
Odocoileus virginianus	N789 E801	60-70 cm	1st Phalanx	Ind.	Dp	17.57	Bp	13.61			
Odocoileus virginianus	N784 E801	70-80 cm	1st Phalanx	Ind.	Bp	15.51					
Odocoileus virginianus	N782 E801	40-50 cm	1st Phalanx	Ind.	Bp	15.51					
Odocoileus virginianus	W82 S2	2.2-2.1	1st Phalanx	Ind.	Bd	14.21					
Odocoileus virginianus	W84 S2	2.8-2.7	1st Phalanx	Ind.	Bp	14.34					
Odocoileus virginianus	W84 S2	2.7-2.6	1st Phalanx	Ind.	Bp	14.88	Bd	12.41			
Odocoileus virginianus	W84 S2	2.6-2.5	1st Phalanx	Ind.	Bp	15.24	Bd	13.36			
Odocoileus virginianus	Feature 23	2.1-2.0	1st Phalanx	Ind.	Bp	14.85	Bd	12.99			
Odocoileus virginianus	Feature 23	1.9-1.8	1st Phalanx	Ind.	Bd	12.59					
Odocoileus virginianus	N782 E801	100-110 cm	1st Phalanx, unf.	Ind.	Bp	13.81					

APPENDIX D—(*Continued*)

Taxa	Unit	Level	Element	Side	Dim.	mm	Dim.	mm	Dim.	mm	Dim.
Odocoileus virginianus	W84 S2	2.8-2.7	2nd Phalanx	Ind.	Bp	13.63					
Odocoileus virginianus	W84 S2	2.8-2.7	2nd Phalanx	Ind.	Bd	12.19					
Odocoileus virginianus	N263 E179	5.5-5.4	2nd phalanx, unf.	Ind.	GL	29.39	Bp	13.64	Bd	9.64	
Odocoileus virginianus	N789 E801	30-40 cm	3rd Phalanx	Ind.	Ld	28.81	DLS	31.25			
Odocoileus virginianus	N789 E801	60-70 cm	3rd Phalanx	Ind.	Ld	30.86	DLS	34.19			
Odocoileus virginianus	N784 E811	70-80 cm	3rd Phalanx	Ind.	Ld	27.87	Hp	18.46			
Odocoileus virginianus	W84 S2	2.8-2.7	3rd Phalanx	Ind.	Ld	35.04					

APPENDIX E

BIOMASS REGRESSION FORMULAE

Taxon	N	Slope (b)	Y-intercept (a)	r^2
Chondrichthyes	17	0.86	1.68	0.85
Actinopterygii	393	0.81	0.90	0.80
Non-Perciformes	119	0.79	0.85	0.88
Lepisosteidae	26	0.87	1.13	0.96
Amiidae	13	1.10	1.10	0.87
Siluriformes	36	0.95	1.15	0.87
Perciformes	274	0.83	0.93	0.76
Centrarchidae	38	0.84	0.76	0.8
Carangidae	17	0.88	1.23	0.86
Haemulidae	25	0.82	0.84	0.42
Sparidae	22	0.92	0.96	0.98
Sciaenidae	99	0.74	0.81	0.73
Pleuronectiformes	21	0.89	1.09	0.95
Alligatoridae	18	1.00	1.16	0.99
Testudines	26	0.67	0.51	0.55
Serpentes	26	1.01	1.17	0.97
Aves	307	0.91	1.04	0.97
Mammalia	97	0.90	1.12	0.94

Note: $Y = aXb$ where Y is biomass or meat weight; x is bone weight; a is the Y-intercept; and **b** is the slope. N is the number of observations (Reitz and Wing 2008:234-242).

APPENDIX F

FISH BODY SIZE REGRESSION FORMULAE

Taxon	N	Slope (b)	Y-Intercept (log a)	r^2
Specimen Otolith Width (mm) to Standard Length (mm)				
Ariidae	214	1.10	1.35	0.76
Specimen Atlas Width (mm) to Standard Length (mm)				
Mugil spp.	55	0.852	1.803	0.96
Specimen Atlas Width (mm) to Standard Length (mm)				
Sciaenidae	152	0.610	1.930	0.65

Note: $Y=axb$ where Y is biomass or meat weight; x is specimen weight; a is the Y-intercept; and b is the slope. N is the number of observations

Sciaenidae formula from Reitz and Wing 2008:68

APPENDIX G

ARCHAEOLOGICAL OTOLOTHS SAMPLED FOR INCREMENTAL AND ISOTOPIC ANALYSES

Accession #	Ring	Species	Otolith #	Unit	Level	Len, mm	Brt, mm	Wdh, mm	Th, mm	Wt, g
FL 01551061	Cannon's Point	*A. felis*	Cannon's 1	18N, 0E	25	9.85	8.80	8.19	3.61	0.294
FL 01550585	Cannon's Point	*M. undulatus*	Cannon's 3	18N, 0E	12	9.39		7.30	4.48	0.253
FL 01610027	West	*A. felis*	West 1	5S, 30E	ZII L1	10.52	9.34	8.80	4.52	0.442
FL 01610161	West	*A. felis*	West 2	5S, 30E	6	10.71	9.49	8.88	4.05	0.407
FL 01610169	West	*M. undulatus*	West 3	5S, 30E	6	8.60		6.57	4.06	0.176
FL 01610169	West	*M. undulatus*	West 4	5S, 30E	6	8.16		6.32	3.34	0.126
FL 01610194	West	*M. undulatus*	West 5	5S, 30E	7	8.62		6.22	3.39	0.149
FL 01610214	West	*M. undulatus*	West 8	5S, 30E	8	8.96		6.31	3.98	0.178
FL 01610214	West	*M. undulatus*	West 9	5S, 30E	8	12.14		10.00	5.00	0.500
FL 01610231	West	*M. undulatus*	West 10	5S, 30E	9	19.94		15.07	8.25	2.225
UGA 02420216	McQueen	*A. felis*	McQueen 1	N263 E179	5.6-5.5	8.85	7.93	7.5	3.52	0.247
UGA 2420227	McQueen	*M. undulatus*	McQueen 2	N263 E179	5.6-5.5	8.14		5.98	3.33	0.142
UGA 2420047	McQueen	*A. felis*	McQueen 3	N213 E179	4.6-4.5	8.08	7.25	6.78	3.72	0.215
UGA 2420187	McQueen	*M. undulatus*	McQueen 4	N263 E179	5.7-5.6	10.85		9.22	4.84	0.356
UGA 2420261	McQueen	*M. undulatus*	McQueen 5	N263 E179	5.5-5.4	7.61		5.83	3.00	0.113
UGA 2420057	McQueen	*M. undulatus*	McQueen 6	N213 E198	4.6-4.5	11.37		8.45	4.65	0.357
UGA 2420100	McQueen	*M. undulatus*	McQueen 7	N213 E198	4.5-4.4	10.38		7.41	4.42	0.302
UGA 2380115	St. Catherines	*A. felis*	0115-O1	N789 E801	10-20 cm	9.36	8.29	7.82	3.56	0.270
UGA 2380115	St. Catherines	*A. felis*	0115-O2	N789 E801	10-20 cm	9.73	8.87	8.41	4.33	0.373
UGA 2380118	St. Catherines	*A. felis*	0118-O3	N789 E801	20-30 cm	7.99	6.87	6.49	3.38	0.179
UGA 2380118	St. Catherines	*A. felis*	0118-O4	N789 E801	20-30 cm	9.27	7.79	7.43	4.39	0.292
UGA 2380118	St. Catherines	*A. felis*	0118-O5	N789 E801	20-30 cm	8.53	7.32	6.85	3.64	0.218
UGA 2380118	St. Catherines	*A. felis*	0118-O6	N789 E801	20-30 cm	8.53	7.32	6.85	3.64	0.218
UGA 2380122	St. Catherines	*A. felis*	0122-O7	N789 E801	30-40 cm	8.87	8.08	7.78	4.13	0.265
UGA 2380120	St. Catherines	*A. felis*	0120-O8	N789 E801	40-50 cm	8.49	7.39	6.93	3.69	0.224
UGA 2381348	St. Catherines	*M. undulatus*	1348-O3	N784 E797	10-20 cm	8.70		6.82	3.69	0.178
UGA 2381373	St. Catherines	*A. felis*	1373-O4	N784 E797	20-30 cm	10.29	8.95	8.52	4.09	0.374
UGA 2381373	St. Catherines	*A. felis*	1373-O5	N784 E797	20-30 cm	9.64	8.56	8.21	4.11	0.344
UGA 2381373	St. Catherines	*A. felis*	1373-O6	N784 E797	20-30 cm	9.70	8.17	7.92	3.77	0.290
UGA 2381373	St. Catherines	*A. felis*	1373-O7	N784 E797	20-30 cm	10.13	8.73	8.38	4.02	0.367
UGA 2381437	St. Catherines	*A. felis*	1437-O8	N784 E797	40-50 cm	8.76	8.07	7.55	3.83	0.274
UGA 2381444	St. Catherines	*M. undulatus*	1444-O9	N784 E797	40-50 cm	9.17		7.03	3.96	0.198
UGA 2381444	St. Catherines	*M. undulatus*	1444-O10	N784 E797	40-50 cm	8.66		6.33	3.41	0.162
UGA 2381477	St. Catherines	*M. undulatus*	1477-O11	N784 E797	50-60 cm	9.64		7.62	4.05	0.232

APPENDIX G—*(Continued)*

Accession #	Ring	Species	Otolith #	Unit	Level	Len, mm	Brt, mm	Wdh, mm	Th, mm	Wt, g
UGA 2381516	St. Catherines	*M. undulatus*	1516-O12	N784 E797	60-70 cm	7.67		5.16	3.17	0.109
UGA 2381554	St. Catherines	*M. undulatus*	1554-O13	N784 E797	70-75.5 cm	10.32		7.62	4.35	0.284
UGA 02380494	St. Catherines	*A. felis*	0494-O14	N784 E801	30-40 cm	8.31	7.23	6.77	3.84	0.228
UGA 2380989	St. Catherines	*A. felis*	0989-O17	N784 E811	20-30 cm	9.36	8.39	8.06	3.55	0.282
UGA 2381037	St. Catherines	*A. felis*	1037-O19	N784 E811	30-40 cm	10.06	8.89	8.30	4.18	0.367
UGA 2380999	St. Catherines	*M. undulatus*	0999-O21	N784 E811	20-30 cm	8.93		6.44	3.93	0.179
UGA 2381203	St. Catherines	*M. undulatus*	1203-O25	N784 E811	60-70 cm	8.15		6.16	3.56	0.163
UGA 2381886	St. Catherines	*M. undulatus*	1886-O26	N771 E819	2.5-2.4	9.24		7.06	4.24	0.207

APPENDIX H

MODERN OTOLITHS SAMPLED FOR INCREMENTAL AND ISOTOPIC ANALYSES

Catalog #	Location	Captured	Collector	Len, mm	Brt, mm	Wdh, mm	Th, mm	Wt, g
UGA 2172	Edisto Island, SC	5/10/81	Lisa Osteen	11.53	10.23	9.62	4.97	0.57
UGA 4457	St. Catherines Island, Ga	6/27/09	Bruce Saul, Carol Colaninno-Meeks	8.61	7.68	6.72	3.59	0.22
UGA 1732	Sapelo Island, Caretta Beach, Ga	7/25/80	Besty Reitz	11.28	10.12	9.72	4.65	0.54
UGA 4269	Camachee Island, St. Johns County, Fl	7/31/03	Kelly Orr	10.81	9.79	8.83	4.15	0.40
UFL 11162	St. Catherines Sound, SCI2, Ga	8/9/79	Richard Casteel	9.55	8.21	8.01	3.72	0.29
UFL 11271	St. Catherines Walburg Creek, Ga	8/9/79	Richard Casteel	10.73	9.58	9.13	3.82	0.39
UFL 11341	St. Catherines Island SCI1, Ga	8/9/79	Richard Casteel	10.20	8.85	8.33	3.85	0.33
UGA 4472	St. Catherines Island, Ga	8/22/09	Bruce Saul, Carol Colaninno-Meeks	8.82	7.81	7.15	3.75	0.25
UGA 4470	St. Catherines Island, Ga	8/22/09	Bruce Saul, Carol Colaninno-Meeks	12.29	10.90	10.55	5.34	0.73
UGA 4295	Vilano Bridge, St. Johns County, Fl	9/16/03	Kelly Orr	12.10	10.62	9.98	5.70	0.75
UGA 4469	St. Catherines Island, North Beach Seine, Ga	9/19/09	Bruce Saul, Carol Colaninno-Meeks	11.10	9.79	9.13	4.51	0.48
UGA 4468	St. Catherines Island, North Beach Seine, Ga	9/19/09	Bruce Saul, Carol Colaninno-Meeks	12.80	11.31	10.78	5.25	0.73
UGA 1075	Skidaway Island, Ga	3/1/80	D. Miller	8.91		6.63	3.60	0.17
UGA 4475	Ossabaw Estuary Trawl, Ga	4/25/09	Carol Colaninno-Meeks	7.72		5.65	3.40	0.11
UGA 4458	St. Catherines Island Trawl, Ga	5/23/09	Carol Colaninno-Meeks	11.39		8.56	4.84	0.39
UGA 3762	Gloucester, Middlsex Co., Va	5/29/87	J. Gayner	11.04		8.14	5.19	0.39
UGA 4462	St. Catherines Island , North Beach Seine, Ga	6/27/09	Carol Colaninno-Meeks	8.98		6.64	3.63	0.19
UFL 11318	St. Catherines McQueen Inlet, Ga	8/8/79	Richard Casteel	7.36		5.39	3.42	0.10
UFL 11319	St. Catherines McQueen Inlet, Ga	8/8/79	Richard Casteel	7.28		5.17	2.80	0.08
UFL 11313	St. Catherines Island SCI2, Ga	8/9/79	Richard Casteel	7.46		5.55	3.29	0.10
UGA 4473	St. Catherines Island, Ga	8/27/09	Bruce Saul, Carol Colaninno-Meeks	8.57		6.37	3.61	0.17
UGA 4474	St. Catherines Island, Ga	8/27/09	Bruce Saul, Carol Colaninno-Meeks	9.99		7.23	4.32	0.25
UGA 4471	St. Simons Estuary trawl, Ga	9/18/09	Bruce Saul, Carol Colaninno-Meeks	7.98		5.60	3.42	0.13
UGA 4476	St. Simons Estuary trawl, Ga	9/18/09	Bruce Saul, Carol Colaninno-Meeks	7.91		5.56	3.22	0.12

APPENDIX I

ISOTOPIC VALUES

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
Cannon's 1.1	—	—	—	—
Cannon's 1.2	-1.30	-0.93	0.07	0.13
Cannon's 1.3	-1.35	-0.89	0.07	0.13
Cannon's 1.4	-2.17	-0.67	0.07	0.13
Cannon's 1.5	-2.52	0.06	0.07	0.13
Cannon's 1.6	-2.18	-1.22	0.07	0.13
Cannon's 1.7	-1.87	-1.48	0.07	0.13
Cannon's 1.8	-1.81	-1.17	0.07	0.13
Cannon's 1.9	-2.13	-1.41	0.07	0.13
Cannon's 1.10	-1.08	-0.08	0.07	0.13
Cannon's 1.11	-1.05	-0.31	0.07	0.13
Cannon's 1.12	0.14	-0.65	0.07	0.13
Cannon's 1.13	-0.32	-0.54	0.07	0.13
Cannon's 1.14	-0.84	-0.12	0.07	0.13
Cannon's 1.15	-0.67	-0.01	0.07	0.13
Cannon's 1.16	-1.13	-0.45	0.07	0.13
Cannon's 1.17	-1.14	-0.72	0.07	0.13
Cannon's 1.18	-1.24	-0.53	0.07	0.13
Cannon's 1.19	-1.77	-1.10	0.07	0.13
Cannon's 1.20	-2.19	-1.56	0.07	0.13
Cannon's 1.21	-1.70	-1.27	0.07	0.13
Cannon's 1.22	-0.44	-1.62	0.07	0.13
Cannon's 3.1	-1.32	1.28	0.07	0.13
Cannon's 3.2	-0.74	0.47	0.07	0.13
Cannon's 3.3	-1.22	-0.60	0.07	0.13
Cannon's 3.4	-1.31	-0.83	0.07	0.13
Cannon's 3.5	-0.88	0.37	0.07	0.13
Cannon's 3.6	-0.44	0.94	0.07	0.13
Cannon's 3.7	-0.90	1.23	0.07	0.13
Cannon's 3.8	-1.16	0.51	0.07	0.13
Cannon's 3.9	-1.81	-0.91	0.07	0.13
Cannon's 3.10	-2.71	-1.45	0.07	0.13
Cannon's 3.11	-2.65	-1.33	0.07	0.13
Cannon's 3.12	-2.93	-1.66	0.07	0.13
Cannon's 3.13	-2.99	-1.55	0.07	0.13
Cannon's 3.14	-2.65	-1.47	0.07	0.13
Cannon's 3.15	-2.04	-1.39	0.07	0.13
McQueen 1.1	-3.71	-0.43	0.05	0.09
McQueen 1.2	-1.38	-0.31	0.05	0.09
McQueen 1.3	-0.89	-0.58	0.05	0.09
McQueen 1.4	-1.69	-0.47	0.05	0.09

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
McQueen 1.5	-2.22	0.05	0.05	0.09
McQueen 1.6	-1.29	-0.78	0.05	0.09
McQueen 1.7	-1.16	-0.41	0.05	0.09
McQueen 1.8	-2.52	-0.03	0.05	0.09
McQueen 1.9	-1.78	-0.28	0.05	0.09
McQueen 1.10	-0.21	-0.87	0.05	0.09
McQueen 1.11	-0.45	-1.09	0.05	0.09
McQueen 1.12	-0.77	-1.02	0.05	0.09
McQueen 1.13	-1.26	-1.15	0.05	0.09
McQueen 1.14	-1.59	-1.19	0.05	0.09
McQueen 1.15	-1.69	-0.82	0.05	0.09
McQueen 1.16	-1.97	-0.48	0.05	0.09
McQueen 1.17	-2.02	-0.27	0.05	0.09
McQueen 1.18	-1.96	-0.04	0.05	0.09
McQueen 1.19	-1.09	-1.01	0.05	0.09
McQueen 1.20	-1.68	-1.10	0.07	0.13
McQueen 1.21	-2.43	-1.58	0.07	0.13
McQueen 1.22	-2.97	-1.58	0.07	0.13
McQueen 1.23	-3.15	-1.49	0.07	0.13
McQueen 1.24	-3.74	-1.40	0.07	0.13
McQueen 1.25	-4.29	-1.37	0.07	0.13
McQueen 2.1	-1.76	0.31	0.05	0.09
McQueen 2.2	-1.09	1.05	0.05	0.09
McQueen 2.3	-0.02	-0.88	0.05	0.09
McQueen 2.4	-0.15	-1.88	0.05	0.09
McQueen 2.5	-1.26	-2.72	0.05	0.09
McQueen 2.6	-2.46	-3.21	0.05	0.09
McQueen 2.7	-3.38	-3.46	0.05	0.09
McQueen 2.8	-3.09	-3.04	0.05	0.09
McQueen 2.9	-3.16	-2.89	0.05	0.09
McQueen 2.10	-3.43	-2.76	0.05	0.09
McQueen 2.11	-5.03	-3.12	0.05	0.09
McQueen 3.1	-1.43	-0.68	0.05	0.09
McQueen 3.2	-2.00	-0.86	0.05	0.09
McQueen 3.3	-1.83	-0.44	0.07	0.13
McQueen 3.4	-2.34	-0.48	0.07	0.13
McQueen 3.5	-2.43	-0.78	0.07	0.13
McQueen 3.6	—	—	—	—
McQueen 3.7	-0.58	-0.79	0.07	0.13
McQueen 3.8	-0.96	-0.43	0.07	0.13
McQueen 3.9	-1.80	0.17	0.07	0.13
McQueen 3.10	-0.13	-0.84	0.07	0.13

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
McQueen 3.11	-1.01	-0.94	0.05	0.09
McQueen 3.12	-1.21	-0.61	0.05	0.09
McQueen 3.13	-1.42	-0.40	0.07	0.13
McQueen 3.14	-0.92	-0.66	0.07	0.13
McQueen 3.15	-0.58	-0.92	0.07	0.13
McQueen 3.16	-0.91	-1.35	0.07	0.13
McQueen 3.17	-1.10	-1.02	0.07	0.13
McQueen 3.18	-0.88	-0.52	0.07	0.13
McQueen 3.19	-1.36	-0.56	0.07	0.13
McQueen 3.20	-1.22	-0.77	0.05	0.09
McQueen 3.21	-1.28	-0.80	0.05	0.09
McQueen 3.22	-0.90	-0.55	0.05	0.09
McQueen 3.23	-1.48	-0.22	0.07	0.13
McQueen 3.24	-1.56	-0.60	0.07	0.13
McQueen 3.25	-1.81	-1.25	0.07	0.13
McQueen 3.26	-2.24	-1.56	0.07	0.13
McQueen 3.27	-2.90	-1.68	0.07	0.13
McQueen 4.1	-2.27	-1.62	0.05	0.09
McQueen 4.2	-2.17	-1.52	0.05	0.09
McQueen 4.3	-1.96	-1.48	0.05	0.09
McQueen 4.4	-2.00	-1.62	0.05	0.09
McQueen 4.5	-2.19	-1.46	0.05	0.09
McQueen 4.6	-2.55	-1.15	0.05	0.09
McQueen 4.7	-2.62	-0.85	0.05	0.09
McQueen 4.8	-2.40	-0.47	0.05	0.09
McQueen 4.9	-2.27	0.04	0.05	0.09
McQueen 4.10	-2.83	0.87	0.05	0.09
McQueen 4.11	-4.36	0.11	0.05	0.09
McQueen 4.12	-2.76	-0.19	0.05	0.09
McQueen 4.13	-4.43	-2.32	0.05	0.09
McQueen 4.14	-7.77	-3.86	0.05	0.09
McQueen 4.15	-8.86	-4.47	0.05	0.09
McQueen 4.16	-6.47	-4.22	0.05	0.09
McQueen 4.17	-8.14	-4.44	0.05	0.09
McQueen 4.18	-10.24	-5.07	0.05	0.09
McQueen 4.19	-10.45	-5.42	0.05	0.09
McQueen 4.20	-10.11	-5.33	0.05	0.09
McQueen 5.1	-1.42	0.69	0.05	0.09
McQueen 5.2	-1.74	-0.75	0.05	0.09
McQueen 5.3	-2.00	-1.19	0.05	0.09
McQueen 5.4	-2.37	-1.75	0.05	0.09
McQueen 5.5	-2.40	-1.64	0.05	0.09

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
McQueen 5.6	-2.77	-1.93	0.05	0.09
McQueen 5.7	-3.18	-2.34	0.05	0.09
McQueen 5.8	-3.34	-2.23	0.05	0.09
McQueen 5.9	-3.44	-2.23	0.05	0.09
McQueen 5.10	-3.82	-2.25	0.05	0.09
McQueen 6.1	-1.33	-0.81	0.07	0.13
McQueen 6.2	-1.19	0.28	0.07	0.13
McQueen 6.3	-0.50	-0.38	0.05	0.09
McQueen 6.4	-0.80	-0.17	0.05	0.09
McQueen 6.5	-3.21	-0.71	0.05	0.09
McQueen 6.6	-2.49	-0.59	0.05	0.09
McQueen 6.7	-3.40	-1.59	0.05	0.09
McQueen 6.8	-3.33	-2.27	0.05	0.09
McQueen 6.9	-3.01	-2.74	0.05	0.09
McQueen 6.10	-4.09	-2.93	0.05	0.09
McQueen 6.11	-4.35	-2.78	0.05	0.09
McQueen 6.12	-4.42	-2.80	0.05	0.09
McQueen 6.13	-4.44	-2.63	0.05	0.09
McQueen 7.1	-1.65	-0.45	0.07	0.13
McQueen 7.2	-1.16	0.51	0.07	0.13
McQueen 7.3	-0.92	-0.79	0.05	0.09
McQueen 7.4	-1.05	-0.67	0.05	0.09
McQueen 7.5	-1.40	0.10	0.07	0.13
McQueen 7.6	-1.18	0.60	0.07	0.13
McQueen 7.7	0.28	-0.35	0.07	0.13
McQueen 7.8	-0.56	-2.13	0.07	0.13
McQueen 7.9	-1.82	-2.59	0.07	0.13
McQueen 7.10	-2.09	-2.86	0.07	0.13
McQueen 7.11	-3.08	-3.10	0.07	0.13
McQueen 7.12	-3.74	-3.63	0.07	0.13
SCSR O115-O1.1	-2.26	-0.54	0.13	0.23
SCSR O115-O1.2	-0.61	-0.73	0.13	0.23
SCSR O115-O1.3	-1.35	-0.82	0.13	0.23
SCSR O115-O1.4	-2.65	-0.72	0.13	0.23
SCSR O115-O1.5	-3.88	0.04	0.13	0.23
SCSR O115-O1.6	-2.42	-0.63	0.13	0.23
SCSR O115-O1.7	-0.52	-1.10	0.13	0.23
SCSR O115-O1.8	—	—	—	—
SCSR O115-O1.9	—	—	—	—
SCSR O115-O1.10	—	—	—	—
SCSR O115-O1.11	—	—	—	—
SCSR O115-O1.12	—	—	—	—

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
SCSR O115-O1.13	—	—	—	—
SCSR O115-O1.14	—	—	—	—
SCSR O115-O1.15	—	—	—	—
SCSR O115-O1.16	—	—	—	—
SCSR O115-O1.17	—	—	—	—
SCSR O115-O1.18	—	—	—	—
SCSR O115-O1.19	—	—	—	—
SCSR O115-O1.20	—	—	—	—
SCSR O115-O1.21	—	—	—	—
SCSR O115-O1.22	-0.38	-2.08	0.12	0.19
SCSR O115-O1.23	0.47	-1.53	0.12	0.19
SCSR O115-O1.24	-0.26	-2.08	0.12	0.19
SCSR O115-O1.25	-0.49	-1.94	0.12	0.19
SCSR O115-O1.26	-0.63	-1.20	0.12	0.19
SCSR O115-O1.27	-0.58	-1.91	0.12	0.19
SCSR O115-O1.28	-0.48	-2.02	0.12	0.19
SCSR O115-O1.29	-0.61	-2.29	0.12	0.19
SCSR O115-O1.30	—	—	—	—
SCSR O115-O1.31	—	—	—	—
SCSR O115-O1.32	-1.36	-0.70	0.12	0.19
SCSR O115-O1.33	-1.59	-1.41	0.12	0.19
SCSR O115-O1.34	-0.41	-0.46	0.12	0.19
SCSR O115-O1.35	-1.25	-0.95	0.12	0.19
SCSR O115-O1.36	-0.80	-1.53	0.12	0.19
SCSR O115-O1.37	-0.71	-1.72	0.12	0.19
SCSR O115-O1.38	-0.59	-1.42	0.12	0.19
SCSR O115-O1.39	-0.76	-1.91	0.12	0.19
SCSR O115-O1.40	-1.00	-1.78	0.12	0.19
SCSR O115-O1.41	-1.63	-2.11	0.12	0.19
SCSR O115-O1.42	-1.74	-2.39	0.12	0.19
SCSR O115-O1.43	-2.24	-2.24	0.12	0.19
SCSR O115-O1.44	-2.43	-2.29	0.12	0.19
SCSR O115-O1.45	-2.59	-2.43	0.12	0.19
SCSR O115-O1.46	-2.88	-2.56	0.12	0.19
SCSR O115-O1.47	-2.85	-2.33	0.12	0.19
SCSR 0115-O2.1	-2.37	-0.95	0.22	0.37
SCSR 0115-O2.2	-0.57	-0.39	0.22	0.37
SCSR 0115-O2.3	-1.98	-0.82	0.22	0.37
SCSR 0115-O2.4	-1.33	-0.69	0.22	0.37
SCSR 0115-O2.5	-1.28	-0.72	0.22	0.37
SCSR 0115-O2.6	-1.82	-0.64	0.22	0.37
SCSR 0115-O2.7	-2.00	-0.87	0.22	0.37

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
SCSR 0115-O2.8	-1.37	-1.13	0.22	0.37
SCSR 0115-O2.9	-0.72	-1.41	0.22	0.37
SCSR 0115-O2.10	-0.66	-1.39	0.22	0.37
SCSR 0115-O2.11	0.00	-0.34	0.22	0.37
SCSR 0115-O2.12	-1.04	0.10	0.22	0.37
SCSR 0115-O2.13	-0.17	-0.80	0.22	0.37
SCSR 0115-O2.14	0.28	-1.08	0.22	0.37
SCSR 0115-O2.15	0.28	-1.72	0.22	0.37
SCSR 0115-O2.16	-3.54	-1.29	0.22	0.37
SCSR 0115-O2.17	-0.46	-1.49	0.22	0.37
SCSR 0115-O2.18	-1.06	-1.75	0.22	0.37
SCSR 0115-O2.19	-1.13	-1.52	0.22	0.37
SCSR 0115-O2.20	-1.26	-1.41	0.22	0.37
SCSR 0115-O2.21	-1.03	-0.91	0.22	0.37
SCSR 0115-O2.22	-1.07	-0.51	0.22	0.37
SCSR 0115-O2.23	-0.21	0.08	0.22	0.37
SCSR 0115-O2.24	-0.21	-1.05	0.22	0.37
SCSR 0115-O2.25	-0.65	-1.53	0.22	0.37
SCSR 0115-O2.26	-0.75	-1.40	0.22	0.37
SCSR 0115-O2.27	-1.38	-1.99	0.22	0.37
SCSR 0115-O2.28	-1.92	-2.12	0.22	0.37
SCSR 0115-O2.29	-2.59	-2.36	0.22	0.37
SCSR 0115-O2.30	-2.93	-1.96	0.22	0.37
SCSR 0115-O2.31	-3.60	-2.32	0.22	0.37
SCSR 0115-O2.32	-3.82	-2.33	0.22	0.37
SCSR 0115-O2.33	-3.69	-1.67	0.22	0.37
SCSR 0118-O3.1	-3.83	-2.21	0.10	0.16
SCSR 0118-O3.2	-2.70	-0.76	0.10	0.16
SCSR 0118-O3.3	-1.53	-0.69	0.10	0.16
SCSR 0118-O3.4	-0.74	-1.12	0.10	0.16
SCSR 0118-O3.5	-1.16	-1.15	0.10	0.16
SCSR 0118-O3.6	-0.58	-1.20	0.10	0.16
SCSR 0118-O3.7	-0.32	-1.07	0.10	0.16
SCSR 0118-O3.8	-1.50	-0.17	0.10	0.16
SCSR 0118-O3.9	-0.47	-0.86	0.10	0.16
SCSR 0118-O3.10	-0.90	-1.31	0.10	0.16
SCSR 0118-O3.11	-0.69	-2.37	0.10	0.16
SCSR 0118-O3.12	-1.31	-1.97	0.10	0.16
SCSR 0118-O3.13	-0.97	-1.22	0.22	0.37
SCSR 0118-O3.14	-0.91	-2.10	0.10	0.16
SCSR 0118-O3.15	-1.62	-1.84	0.10	0.16
SCSR 0118-O3.16	-2.14	-1.03	0.10	0.16

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
SCSR 0118-O3.17	-1.98	-1.11	0.22	0.37
SCSR 0118-O3.18	-1.94	-0.43	0.22	0.37
SCSR 0118-O3.19	-1.70	-1.27	0.10	0.16
SCSR 0118-O3.20	-1.16	-0.69	0.10	0.16
SCSR 0118-O3.21	-1.12	-0.98	0.10	0.16
SCSR 0118-O3.22	-1.02	-0.83	0.22	0.37
SCSR 0118-O3.23	-1.78	-2.65	0.10	0.16
SCSR 0118-O3.24	-2.96	-2.82	0.22	0.37
SCSR 0118-O3.25	-3.29	-3.30	0.22	0.37
SCSR 0118-O3.26	-3.15	-3.60	0.10	0.16
SCSR 0118-O3.27	-2.88	-2.83	0.22	0.37
SCSR 0118-O3.28	-3.18	-1.64	0.22	0.37
SCSR 0118-O3.29	-3.93	-2.66	0.10	0.16
SCSR 0118-O3.30	-4.14	-2.04	0.10	0.16
SCSR 0118-O3.31	-4.35	-2.08	0.22	0.37
SCSR 0118-O4.1	-8.61	-3.37	0.12	0.19
SCSR 0118-O4.2	-2.87	-1.39	0.12	0.19
SCSR 0118-O4.3	-1.49	-1.16	0.12	0.19
SCSR 0118-O4.4	-2.54	-0.99	0.12	0.19
SCSR 0118-O4.5	-2.66	-0.80	0.12	0.19
SCSR 0118-O4.6	-1.90	-1.19	0.12	0.19
SCSR 0118-O4.7	-1.18	-1.15	0.12	0.19
SCSR 0118-O4.8	-0.85	-1.31	0.12	0.19
SCSR 0118-O4.9	-1.17	-1.50	0.12	0.19
SCSR 0118-O4.10	-0.82	-1.22	0.12	0.19
SCSR 0118-O4.11	-0.46	-0.93	0.12	0.19
SCSR 0118-O4.12	-0.20	-0.81	0.12	0.19
SCSR 0118-O4.13	0.46	-1.16	0.12	0.19
SCSR 0118-O4.14	0.41	-1.10	0.12	0.19
SCSR 0118-O4.15	0.09	-1.57	0.12	0.19
SCSR 0118-O4.16	-0.68	-1.26	0.10	0.16
SCSR 0118-O4.17	-0.75	-1.47	0.10	0.16
SCSR 0118-O4.18	-1.35	-1.86	0.10	0.16
SCSR 0118-O4.19	-1.52	-1.42	0.10	0.16
SCSR 0118-O4.20	-1.51	-1.60	0.10	0.16
SCSR 0118-O4.21	-1.35	-1.61	0.10	0.16
SCSR 0118-O4.22	-1.38	-1.59	0.10	0.16
SCSR 0118-O4.23	-1.02	-1.23	0.10	0.16
SCSR 0118-O4.24	-1.25	-1.08	0.10	0.16
SCSR 0118-O4.25	-1.45	-0.60	0.10	0.16
SCSR 0118-O4.26	-0.79	-0.08	0.10	0.16
SCSR 0118-O4.27	-0.46	0.23	0.10	0.16

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
SCSR 0118-O4.28	-0.41	-0.74	0.10	0.16
SCSR 0118-O4.29	-0.72	-1.19	0.10	0.16
SCSR 0118-O4.30	-1.19	-1.18	0.10	0.16
SCSR 0118-O4.31	-2.19	-1.66	0.10	0.16
SCSR 0118-O4.32	-2.12	-1.85	0.10	0.16
SCSR 0118-O4.33	-2.88	-1.78	0.10	0.16
SCSR 0118-O4.34	-3.24	-1.79	0.10	0.16
SCSR 0118-O5.1	—	—	—	—
SCSR 0118-O5.2	-0.19	-0.67	0.27	1.76
SCSR 0118-O5.3	-0.82	-0.29	0.27	1.76
SCSR 0118-O5.4	-0.82	-1.32	0.27	1.76
SCSR 0118-O5.5	-1.24	-1.54	0.27	1.76
SCSR 0118-O5.6	-1.36	-0.62	0.27	1.76
SCSR 0118-O5.7	-0.37	-1.36	0.27	1.76
SCSR 0118-O5.8	-1.01	-2.06	0.27	1.76
SCSR 0118-O5.9	-0.39	-0.98	0.27	1.76
SCSR 0118-O5.10	-0.86	-0.38	0.27	1.76
SCSR 0118-O5.11	-0.31	-0.67	0.27	1.76
SCSR 0118-O5.12	-0.29	-0.97	0.27	1.76
SCSR 0118-O5.13	-0.33	-1.06	0.27	1.76
SCSR 0118-O5.14	-0.58	-1.01	0.27	1.76
SCSR 0118-O5.15	-0.50	-0.36	0.27	1.76
SCSR 0118-O5.16	-0.70	-0.67	0.27	1.76
SCSR 0118-O5.17	-0.67	-1.68	0.27	1.76
SCSR 0118-O5.18	-0.44	-1.20	0.27	1.76
SCSR 0118-O5.19	0.02	-0.56	0.27	1.76
SCSR 0118-O5.20	-0.27	-1.15	0.27	1.76
SCSR 0118-O5.21	-0.42	-0.59	0.27	1.76
SCSR 0118-O5.22	-0.72	-0.46	0.27	1.76
SCSR 0118-O6.1	-2.89	-1.01	0.22	0.37
SCSR 0118-O6.2	-2.24	0.02	0.22	0.37
SCSR 0118-O6.3	-1.05	-1.23	0.10	0.16
SCSR 0118-O6.4	-1.64	-1.35	0.10	0.16
SCSR 0118-O6.5	-2.19	-1.14	0.22	0.37
SCSR 0118-O6.6	-1.24	-0.24	0.22	0.37
SCSR 0118-O6.7	-1.47	0.89	0.22	0.37
SCSR 0118-O6.8	-0.69	-0.72	0.10	0.16
SCSR 0118-O6.9	-0.40	-1.12	0.10	0.16
SCSR 0118-O6.10	-0.68	-1.85	0.10	0.16
SCSR 0118-O6.11	-0.77	-1.48	0.10	0.16
SCSR 0118-O6.12	-0.90	-1.75	0.22	0.37
SCSR 0118-O6.13	-0.98	-1.19	0.22	0.37

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
SCSR 0118-O6.14	-1.29	-1.45	0.22	0.37
SCSR 0118-O6.15	-1.39	-0.74	0.22	0.37
SCSR 0118-O6.16	-1.73	-1.38	0.22	0.37
SCSR 0118-O6.17	-1.50	0.01	0.22	0.37
SCSR 0118-O6.18	-0.73	-0.58	0.10	0.16
SCSR 0118-O6.19	-0.82	-0.42	0.10	0.16
SCSR 0118-O6.20	0.34	0.06	0.22	0.37
SCSR 0118-O6.21	0.60	-0.83	0.22	0.37
SCSR 0118-O6.22	-0.60	-1.44	0.22	0.37
SCSR 0118-O6.23	-1.30	-1.63	0.22	0.37
SCSR 0118-O6.24	-1.42	-1.80	0.22	0.37
SCSR 0118-O6.25	-1.91	-2.73	0.22	0.37
SCSR 0118-O6.26	-2.38	-2.45	0.22	0.37
SCSR 0118-O6.27	-2.89	-2.44	0.22	0.37
SCSR 0118-O6.28	-3.00	-2.11	0.22	0.37
SCSR 0118-O6.29	-3.78	-2.55	0.10	0.16
SCSR 0118-O6.30	-3.75	-1.85	0.22	0.37
SCSR 0122-O7.1	-4.67	-2.27	0.10	0.16
SCSR 0122-O7.2	-2.13	-0.66	0.10	0.16
SCSR 0122-O7.3	-1.10	-0.28	0.22	0.37
SCSR 0122-O7.4	-1.66	-0.59	0.22	0.37
SCSR 0122-O7.5	-1.29	-0.70	0.22	0.37
SCSR 0122-O7.6	-1.46	-0.66	0.22	0.37
SCSR 0122-O7.7	-1.54	-0.24	0.22	0.37
SCSR 0122-O7.8	-1.18	-0.52	0.22	0.37
SCSR 0122-O7.9	-0.94	-0.83	0.22	0.37
SCSR 0122-O7.10	-1.04	-1.12	0.22	0.37
SCSR 0122-O7.11	-1.02	-1.56	0.22	0.37
SCSR 0122-O7.12	-0.90	-1.01	0.22	0.37
SCSR 0122-O7.13	-0.75	-1.06	0.22	0.37
SCSR 0122-O7.14	-0.85	-0.49	0.22	0.37
SCSR 0122-O7.15	-1.98	-0.91	0.22	0.37
SCSR 0122-O7.16	-1.12	-1.12	0.22	0.37
SCSR 0122-O7.17	-0.96	-0.66	0.22	0.37
SCSR 0122-O7.18	-0.91	-0.90	0.22	0.37
SCSR 0122-O7.19	-0.65	-0.99	0.22	0.37
SCSR 0122-O7.20	-0.70	-1.08	0.22	0.37
SCSR 0122-O7.21	-0.25	-0.87	0.22	0.37
SCSR 0122-O7.22	-0.45	-1.09	0.22	0.37
SCSR 0122-O7.23	-0.59	-1.33	0.22	0.37
SCSR 0122-O7.24	-1.55	-2.57	0.10	0.16
SCSR 0122-O7.25	-1.40	-1.88	0.22	0.37

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
SCSR 0122-O7.26	-1.72	-1.96	0.22	0.37
SCSR 0122-O7.27	-1.38	-1.31	0.22	0.37
SCSR 0122-O7.28	-1.77	-1.80	0.10	0.16
SCSR 0122-O7.29	-1.74	-1.51	0.22	0.37
SCSR 0122-O7.30	-1.19	-0.10	0.22	0.37
SCSR 0122-O7.31	-0.54	-0.34	0.22	0.37
SCSR 0122-O7.32	-0.32	-1.63	0.22	0.37
SCSR 0122-O7.33	-0.47	-1.93	0.22	0.37
SCSR 0122-O7.34	-1.59	-3.00	0.22	0.37
SCSR 0122-O7.35	-1.67	-2.62	0.22	0.37
SCSR 0122-O7.36	-2.03	-2.02	0.22	0.37
SCSR 0122-O7.37	-1.77	-2.32	0.22	0.37
SCSR 0122-O7.38	-2.58	-2.81	0.22	0.37
SCSR 0120-O8.1	-3.20	-1.75	0.22	0.37
SCSR 0120-O8.2	-0.65	0.06	0.22	0.37
SCSR 0120-O8.3	-0.25	-0.78	0.22	0.37
SCSR 0120-O8.4	-0.57	-1.29	0.22	0.37
SCSR 0120-O8.5	-0.04	-0.32	0.22	0.37
SCSR 0120-O8.6	0.18	-0.53	0.22	0.37
SCSR 0120-O8.7	0.16	-0.51	0.22	0.37
SCSR 0120-O8.8	0.28	-0.81	0.10	0.16
SCSR 0120-O8.9	-0.04	0.12	0.22	0.37
SCSR 0120-O8.10	0.27	-0.84	0.10	0.16
SCSR 0120-O8.11	-0.07	-1.55	0.10	0.16
SCSR 0120-O8.12	-0.04	-1.56	0.10	0.16
SCSR 0120-O8.13	-0.78	-2.12	0.10	0.16
SCSR 0120-O8.14	-0.57	-1.75	0.10	0.16
SCSR 0120-O8.15	-0.46	-1.76	0.10	0.16
SCSR 0120-O8.16	-0.83	-1.76	0.10	0.16
SCSR 0120-O8.17	-0.68	-1.56	0.10	0.16
SCSR 0120-O8.18	-0.65	-1.90	0.10	0.16
SCSR 0120-O8.19	-0.79	-1.46	0.10	0.16
SCSR 0120-O8.20	-0.39	-0.95	0.10	0.16
SCSR 0120-O8.21	-1.05	-1.82	0.10	0.16
SCSR 0120-O8.22	-0.34	-1.43	0.10	0.16
SCSR 0120-O8.23	-0.24	-1.01	0.10	0.16
SCSR 0120-O8.24	—	—	—	—
SCSR 0120-O8.25	-0.24	-0.79	0.10	0.16
SCSR 1348-O3.1	-1.40	0.32	0.12	0.16
SCSR 1348-O3.2	-1.40	-0.17	0.12	0.16
SCSR 1348-O3.3	-1.61	-0.91	0.12	0.16
SCSR 1348-O3.4	-2.44	-1.36	0.12	0.16

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
SCSR 1348-O3.5	-2.99	-1.56	0.12	0.16
SCSR 1348-O3.6	-3.36	-1.55	0.12	0.16
SCSR 1348-O3.7	-3.49	-1.75	0.12	0.16
SCSR 1348-O3.8	-4.24	-2.33	0.12	0.16
SCSR 1348-O3.9	-5.00	-2.38	0.12	0.16
SCSR 1348-O3.10	-5.55	-2.43	0.12	0.16
SCSR 1373-O4.1	-0.57	-0.18	0.06	0.12
SCSR 1373- O4.2	-1.43	-0.14	0.06	0.12
SCSR 1373-O4.3	-1.52	-0.37	0.06	0.12
SCSR 1373-O4.4	-1.11	0.42	0.06	0.12
SCSR 1373-O4.5	—	—	—	—
SCSR 1373-O4.6	-1.18	-0.05	0.06	0.12
SCSR 1373-O4.7	-1.33	0.03	0.06	0.12
SCSR 1373-O4.8	-1.33	0.11	0.06	0.12
SCSR 1373-O4.9	-1.45	-0.51	0.06	0.12
SCSR 1373-O4.10	-1.85	0.15	0.06	0.12
SCSR 1373-O4.11	-0.55	-0.25	0.06	0.12
SCSR 1373-O4.12	-0.39	-0.77	0.06	0.12
SCSR 1373-O4.13	-1.69	-0.35	0.06	0.12
SCSR 1373-O4.14	-1.66	-0.05	0.06	0.12
SCSR 1373-O4.15	-1.20	-0.73	0.06	0.12
SCSR 1373-O4.16	-1.14	-0.62	0.06	0.12
SCSR 1373-O4.17	-1.78	-0.94	0.06	0.12
SCSR 1373-O4.18	-1.51	-0.61	0.06	0.12
SCSR 1373-O4.19	-1.03	-0.70	0.06	0.12
SCSR 1373-O4.20	-1.73	-0.98	0.06	0.12
SCSR 1373-O4.21	-1.58	-0.47	0.06	0.12
SCSR 1373-O4.22	-0.94	-0.86	0.06	0.12
SCSR 1373-O4.23	-1.67	-1.23	0.06	0.12
SCSR 1373-O4.24	-1.31	-0.99	0.06	0.12
SCSR 1373-O4.25	—	—	—	—
SCSR 1373-O4.26	-1.01	-1.21	0.06	0.12
SCSR 1373-O4.27	-0.67	-1.16	0.06	0.12
SCSR 1373-O4.28	-0.92	-0.98	0.06	0.12
SCSR 1373-O4.29	-0.85	-0.99	0.06	0.12
SCSR 1373-O4.30	-0.72	-1.08	0.06	0.12
SCSR 1373-O4.31	-1.03	-1.05	0.06	0.12
SCSR 1373-O4.32	-0.96	-0.78	0.06	0.12
SCSR 1373-O4.33	-1.08	-0.71	0.06	0.12
SCSR 1373-O4.34	-0.97	-0.50	0.06	0.12
SCSR 1373-O4.35	-1.23	-1.00	0.06	0.12
SCSR 1373-O4.36	-0.99	-0.64	0.06	0.12

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
SCSR 1373-O4.37	-1.22	-0.62	0.06	0.12
SCSR 1373-O4.38	-1.30	-0.70	0.06	0.12
SCSR 1373-O4.39	-1.31	-0.60	0.06	0.12
SCSR 1373-O4.40	-1.73	-0.98	0.06	0.12
SCSR 1373-O5.1	-1.94	-0.33	0.08	0.17
SCSR 1373-O5.2	-1.74	-0.28	0.08	0.17
SCSR 1373-O5.3	-1.59	-0.02	0.08	0.17
SCSR 1373-O5.4	-1.72	-0.78	0.08	0.17
SCSR 1373-O5.5	-1.95	-0.27	0.08	0.17
SCSR 1373-O5.6	-2.41	-0.50	0.08	0.17
SCSR 1373-O5.7	-1.04	-0.20	0.08	0.17
SCSR 1373-O5.8	-2.07	-0.14	0.08	0.17
SCSR 1373-O5.9	-1.38	-0.16	0.08	0.17
SCSR 1373-O5.10	-0.60	-0.99	0.08	0.17
SCSR 1373-O5.11	-1.83	-0.17	0.08	0.17
SCSR 1373-O5.12	-1.77	-0.53	0.08	0.17
SCSR 1373-O5.13	-1.74	-0.48	0.08	0.17
SCSR 1373-O5.14	-1.94	-0.29	0.08	0.17
SCSR 1373-O5.15	-0.94	-0.70	0.08	0.17
SCSR 1373-O5.16	-0.90	-1.03	0.08	0.17
SCSR 1373-O5.17	—	—	—	—
SCSR 1373-O5.18	-0.58	-0.82	0.08	0.17
SCSR 1373-O5.19	—	—	—	—
SCSR 1373-O5.20	-0.56	-0.74	0.08	0.17
SCSR 1373-O5.21	-0.56	-0.72	0.08	0.17
SCSR 1373-O5.22	-0.49	-0.44	0.08	0.17
SCSR 1373-O5.23	-0.97	-0.92	0.08	0.17
SCSR 1373-O5.24	-0.98	-0.91	0.08	0.17
SCSR 1373-O5.25	-1.19	-0.52	0.06	0.12
SCSR 1373-O5.26	-1.44	-0.87	0.06	0.12
SCSR 1373-O6.1	-2.00	-0.28	0.08	0.17
SCSR 1373-O6.2	-1.40	-0.30	0.08	0.17
SCSR 1373-O6.3	-1.76	0.02	0.08	0.17
SCSR 1373-O6.4	-1.57	-0.20	0.08	0.17
SCSR 1373-O6.5	-1.22	-0.40	0.08	0.17
SCSR 1373-O6.6	-2.23	0.02	0.08	0.17
SCSR 1373-O6.7	-2.56	-0.18	0.08	0.17
SCSR 1373-O6.8	-2.58	-0.40	0.08	0.17
SCSR 1373-O6.9	-2.10	-0.71	0.08	0.17
SCSR 1373-O6.10	-2.65	-0.01	0.08	0.17
SCSR 1373-O6.11	-1.61	-0.97	0.08	0.17
SCSR 1373-O6.12	-2.74	-1.31	0.08	0.17

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
SCSR 1373-O6.13	-2.79	-0.14	0.08	0.17
SCSR 1373-O6.14	-1.22	-0.33	0.08	0.17
SCSR 1373-O6.15	-1.03	-0.95	0.08	0.17
SCSR 1373-O6.16	-2.01	-1.29	0.08	0.17
SCSR 1373-O6.17	-2.28	-1.70	0.08	0.17
SCSR 1373-O6.18	-2.06	-1.55	0.08	0.17
SCSR 1373-O6.19	-1.56	-1.13	0.08	0.17
SCSR 1373-O6.20	-2.12	-1.14	0.08	0.17
SCSR 1373-O6.21	-1.44	0.24	0.08	0.17
SCSR 1373-O6.22	-1.27	-0.24	0.08	0.17
SCSR 1373-O6.23	-1.58	-0.94	0.08	0.17
SCSR 1373-O6.24	-2.16	-1.72	0.08	0.17
SCSR 1373-O6.25	-2.29	-1.86	0.08	0.17
SCSR 1373-O6.26	-2.49	-1.74	0.08	0.17
SCSR 1373-O6.27	-3.33	-2.28	0.08	0.17
SCSR 1373-O7.1	-0.67	0.40	0.06	0.12
SCSR 1373-O7.2	-1.02	0.12	0.09	0.09
SCSR 1373-O7.3	-1.66	0.19	0.09	0.09
SCSR 1373-O7.4	-0.39	0.19	0.09	0.09
SCSR 1373-O7.5	-1.53	-0.11	0.09	0.09
SCSR 1373-O7.6	-1.22	-0.04	0.06	0.12
SCSR 1373-O7.7	-1.34	-0.31	0.09	0.09
SCSR 1373-O7.8	-1.58	-0.21	0.09	0.09
SCSR 1373-O7.9	-1.50	-0.33	0.09	0.09
SCSR 1373-O7.10	-1.70	-0.02	0.09	0.09
SCSR 1373-O7.11	-1.44	-0.37	0.06	0.12
SCSR 1373-O7.12	-1.96	-0.52	0.09	0.09
SCSR 1373-O7.13	—	—	—	—
SCSR 1373-O7.14	—	—	—	—
SCSR 1373-O7.15	-1.29	-0.37	0.09	0.09
SCSR 1373-O7.16	-0.84	-0.65	0.06	0.12
SCSR 1373-O7.17	-0.45	-0.89	0.09	0.09
SCSR 1373-O7.18	-0.62	-1.18	0.09	0.09
SCSR 1373-O7.19	-1.15	-0.74	0.09	0.09
SCSR 1373-O7.20	-1.29	-0.84	0.09	0.09
SCSR 1373-O7.21	-1.61	-1.19	0.06	0.12
SCSR 1373-O7.22	-1.94	-1.04	0.09	0.09
SCSR 1373-O7.23	-2.43	-1.42	0.09	0.09
SCSR 1437-O8.1	-2.76	-0.08	0.08	0.17
SCSR 1437-O8.2	—	—	—	—
SCSR 1437-O8.3	-0.97	-1.07	0.06	0.12
SCSR 1437-O8.4	-1.78	-0.35	0.06	0.12

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
SCSR 1437-O8.5	-1.31	-0.49	0.08	0.17
SCSR 1437-O8.6	-1.06	-0.40	0.08	0.17
SCSR 1437-O8.7	-0.69	-0.32	0.06	0.12
SCSR 1437-O8.8	-1.35	-0.61	0.06	0.12
SCSR 1437-O8.9	-1.55	-1.08	0.06	0.12
SCSR 1437-O8.10	-2.04	-1.57	0.08	0.17
SCSR 1437-O8.11	-2.53	-1.12	0.08	0.17
SCSR 1437-O8.12	-2.52	-0.98	0.06	0.12
SCSR 1437-O8.13	-2.08	-1.06	0.06	0.12
SCSR 1437-O8.14	-1.39	-0.72	0.06	0.12
SCSR 1437-O8.15	-1.01	-0.54	0.08	0.17
SCSR 1437-O8.16	-1.08	-0.74	0.08	0.17
SCSR 1437-O8.17	-0.29	-0.90	0.06	0.12
SCSR 1437-O8.18	-1.74	-1.40	0.06	0.12
SCSR 1437-O8.19	-1.80	-1.53	0.06	0.12
SCSR 1437-O8.20	—	—	—	—
SCSR 1444-O9.1	-0.90	-1.90	0.12	0.16
SCSR 1444-O9.2	-1.18	-1.97	0.12	0.16
SCSR 1444-O9.3	-0.67	-1.45	0.12	0.16
SCSR 1444-O9.4	-0.59	-1.02	0.12	0.16
SCSR 1444-O9.5	-1.25	-1.02	0.12	0.16
SCSR 1444-O9.6	-1.71	-0.03	0.12	0.16
SCSR 1444-O9.7	-2.65	-0.43	0.12	0.16
SCSR 1444-O9.8	-4.08	-2.44	0.12	0.16
SCSR 1444-O9.9	-4.25	-2.79	0.12	0.16
SCSR 1444-O9.10	-4.26	-2.82	0.12	0.16
SCSR 1444-O9.11	-3.72	-2.43	0.12	0.16
SCSR 1444-O10.1	-0.08	-1.07	0.09	0.09
SCSR 1444-O10.2	0.39	-0.53	0.09	0.09
SCSR 1444-O10.3	-0.24	0.18	0.06	0.12
SCSR 1444-O10.4	-0.91	0.64	0.09	0.09
SCSR 1444-O10.5	-0.18	0.86	0.09	0.09
SCSR 1444-O10.6	-0.86	-0.71	0.09	0.09
SCSR 1444-O10.7	-0.90	-0.88	0.09	0.09
SCSR 1444-O10.8	-1.02	-0.88	0.06	0.12
SCSR 1444-O10.9	-1.39	-0.54	0.09	0.09
SCSR 1444-O10.10	-1.82	-0.31	0.09	0.09
SCSR 1444-O10.11	-2.03	-0.57	0.09	0.09
SCSR 1444-O10.12	-1.59	-0.68	0.09	0.09
SCSR 1444-O10.13	-1.76	-0.80	0.06	0.12
SCSR 1444-O10.14	-2.21	-0.97	0.09	0.09
SCSR 1444-O10.15	-2.38	-0.22	0.09	0.09

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
SCSR 1477-O11.1	-1.27	-0.74	0.12	0.16
SCSR 1477-O11.2	-1.34	-0.81	0.12	0.16
SCSR 1477-O11.3	-0.82	0.02	0.12	0.16
SCSR 1477-O11.4	-1.54	0.13	0.12	0.16
SCSR 1477-O11.5	-4.42	-0.16	0.12	0.16
SCSR 1477-O11.6	-4.52	-1.66	0.12	0.16
SCSR 1477-O11.7	-3.76	-1.72	0.12	0.16
SCSR 1477-O11.8	-5.04	-2.67	0.12	0.16
SCSR 1477-O11.9	-4.62	-2.77	0.12	0.16
SCSR 1516-O12.1	—	—	—	—
SCSR 1516-O12.2	-2.42	-0.75	0.09	0.09
SCSR 1516-O12.3	-2.85	-1.34	0.09	0.09
SCSR 1516-O12.4	-3.40	-1.45	0.09	0.09
SCSR 1516-O12.5	-3.90	-1.27	0.09	0.09
SCSR 1516-O12.6	-3.94	-1.08	0.09	0.09
SCSR 1516-O12.7	-4.87	-1.47	0.09	0.09
SCSR 1516-O12.8	-5.37	-1.76	0.09	0.09
SCSR 1516-O12.9	-4.96	-1.65	0.09	0.09
SCSR 1554-O13.1	-1.68	-0.74	0.12	0.16
SCSR 1554-O13.2	-0.58	0.63	0.12	0.16
SCSR 1554-O13.3	-1.36	-0.90	0.12	0.16
SCSR 1554-O13.4	-1.03	-0.49	0.12	0.16
SCSR 1554-O13.5	-1.20	-0.30	0.12	0.16
SCSR 1554-O13.6	-0.85	-0.79	0.12	0.16
SCSR 1554-O13.7	-1.03	-1.55	0.12	0.16
SCSR 1554-O13.8	-1.76	-2.33	0.12	0.16
SCSR 1554-O13.9	-1.70	-2.48	0.12	0.16
SCSR 1554-O13.10	-2.60	-2.78	0.12	0.16
SCSR 1554-O13.11	-3.18	-3.26	0.12	0.16
SCSR 0494-O14.1	—	—	—	—
SCSR 0494-O14.2	-1.12	-0.67	0.09	0.09
SCSR 0494-O14.3	-2.24	-0.34	0.09	0.09
SCSR 0494-O14.4	-3.08	-0.73	0.09	0.09
SCSR 0494-O14.5	-2.61	-1.01	0.09	0.09
SCSR 0494-O14.6	-2.36	-0.62	0.08	0.17
SCSR 0494-O14.7	-2.48	-0.90	0.08	0.17
SCSR 0494-O14.8	-2.50	-0.52	0.08	0.17
SCSR 0494-O14.9	-2.14	-0.66	0.08	0.17
SCSR 0494-O14.10	-2.80	-0.78	0.12	0.16
SCSR 0494-O14.11	-2.06	-1.08	0.12	0.16
SCSR 0494-O14.12	-1.65	-1.88	0.12	0.16
SCSR 0494-O14.13	-2.00	-3.28	0.08	0.17

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
SCSR 0494-O14.14	-2.49	-1.28	0.08	0.17
SCSR 0494-O14.15	-3.80	-1.56	0.06	0.12
SCSR 0494-O14.16	-5.11	-1.74	0.06	0.12
SCSR 0494-O14.17	-4.29	-0.79	0.06	0.12
SCSR 0494-O14.18	-2.41	-0.01	0.06	0.12
SCSR 0494-O14.19	-2.34	-1.01	0.06	0.12
SCSR 0494-O14.20	—	—	—	—
SCSR 0494-O14.21	-4.74	-1.76	0.06	0.12
SCSR 0494-O14.22	-5.26	-1.98	0.06	0.12
SCSR 0494-O14.23	-4.99	-2.04	0.06	0.12
SCSR 0989-O17.1	—	—	—	—
SCSR 0989-O17.2	-1.87	-0.23	0.09	0.09
SCSR 0989-O17.3	-0.65	-0.57	0.09	0.09
SCSR 0989-O17.4	-1.25	0.06	0.09	0.09
SCSR 0989-O17.5	-1.81	0.00	0.09	0.09
SCSR 0989-O17.6	-0.90	-0.67	0.09	0.09
SCSR 0989-O17.7	-0.39	-0.78	0.09	0.09
SCSR 0989-O17.8	-1.68	-0.38	0.09	0.09
SCSR 0989-O17.9	-1.15	-0.25	0.09	0.09
SCSR 0989-O17.10	-2.34	-0.64	0.09	0.09
SCSR 0989-O17.11	-1.94	-0.66	0.09	0.09
SCSR 0989-O17.12	-1.86	-0.49	0.09	0.09
SCSR 0989-O17.13	—	—	—	—
SCSR 0989-O17.14	-2.21	-0.54	0.09	0.09
SCSR 0989-O17.15	-1.64	-0.43	0.09	0.09
SCSR 0989-O17.16	-1.89	-0.60	0.09	0.09
SCSR 0989-O17.17	-1.79	-0.70	0.09	0.09
SCSR 0989-O17.18	-1.66	-0.55	0.09	0.09
SCSR 0989-O17.19	-1.71	-0.51	0.09	0.09
SCSR 0989-O17.20	-1.12	-0.38	0.09	0.09
SCSR 0989-O17.21	-1.24	-0.50	0.09	0.09
SCSR 0989-O17.22	-1.08	-0.36	0.09	0.09
SCSR 0989-O17.23	-1.43	-0.42	0.09	0.09
SCSR 0989-O17.24	-1.54	-0.63	0.09	0.09
SCSR 0989-O17.25	-1.69	-0.66	0.09	0.09
SCSR 0989-O17.26	-1.53	-0.49	0.09	0.09
SCSR 0989-O17.27	-1.41	-0.49	0.09	0.09
SCSR 0989-O17.28	-1.61	-0.76	0.09	0.09
SCSR 0989-O17.29	-1.40	-0.86	0.09	0.09
SCSR 0989-O17.30	-1.22	-0.98	0.09	0.09
SCSR 0989-O17.31	-1.47	-1.04	0.09	0.09
SCSR 0989-O17.32	-1.54	-1.00	0.09	0.09

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
SCSR 0989-O17.33	-1.79	-1.12	0.09	0.09
SCSR 0989-O17.34	-1.92	-1.23	0.09	0.09
SCSR 0989-O17.35	-2.22	-0.97	0.09	0.09
SCSR 0989-O17.36	-2.48	-1.26	0.09	0.09
SCSR 1037-O19.1	-1.42	-1.11	0.08	0.17
SCSR 1037-O19.2	—	—	—	—
SCSR 1037-O19.3	-1.15	-1.02	0.06	0.12
SCSR 1037-O19.4	-1.52	-0.86	0.06	0.12
SCSR 1037-O19.5	-1.32	-2.46	0.06	0.12
SCSR 1037-O19.6	-1.28	-0.81	0.08	0.17
SCSR 1037-O19.7	-1.34	-0.90	0.08	0.17
SCSR 1037-O19.8	—	—	—	—
SCSR 1037-O19.9	-1.31	-1.41	0.06	0.12
SCSR 1037-O19.10	-1.67	-0.81	0.06	0.12
SCSR 1037-O19.11	-1.37	-1.81	0.08	0.17
SCSR 1037-O19.12	-1.67	-3.14	0.08	0.17
SCSR 1037-O19.13	-2.35	-2.74	0.06	0.12
SCSR 1037-O19.14	-2.69	-0.38	0.06	0.12
SCSR 1037-O19.15	-2.70	-0.89	0.06	0.12
SCSR 1037-O19.16	-1.04	-1.21	0.08	0.17
SCSR 1037-O19.17	-1.77	-1.66	0.08	0.17
SCSR 1037-O19.18	-1.99	-0.90	0.06	0.12
SCSR 1037-O19.19	-2.10	-1.46	0.06	0.12
SCSR 1037-O19.20	-2.58	0.11	0.06	0.12
SCSR 1037-O19.21	—	—	—	—
SCSR 1037-O19.22	-3.22	-1.45	0.08	0.17
SCSR 1037-O19.23	-3.65	-1.87	0.06	0.12
SCSR 1037-O19.24	-4.03	-2.27	0.06	0.12
SCSR 1037-O19.25	-4.14	-2.11	0.06	0.12
SCSR 1037-O19.26	—	—	—	—
SCSR 0999-O21.1	-1.06	-1.28	0.12	0.16
SCSR 0999-O21.2	-0.94	-1.07	0.12	0.16
SCSR 0999-O21.3	-1.42	0.94	0.12	0.16
SCSR 0999-O21.4	-1.04	0.33	0.12	0.16
SCSR 0999-O21.5	-1.10	-1.10	0.12	0.16
SCSR 0999-O21.6	-1.35	-1.46	0.12	0.16
SCSR 0999-O21.7	-1.34	-1.11	0.12	0.16
SCSR 0999-O21.8	-1.67	-1.45	0.12	0.16
SCSR 0999-O21.9	-1.87	-1.69	0.12	0.16
SCSR 0999-O21.10	-1.95	-2.05	0.12	0.16
SCSR 0999-O21.11	-1.97	-2.34	0.12	0.16
SCSR 0999-O21.12	-1.71	-1.74	0.12	0.16

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
SCSR 1203-O25.1	-0.98	-0.08	0.12	0.16
SCSR 1203-O25.2	-0.88	-1.41	0.12	0.16
SCSR 1203-O25.3	-1.39	-1.53	0.12	0.16
SCSR 1203-O25.3	-1.39	-1.53	0.12	0.16
SCSR 1203-O25.4	-1.29	-1.25	0.12	0.16
SCSR 1203-O25.5	-1.29	-0.91	0.12	0.16
SCSR 1203-O25.6	-1.30	-0.07	0.12	0.16
SCSR 1203-O25.7	-1.38	0.02	0.12	0.16
SCSR 1203-O25.8	-1.57	-0.54	0.12	0.16
SCSR 1203-O25.9	-2.12	-1.79	0.12	0.16
SCSR 1203-O25.10	-2.60	-1.38	0.12	0.16
SCSR 1203-O25.11	-2.80	-1.50	0.12	0.16
SCSR 1203-O25.12	-3.00	-1.57	0.12	0.16
SCSR 1203-O25.13	-3.76	-1.24	0.12	0.16
SCSR 1203-O25.14	-3.99	-1.76	0.12	0.16
SCSR 1203-O25.15	-4.62	-2.13	0.12	0.16
SCSR 1886-O26.1	-0.52	-2.67	0.12	0.16
SCSR 1886-O26.2	-0.33	-1.74	0.12	0.16
SCSR 1886-O26.3	-0.03	0.33	0.12	0.16
SCSR 1886-O26.4	-1.36	1.05	0.12	0.16
SCSR 1886-O26.5	-0.19	-0.06	0.12	0.16
SCSR 1886-O26.6	-1.08	-1.14	0.12	0.16
SCSR 1886-O26.7	-4.52	-3.44	0.12	0.16
SCSR 1886-O26.8	-6.31	-4.50	0.12	0.16
SCSR 1886-O26.9	-6.75	-4.69	0.12	0.16
West 1.1	0.25	-0.70	0.05	0.10
West 1.2	-1.35	-0.70	0.05	0.10
West 1.3	-2.06	-0.71	0.10	0.14
West 1.4	-2.56	-1.10	0.10	0.14
West 1.5	-1.42	-0.80	0.10	0.14
West 1.6	-0.24	-0.53	0.10	0.14
West 1.7	-0.10	-0.57	0.10	0.14
West 1.8	0.47	-0.60	0.10	0.14
West 1.9	0.57	-0.74	0.10	0.14
West 1.10	0.38	-0.96	0.05	0.10
West 1.11	0.57	-1.01	0.05	0.10
West 1.12	0.76	-0.71	0.05	0.10
West 1.13	0.86	-0.27	0.10	0.14
West 1.14	0.12	-0.45	0.10	0.14
West 1.15	-0.03	-0.35	0.10	0.14
West 1.16	-0.97	0.32	0.10	0.14
West 1.17	0.45	-0.39	0.10	0.14

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
West 1.18	0.19	-1.72	0.10	0.14
West 1.19	-0.26	-0.42	0.10	0.14
West 1.20	-0.84	-1.33	0.05	0.10
West 1.21	0.53	-1.33	0.05	0.10
West 1.22	0.78	-1.22	0.05	0.10
West 1.23	-0.87	-0.73	0.10	0.14
West 1.24	-1.53	0.14	0.10	0.14
West 1.25	-1.43	-0.49	0.10	0.14
West 1.26	-1.65	-1.17	0.10	0.14
West 1.27	-1.64	-1.37	0.10	0.14
West 1.28	-1.44	-1.31	0.10	0.14
West 1.29	-1.29	-1.05	0.10	0.14
West 1.30	-0.71	-0.91	0.05	0.10
West 1.31	-0.77	-0.80	0.05	0.10
West 1.32	-0.60	-0.96	0.05	0.10
West 1.33	-0.55	-1.02	0.10	0.14
West 1.34	-1.53	-1.62	0.10	0.14
West 1.35	-1.93	-2.19	0.10	0.14
West 1.36	-2.18	-2.43	0.10	0.14
West 1.37	-2.28	-2.49	0.10	0.14
West 1.38	-3.25	-2.88	0.10	0.14
West 1.39	-2.77	-2.75	0.10	0.14
West 1.40	-3.32	-2.79	0.05	0.10
West 1.41	-3.93	-2.72	0.05	0.10
West 1.42	-4.27	-2.78	0.05	0.10
West 2.1	0.17	-0.96	0.10	0.14
West 2.2	-0.90	-0.44	0.07	0.13
West 2.3	-0.42	-0.34	0.10	0.14
West 2.4	-0.19	-0.90	0.10	0.14
West 2.5	-0.35	-0.80	0.10	0.14
West 2.6	-1.17	-0.30	0.10	0.14
West 2.7	-1.16	0.29	0.10	0.14
West 2.8	-0.32	-0.20	0.10	0.14
West 2.9	-0.40	-0.90	0.10	0.14
West 2.10	-0.06	-0.55	0.10	0.14
West 2.11	-0.32	-0.83	0.10	0.14
West 2.12	-0.64	-0.66	0.07	0.13
West 2.13	-1.73	-0.62	0.10	0.14
West 2.14	-1.53	-0.18	0.10	0.14
West 2.15	-1.43	0.36	0.10	0.14
West 2.16	-0.91	0.66	0.10	0.14
West 2.17	-0.92	0.47	0.10	0.14

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
West 2.18	-0.20	-0.34	0.10	0.14
West 2.19	1.36	-0.79	0.10	0.14
West 2.20	1.22	-1.39	0.10	0.14
West 2.21	0.06	-1.80	0.10	0.14
West 2.22	-0.76	-1.80	0.07	0.13
West 2.23	-1.68	-1.98	0.10	0.14
West 2.24	-2.54	-2.12	0.10	0.14
West 2.25	-3.33	-2.11	0.10	0.14
West 2.26	-4.19	-2.63	0.10	0.14
West 2.27	-6.01	-3.13	0.10	0.14
West 3.1	-1.96	0.58	0.10	0.14
West 3.2	-2.83	-1.28	0.10	0.14
West 3.3	-2.78	-1.90	0.10	0.14
West 3.4	-2.76	-2.04	0.10	0.14
West 3.5	-3.03	-3.28	0.05	0.10
West 3.6	-3.28	-3.29	0.05	0.10
West 3.7	-3.89	-3.21	0.10	0.14
West 3.8	-4.33	-3.12	0.10	0.14
West 3.9	-3.35	-2.03	0.10	0.14
West 3.10	-3.30	-2.29	0.10	0.14
West 3.11	-4.28	-3.71	0.10	0.14
West 3.12	-4.27	-3.96	0.10	0.14
West 3.13	-4.14	-3.97	0.10	0.14
West 3.14	-3.85	-4.25	0.10	0.14
West 3.15	-3.58	-4.29	0.05	0.10
West 4.1	-1.31	1.51	0.05	0.10
West 4.2	-3.70	-0.03	0.05	0.10
West 4.3	-3.81	-0.92	0.05	0.10
West 4.4	-4.10	-1.71	0.05	0.10
West 4.5	-4.59	-1.80	0.05	0.10
West 4.6	-4.88	-1.90	0.05	0.10
West 4.7	-5.05	-1.56	0.05	0.10
West 4.8	-4.51	-1.16	0.05	0.10
West 4.9	-3.68	-0.86	0.05	0.10
West 5.1	-0.54	1.19	0.05	0.10
West 5.2	-0.66	-0.39	0.05	0.10
West 5.3	-2.17	-1.89	0.05	0.10
West 5.4	-1.68	-2.18	0.05	0.10
West 5.5	-1.88	-2.21	0.05	0.10
West 5.6	-2.44	-2.36	0.05	0.10
West 5.7	-2.41	-2.09	0.05	0.10
West 5.8	-1.54	-1.65	0.05	0.10

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
West 5.9	-1.04	-1.38	0.05	0.10
West 8.1	0.44	-0.71	0.05	0.10
West 8.2	-0.39	0.21	0.05	0.10
West 8.3	-0.96	0.78	0.05	0.12
West 8.4	-0.56	-0.10	0.05	0.10
West 8.5	-3.95	-1.63	0.05	0.10
West 8.6	-5.43	-3.07	0.05	0.10
West 8.7	-5.95	-3.26	0.05	0.12
West 8.8	-7.02	-2.89	0.05	0.10
West 8.9	-8.46	-3.01	0.05	0.10
West 8.10	-8.42	-3.01	0.05	0.10
West 9.1	-0.55	1.12	0.07	0.13
West 9.2	-1.34	-0.14	0.07	0.13
West 9.3	-1.52	-0.42	0.10	0.14
West 9.4	-1.78	-0.27	0.10	0.14
West 9.5	-1.79	0.05	0.10	0.14
West 9.6	-1.70	-0.04	0.10	0.14
West 9.7	-2.01	-0.07	0.10	0.14
West 9.8	-1.73	0.42	0.10	0.14
West 9.9	-1.59	0.96	0.10	0.14
West 9.10	-1.30	1.20	0.10	0.14
West 9.11	-1.01	1.05	0.07	0.13
West 9.12	-1.20	0.12	0.10	0.14
West 9.13	-1.54	-0.41	0.10	0.14
West 9.14	-1.81	-0.89	0.10	0.14
West 9.15	-2.46	-1.16	0.10	0.14
West 9.16	-3.16	-1.57	0.10	0.14
West 9.17	-3.33	-1.47	0.10	0.14
West 9.18	-3.28	-1.38	0.10	0.14
West 9.19	-3.25	-1.42	0.10	0.14
West 10.1	—	—	—	—
West 10.2	-1.66	0.62	0.05	0.10
West 10.3	-0.90	0.84	0.05	0.10
West 10.4	-1.02	0.66	0.05	0.10
West 10.5	-0.47	0.64	0.05	0.10
West 10.6	-0.72	0.66	0.05	0.10
West 10.7	-0.74	0.77	0.05	0.10
West 10.8	-0.92	1.05	0.05	0.10
West 10.9	-1.24	0.58	0.05	0.10
West 10.10	-1.13	0.67	0.05	0.10
West 10.11	-1.19	0.65	0.05	0.10
West 10.12	-1.26	0.52	0.05	0.10

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
West 10.13	-1.09	0.33	0.05	0.10
West 10.14	-0.68	0.96	0.05	0.10
West 10.15	-0.75	0.43	0.05	0.10
West 10.16	-0.90	0.57	0.05	0.10
West 10.17	-0.88	0.63	0.05	0.10
West 10.18	-0.90	-0.16	0.05	0.10
West 10.19	-1.03	0.42	0.05	0.10
West 10.20	-0.60	0.64	0.05	0.10
West 10.21	-0.48	-0.06	0.05	0.10
West 10.22	-0.41	0.60	0.05	0.10
West 10.23	-0.96	0.64	0.05	0.10
West 10.24	-0.91	0.31	0.05	0.10
West 10.25	-1.09	-0.25	0.05	0.10
West 10.26	-1.28	0.02	0.05	0.10
West 10.27	-1.51	0.43	0.05	0.10
West 10.28	-1.48	0.21	0.05	0.10
West 10.29	-1.43	0.26	0.05	0.10
West 10.30	-1.29	0.24	0.05	0.10
West 10.31	-1.52	-0.20	0.05	0.10
West 10.32	-1.78	0.11	0.05	0.10
West 10.33	-1.89	0.04	0.05	0.10
West 10.34	-2.25	-0.22	0.05	0.10
West 10.35	-3.22	-1.16	0.05	0.10
West 10.36	-4.09	-1.95	0.05	0.10
West 10.37	-4.76	-2.62	0.05	0.10
GMNH 2172.1	-2.98	-0.99	0.04	0.08
GMNH 2172.2	-2.76	-1.17	0.04	0.08
GMNH 2172.3	-2.27	-0.83	0.04	0.08
GMNH 2172.4	-2.30	-1.14	0.04	0.08
GMNH 2172.5	-2.25	-0.79	0.04	0.08
GMNH 2172.6	-2.14	-1.01	0.04	0.08
GMNH 2172.7	-1.96	-0.74	0.04	0.08
GMNH 2172.8	-2.24	-1.14	0.04	0.08
GMNH 2172.9	-2.46	-1.09	0.04	0.08
GMNH 2172.10	-2.26	-1.26	0.04	0.08
GMNH 2172.11	-2.30	-1.24	0.04	0.08
GMNH 2172.12	-2.16	-1.30	0.04	0.08
GMNH 2172.13	-2.01	-1.80	0.04	0.08
GMNH 2172.14	-2.26	-1.56	0.04	0.08
GMNH 2172.15	-1.98	-1.05	0.04	0.08
GMNH 2172.16	-1.62	-1.46	0.04	0.08
GMNH 2172.17	-2.29	-1.32	0.04	0.08

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
GMNH 2172.18	-2.86	-1.15	0.04	0.08
GMNH 2172.19	-3.25	-1.16	0.04	0.08
GMNH 2172.20	-3.21	-3.85	0.04	0.08
GMNH 2172.21	-2.88	-2.23	0.05	0.10
GMNH 2172.22	-3.03	-2.13	0.05	0.10
GMNH 2172.23	-2.88	-1.64	0.05	0.10
GMNH 2172.24	-2.64	-1.18	0.05	0.10
GMNH 2172.25	-2.50	-0.94	0.05	0.10
GMNH 2172.26	-2.39	-0.31	0.05	0.10
GMNH 2172.27	-3.13	0.89	0.05	0.10
GMNH 2172.28	-1.17	-0.17	0.05	0.10
GMNH 2172.29	-0.65	-0.72	0.05	0.10
GMNH 2172.30	-1.10	-1.17	0.05	0.10
GMNH 2172.31	-1.26	-1.07	0.05	0.10
GMNH 2172.32	-2.77	-1.45	0.05	0.10
GMNH 4457.1	-3.47	-0.52	0.08	0.15
GMNH 4457.2	-2.47	-1.07	0.08	0.15
GMNH 4457.3	-3.14	-0.44	0.08	0.15
GMNH 4457.4	-3.36	-0.20	0.08	0.15
GMNH 4457.5	-6.48	-0.16	0.08	0.15
GMNH 4457.6	-6.50	-2.07	0.08	0.15
GMNH 4457.7	-5.97	-1.95	0.08	0.15
GMNH 4457.8	-5.93	-1.67	0.08	0.15
GMNH 4457.9	-5.26	-0.97	0.08	0.15
GMNH 4457.10	-5.36	-0.49	0.08	0.15
GMNH 4457.11	-5.61	-0.03	0.08	0.15
GMNH 4457.12	-5.49	0.16	0.08	0.15
GMNH 4457.13	-5.92	0.44	0.08	0.15
GMNH 4457.14	-4.75	0.27	0.08	0.15
GMNH 4457.15	-3.62	0.06	0.08	0.15
GMNH 4457.16	-2.05	-0.49	0.08	0.15
GMNH 4457.17	-1.03	-0.85	0.08	0.15
GMNH 4457.18	-0.74	-1.23	0.08	0.15
GMNH 4457.19	-1.33	-1.75	0.08	0.15
GMNH 4457.20	-2.60	-1.39	0.08	0.15
GMNH 4457.21	-1.91	-1.24	0.08	0.15
GMNH 4457.22	-2.36	-1.31	0.08	0.15
GMNH 4457.23	-2.77	-1.48	0.08	0.15
GMNH 4457.24	-3.72	-1.40	0.08	0.15
GMNH 4457.25	-4.35	-1.24	0.08	0.15
GMNH 4457.26	-4.94	-1.34	0.08	0.15
GMNH 4457.27	-4.71	-1.52	0.08	0.15

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
GMNH 4457.28	-4.99	-1.20	0.08	0.15
GMNH 4457.29	-5.28	-1.26	0.08	0.15
GMNH 4457.30	-5.03	-1.48	0.08	0.15
GMNH 1732.1	-3.48	-1.01	0.08	0.15
GMNH 1732.2	-3.74	-0.54	0.08	0.15
GMNH 1732.3	-3.31	-0.67	0.08	0.15
GMNH 1732.4	-3.59	-0.71	0.05	0.13
GMNH 1732.5	-3.64	-0.56	0.05	0.13
GMNH 1732.6	-3.89	-0.39	0.05	0.13
GMNH 1732.7	-3.76	-0.71	0.05	0.13
GMNH 1732.8	-4.13	-0.42	0.05	0.13
GMNH 1732.9	-4.45	-0.23	0.05	0.13
GMNH 1732.10	-3.85	-1.27	0.05	0.13
GMNH 1732.11	-4.01	-0.21	0.05	0.13
GMNH 1732.12	-3.87	-1.33	0.05	0.13
GMNH 1732.13	-4.16	-0.20	0.05	0.13
GMNH 1732.14	-3.46	-0.27	0.05	0.13
GMNH 1732.15	-2.72	-0.95	0.05	0.13
GMNH 1732.16	-2.21	-1.14	0.05	0.13
GMNH 1732.17	-1.59	-1.11	0.05	0.13
GMNH 1732.18	-1.19	-0.79	0.05	0.13
GMNH 1732.19	-3.12	0.47	0.05	0.13
GMNH 1732.20	-2.30	-0.11	0.05	0.13
GMNH 1732.21	-1.58	-1.26	0.05	0.13
GMNH 1732.22	-1.73	-1.25	0.05	0.13
GMNH 1732.23	-2.27	-1.20	0.05	0.13
GMNH 1732.24	-2.81	-1.24	0.05	0.13
GMNH 1732.25	-2.82	-0.72	0.05	0.13
GMNH 1732.26	-2.53	-0.21	0.05	0.13
GMNH 1732.27	-1.77	-0.76	0.05	0.13
GMNH 1732.28	-1.74	-1.31	0.05	0.13
GMNH 1732.29	-2.27	-1.48	0.05	0.13
GMNH 1732.30	-2.40	-1.70	0.05	0.13
GMNH 1732.31	-3.69	-1.56	0.05	0.13
GMNH 1732.32	—	—	—	—
GMNH 1732.33	-6.07	-2.35	0.05	0.13
GMNH 4269.1	-4.28	-0.49	0.05	0.13
GMNH 4269.2	-2.82	-0.22	0.05	0.13
GMNH 4269.3	-2.16	-0.06	0.05	0.13
GMNH 4269.4	-2.98	-0.23	0.05	0.13
GMNH 4269.5	-1.42	-0.58	0.05	0.13
GMNH 4269.6	-2.09	0.31	0.05	0.13

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
GMNH 4269.7	-2.71	0.01	0.05	0.13
GMNH 4269.8	-1.28	-0.40	0.05	0.13
GMNH 4269.9	-1.39	-0.32	0.05	0.13
GMNH 4269.10	-1.21	0.01	0.05	0.13
GMNH 4269.11	-2.12	0.20	0.05	0.13
GMNH 4269.12	-1.97	-0.22	0.05	0.13
GMNH 4269.13	-4.23	-0.25	0.05	0.13
GMNH 4269.14	-5.26	-0.70	0.05	0.13
GMNH 4269.15	-5.45	-1.01	0.05	0.13
GMNH 4269.16	-6.03	-0.25	0.05	0.13
GMNH 4269.17	-6.11	0.11	0.05	0.13
GMNH 4269.18	-5.99	-0.15	0.05	0.13
GMNH 4269.19	-6.40	-0.75	0.05	0.13
GMNH 4269.20	-6.81	-1.45	0.05	0.13
GMNH 4269.21	-6.25	-1.04	0.05	0.13
GMNH 4269.22	-6.26	-1.17	0.05	0.13
GMNH 4269.23	-6.19	-0.96	0.05	0.13
GMNH 4269.24	-6.13	-0.58	0.05	0.13
GMNH 4269.25	-6.36	-0.99	0.05	0.13
GMNH 4269.26	-6.04	-2.05	0.06	0.09
GMNH 4269.27	-5.82	-1.79	0.06	0.09
GMNH 4269.28	-5.98	-1.40	0.06	0.09
GMNH 4269.29	-6.28	-1.59	0.06	0.09
GMNH 4269.30	-6.35	-1.57	0.06	0.09
FLMNH 11162.1	-3.29	-1.68	0.06	0.09
FLMNH 11162.2	-3.06	-0.19	0.06	0.09
FLMNH 11162.3	-2.84	-0.64	0.06	0.09
FLMNH 11162.4	-3.14	-0.24	0.06	0.09
FLMNH 11162.5	-3.48	-0.44	0.06	0.09
FLMNH 11162.6	-3.53	-0.42	0.06	0.09
FLMNH 11162.7	-3.33	-0.59	0.06	0.09
FLMNH 11162.8	-3.82	-0.28	0.06	0.09
FLMNH 11162.9	-3.34	-1.09	0.06	0.09
FLMNH 11162.10	-3.03	-1.08	0.06	0.09
FLMNH 11162.11	-2.79	-1.48	0.06	0.09
FLMNH 11162.12	-3.03	-0.10	0.06	0.09
FLMNH 11162.13	-2.28	-1.00	0.06	0.09
FLMNH 11162.14	-2.57	-1.52	0.06	0.09
FLMNH 11162.15	-2.96	-1.60	0.06	0.09
FLMNH 11162.16	-3.12	-1.47	0.06	0.09
FLMNH 11162.17	-3.31	-1.26	0.06	0.09
FLMNH 11162.18	-3.08	-0.56	0.06	0.09

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
FLMNH 11162.19	-2.90	0.13	0.06	0.09
FLMNH 11162.20	-2.78	0.04	0.06	0.09
FLMNH 11162.21	-1.94	-1.29	0.06	0.09
FLMNH 11162.22	-2.93	-2.24	0.06	0.09
FLMNH 11162.23	-4.08	-2.90	0.06	0.09
FLMNH 11162.24	-4.20	-2.38	0.06	0.09
FLMNH 11162.25	-5.26	-2.46	0.06	0.09
FLMNH 11162.26	-5.39	-2.32	0.06	0.09
FLMNH 11162.27	-5.78	-2.06	0.06	0.09
FLMNH 11162.28	-6.27	-1.85	0.06	0.09
FLMNH 11271.1	-1.46	-1.47	0.06	0.09
FLMNH 11271.2	-1.92	-0.74	0.06	0.09
FLMNH 11271.3	-1.77	-0.46	0.06	0.09
FLMNH 11271.4	-1.68	-0.36	0.06	0.09
FLMNH 11271.5	-1.43	-0.47	0.06	0.09
FLMNH 11271.6	-1.87	-0.26	0.06	0.09
FLMNH 11271.7	-2.27	-0.50	0.06	0.09
FLMNH 11271.8	-1.54	-1.71	0.06	0.09
FLMNH 11271.9	-1.91	-0.60	0.06	0.09
FLMNH 11271.10	-3.33	-0.14	0.06	0.09
FLMNH 11271.11	-2.87	-0.93	0.06	0.09
FLMNH 11271.12	-1.34	-1.59	0.06	0.09
FLMNH 11271.13	-1.84	-1.48	0.06	0.09
FLMNH 11271.14	-2.96	-0.94	0.06	0.09
FLMNH 11271.15	-3.08	0.03	0.06	0.09
FLMNH 11271.16	-2.83	-0.93	0.06	0.09
FLMNH 11271.17	-2.49	-1.28	0.06	0.09
FLMNH 11271.18	-2.22	-1.40	0.06	0.09
FLMNH 11271.19	-2.28	-1.12	0.06	0.09
FLMNH 11271.20	-2.56	-0.78	0.05	0.10
FLMNH 11271.21	-2.62	-0.48	0.05	0.10
FLMNH 11271.22	-2.70	-0.45	0.05	0.10
FLMNH 11271.23	-2.79	-0.26	0.05	0.10
FLMNH 11271.24	-1.97	-0.79	0.04	0.11
FLMNH 11271.25	-1.68	-1.39	0.04	0.11
FLMNH 11271.26	-2.15	-1.73	0.04	0.11
FLMNH 11271.27	-2.37	-1.93	0.04	0.11
FLMNH 11271.28	-2.70	-1.92	0.04	0.11
FLMNH 11271.29	-2.99	-2.17	0.04	0.11
FLMNH 11271.30	-3.35	-2.60	0.04	0.11
FLMNH 11341.1	-3.84	-1.18	0.04	0.11
FLMNH 11341.2	-3.09	-0.34	0.04	0.11

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
FLMNH 11341.3	-3.30	-0.37	0.08	0.15
FLMNH 11341.4	-2.89	-0.29	0.08	0.15
FLMNH 11341.5	-2.31	-0.11	0.08	0.15
FLMNH 11341.6	-2.65	-0.36	0.08	0.15
FLMNH 11341.7	-3.51	-0.18	0.08	0.15
FLMNH 11341.8	-3.24	-0.40	0.08	0.15
FLMNH 11341.9	-2.56	-0.58	0.08	0.15
FLMNH 11341.10	-2.41	-0.32	0.08	0.15
FLMNH 11341.11	-2.69	-0.42	0.08	0.15
FLMNH 11341.12	-2.70	-0.66	0.08	0.15
FLMNH 11341.13	-2.82	-0.99	0.08	0.15
FLMNH 11341.14	-2.81	-1.32	0.08	0.15
FLMNH 11341.15	-3.21	-1.35	0.08	0.15
FLMNH 11341.16	-3.12	-1.50	0.08	0.15
FLMNH 11341.17	-3.05	-1.44	0.08	0.15
FLMNH 11341.18	-3.30	-0.33	0.08	0.15
FLMNH 11341.19	-3.00	-0.21	0.08	0.15
FLMNH 11341.20	-2.43	-1.02	0.08	0.15
FLMNH 11341.21	-2.97	-1.75	0.08	0.15
FLMNH 11341.22	-3.19	-1.87	0.08	0.15
FLMNH 11341.23	-3.88	-2.07	0.08	0.15
FLMNH 11341.24	-4.63	-2.10	0.08	0.15
FLMNH 11341.25	-4.87	-1.35	0.08	0.15
FLMNH 11341.26	-5.29	-1.36	0.08	0.15
FLMNH 11341.27	-5.41	-1.32	0.08	0.15
FLMNH 11341.28	-5.28	-1.38	0.08	0.15
GMNH 4472.1	-1.71	-1.02	0.05	0.10
GMNH 4472.2	-1.69	-0.91	0.05	0.10
GMNH 4472.3	-1.65	-0.88	0.05	0.10
GMNH 4472.4	-2.55	-0.15	0.05	0.10
GMNH 4472.5	-3.21	-1.13	0.05	0.10
GMNH 4472.6	-3.84	-1.46	0.05	0.10
GMNH 4472.7	-3.24	-1.88	0.05	0.10
GMNH 4472.8	-3.99	-1.81	0.05	0.10
GMNH 4472.9	-4.86	-1.00	0.05	0.10
GMNH 4472.10	-4.93	-0.45	0.05	0.10
GMNH 4472.11	-5.09	0.21	0.05	0.10
GMNH 4472.12	-4.53	0.26	0.05	0.10
GMNH 4472.13	-3.90	-0.20	0.05	0.10
GMNH 4472.14	-3.50	-0.34	0.05	0.10
GMNH 4472.15	-3.06	-0.53	0.05	0.10
GMNH 4472.16	-3.00	-0.76	0.05	0.10

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
GMNH 4472.17	-2.28	-1.18	0.05	0.10
GMNH 4472.18	-2.71	-1.36	0.05	0.10
GMNH 4472.19	-3.04	-1.58	0.05	0.10
GMNH 4472.20	-3.61	-1.65	0.05	0.10
GMNH 4472.21	-4.11	-1.76	0.05	0.10
GMNH 4472.22	-4.71	-1.76	0.05	0.10
GMNH 4472.23	-5.46	-1.55	0.05	0.10
GMNH 4470.1	-4.87	-1.09	0.05	0.10
GMNH 4470.2	-4.83	-0.09	0.05	0.10
GMNH 4470.3	-4.86	-0.37	0.05	0.10
GMNH 4470.4	-4.72	-0.22	0.05	0.10
GMNH 4470.5	-4.68	-0.31	0.05	0.10
GMNH 4470.6	-4.68	-0.85	0.05	0.10
GMNH 4470.7	-4.26	-0.63	0.05	0.10
GMNH 4470.8	-4.19	-0.53	0.05	0.10
GMNH 4470.9	-3.77	-0.40	0.05	0.10
GMNH 4470.10	-3.99	-0.17	0.05	0.10
GMNH 4470.11	-3.82	-0.28	0.03	0.11
GMNH 4470.12	-2.48	-0.28	0.03	0.11
GMNH 4470.13	-2.34	-0.16	0.05	0.10
GMNH 4470.14	-3.36	-0.68	0.03	0.11
GMNH 4470.15	-4.21	-0.27	0.03	0.11
GMNH 4470.16	-4.60	0.17	0.05	0.10
GMNH 4470.17	-4.10	0.31	0.05	0.10
GMNH 4470.18	-2.63	-0.16	0.03	0.11
GMNH 4470.19	-0.87	-0.50	0.05	0.10
GMNH 4470.20	-2.02	-0.27	0.05	0.10
GMNH 4470.21	-1.76	-0.41	0.03	0.11
GMNH 4470.22	-2.91	-0.26	0.05	0.10
GMNH 4470.23	-3.17	-0.26	0.03	0.11
GMNH 4470.24	-1.73	0.53	0.05	0.10
GMNH 4470.25	—	—	—	—
GMNH 4470.26	-2.11	0.51	0.05	0.10
GMNH 4470.27	-1.46	-0.14	0.05	0.10
GMNH 4470.28	-1.42	-0.60	0.03	0.11
GMNH 4470.29	-2.14	-0.68	0.03	0.11
GMNH 4470.30	-3.34	-0.78	0.03	0.11
GMNH 4470.31	-3.37	-0.97	0.03	0.11
GMNH 4470.32	-4.72	-1.16	0.03	0.11
GMNH 4470.33	-6.11	-1.29	0.03	0.11
GMNH 4470.34	-6.49	-0.70	0.03	0.11
GMNH 4295.1	-2.61	-0.09	0.04	0.11

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
GMNH 4295.2	-2.82	-0.01	0.04	0.11
GMNH 4295.3	-3.13	0.01	0.04	0.11
GMNH 4295.4	-2.29	-0.05	0.04	0.11
GMNH 4295.5	-2.53	0.00	0.04	0.11
GMNH 4295.6	-3.25	0.25	0.04	0.11
GMNH 4295.7	-2.63	-0.23	0.04	0.11
GMNH 4295.8	-3.35	-0.01	0.04	0.11
GMNH 4295.9	-2.89	-0.55	0.04	0.11
GMNH 4295.10	-3.83	0.16	0.04	0.11
GMNH 4295.11	-3.21	-0.66	0.04	0.11
GMNH 4295.12	-2.65	-0.38	0.04	0.11
GMNH 4295.13	-3.00	-0.71	0.04	0.11
GMNH 4295.14	-3.38	-0.58	0.04	0.11
GMNH 4295.15	-4.19	-0.58	0.04	0.11
GMNH 4295.16	-3.80	-0.68	0.04	0.11
GMNH 4295.17	-3.85	-0.55	0.04	0.11
GMNH 4295.18	-3.91	-0.49	0.04	0.11
GMNH 4295.19	-3.55	-0.42	0.04	0.11
GMNH 4295.20	-3.45	-0.14	0.04	0.11
GMNH 4295.21	-3.24	0.01	0.04	0.11
GMNH 4295.22	-2.96	0.13	0.04	0.11
GMNH 4295.23	-2.57	-0.04	0.04	0.11
GMNH 4295.24	-2.76	0.13	0.04	0.11
GMNH 4295.25	-2.83	0.35	0.04	0.11
GMNH 4295.26	-2.97	0.08	0.04	0.11
GMNH 4295.27	-3.15	0.16	0.04	0.11
GMNH 4295.28	-3.02	0.21	0.04	0.11
GMNH 4295.29	-3.49	0.32	0.04	0.11
GMNH 4295.30	-3.73	0.17	0.04	0.11
GMNH 4295.31	-3.66	0.11	0.04	0.11
GMNH 4295.32	-3.81	0.00	0.04	0.11
GMNH 4295.33	-3.72	0.22	0.04	0.11
GMNH 4295.34	-3.68	0.12	0.04	0.11
GMNH 4295.35	-3.90	0.16	0.04	0.11
GMNH 4469.1	-3.89	-0.94	0.04	0.11
GMNH 4469.2	-3.28	-0.93	0.04	0.11
GMNH 4469.3	-3.54	-0.35	0.04	0.11
GMNH 4469.4	-4.11	0.01	0.04	0.11
GMNH 4469.5	-3.72	-0.38	0.04	0.11
GMNH 4469.6	-3.93	0.08	0.04	0.11
GMNH 4469.7	-4.36	-0.13	0.04	0.11
GMNH 4469.8	-2.85	-1.08	0.04	0.11

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
GMNH 4469.9	-3.04	-1.16	0.04	0.11
GMNH 4469.10	-2.90	-0.70	0.04	0.11
GMNH 4469.11	-2.92	-0.22	0.04	0.11
GMNH 4469.12	-3.31	0.35	0.06	0.15
GMNH 4469.13	-2.60	0.06	0.06	0.15
GMNH 4469.14	-1.69	-0.86	0.06	0.15
GMNH 4469.15	-1.60	-0.79	0.06	0.15
GMNH 4469.16	-2.09	-0.58	0.06	0.15
GMNH 4469.17	-2.12	-0.32	0.06	0.15
GMNH 4469.18	-2.65	-0.38	0.06	0.15
GMNH 4469.19	-2.87	-0.53	0.06	0.15
GMNH 4469.20	-2.89	-0.33	0.06	0.15
GMNH 4469.21	-3.17	-0.50	0.04	0.11
GMNH 4469.22	-3.17	-0.37	0.06	0.15
GMNH 4469.23	-3.02	-0.61	0.06	0.15
GMNH 4469.24	-2.68	-1.71	0.06	0.15
GMNH 4469.25	-2.92	-1.47	0.06	0.15
GMNH 4469.26	-2.58	-1.61	0.06	0.15
GMNH 4469.27	-3.09	-1.66	0.06	0.15
GMNH 4469.28	-3.23	-1.63	0.06	0.15
GMNH 4469.29	-4.23	-1.93	0.06	0.15
GMNH 4469.30	-4.34	-2.05	0.06	0.15
GMNH 4469.31	-4.52	-2.10	0.06	0.15
GMNH 4469.32	-4.96	-2.29	0.06	0.15
GMNH 4469.33	-5.81	-2.05	0.06	0.15
GMNH 4469.34	-6.63	-2.42	0.06	0.15
GMNH 4468.1	-2.86	-0.46	0.06	0.15
GMNH 4468.2	-2.58	-0.28	0.06	0.15
GMNH 4468.3	-3.17	0.14	0.06	0.15
GMNH 4468.4	-2.81	-0.09	0.06	0.15
GMNH 4468.5	-2.90	-0.14	0.06	0.15
GMNH 4468.6	-2.81	-0.30	0.06	0.15
GMNH 4468.7	-3.12	0.06	0.06	0.15
GMNH 4468.8	-2.55	-0.32	0.06	0.15
GMNH 4468.9	-4.24	0.43	0.06	0.15
GMNH 4468.10	-2.46	-0.46	0.06	0.15
GMNH 4468.11	-2.86	-0.16	0.06	0.15
GMNH 4468.12	-1.96	-0.21	0.06	0.15
GMNH 4468.13	-2.26	-0.24	0.06	0.15
GMNH 4468.14	-2.45	0.05	0.06	0.15
GMNH 4468.15	-2.79	-0.21	0.06	0.15
GMNH 4468.16	-1.92	-0.95	0.06	0.15

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
GMNH 4468.17	-1.78	-0.91	0.06	0.15
GMNH 4468.18	-2.20	-0.69	0.06	0.15
GMNH 4468.19	-1.83	-0.37	0.06	0.15
GMNH 4468.20	-1.92	-0.50	0.06	0.15
GMNH 4468.21	-1.89	0.12	0.06	0.15
GMNH 4468.22	-1.69	-0.20	0.06	0.15
GMNH 4468.23	-0.58	-0.49	0.06	0.15
GMNH 4468.24	-1.30	-0.58	0.06	0.15
GMNH 4468.25	-1.57	-0.44	0.06	0.15
GMNH 4468.26	-1.81	-0.54	0.06	0.15
GMNH 4468.27	-1.85	-0.19	0.06	0.15
GMNH 4468.28	-1.97	0.07	0.06	0.15
GMNH 4468.29	-1.81	0.08	0.06	0.15
GMNH 4468.30	-1.85	-0.25	0.06	0.15
GMNH 4468.31	-2.30	-0.20	0.06	0.15
GMNH 4468.32	-2.59	-0.56	0.06	0.15
GMNH 4468.33	-2.78	-0.96	0.06	0.15
GMNH 4468.34	-3.17	-0.97	0.06	0.15
GMNH 4468.35	-3.36	-1.24	0.06	0.15
GMNH 1075.1	-2.24	1.74	0.04	0.08
GMNH 1075.2	-3.00	0.96	0.04	0.08
GMNH 1075.3	-2.86	0.84	0.04	0.08
GMNH 1075.4	-3.14	0.19	0.04	0.08
GMNH 1075.5	-2.86	-0.72	0.04	0.08
GMNH 1075.6	-2.88	-0.70	0.04	0.08
GMNH 1075.7	-1.64	-2.05	0.04	0.08
GMNH 1075.8	-1.54	-2.29	0.04	0.08
GMNH 1075.9	-1.47	-2.73	0.04	0.08
GMNH 1075.10	-1.53	-3.08	0.04	0.08
GMNH 1075.11	-1.60	-3.03	0.04	0.08
GMNH 1075.12	-2.78	-3.90	0.04	0.08
GMNH 1075.13	-3.25	-4.31	0.04	0.08
GMNH 1075.14	-4.52	-4.62	0.04	0.08
GMNH 1075.15	-4.73	-4.72	0.04	0.08
GMNH 1075.16	-4.65	-4.71	0.04	0.08
GMNH 4475.1	-2.75	1.19	0.08	0.15
GMNH 4475.2	-3.26	1.34	0.08	0.15
GMNH 4475.3	-3.60	0.90	0.08	0.15
GMNH 4475.4	-4.43	-0.43	0.08	0.15
GMNH 4475.5	-4.88	-0.78	0.08	0.15
GMNH 4475.6	-5.15	-1.02	0.08	0.15
GMNH 4475.7	-5.12	-1.34	0.08	0.15

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
GMNH 4475.8	-4.53	-0.85	0.08	0.15
GMNH 4458.1	-2.36	0.05	0.05	0.13
GMNH 4458.2	-1.19	1.04	0.05	0.13
GMNH 4458.3	-2.69	0.42	0.05	0.13
GMNH 4458.4	-1.96	0.17	0.05	0.13
GMNH 4458.5	-2.58	0.43	0.05	0.13
GMNH 4458.6	-2.40	0.37	0.05	0.13
GMNH 4458.7	-2.53	0.67	0.05	0.13
GMNH 4458.8	-2.41	0.48	0.05	0.13
GMNH 4458.9	-2.69	0.27	0.05	0.13
GMNH 4458.10	-2.85	-0.15	0.05	0.13
GMNH 4458.11	-3.19	-0.35	0.05	0.13
GMNH 4458.12	-3.35	-0.56	0.05	0.13
GMNH 4458.13	-3.18	-0.88	0.05	0.13
GMNH 4458.14	-2.66	-0.64	0.05	0.13
GMNH 4458.15	-2.83	-0.74	0.05	0.13
GMNH 4458.16	-3.24	-0.91	0.05	0.13
GMNH 4458.17	-3.12	-0.74	0.05	0.13
GMNH 4458.18	-3.18	-0.66	0.05	0.13
GMNH 4458.19	-3.63	-1.06	0.05	0.13
GMNH 4458.20	-5.42	-1.42	0.05	0.13
GMNH 3762.1	-2.37	0.18	0.06	0.09
GMNH 3762.2	-1.81	0.55	0.06	0.09
GMNH 3762.3	-1.98	-1.13	0.06	0.09
GMNH 3762.4	-1.76	-2.53	0.06	0.09
GMNH 3762.5	-2.55	0.17	0.06	0.09
GMNH 3762.6	-2.40	-0.50	0.06	0.09
GMNH 3762.7	-2.59	-0.21	0.06	0.09
GMNH 3762.8	-2.84	0.95	0.06	0.09
GMNH 3762.9	-3.64	-1.48	0.06	0.09
GMNH 3762.10	-4.69	-2.75	0.06	0.09
GMNH 3762.11	-4.35	-3.20	0.06	0.09
GMNH 3762.12	-4.50	-3.41	0.06	0.09
GMNH 3762.13	-4.73	-3.45	0.06	0.09
GMNH 3762.14	-4.49	-3.27	0.06	0.09
GMNH 3762.15	-3.77	-2.74	0.06	0.09
GMNH 4462.1	-1.90	-1.08	0.06	0.09
GMNH 4462.2	-2.13	0.31	0.06	0.09
GMNH 4462.3	-2.59	1.09	0.06	0.09
GMNH 4462.4	-3.15	-0.66	0.06	0.09
GMNH 4462.5	-3.46	-1.23	0.06	0.09
GMNH 4462.6	-4.06	-1.21	0.06	0.09

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
GMNH 4462.7	-5.61	-2.01	0.06	0.09
GMNH 4462.8	-8.58	-3.44	0.06	0.09
GMNH 4462.9	-10.89	-4.30	0.06	0.09
GMNH 4462.10	-11.02	-4.19	0.06	0.09
GMNH 4462.11	-8.36	-3.14	0.06	0.09
GMNH 4462.12	-6.32	-1.61	0.06	0.09
GMNH 4462.13	-6.92	-0.51	0.06	0.09
FLMNH 11318.1	-1.69	-1.80	0.08	0.15
FLMNH 11318.2	-1.50	-1.87	0.08	0.15
FLMNH 11318.3	-1.50	-1.56	0.08	0.15
FLMNH 11318.4	-1.67	-1.42	0.08	0.15
FLMNH 11318.5	-2.10	-1.33	0.08	0.15
FLMNH 11318.6	-2.36	-1.37	0.08	0.15
FLMNH 11318.7	-2.49	-1.66	0.08	0.15
FLMNH 11318.8	-1.96	-1.11	0.08	0.15
FLMNH 11318.9	-2.02	-1.06	0.08	0.15
FLMNH 11318.10	-2.30	-1.12	0.08	0.15
FLMNH 11318.11	-2.66	-1.74	0.08	0.15
FLMNH 11318.12	-3.18	-2.29	0.08	0.15
FLMNH 11318.13	-3.60	-2.34	0.08	0.15
FLMNH 11313.1	-2.44	-1.91	0.05	0.10
FLMNH 11313.2	-2.47	-1.38	0.05	0.10
FLMNH 11313.3	-2.52	-1.14	0.05	0.10
FLMNH 11313.4	-2.65	-1.13	0.05	0.10
FLMNH 11313.5	-2.64	-0.73	0.05	0.10
FLMNH 11313.6	-2.36	-0.65	0.05	0.10
FLMNH 11313.7	-2.78	-0.95	0.05	0.10
FLMNH 11313.8	-2.97	-0.98	0.05	0.10
FLMNH 11313.9	-2.86	-0.14	0.05	0.10
FLMNH 11313.10	-2.78	0.35	0.05	0.10
FLMNH 11313.11	-2.66	0.67	0.05	0.10
FLMNH 11319.1	-1.73	-1.94	0.05	0.10
FLMNH 11319.2	-2.30	-1.99	0.05	0.10
FLMNH 11319.3	-1.99	-1.18	0.05	0.10
FLMNH 11319.4	-2.26	-1.16	0.05	0.10
FLMNH 11319.5	-2.45	-1.07	0.05	0.10
FLMNH 11319.6	-2.80	-1.71	0.05	0.10
FLMNH 11319.7	-2.98	-1.59	0.05	0.10
FLMNH 11319.8	-4.04	-1.45	0.05	0.10
FLMNH 11319.9	-6.30	-1.91	0.05	0.10
GMNH 4473.1	-3.76	-1.45	0.03	0.11
GMNH 4473.2	-3.48	-1.71	0.03	0.11

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
GMNH 4473.3	-3.61	-2.02	0.03	0.11
GMNH 4473.4	-3.93	-2.22	0.05	0.10
GMNH 4473.5	-4.16	-1.92	0.03	0.11
GMNH 4473.6	-4.53	-2.02	0.03	0.11
GMNH 4473.7	-5.21	-1.89	0.03	0.11
GMNH 4473.8	-6.05	-2.24	0.05	0.10
GMNH 4473.9	-6.94	-2.79	0.03	0.11
GMNH 4473.10	-8.25	-2.24	0.03	0.11
GMNH 4473.11	-5.32	-0.24	0.03	0.11
GMNH 4473.12	-5.33	0.08	0.03	0.11
GMNH 4474.1	-2.39	-3.78	0.04	0.11
GMNH 4474.2	-2.40	-3.76	0.04	0.11
GMNH 4474.3	-2.66	-2.50	0.04	0.11
GMNH 4474.4	-3.45	-1.45	0.04	0.11
GMNH 4474.5	-4.81	-3.30	0.04	0.11
GMNH 4474.6	-5.07	-3.86	0.04	0.11
GMNH 4474.7	-4.97	-1.41	0.05	0.10
GMNH 4474.8	-4.43	-4.23	0.04	0.11
GMNH 4474.9	-4.63	-4.17	0.04	0.11
GMNH 4474.10	-4.58	-4.32	0.04	0.11
GMNH 4474.11	-4.45	-3.76	0.04	0.11
GMNH 4474.12	-4.50	-1.16	0.04	0.11
GMNH 4474.13	-5.00	-0.34	0.04	0.11
GMNH 4471.1	-1.67	-0.94	0.04	0.11
GMNH 4471.2	-2.08	-0.96	0.04	0.11
GMNH 4471.3	-2.28	-1.16	0.04	0.11
GMNH 4471.4	-2.87	-1.32	0.04	0.11
GMNH 4471.5	-3.52	-1.44	0.04	0.11
GMNH 4471.6	-3.54	-1.34	0.04	0.11
GMNH 4471.7	-3.62	-1.11	0.04	0.11
GMNH 4471.8	-3.59	-0.49	0.04	0.11
GMNH 4471.9	-3.77	-0.79	0.04	0.11
GMNH 4476.1	-2.25	-1.04	0.04	0.11
GMNH 4476.2	-2.65	-0.91	0.04	0.11
GMNH 4476.3	-3.04	-1.28	0.04	0.11
GMNH 4476.4	-3.38	-1.35	0.04	0.11
GMNH 4476.5	-3.90	-1.98	0.04	0.11
GMNH 4476.6	-4.22	-2.03	0.04	0.11
GMNH 4476.7	-4.44	-2.03	0.04	0.11
GMNH 4476.8	-4.73	-1.87	0.04	0.11
GMNH 4476.9	-4.79	-1.69	0.04	0.11
GMNH 4476.10	-4.97	-1.71	0.04	0.11

APPENDIX I—(*Continued*)

Sample Number	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$ Precision	$\delta^{18}O$ Precision
GMNH 4476.11	-5.19	-1.68	0.04	0.11
GMNH 4476.12	-5.33	-1.79	0.04	0.11
GMNH 4476.13	-5.87	-1.65	0.04	0.11