EXAMINING 5,000 YEARS OF HARVEST PATTERNS OF THE EASTERN OYSTER VIA SCLEROCHRONOLOGY ON OSSABAW ISLAND, GEORGIA

by

SOPHIE GRACE FORBES

(Under the Direction of Victor D. Thompson)

ABSTRACT

In this thesis, I assess how oyster harvesting practices changed on Ossabaw Island over ca. 5,000 years from the Late Archaic (ca. 3000 BC) to the Plantation Period (AD 1861). I present the results of incremental oxygen isotope ($\delta^{18}O$) analysis on oyster shell samples from four sites, determining how harvesting patterns changed through time via season of collection and range of habitat extraction. I found that Indigenous communities harvested oysters primarily in the winter and secondarily throughout the year, and extensively throughout estuaries for ca. 5,000 years. Conversely, enslaved individuals harvested oysters during the winter/spring transition and likely at one open ocean location close to the plantation core. This demonstrates that oyster harvesting practices changed Post-Contact from extensive to intensive, owing to the different social circumstances that governed oyster harvest and collection. This data can be used to inform contemporary oyster reef management on the Georgia coast.

INDEX WORDS: Archaeology, Georgia Coast, Ossabaw Island, Human-Environmental Interactions, Stable Isotope Geochemistry, Sclerochronology

EXAMINING 5,000 YEARS OF HARVEST PATTERNS OF THE EASTERN OYSTER VIA SCLEROCHRONOLOGY ON OSSABAW ISLAND, GEORGIA

by

SOPHIE GRACE FORBES

B.A., The University of Georgia, 2024

B.A., The University of Georgia, 2024

A Thesis Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment of the Requirements for the Degree

MASTER OF ARTS

ATHENS, GEORGIA

2025

EXAMINING 5,000 YEARS OF HARVEST PATTERNS OF THE EASTERN OYSTER VIA SCLEROCHRONOLOGY ON OSSABAW ISLAND, GEORGIA

by

SOPHIE GRACE FORBES

Major Professor:	Victor D. Thompson
Committee:	Carey J. Garland
	Brita E. Lorentzen
	Suzanne Pilaar Birch

Electronic Version Approved:

Ron Walcott
Vice Provost for Graduate Education and Dean of the Graduate School
The University of Georgia
May 2025

ACKNOWLEDGEMENTS

This thesis is a culmination of work I completed first as an undergraduate student intern at the Georgia Museum of Natural History, secondly as an undergraduate researcher affiliated with the UGA Center for Undergraduate Research Opportunities and Morehead Honors College, and lastly as a master’s student. I am indebted to Dr. Victor Thompson for first taking me on as a student intern in spring 2022 and allowing me to keep extending my time working with him on this project, accumulating lots of data and a hefty bill for all the stable isotope samples I ran! I am so grateful for his confidence and trust in me as a researcher, which I hope I have strengthened over the past three years. I also hope that I can live up to the prestigious title of being Victor’s former student.

I would like to profusely thank Dr. Carey Garland for also being with me since the beginning of this project back in spring 2022. Carey trained me on every step of this project, from selecting oyster samples to using the benchtop micromill to filling out the paperwork for CAIS and even interpreting the first data I got back. Without Carey’s expertise, patience, and kindness, there would’ve been no thesis.

Thank you to my committee members, Dr. Brita Lorentzen and Dr. Suzie Birch, for your guidance and insightful comments on my research. I hope that my work reflects the suggestions you have made to improve it.

I am thankful for the funding I have received to complete this project, including the Joshua Laerm Academic Support Fund from the Georgia Museum of Natural History, a UGA Center for Undergraduate Research Opportunities research award, and the Claude C. Albritton,

Jr. Award from the Geological Society of America Geoarchaeology Division, as well as funds from Dr. Victor Thompson's Georgia Coastal Ecosystems LTER project National Science Foundation grants.

I am very excited to thank Brett, Marcie, and Chris for being my mentors at the UGA Laboratory of Archaeology and quickly welcoming me in as a fellow student of Victor's. I would also like to acknowledge Bronwyn as my fellow cohort member in the M.A. Anthropology Double Dawgs class of 2025 and thank her for all the support and kindness that comes along with being her friend. There is nobody I would rather have by my side when completing this program. I am an only child, but I would consider Brett, Marcie, Chris, and Bronwyn my older siblings at the Lab.

Thank you to all of my mentors and friends at the UGA Laboratory of Archaeology and Department of Anthropology. A special thank you to the University of Georgia's 2016 and 2022 Field Schools (very well-excavated by Brett, Marcie, and Bronwyn, among others) for collecting the cultural material I analyzed for this research.

And lastly, thank you to my mom and Alex for supporting me through everything! Every poster presentation you watched, email you proofread, practice run of a talk you sat through, figure you looked at, all of the hours and hours you put into helping me through undergraduate and graduate school could never be paid back except with a heartfelt thank you.

TABLE OF CONTENTS

Page

CHAPTER

APPENDICES

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION AND RESEARCH DESIGN

1.1 Project Background

Human adaptation to coastal environments and concomitant settling along shorelines is a key transition in human history (Erlandson 2001; Thompson et al. 2024a; Will et al. 2019). Beginning in the Late Pleistocene in Africa and Eurasia and the Early Holocene in the Americas, humans began living in semi-settled communities while relying on coastal resources (Erlandson et al. 2019; Singh and Glowacki 2021). Arguably, the emergence of sedentary communities is the first instance of resource management issues in human history because co-residence can catalyze challenges in provisioning (Thompson 2018:21; e.g., Ford and Nigh 2023). Feeding a growing and sedentary population can be difficult, especially considering the nature of coastal resources (i.e., common pool resources that are characterized by ease of overexploitation) that these early settled communities relied upon (Ghorbani and Bravo 2016:202-203). Resource management likely transformed human-environmental interactions such that interactions became potentially higher in impact to the environment and humans, long-ranging, and institutionalized. Examining coastal resource management in the archaeological record allows researchers to explore the origins and development of these unique human-environmental interactions.

Shell middens are excellent features to examine coastal resource use in the archaeological record as their ubiquity and preservation make them easy to research and the information found within speaks to topics of interdisciplinary significance, such as human coastal adaptations and anthropogenic impacts on coastal organisms and environments (Rick 2023a:310-311). Shell middens are deposits of predominantly shell (by volume) that represent the accumulation of byproducts of domestic shellfish consumption (Marquardt 2017; Thompson and Worth 2011:57-58, 63). These features also often contain other ecofacts (e.g., fish bone, otoliths), artifacts (e.g., pottery sherds), and sediments (Thompson and Worth 2011:62-63). Oysters in particular are a great analytical tool for studying shell middens as demonstrated by archaeological studies in Asia, Europe, and North America (e.g., Jenkins and Gallivan 2024; Milner 2013; Rick et al. 2016; Yamazaki and Oda 2009). For example, the decrease in shell size of oysters from Danish shell middens points to increasing human pressures on coastal resources at the Mesolithic-Neolithic transition, ca. 4000 BC (Milner 2013). Conversely, the maintenance in oyster shell size seen in Indigenous-constructed Chesapeake Bay shell middens points to sustainable harvesting across millennia (Jenkins and Gallivan 2024; Rick et al. 2016).

Eastern oysters (*Crassostrea virginica*) were an important food source and construction material for people living on the barrier islands of the South Atlantic Bight, including Ossabaw Island, for the duration of the islands' ≥5,000-year human history. Oysters filled a similar niche as domesticated plant species for South Atlantic coastal communities, being similarly abundant and spatially and temporally predictable resources from which surpluses could be generated (Lulewicz et al. 2017; Price and Brown 1985; Thomas 2014a; Thompson and Moore 2015). They are the most abundant fauna found in shell rings, shell midden mounds and sheets, and shell pits in the region across all time periods (Lulewicz et al. 2017; Reeder-Myers et al. 2022:3; Thompson 2018; Thompson et al. 2024a). In this thesis, I explore coastal resource management on Ossabaw Island through analyzing Eastern oysters from archaeological shell middens.

Intensive oyster harvesting began in the Late Archaic Period (ca. 3000–1150 BC) when Ossabaw Island was first settled by Indigenous (Ancestral Muskogean) peoples (Garland et al.

2024; Thompson and Turck 2010; Thompson et al. 2024a). While Indigenous groups likely made foraging excursions to Ossabaw prior to 3000 BC, the switch to living on the island year-round probably occurred as soon as oyster reefs could support sedentary populations due to sea level stabilization (Garland et al. 2024; Thompson and Turck 2010; Thompson et al. 2024a). The first permanent architecture in this region are shell ring villages (Cajigas et al. 2024; Thompson et al. 2024a, 2024b). Shell rings are large, circular to arcuate shaped deposits of predominantly shellfish that also include other faunal remains, botanical remains, lithics, and pottery sherds. Shell rings were built up around wooden houses that faced cleared interior central plazas (Cajigas et al. 2024; Thompson et al. 2024a, 2024b). During the Late Archaic Period, shell ring villages and associated shell midden mounds are the only site type found along the South Atlantic Bight (Turk and Thompson 2016).

Throughout the Woodland (1150 BC–AD 950) and Mississippian (AD 950–1580) Periods, Indigenous people continued to harvest oysters and use their shells for construction materials, but harvesting intensity changed in a non-continuous fashion following sea level fluctuations (Thompson and Turck 2009; Thompson et al. 2024a). Drops in sea level led to declines in oyster reef productivity, but environmental and archaeological data demonstrate that as soon as sea level rose and oyster reefs became productive again, oyster harvesting near-simultaneously rebounded (Thompson and Turck 2009; Thompson et al. 2020, 2024a, 2024b; Turck and Thompson 2016). For example, a precipitous drop in sea level beginning in the terminal Late Archaic Period and lasting into the Early Woodland Period likely reduced estuarine resource availability, which resulted in a decrease in population size and number of sites on the island as groups resettled upland (Thompson and Turck 2009, 2010; Turck and Thompson 2016, 2019). This trend reversed in the Early to Middle Woodland Periods as sea level increased and Indigenous groups resettled the island, intensively harvesting oysters once more as evidenced by the construction of large shell midden mounds, sheet middens, and shell pits (DePratter 1991; Garland et al. 2023; Parbus et al. 2023:274; Pearson 2014).

The increase in population size, number of sites, and intensification of oyster harvesting continued into the Mississippian Period as sea levels stabilized near modern levels; these favorable conditions resulted in an exponential increase in population and number of sites on the island (Pearson 2014; Thomas 2008; Turck and Thompson 2019:181-183). This demographic increase was supported by estuarine resources as evidenced by the presence of numerous shell middens at Mississippian sites, which sometimes number in the hundreds and likely averaged 1 m in height and 10 m in diameter before they were disturbed and scattered by Post-Contact (post-AD 1492) plowing and shell mining (Crook 1992; Keene 2004; Pearson 2014; Thompson et al. 2020:3). To illustrate the intensity of this oyster harvesting, if a hypothetical Late Mississippian Period site contained 100 shell middens, each covering an area of 10 m^2, then this would represent approximately 1.5 to 2 million oysters harvested over (maximally) a 255-year period (oysters per square meter estimate derived from Reeder-Myers et al. 2022:4). Intensive oyster harvesting continued even after the adoption of maize agriculture on the coast during the Middle Mississippian Period (ca. AD 1300) (Thomas 2014a; Turck and Thompson 2016).

Indigenous groups left Ossabaw Island under the threat of colonization ca. AD 1550; however, oysters continued to be important for the non-Indigenous communities that later repopulated Ossabaw (Jefferies and Moore 2013). During the Plantation Period (AD 1700–1866) oysters were harvested by Euroamerican and enslaved African and African American island inhabitants, entering the archaeological record via shell pits and shell middens. Indigenous shell constructions were also dug out to build tabby houses, dikes, and used for road fill, among other uses (Pearson 2014:12; Roberts Thompson 2020).

Oyster harvesting was so ubiquitous, and the use of oyster shells for construction so prevalent, that archaeologists have used the presence of oyster shells to determine the location of Indigenous and Post-Contact cultural sites for all time periods on Ossabaw during pedestrian surveys of the island (e.g., DePratter 1974; Pearson 2014:7,10). Oysters held and continue to hold cultural significance for Indigenous (Muscogee Nation) and Gullah-Geechee communities, demonstrating the past and present importance of this shellfish to Ossabaw Island's descendant communities (Pluckhahn and Thompson 2017; Reeder-Myers et al. 2022:4).

Eastern oysters are also an important component of the estuarine system of Ossabaw Island. In estuarine coastal ecosystems, oysters are considered keystone species as they offer a suite of ecosystem services, including the stabilization and expansion of marshes and the creation of a reef habitat that promotes aquatic diversity (Bahr and Lanier 1981; Coen et al. 1999, 2007; Dame 1993, 1996). Oyster reefs are an essential habitat for juvenile and adult fish and attract a wide variety of organisms, such as arthropods, gastropods, sponges, and other mollusks (Bahr and Lanier 1981; Coen et al. 1999). Oysters live within subtidal and intertidal zones, encompassing the estuarine rivers, tidal creeks, and beaches of Ossabaw Island (Crook 1992). In these locations, oysters thrive: spawning and oyster growth occurs in all seasons except winter, when water temperature drops below 20°C (Berrigen et al. 1991; Breuer 1962).

Garland and colleagues (2023:351) characterize the 5,000-year Indigenous human history of the Georgia coast by "near-continuous and accelerating population growth" and "significant shifts in political organization and settlement organization." To this I add dramatic changes in the environment, especially concerning sea level, which impacted oyster reef productivity (Turck and Thompson 2016). Despite striking demographic, sociopolitical, and environmental change, including Indigenous depopulation of the island and Euroamerican colonization, the importance of oysters to the communities of Ossabaw Island persisted for five millennia (Garland et al. 2023; Pluckhahn and Thompson 2017; Reeder-Myers et al. 2022; Thompson et al. 2020a, 2024b; Turck and Thompson 2016). Garland and Thompson (2023) argue that Indigenous oyster harvesting on Ossabaw Island was a sustainable socioecological system that ultimately collapsed following Euroamerican colonization (Garland et al. 2024; Thompson et al. 2020, 2024a). In order to understand how this coastal resource management scheme was sustainably maintained for 5,000 years despite immense human and environmental changes, and the eventual collapse of the system, there is a need for long-ranging, yet fine-grained data on oyster harvesting practices on Ossabaw Island. In particular, there is a need for specific data on oyster harvesting practices (i.e., season of harvest and extent of harvesting) of the Pre- and Post-Contact groups (i.e., Indigenous communities and enslaved community) that fished in the Ossabaw estuarine system throughout the island's human history.

1.2 Wider Implications

There are growing calls for archaeological projects that investigate human-environmental interactions to contextualize contemporary environmental challenges (e.g., climate change and resource overexploitation) and aid in advancing sustainable resource management solutions (i.e., conservation archaeobiology) (Rick 2023a, 2023b; Rick and Lockwood 2012). The idea is that archaeological data are important for understanding the "past, present, and future of Earth's ecosystems" (Reeder-Myers et al. 2022:1). Archaeological data bridge the temporal gap that exists between paleo- (e.g., paleoclimate, paleoecology, or pre-human) data and instrumental (i.e., Industrialization or ca. AD 1850 onwards) data and are well-suited to provide long-term perspectives on human-environmental interactions on the timespan of millennia (Dearing et al. 2006; Rick and Lockwood 2012). Archaeological data also engages with the sociocultural dimensions that influence resource management decision making of the past, which is relevant in contemporary management decisions (B. E. Lorentzen, pers. comm. 2025).

Recently, researchers have highlighted the need for long-term data in coastal ecosystems in particular (see Erlandson and Rick 2010; Jackson et al. 2001; Rick 2023b). Worldwide, estuarine systems are in a state of decline and oyster reef fisheries along the Atlantic Coast are facing collapse spurred by commercial overharvesting that began in the late 1800s, as well as pollution, disease, and modern climate change (Kirby 2004; Jackson et al. 2001; Reeder-Myers et al. 2022; Rick et al. 2016). Current oyster reef management strategies rely on instrumental data gathered over the past 150 years and ecological data gathered over the past 70 years, which were measured after the onset of oyster reef collapse and therefore suffer from shifting baselines syndrome, which occurs when strategies are built on the assumption that well-documented post-collapse reefs are the baseline that ecologists should be attempting to restore instead of earlier, under-documented reefs (Jackson et al. 2001; Pauly 1995; Reeder-Myers et al. 2022). Attempting to determine the ‘natural’ state of equilibrium of the estuarine system or oyster reef fisheries based on short-term instrumental and ecological data is at best challenging and at worst problematic (Butler et al. 2019:218). The use of written records to reach back further in time can also prove questionable, as historical baseline data is often coarse, fragmentary, and prone to further distortion if adopted uncritically (Alagona et al. 2012:50).

Archaeological data helps ameliorate these issues. Reeder-Myers and colleagues (2022:1-2) argue that successful oyster reef management must include Indigenous histories and perspectives as they provide information on intensive, yet sustainable, oyster reef management that persisted for millennia (i.e., legacy effects) and better contextualize past conditions for restoration efforts. Furthermore, there is a need to understand the roots of oyster reef fishery collapse beginning with Euroamerican colonization, as the switch from an endogenous (i.e., place-based and observation-informed) coastal management system to an exogenous (i.e., not built upon local knowledge) one marked the end of the sustainable socioecological oyster harvesting system (Berkes et al. 2000; Garland and Thompson 2023). On Ossabaw Island, colonization and Euroamerican ownership of the island first occurs in the Plantation Period. There is currently sparse documentary information and no archaeological data on oyster harvesting practices during this time period.

1.3 Theoretical Background

Historical ecology is a research program designed to understand dynamic human-environmental interactions on multiple timescales (Balée 2006). The four postulates of historical ecology include: 1. practically all environments on Earth have been impacted by humans, 2. humans are not predetermined to degrade the environment, 3. sociopolitical, economic, and cultural characteristics of societies lead to them impacting the environment in different ways, and 4. human-environmental interactions may be studied as integrative phenomena (Balée 2006:76). Extending the fourth postulate, it is helpful to use a socioecological systems approach when studying human-environmental interactions. Whereas traditional perspectives viewed humans as external entities that exert pressure on the environment and the environment as an external force that impacts humans, the socioecological systems approach instead views both as coupled: the sociocultural dimension (involving the social, cultural, economic, and political spheres) and ecological dimension are inseparable, dependent components of an integrated whole that develop together through reciprocal relationships (Olmos-Martínez and Ortega-Rubio 2020). The interactions that occur between the two dimensions are dynamic, complex, and spatially and temporally heterogeneous (Olmos-Martínez and Ortega-Rubio 2020). While the sociocultural and ecological dimensions are integrated, they can also be separated for analytical purposes, aiding further research into a particular area of interest (Olmos-Martínez and Ortega-Rubio 2020). Employing historical ecology and the socioecological systems approach is useful for studying the complex human-environmental interactions in the archaeological record that occur from resource management.

Long before European colonization, Indigenous groups significantly altered the coastal landscapes in which they lived and fished (Jenkins and Gallivan 2020). Balée (2006:79) asserts that "humans created the landscapes typically referred to as examples of Holocene environments," and nowhere is this statement more relevant than Ossabaw Island, where some portions of the landscape were continuously occupied since their formation in the Holocene (Pearson 2014). Rick (2023b) argues that archaeological projects using historical ecological perspectives are the best at providing relevant data for contemporary conservation issues.

For this thesis, a combined historical ecology/socioecological systems perspective is used to understand the role of human agency in shaping oyster reef fisheries through time and the entangled human-environmental interactions occurring on the *longue durée* (Balée 2006). From this perspective, Indigenous sustainable resource management can still be understood as an impact on the environment even though it was not degradational, and impacts can be understood without need for intent in any particular direction (cf. Thomas 2014b).

1.4 Terminology Note

To be more respectful and humanizing to descendant communities when discussing their histories, I have employed a few language shifts in this thesis (Roberts Thompson et al. 2023).

Many of these language shifts were recommended to the University of Georgia's Laboratory of Archaeology by Tribal partners, namely partners from the Coushatta Tribe of Louisiana, Eastern Band of Cherokee Indians, Muscogee (Creek) Nation, and the Seminole Tribe of Florida (Roberts Thompson et al. 2023). Instead of using the term 'prehistoric', I have used the term 'Indigenous' or specified which time I am talking about by using periods (e.g., Late Mississippian Period) or used quantitative radiocarbon dates where available. Instead of using the term 'historic' I have either used the term 'Post-Contact' in reference to sites occupied after AD 1492 or to the subfield of archaeology that studies those sites, or 'written' in reference to records. I have replaced the term 'slave' with 'enslaved individuals' to emphasize that slavery is not an inherent state of being or identity, rather that enslavement was forced upon African and African American individuals by European and Euroamerican individuals (Browning-Mullis 2020). Instead of the term 'Antebellum Period' I use the term 'Plantation Period' to avoid any romanticizing elements the former might contain and emphasize the use of enslaved individuals' labor from AD 1700–1866. Instead of using terms like 'material culture' and 'archaeological site' I have used 'cultural material' and 'cultural site'. Derivates of the word 'archaeology' remain for clarity (e.g., when discussing the field of archaeology, distinguishing archaeological data from paleodata or documentary evidence, etc.). Instead of using the term 'discover' I have used the more neutral term 'encounter'. Instead of using the term 'populations' I have used the terms 'communities', 'groups', 'people', or 'individuals'. I have also attempted to emphasize the continued importance these cultural materials and sites have for the people of the Muscogee (Creek) Nation and the Gullah-Geechee community of the South Atlantic region.

1.5 Project Justification and Research Questions

Currently, research projects investigating oyster harvesting patterns are well-represented at the site level for singular time periods (e.g., Pumpkin Hammock, Sapelo Shell Ring Complex) and at the regional level across multiple time periods (e.g., South Atlantic Bight, Florida Gulf Coast) (Andrus and Thompson 2012; Garland and Thompson 2023; Garland et al. 2024; Holland-Lulewicz et al. 2019, 2020; Lulewicz et al. 2018; Thompson and Andrus 2013; Thompson et al. 2015, 2020, 2024a). However, there is a lack of research examining oyster harvesting across multiple time periods at one location (cf. Andrus and Crowe 2008). Finer-grained scales of temporal and spatial data allow for a better understanding of historical and ecological processes to contextualize results.

Data on the oyster harvesting practices of Post-Contact Indigenous populations is sparse in the region (see Colclasure et al. 2023), and there is virtually no data on non-Indigenous (e.g., enslaved communities') oyster harvesting practices. To truly understand the full scope of oyster harvesting practices on Ossabaw Island and adequately contextualize modern oyster reef collapse, it is necessary to bridge this temporal gap by investigating enslaved community subsistence. Further, investigating the lifeways of this community that has traditionally been left out of written records and narratives via the archaeological record is a way to explore the 'hidden lives' of these individuals (Holland-Lulewicz and Roberts Thompson 2022).

This thesis brings together data from multiple sites on Ossabaw Island to provide a long-ranging, single-island trajectory of the oyster harvesting practices of Indigenous and enslaved communities over five millennia. Results from this thesis will contribute to oyster harvesting studies from the South Atlantic Bight to provide a multi-scalar approach, highlighting local variability within regional trends. The data is also used to contextualize modern oyster reef fishery collapse and provide suggestions for sustainable resource management practices.

The purpose of this research is to investigate how oysters were harvested by Indigenous and enslaved communities on Ossabaw Island over a period of five millennia, from 3000 BC to AD 1861. The two guiding research questions are as follows:

1. During which seasons were oysters harvested?
2. From which estuarine zones were oysters harvested?

Knowing when and where communities on Ossabaw Island harvested oysters allows me to address the following subsidiary research questions:

a. How were Indigenous groups harvesting oysters from their landscape? Was there change or continuity in harvesting practices from the Late Archaic Period to the Late Mississippian Period?

b. How were enslaved communities harvesting oysters from their surrounding landscape during the Plantation Period?

c. Were there differences in oyster harvesting practices between Indigenous and enslaved communities?

d. How does this information fit with previously collected data on oyster harvesting practices in the South Atlantic Bight and Gulf Coast, including sclerochronological data and oyster archaeobiological data?

In order to answer these research questions, I present the results of incremental stable oxygen ($\delta^{18}O$) isotope (sclerochronological) analysis conducted on oysters from four sites: 1. *Hokfv-Mocvse* Shell Ring, a Late Archaic shell ring village; 2. Bluff Field, a Late Woodland/Early Mississippian shell midden mound; 3. Finley’s Pond, a Late Mississippian shell midden mound; and 4. South End, a Plantation Period shell pit. The stable isotope data from *Hokfv-Mocvse* Shell Ring was collected by Garland and colleagues (2024), while I collected new stable isotope data for the remaining three sites. Samples from these four sites are snapshots of oyster harvesting in time and place that are used to create a 5,000-year timeline of oyster harvesting on Ossabaw Island, encompassing the harvesting practices of both Indigenous and enslaved communities.

1.6 Organization of the Thesis

This thesis is organized into five chapters. In this chapter, I have provided the rationale for the thesis and presented the research questions. In the following chapter, I summarize the environmental and human history of Ossabaw Island and previous archaeological research conducted on the four sites discussed in the thesis to provide context for the research.

In Chapter 3, I outline the methodology of the study. I explain the procedure for sample selection, processing samples, analyzing the data, and the methodological limitations. Additionally, I overview laboratory methods for measuring oyster shell size as oyster archaeobiology data is drawn upon in the discussion.

In Chapter 4, I present the results of the sclerochronological analysis. The results include the estimated seasons and estuarine zones of harvest of oysters from *Hokfv-Mocvse* Shell Ring (n=13), Bluff Field (n=10), Finley’s Pond (n=10), and South End (n=8). These results answer the two guiding research questions and provide a foundation to answer the subsidiary research questions about the nature of oyster harvesting on Ossabaw Island through time and between different communities. I also present the results of previously conducted oyster archaeobiology research to further contextualize the sclerochronology results.

In the last chapter, I address the subsidiary research questions. I contextualize my results within the human history of Ossabaw Island and extend the scope of my research by investigating patterns with previous oyster harvesting research in the South Atlantic Bight and Gulf Coast. I also touch on questions of sustainability by linking my results with previous oyster size data from the four sites. I bridge the archaeological oyster harvesting data with written records to trace the history of oyster reef fishery collapse on the Georgia coast and discuss how these data can inform contemporary oyster reef management efforts. Finally, I provide recommendations for future research, such as a shift to focusing on institutions that governed oyster harvesting practices, as well as incorporating more research on the oyster harvesting practices of non-Indigenous communities.

CHAPTER 2

THE ARCHAEOLOGY OF OSSABAW ISLAND

2.1 Environmental and Human History of Ossabaw Island

The Georgia coast is made up of 15 barrier islands and over 1,400 small islands (Thompson and Turck 2010:284). Ossabaw Island is the third largest barrier island, measuring 13.7 km long and 6.3 km wide, and has the second largest upland area of approximately 11,000 acres (Pearson 2014:3) (see Figure 1). Ossabaw is thought to have gained its name from an Anglicized spelling of a Guale village on the island called Asapo; the first indication of this is found in the 1683 map of the Spanish colony of La Florida titled *Mapa de la Ysla de la Florida* (Anderson 1929; Arana 1964; Ribble 2005). Geographically, Ossabaw lies within the South Atlantic Bight region, which encompasses the barrier islands located in the South Atlantic mesotidal zone from Florida to South Carolina (Pearson 2014:3). Culturally, Ossabaw Island is part of the Ancestral homelands of the Muscogee (Creek) Nation and is located within the Gullah-Geechee Cultural Heritage Corridor (Garland et al. 2021; Gullah Geechee Cultural Heritage Corridor Commission 2012). The landmass of Ossabaw Island is fragmented, cross-cut by tidal creeks and large expanses of salt marsh (Pearson 2014:3). This fragmentation results in multiple habitats occurring together in small areas with transitional zones of overlap; these ecotones have high biodiversity and productivity (Odum 1971, 1990; Pearson 2014:8; Reitz 1988:138). The Pleistocene core is a mix of patches of low-lying, poorly-drained, acidic soils and high-lying, well-drained soils that support a maritime live oak forest (Pearson 2014:5). Most documented cultural sites are situated on the upland Pleistocene core, which Thomas (2008:874) considers a “first-tier” habitat, providing access to salt marsh and estuaries, maritime forest, and open ocean resources.

Figure 1. Georgia barrier islands, with Ossabaw Island starred. Basemap source: Esri (2024). Figure made by S. Forbes.

Ossabaw has at least a 5,000-year history of human occupation, and research on the settlement and demography of the island is typically structured around sea level changes (DePratter and Howard 1981; DePratter and Thompson 2013; Garland et al. 2024; Thompson and Turck 2009; Thompson et al. 2024a; Turck and Thompson 2016, 2019) (see Figures 2 and 3). During the early Late Archaic (3000–1150 BC), sea level rose, resulting in the deposition of Holocene sediment around preexisting Pleistocene landmasses and the extension of salt marshes around Ossabaw (Turck 2011; Turck and Thompson 2019). The onset of viable oyster reef fisheries in the South Atlantic Bight region likely occurred during this time (Garland et al. 2024:2,16-17). The earliest known human settlements on Ossabaw date to this period and occur in the form of large shell ring villages that housed sedentary populations (Garland et al. 2024).

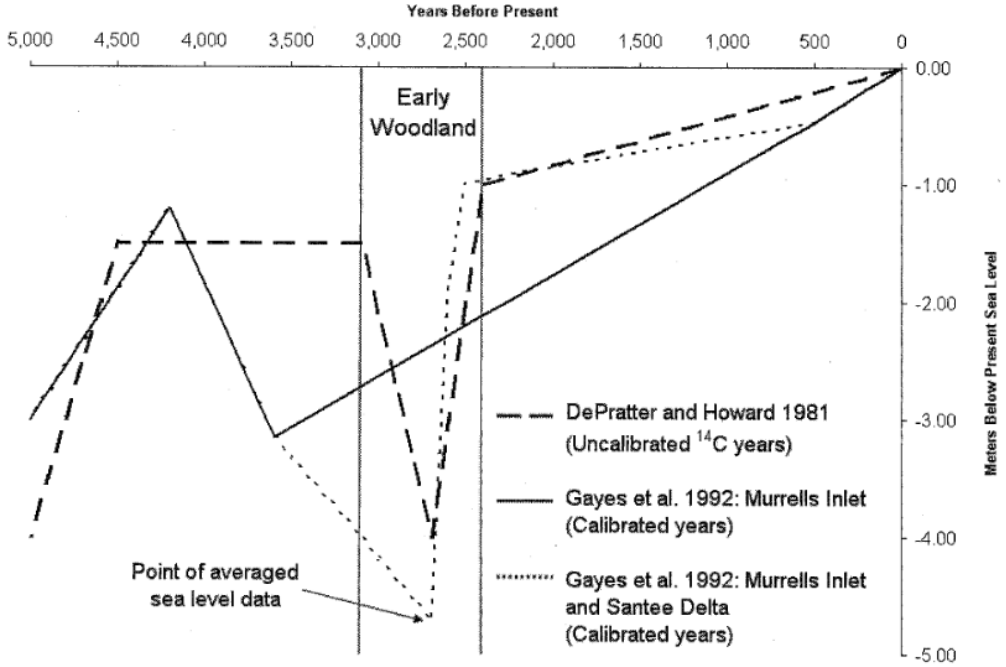


Figure 2. Estimated sea level curves for the Georgia coast from the Late Archaic Period to the present. From Thompson and Turck (2009), figure 9, adapted from DePratter and Howard (1981) and Gayes et al. (1992).

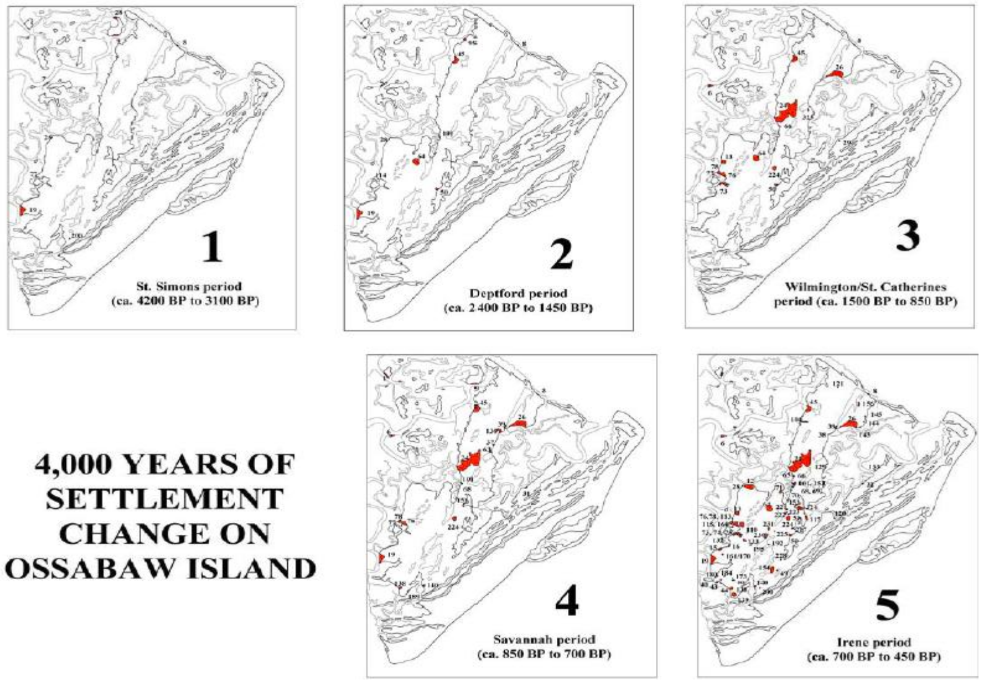


Figure 3. Size and location of Indigenous cultural sites on Ossabaw Island. From Pearson (2014), figure 13.

The cessation of shell ring and midden mound construction is used as evidence for a depopulation of the Georgia coast during the Early Woodland Period (ca. 1100–450 BC) (DePratter and Howard 1981; DePratter and Thompson 2013; Thompson and Turck 2009; Thompson et al. 2013; Turck and Thompson 2016, 2019). This demographic change was spurred by a 4 m drop in sea level that resulted in the contraction of estuarine resources and a general decrease in the inhabitability of the island, such that intense human occupation could no longer be supported (DePratter and Howard 1981; DePratter and Thompson 2013; Thompson and Turck 2009; Thompson et al. 2013, 2024a; Turck and Thompson 2016, 2019:175). During the end of the Early Woodland Period and into the Middle Woodland Period (ca. 450 BC–AD 450), sea level rebounded rapidly and the estuarine system began to return to its earlier productivity, resulting in population size increasing on the island as seen in the archaeological record by the construction of new sheet middens and midden mounds (Thompson and Turck 2009; Turck and Thompson 2019:175, 179-181). Sites were inhabited year-round as sedentary villages, and these trends continued into the Late Woodland Period (ca. AD 450–950) (Thomas 2008; Turck and Thompson 2019).

During the Mississippian Period (ca. AD 950–1580), sea level did not change substantially; however, the demographic and sociopolitical landscape transformed, with changes coming to a head during the Late Mississippian (ca. AD 1352–1580) (Anderson 1994; Ritchison 2019; Ritchison and Anderson 2022; Turck and Thompson 2019:183). Ritchison (2019:20-21) asserts that the myriad changes that occurred on the Georgia coast during this period can be attributed to the migrations of people from the Savannah River Valley following the collapse of chiefdoms in the region in the 13th-15th centuries AD (Anderson 1994; Ritchison and Anderson 2022). This influx of new people created a domino effect, spurring the revival of large shell midden mound construction, the appearance of institutionalized status differentiation, the emergence of a four-tiered regional settlement hierarchy, the use of council houses as a new egalitarian political arena, the intensification of shell bead production, and the eventual adoption of maize agriculture (Anderson 1994; Garland et al. 2023; Pearson 1979; Ritchison 2019; Ritchison and Anderson 2022; Thomas 2008).

Spanish explorers and missionaries arrived on the Georgia coast in the 16th century, beginning with Hernando de Soto's exploration of the Georgia interior. This marked a shift into the Post-Contact (post-AD 1492) world of European and Euroamerican colonization. Notably, Ossabaw lacks a Spanish Mission Period (ca. AD 1580–1700) component. Indigenous occupation on Ossabaw Island likely ceased around AD 1550 with the abandonment of the island following European contact based on ethnographic accounts of the Guale (the named Indigenous inhabitants of the Georgia coast during the 16th and 17th centuries) as well as a lack of Post-Contact Indigenous pottery types (i.e., Altamaha type wares) on the island (Jefferies and Moore 2013; Pearson 2014; Thomas 2008; Thompson et al. 2020).

The final transition from Indigenous to non-Indigenous inhabitation of Ossabaw Island can be structured around the ownership of the island. *Coosaponakeesa* (also known by her English name Mary Musgrove Bosomworth) is the earliest documented owner of Ossabaw Island; she was deeded the island by Creek (now Muscogee) leaders in 1747 in exchange for negotiating treaties between the Creek and the British (Elliott 2007; Frank 2019; Honerkamp et al. 2007). Quickly after Ossabaw Island came under individual ownership, the island was split into land tracts and put up for public auction by the governor of Georgia, Henry Ellis (Elliott 2007; Honerkamp et al. 2007; Price 2007). This opened the island to plantation development by Euroamericans. From 1776 to 1861, the majority of activities on Ossabaw Island occurred at the

North End, Middle Place, South End, and Buckhead Plantations, which were largely worked by enslaved individuals underneath the U.S. system of chattel slavery (Elliott 2007, 2008). After the island was abandoned by Euroamerican plantation owners in 1861, freedmen communities were established on Ossabaw, including those descended from or that were formerly enslaved on the Ossabaw Island plantations (Dorsey 2010; Duncan 1986; Elliott 2005, 2007). Following a series of damaging hurricanes in the 1890s, most freedmen communities abandoned Ossabaw Island and the Georgia coast and resettled on the mainland, establishing the Gullah-Geechee communities of Harris Neck and Pin Point, which resulted in very few people living on Ossabaw from the 1890s to now (Roberts Thompson 2020:60-61). Currently, Ossabaw Island is owned and managed by the Georgia Department of Natural Resources, which protects the island from development (Georgia Department of Natural Resources, Wildlife Resources Division n.d.).

2.2 Previous Archaeological Research on Ossabaw Island

Archaeological research on Ossabaw Island can be grouped into three main periods: Moore's excavations in the 1890s, DePratter and Pearson's island-wide surface survey in the 1970s, and contemporary archaeological work beginning in the 1990s and accelerating in the 2000s and 2010s. The presumably first archaeological investigations on Ossabaw Island were conducted by C. B. Moore between November 1896 and February 1897 (Moore 1897; Pearson 2014). Moore's goal was to excavate Indigenous burial mounds on the Georgia and South Carolina coasts, ignoring all other sites (Pearson 2014). Moore excavated six earthen Ancestral burial mounds at Middle Place and three at Bluff Field, most of which can no longer be located as it is believed that they were completely leveled by excavations (Moore 1897; Pearson 2014). Moore's excavations fall on the side of antiquarian looting rather than modern archaeology, as it seems the excavations were conducted in a non-scientific manner and Moore left few descriptions or maps with which to contextualize his finds (Moore 1897; Pearson 2014).

From 1974 to 1977, University of Georgia students Chester DePratter and Charles Pearson conducted an island-wide surface survey of Ossabaw Island, identifying and mapping sites (see Figure 4). As of 2014, over 220 cultural sites have been identified on the island (DePratter 1974; Pearson 1977, 1979, 1980, 2014:1,12). Pearson also conducted test excavations at 37 sites (Pearson 1977, 1979, 1980, 2014). Pearson (2014:12) estimates that 35-40% of the habitable (i.e., high ground) portion of Ossabaw Island has been surveyed. After DePratter and Pearson's survey, archaeological investigations lulled on Ossabaw until the Georgia Department of Natural Resources (GDNR), Historic Preservation Division began routinely monitoring cultural sites on the island starting in 1999, especially those at risk of erosion (Roberts Thompson 2020:21-22). Erosion mitigation projects and other archaeological projects have increased on the island in the 21st century (Roberts Thompson 2020:21-22).

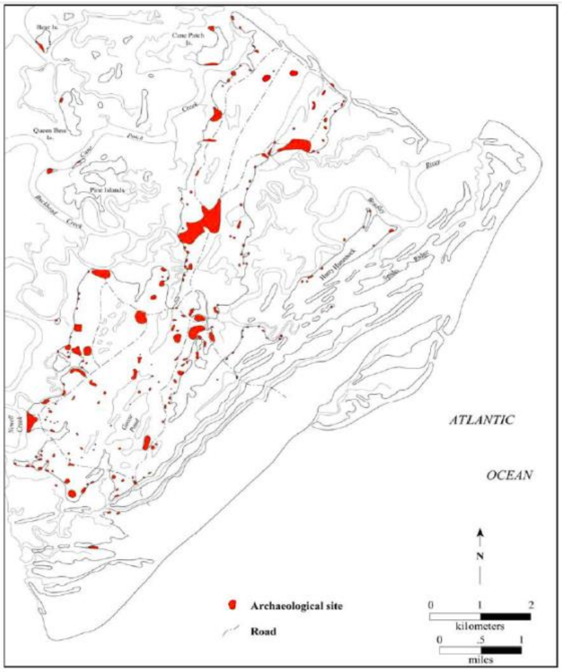
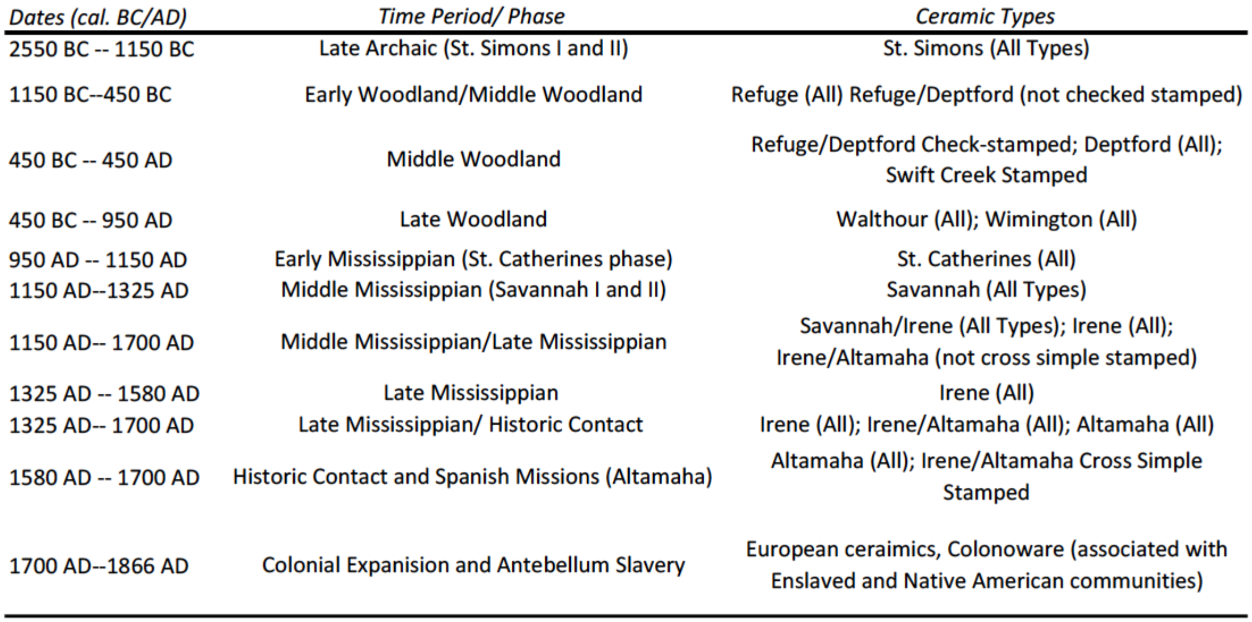


Figure 4. Cultural sites mapped on Ossabaw Island as of 1980. From Pearson (2014), figure 3.

Currently, the demographic history of Ossabaw Island heavily relies on the coastal ceramic series first proposed by DePratter and Howard (1981) and later expanded on by DePratter (1991) and Thomas (2008), which group sites into named phases based on the presence of ceramic types (e.g., presence of Wilmington types indicates the site is from the Wilmington phase) (Parbus et al. 2023; Ritchison 2018) (see Figure 5). The coastal ceramic series is problematic because the original chronology was built on uncorrected shell dates, which lacks accuracy as the Marine Reservoir Correction was not considered (DePratter 1974, 1991; Hadden et al. 2023; Parbus et al. 2023; Ritchison 2018).



Dates (cal. BC/AD)	*Time Period/ Phase*	*Ceramic Types*
2550 BC -- 1150 BC	Late Archaic (St. Simons I and II)	St. Simons (All Types)
1150 BC--450 BC	Early Woodland/Middle Woodland	Refuge (All) Refuge/Deptford (not checked stamped)
450 BC -- 450 AD	Middle Woodland	Refuge/Deptford Check-stamped; Deptford (All); Swift Creek Stamped
450 BC -- 950 AD	Late Woodland	Walthour (All); Wimington (All)
950 AD -- 1150 AD	Early Mississippian (St. Catherines phase)	St. Catherines (All)
1150 AD--1325 AD	Middle Mississippian (Savannah I and II)	Savannah (All Types)
1150 AD-- 1700 AD	Middle Mississippian/Late Mississippian	Savannah/Irene (All Types); Irene (All); Irene/Altamaha (not cross simple stamped)
1325 AD -- 1580 AD	Late Mississippian	Irene (All)
1325 AD-- 1700 AD	Late Mississippian/ Historic Contact	Irene (All); Irene/Altamaha (All); Altamaha (All)
1580 AD -- 1700 AD	Historic Contact and Spanish Missions (Altamaha)	Altamaha (All); Irene/Altamaha Cross Simple Stamped
1700 AD--1866 AD	Colonial Expanision and Antebellum Slavery	European ceraimics, Colonoware (associated with Enslaved and Native American communities)

Figure 5. Traditional ceramic series of the Georgia coast. From Chapman (2022), table 3, adapted from DePratter (1991) and Garland et al. (2023).

Parbus et al. (2023:287) recently argued for a reassessment of coastal chronologies utilizing Bayesian radiocarbon analysis on short-lived organic samples (i.e., carbonized hickory nut shells/*Carya* spp.) in light of their analysis of the Wilmington style. The authors found that the Wilmington style was in use longer than expected with significant overlaps with other ceramic styles and therefore phases, which has wide-ranging implications for site histories and interpretations (Parbus et al. 2023:298; see also Ritchison 2018) (see Figure 6). This sentiment echoes wider calls to move past traditional culture historical periods in North American archaeology through utilizing fine-grained chronological models based on scientific dating methods and Bayesian modeling to identify sites and features by absolute time ranges rather than terms like "Mississippian" or "Irene," which are vague and can be problematic (Feinman and Neitzel 2020; e.g., Buchanan et al. 2022; Manning et al. 2018; Thompson et al. 2024b).

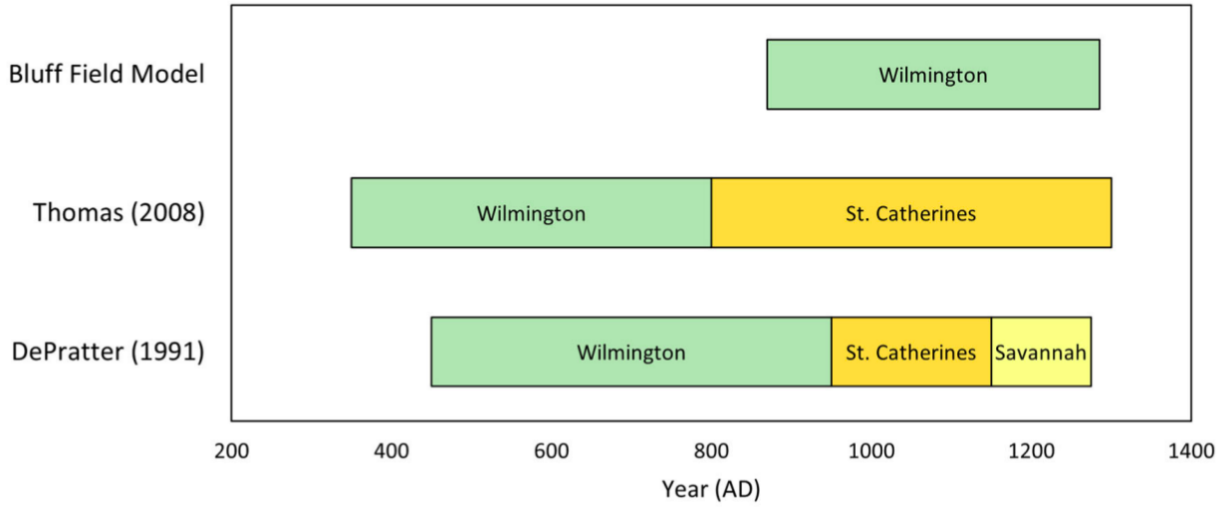


Figure 6. Comparison of depositional history of select coastal ceramic series as proposed in different models by Parbus et al. (2023). From Parbus et al. (2023), figure 12. The Bluff Field Model is constructed from radiocarbon dates on short-lived organic samples, whereas Thomas' (2008) and DePratter's (1991) models were constructed using uncorrected radiocarbon dates on shells.

2.3 Sites Background

This section overviews the human history and previous excavations conducted at the four sites from which oyster samples were sourced for this study: *Hokfv-Mocvse* Shell Ring, Bluff Field, Finley's Pond, and South End (see Figure 7). These overviews provide context for interpreting the results of this research, both in terms of human activities occurring at the sites, as well as the excavation contexts and information about dating the sites.

Figure 7. Ossabaw Island and location of cultural sites discussed in this thesis. Basemap source: Esri (2024). Figure made by S. Forbes.

2.3.1 Hokfv-Mocvse Shell Ring

The *Hokfv-Mocvse* Shell Ring is a preceramic shell ring village situated within the larger Bluff Field site (Garland et al. 2024:3). It was first located in summer 2022 during a probe survey of Bluff Field and confirmed with LiDAR images (Garland et al. 2024:4) (see Figure 8). The University of Georgia's 2022 Archaeology Field School conducted shovel tests along the arm and backside of the shell ring and excavated four 1 x 1 m units along the shell ring (Garland et al. 2024:5). Garland and colleagues (2024:1, 6-8) conducted Bayesian radiocarbon analysis of

19 short-lived samples (i.e., deer/*Odocoileus virginianus* bone and charred hickory nut/*Carya* spp.) from around and within the shell ring, dating the *Hokfv-Mocvse* Shell Ring construction and village occupation to ca. 3140–2785 BC (95% confidence) or the Late Archaic, making it the oldest known shell ring and year-round-occupied village in the South Atlantic Bight region.

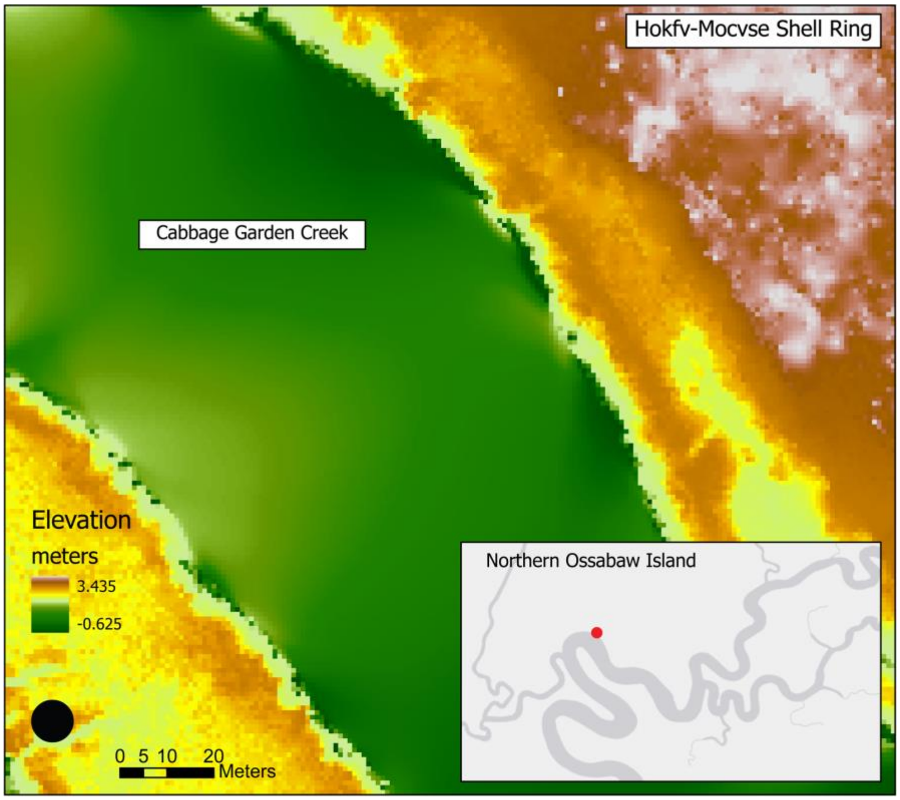


Figure 8. LiDAR image of *Hokfv-Mocvse* Shell Ring. From Garland et al. (2024), figure 2.

2.3.2 Bluff Field (9CH160)

Bluff Field is a large, multicomponent site located alongside an eroding bluff edge of Cabbage Garden Creek on the northwestern Pleistocene core of Ossabaw Island (Parbus et al. 2023:274). Bluff Field is the second largest cultural site on Ossabaw and, to date, archaeologists have identified Late Archaic, Woodland, and Mississippian components at the site, including the aforementioned *Hokfv-Mocvse* Shell Ring (Parbus et al. 2023:272, 275; Pearson 2014:26). The first excavations at Bluff Field were carried out by Moore in the 1890s and were constrained to the demolition of three burial mounds, the location of only one of which (Mound A) has been tentatively re-identified (Moore 1897; Parbus et al. 2023:273; Pearson 2014). Work at Bluff Field ceased until the 1970s when DePratter and Pearson undertook their survey of Ossabaw Island; the two conducted a surface collection at the site, with Pearson (2014:76) noting that Post-Contact agricultural activity at the site had dispersed shell middens (DePratter 1974, 1991; Pearson 1975, 1977) (see Figure 9). Thorough investigations of the site began in 2018, when the University of Georgia and GDNR began to evaluate the site after observing significant erosion into Cabbage Garden Creek (Parbus et al. 2023:272). Tucker and Thompson (2018) determined that roughly 50 feet of erosion had occurred at the site since Moore's initial excavations (see also Parbus et al. 2023:283).

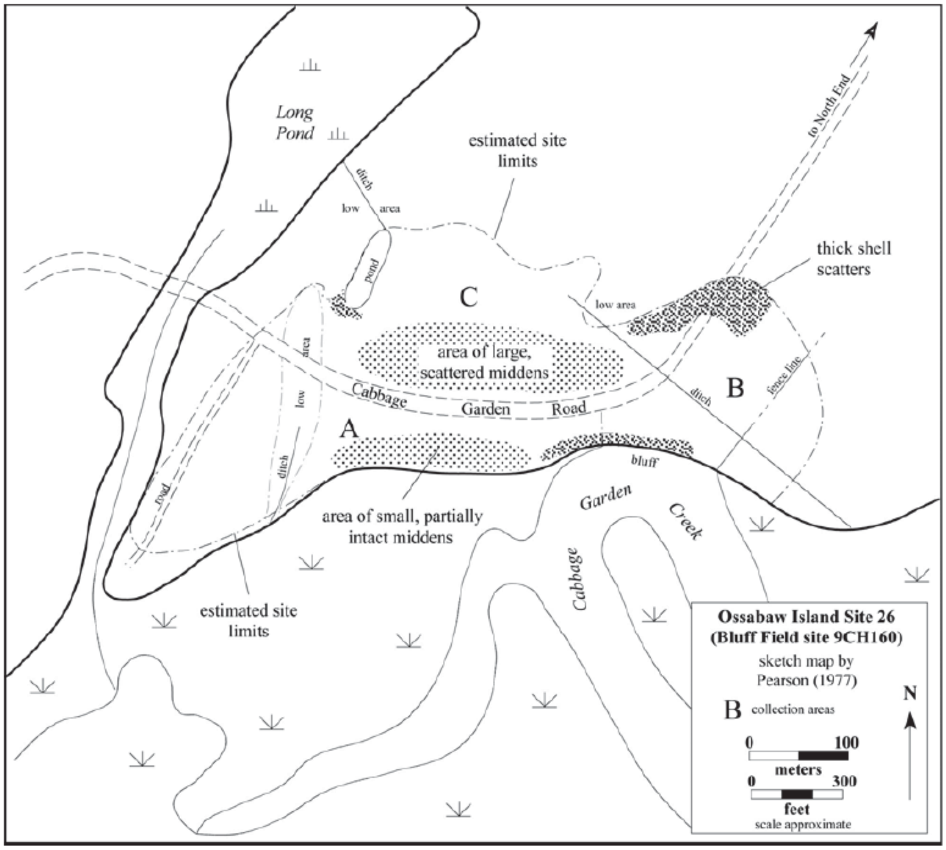


Figure 9. Surface features at Bluff Field site as mapped by Pearson in 1977. From Pearson (2014), figure 25.

The University of Georgia’s 2022 Archaeology Field School conducted eight shovel tests and excavated two 1 x 2 m units (Unit A-1, Unit B-1) on the Woodland/Mississippian Period components of Bluff Field (Parbus et al. 2023:275) (see Figure 10). Unit A-1 was placed on the top of a small shell midden mound originally identified by Pearson (1977) during a surface survey, and Unit B-1 was placed on top of a shell scatter at the eroding bluff edge that potentially contained shell pits (Parbus et al. 2023:277-279). Parbus and colleagues (2023:280) conducted Bayesian radiocarbon analysis of 14 short-lived carbonized plant remains (i.e., hickory nut shells/*Carya* spp.) from multiple levels of Units A-1 and B-1 and the shovel test pits, which dated the shell midden mound (Unit A-1) to ca. AD 880–1030 (95% confidence), the Late Woodland/Early Mississippian Period, and the shell scatter and pits (Unit B-1) to ca. AD 1050–1230 (95% confidence), the Early/Middle Mississippian Period (Parbus et al. 2023:280).

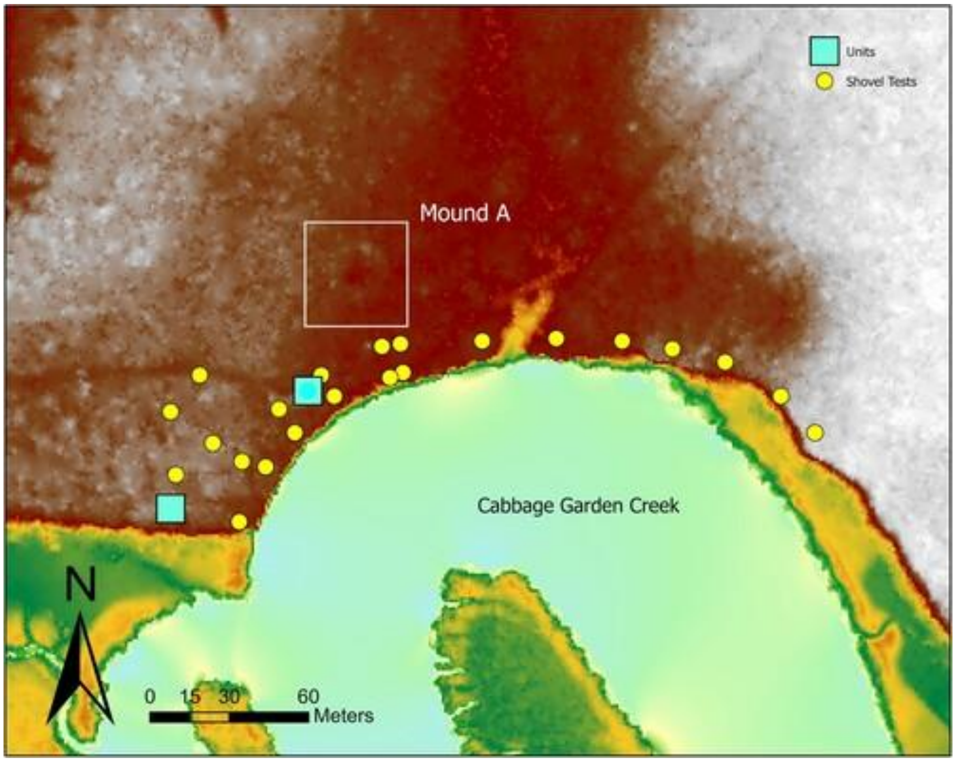


Figure 10. LiDAR image of Bluff Field with locations of two excavation units and shovel tests conducted by the University of Georgia’s 2022 Archaeology Field School. From Parbus et al. (2023), figure 3.

2.3.3 Finley's Pond (9CH204)

Finley's Pond is a multicomponent site situated along a tidal creek embayment surrounded by extensive saltmarsh on the southwestern Pleistocene core of Ossabaw Island (Garland et al. 2023; Lulewicz et al. 2017:285; Pearson 2014). The site was first mapped by DePratter and Pearson in the 1970s (DePratter 1974, 1991; Pearson 1975, 1977, 2014) (see Figure 11). There are approximately 25 low-mounded shell middens at the site, which is generally interpreted as a large village where shell bead production occurred (Garland et al. 2023:359; Lulewicz et al. 2017:285). Chapman (2022:31, 37) conducted Bayesian radiocarbon analysis on 31 organic samples (i.e., unidentified wood charcoal and hickory nut/*Carya* spp.) recovered from mixed proveniences at Finley's Pond and found that the site was occupied from the Late Archaic Period to the Late Mississippian Period, with occupation beginning ca. 5830–5140 BC (95% confidence) and ending ca. AD 1360–1600 (95% confidence). Additionally, the site has little to no disturbance from original site occupation by Post-Contact agricultural activity (Chapman 2022:42; Lulewicz et al. 2017:284).

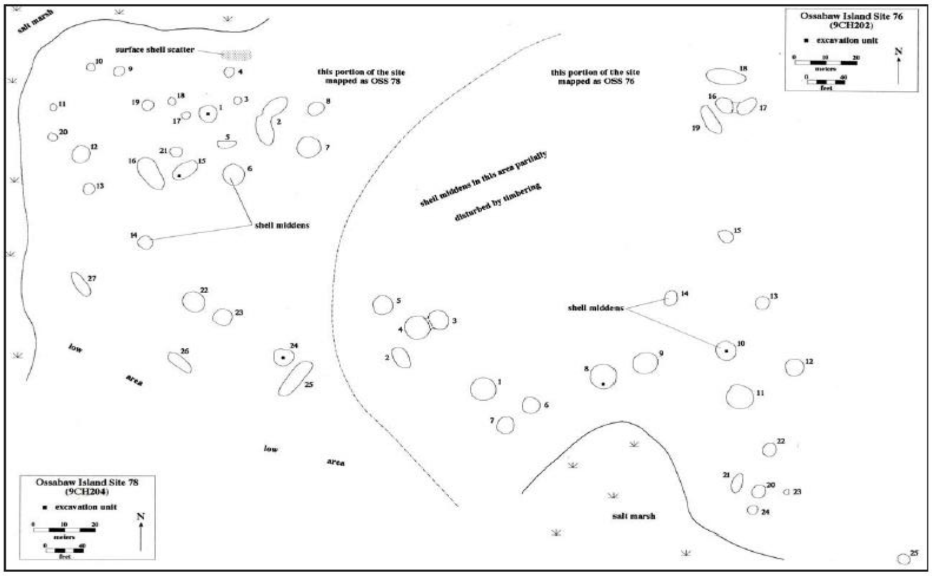


Figure 11. Surface features at Finley's Pond site as mapped by Pearson in 1977. From Pearson (2014), figure 39.

The University of Georgia’s 2016 Archaeology Field School conducted a ground penetrating radar (GPR) survey and excavated 55 shovel tests, a 2 x 2 m unit (Unit A-1), and a 2 x 1 m unit (Unit B-1) at the site (Garland et al. 2023:356-357; Lulewicz et al. 2017:285) (see Figure 12).

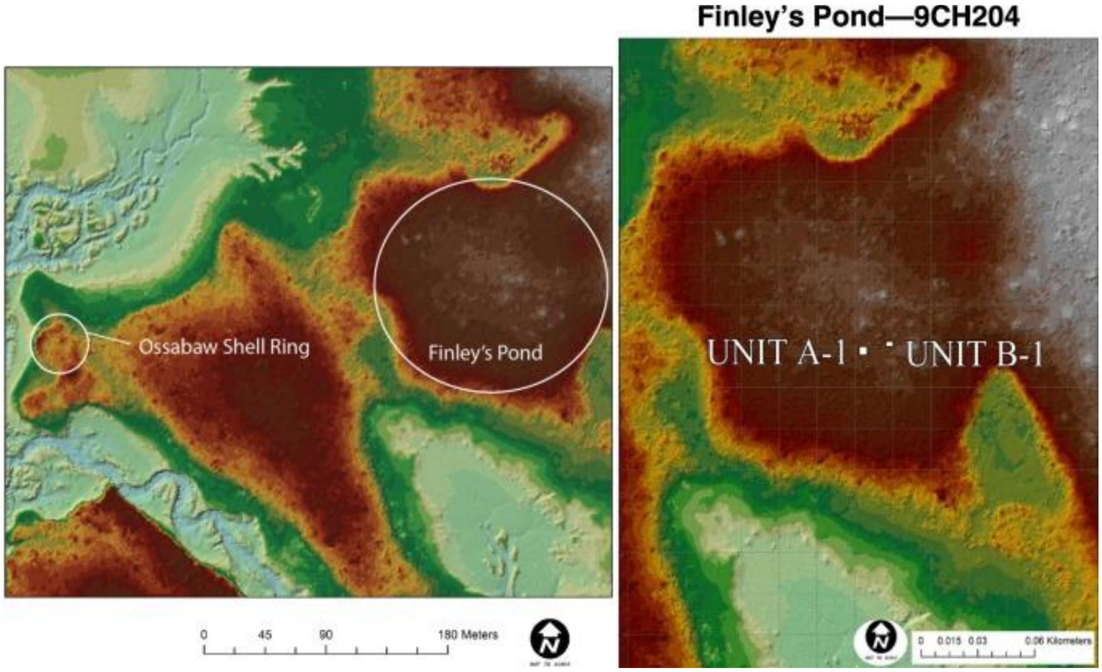


Figure 12. LiDAR image of location of Finley’s Pond (left) and LiDAR image of locations of units excavated by the University of Georgia’s 2016 Archaeology Field School, edited to only display Finley’s Pond (right). From Lulewicz et al. (2017), figures 2 and 3.

Unit A-1 was placed to bisect a GPR-identified anomaly (Garland et al. 2023:357; Lulewicz et al. 2017). A palimpsest of six features was encountered in Unit A-1, the largest of which (Feature 1) was interpreted as a Late Woodland Period shell-filled pit based on the presence of clay-tempered ceramics (Garland et al. 2023:358; Lulewicz et al. 2017:285). However, based on the presence of Wilmington and Irene ceramics throughout the unit, it is likely that Unit A-1 is rather a Mississippian Period shell pit intruding into a Woodland feature (Parbus et al. 2023; Williams and Thompson 1999). Unit B-1 was placed on the apex to edge of a low-mounded shell midden mound (Garland et al. 2023; Lulewicz et al. 2017:285). Garland and colleagues (2023:358) conducted Bayesian radiocarbon analysis on two short-lived carbonized plant remains (i.e., hickory nut shells/*Carya* spp.) from Levels 2 and 3 of Unit B-1, which dated the upper portion of the shell midden mound to ca. AD 1445–1490 (68% confidence interval), the Late Mississippian Period. The authors excluded the 98% confidence interval date from consideration as it yielded a Post-Contact date range (ca. AD 1440–1625), which is not supported by ethnographic or archaeological accounts (Garland et al. 2023:358). The shell midden mound of Unit B-1 intrudes into a Woodland Period feature based on the presence of check stamped pottery (Garland et al. 2023:358).

2.3.4 South End (9CH155)

South End is a multicomponent site located along Newell Creek on the southeastern edge of the Pleistocene core of Ossabaw Island (Roberts Thompson 2020:169). South End has both Indigenous and Post-Contact components. Archaeological work at South End began in the 1970s with DePratter and Pearson’s survey. In this survey, they noted the site contained mostly Post-Contact cultural material (DePratter 1974; Pearson 1975, 1977, 2014). However, they also encountered St. Simon’s, Savannah, and Irene ceramic types, indicating Indigenous occupation of the site during the Late Archaic and Middle to Late Mississippian (Pearson 2014:17, 27, 31).

Similar to Bluff Field, concerns about the rapid erosion of the site into Newell Creek prompted GDNR to renew archaeological investigations at South End (Roberts Thompson 2020:21). The Georgia Department of Natural Resources collaborated with the Boy Scouts of America, the Lamar Institute, the University of Tennessee at Chattanooga, and the University of Georgia at different points from 2002 to 2017 to conduct pedestrian, shovel test, and remote sensing surveys and minimal excavations at the site (Elliott 2009, 2010; Honerkamp 2011, 2013;

Roberts Thompson 2020:22; Rogers 2002, 2003; State Archaeologist Office 2004). Sparse Indigenous cultural material and features were encountered, including an exposed Ancestral burial feature, though the majority is Post-Contact (Roberts Thompson 2020:22, 153).

South End is more widely known as the site of a Sea Island cotton plantation, which was in operation from AD 1849 to 1861 (Roberts Thompson 2020). During this time, George J. Kollock owned the plantation and at minimum 69 enslaved individuals (the number recorded in AD 1861) who worked on the plantation (Roberts Thompson 2020:64). Extensive human modification of the landscape occurred while the plantation was in use, including clearing and draining of the marsh to establish agricultural fields, the construction of a system of ditches, roads, and at least one canal, and the construction of many outbuildings and structures (Roberts Thompson 2020). In 2018, the University of Georgia began large-scale excavations on the Post-Contact component of the site, focusing their attention on the area most at-risk of erosion: the bluff alongside Newell Creek (Ritchison et al. 2018; Roberts Thompson 2020:22).

Archaeologists determined that this area was the plantation core of South End because of the high concentrations of artifacts and features in the area (Roberts Thompson 2020:153-154) (see Figure 13). Specifically, the actively eroding edge was the location of a row of houses where enslaved individuals lived; the post and pit features visibly eroding out of the bluff edge are from a domestic, enslaved community context (Roberts Thompson 2020:225) (see Figure 14).

South End was abandoned as a plantation in AD 1861 due to the Civil War and beginning in 1865, individuals that were formerly enslaved on Ossabaw Island moved back onto the island as emancipated individuals, creating new freedmen's communities and cultivating the land of the former South End plantation fields (Dorsey 2010; Duncan 1986; Elliott 2007; Kollock 1866; Roberts Thompson 2020:59-60). Owing to the lack of documentary evidence, it is unknown how many freedmen and women lived on South End, or for how long, other than all freedmen communities on Ossabaw Island either relocated to Middle Place to work as sharecroppers or moved off the island to different Gullah-Geechee communities on the mainland such as Harris Neck and Pin Point by AD 1895 (Price 2014; Roberts Thompson 2020:60-61).

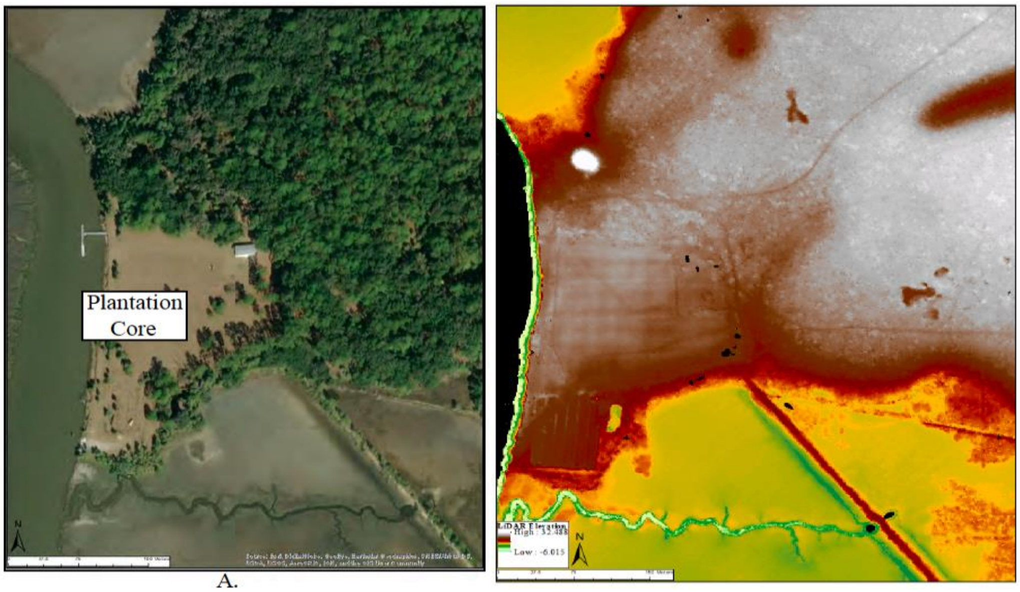


Figure 13. Aerial image (left) and LiDAR image (right) of the plantation core of South End, which is eroding into Newell Creek. From Roberts Thompson (2020), figures 5.17A and 5.16.

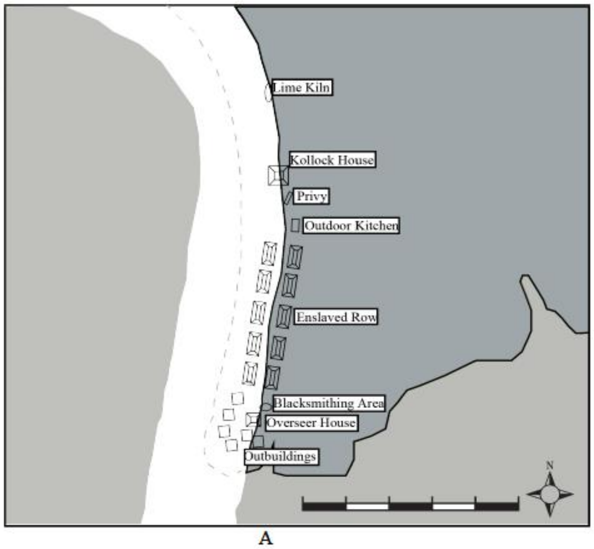


Figure 14. Reconstruction of the projected layout of the South End plantation core. From Roberts Thompson (2020), figure 6.39A.

CHAPTER 3

METHODOLOGY

3.1 Laboratory Methods

Sclerochronology is the study of the accretionary growth bands of hard tissue to create time-ordered data (Andrus 2011:2893; Peharda et al. 2021). Studies utilize samples ranging from corals to fish otoliths to mollusks; all samples are united by the semi-regular deposition of hard tissue growth bands (Andrus 2011; Peharda et al. 2021). Visual assessment of the incremental growth microstructure of hard tissue and geochemical analysis are the two methods most commonly used in sclerochronology studies (Andrus 2011; Peharda et al. 2021). Sclerochronology is often applied to reconstruct paleoenvironments on the geologic timescale and model climate change and human-environmental interactions on the human timescale, and pairs well with other incremental data such as dendrochronology for multi-proxy assessments (Andrus 2011; Black et al. 2019; Martino et al. 2019; Peharda et al. 2021; Ye et al. 2018).

‘Midden sclerochronology’, referring to the analysis of primarily mollusk shells from midden contexts, is a common method used in archaeological studies (Andrus 2011:2893; Waselkov 1987). This is due to the direct association available between human and environmental data (as middens are human-generated deposits) and the prevalence of shell middens at human-occupied coastal and aquatic locations worldwide beginning in the Late Pleistocene (Andrus 2011, Erlandson 2001; examples include Gosselin et al. 2023; Helama and Hood 2011; Höpker et al. 2019; Jenkins and Gallivan 2020; Jew et al. 2013 among others). In the North American Southeast, eastern oyster (*Crassostrea virginica*) is the most abundant species in coastal shell middens and therefore the bulk of midden sclerochronology studies in the region utilize this species (Garland et al. 2022; Lulewicz et al. 2017).

The subannually secreted calcite growth bands of the oyster's shell record the oxygen isotope composition of the ambient water the oyster grew in during its lifetime (Surge et al. 2001). The ratio of ^{16}O and ^{18}O isotopes in oyster shells (henceforth referred to as $\delta^{18}O$ values), covaries with seasonal water temperature fluctuations in temperate locations and changes in salinity in coastal estuarine environments (Surge et al. 2001). Ambient water temperature is the primary driver of $\delta^{18}O$ value variation in the growth lines of an oyster shell, while salinity is recorded in the bulk $\delta^{18}O$ composition of the shell (Andrus 2011; Andrus and Thompson 2012; Thompson and Andrus 2011, 2013). Oxygen isotope values and ambient water temperature display an inverse relationship such that higher $\delta^{18}O$ values correspond to colder temperatures and vice versa (Kumar and Verma 2021; Thompson and Andrus 2013). Thus, $\delta^{18}O$ values from oyster shells can be used as a proxy for temperature. In a temperate location, water temperatures fluctuate seasonally. Plotting $\delta^{18}O$ values from a single oyster shell results in a sinusoidal graph where complete cycles in the $\delta^{18}O$ value correspond to one year of oyster growth (Surge et al. 2003). From this relationship the season of harvest of each oyster sample can be estimated by plotting $\delta^{18}O$ values and determining if the last growth line of the oyster in the shell isotope profile corresponds to the winter, fall, spring, or summer. Oxygen isotope values can be used to estimate salinity by using the relationship between the lowest $\delta^{18}O$ values in each shell isotope profile, the assumed summer growth cessation temperature of oysters (28°C), and a linear regression equation relating salinity and $\delta^{18}O$ values in modern water samples.

Below, I describe the laboratory methods for the sclerochronological analysis conducted on oyster shells from shell ring, shell midden, and shell pit contexts from *Hokfv-Mocvse* Shell

Ring, Bluff Field, Finley's Pond, and South End. Using these laboratory methods, it is possible to determine the season of collection and estuarine zone of harvest of the oyster samples, allowing me to answer the two primary research questions of this thesis. I also provide additional information, including the provenience of the samples, the limitations of the method, and briefly discuss laboratory methods for oyster archaeobiology studies as these results are integrated into the interpretation and discussion of the results of this research.

Incremental oxygen isotope analysis was conducted on oysters from *Hokfv-Mocvse* Shell Ring (n=13), Bluff Field (n=10), Finley's Pond (n=10), and South End (n=8). Oyster shells used in this research project are curated at UGA's Laboratory of Archaeology and were pulled from previously excavated collections, and preparation and sampling occurred within the Laboratory of Archaeology's Archaeological Sciences Lab. The *Hokfv-Mocvse* Shell Ring data was previously published by Garland and colleagues (2024). Oysters from the other three sites were recently sampled for this research. Because of the technical nature of this methodology, the laboratory methods section is adapted from Thompson and Andrus (2011, 2013) and Garland and colleagues (2022), where a further discussion of the method can be found. Additionally, see Andrus and Crowe (2000) for the first use of the method.

Complete left oyster valves with intact and large chondrophores and no evidence of parasitic activity (i.e., sponge boring holes) were selected for milling. This controls for oysters harvested while alive. Selected shells were cleaned of surficial debris using water and a toothbrush and bisected along the chondrophore using a diamond wafering saw. Chondrophore sections were then mounted on glass microscope slides using Crystalbond™ adhesive. Shells were milled using a Grizzly™ benchtop micro-mill setup. The shells were milled to sample successive growth bands, beginning at the growing edge and representing time at death (i.e., time of harvest/sample 1) and moving outwards, thus following reverse ontogeny (see Figure 15).

Figure 15. Example of a mounted and drilled oyster shell chondrophore section. Photo was taken using Dino-Lite™ USB microscope camera and DinoXcope™ software. Width is approximately 2 cm. Photo taken by S. Forbes.

Approximately 20 powdered carbonate samples were milled from each oyster shell, which correlates to roughly one year of oyster growth prior to harvest. Each sample was weighed in tin capsules and deposited into Exetainer® 12mL borosilicate vials for processing at UGA's Center for Applied Isotope Studies (CAIS). At CAIS, samples were analyzed using a Thermo Gas Bench coupled to a Delta V Isotope Ratio Mass Spectrometer with a Gas Chromatography Pal auto-sampler for stable oxygen and carbon isotope values. These values were reported in per mille (‰) relative to the Vienna Pee Dee Belemnite (VPDB) standard.

To determine season of capture, each shell isotope profile was plotted (δ^{18}O value versus sample number) and the resultant graph divided into equal thirds such that if sample 1 fell within the upper third, that corresponded to the oyster being captured in the winter; if sample 1 fell within the middle third, that corresponded to either fall or spring capture (assessed based on the sequence of seasonality); and if sample 1 fell within the bottom third, that corresponded to summer capture (Garland and Thompson 2023; Thompson and Andrus 2011) (see Figure 16).

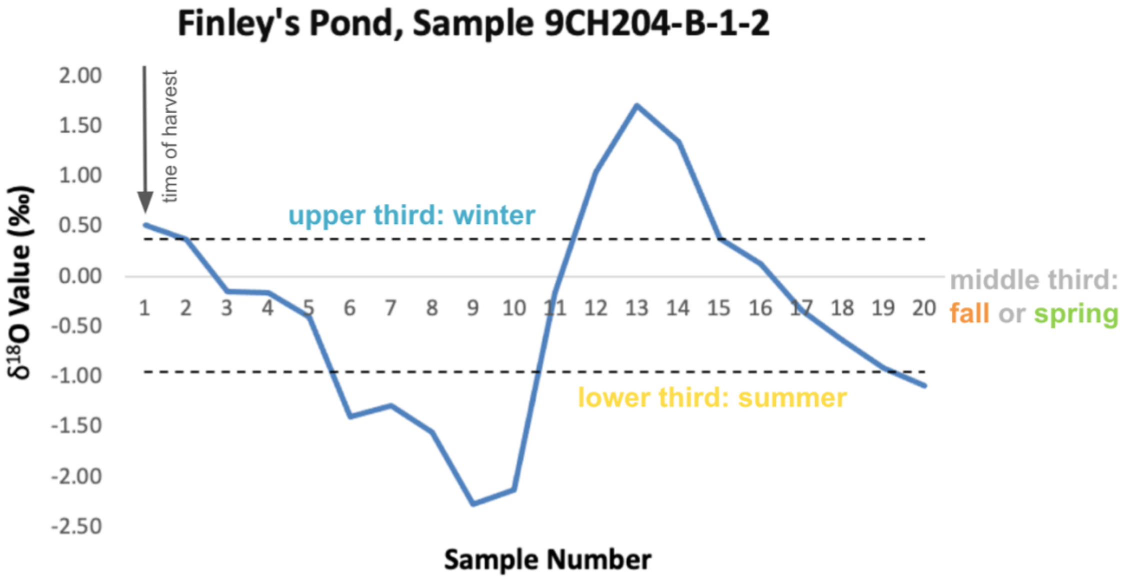


Figure 16. Example of a shell isotope profile graph used to determine which season an oyster was harvested. Sample 9CH204-B-1-2 was harvested in the winter. This graph is annotated for explanatory purposes. For all shell isotope profile graphs, see Appendix. Figure made by S. Forbes.

Salinity values were estimated using the relationship between the lowest δ^{18}O values in each shell isotope profile, the assumed summer growth cessation temperature of oysters (28°C), and a linear regression equation for the relationship between salinity and $\delta^{18}O_{water}$ in 12 modern water samples collected from the estuaries surrounding Ossabaw Island (Garland et al. 2024; for further discussion of this method see Andrus and Thompson 2012) (see Figure 17). The following equations were used to estimate summer $^{18}O_{water}$ (Equation 1) and then salinity for each shell (Equation 2).

3.1.1 Equations

1. Water temperature (°C) $= 16.5 - 4.3(\delta^{18}O_{calcite} - x) + 0.14(\delta^{18}O_{calcite} - x)^2$

Where water temperature is 28°C, the assumed summer growth cessation threshold for oysters, $\delta^{18}O_{calcite}$ is the most negative $\delta^{18}O$ value in each oyster's profile, and $x = \delta^{18}O_{water}$. A 0.2‰ correction was applied to convert VPDB to Vienna Standard Mean Ocean Water (Garland et al. 2024).

2. $\delta^{18}O_{water} = 0.093(y) - 2.1$

Where δ^{18}Owater is calculated using Equation 1, and y = estimated salinity (psu). This linear regression equation is specifically used for Ossabaw Island and is assumed to apply to the time of site occupation (Garland et al. 2024; Thompson and Andrus 2013). For all values used in the salinity calculations, see Appendix.

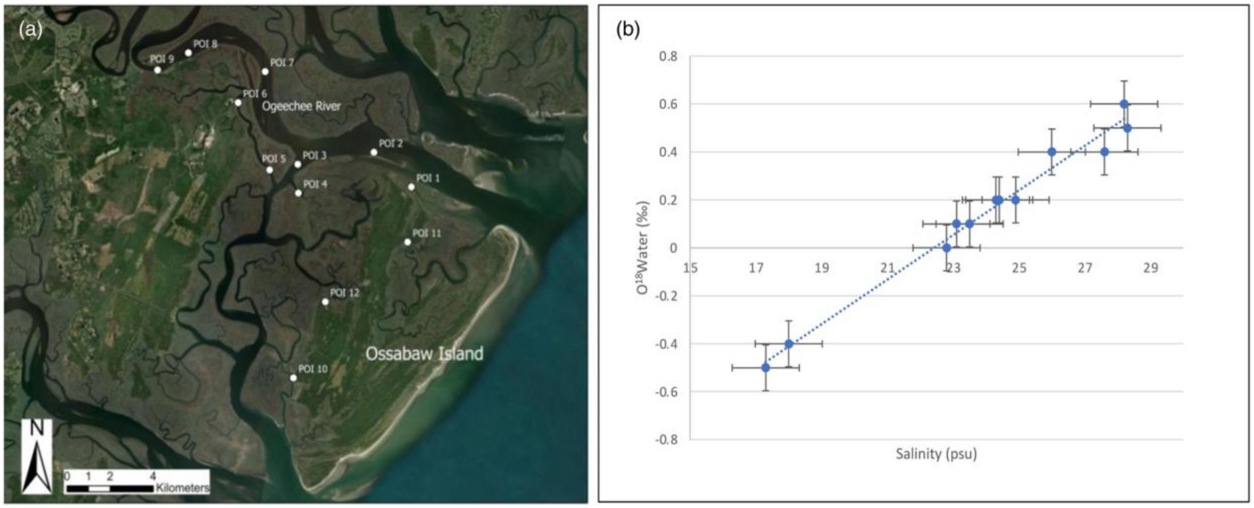


Figure 17. Map of 12 locations where modern water samples were taken (a) to create a linear regression equation linking modern salinity to $\delta^{18}O_{water}$ values (b). From Garland et al. (2024), figure 5.

3.1.2 Provenience of Samples and Sample Size Note

The oyster samples in Garland et al.'s (2024) incremental oxygen isotope analysis were taken from multiple proveniences (both excavation units and levels within the units) along the *Hokfv-Mocvse* Shell Ring from the University of Georgia's 2022 Archaeology Field School excavations. The oyster samples from Bluff Field are from Unit A-1, Level 3 (n=10), also collected during UGA's 2022 Archaeology Field School excavations. The oyster samples from Finley's Pond are from Unit A-1, Level 4 (n=1) and Unit B-1, Levels 2 through 6 (n=9) from the University of Georgia's 2016 Archaeology Field School excavations. The oyster samples from South End are from an exposed shell pit located on the eroding bluff edge of Newell Creek (n=8), determined to be a Plantation Period domestic shell pit associated with an enslaved family's residence using the diagnostic artifact assemblage contained within the feature (Roberts Thompson 2020, pers. comm. 2024) (see Tables 1 and 2 and Figure 18 for more provenience and dating details).

It is important to note that the samples were non-randomly selected and therefore are representative of their respective sites to varying degrees. Because only complete left oyster valves with large and intact chondrophores and no evidence of parasitic activity were suitable for analysis, and samples were taken from the collections available at UGA's Laboratory of Archaeology, this limited the potential sample pool. This resulted in some sites being represented by multiple excavation units and levels within those units (*Hokfv-Mocvse* Shell Ring and Finley's Pond), one represented by only one level within an excavation unit (Bluff Field), and one represented by an indeterminate number of levels within a feature (South End). Additionally, the sample size number is small ($n \leq 13$) for each site. Both the non-random nature of the sample and the sample size are comparable with other incremental oxygen isotope analyses on shellfish in the region. Time and cost prohibit larger sample sizes (Colclasure et al. 2023). Sample sizes range from 10 to 46 oysters and are often below 20 oysters unless the study is a composite of previous work (e.g., Andrus and Thompson 2012; Colclasure et al. 2023; Garland and Thompson 2023; Holland-Lulewicz et al. 2020; Lulewicz et al. 2018; Thompson and Andrus 2011, 2013; Thompson et al. 2015, 2024a). The data from these small sample sizes are often extrapolated to make general assumptions about the oyster harvesting practices occurring at a site during a particular time period (e.g., Andrus and Thompson 2012; Colclasure et al. 2023; Garland and Thompson 2023; Holland-Lulewicz et al. 2020; Lulewicz et al. 2018; Thompson and Andrus 2011, 2013; Thompson et al. 2015).

It is worth noting that the data gleaned from oyster samples from one level might not be representative of an entire excavation unit, or data from one shell midden mound or shell pit might not be representative of an entire site, and an entire site might not be representative of a multi-hundred-year time period. Each time data is extrapolated to generalize, the grain becomes coarser. Rather than a continuous time-series of data, this thesis is a rough 5,000-year timeline of oyster harvesting made up of snapshots of data from four sites that are taken to represent four different time periods and two different communities (Brehmer et al. 2017:2152). From this timeline, coarse-grained assumptions about the general trends in oyster harvesting behavior through time and across communities can be made, such as the seasons and range of estuarine zones oysters were harvested from. Absence of evidence is not evidence of absence, which comes to bear in the interpretation of seasonality and estuarine zone data. That being said, the only data that can be interpreted is the data in-hand, which I have done here.

Table 1. Provenience of samples, first half. *Hokfv-Mocvse* Shell Ring data from Garland et al. (2024), table 1.

Sample ID	Context	Sample ID	Context
***Hokfv-Mocvse* Shell Ring (9CH160)**	UGA's 2022 Field School. Shell ring construction ^{14}C dated to 3140–2785 BC, Late Archaic Period (Garland et al. 2024:1, 7-8).	**Bluff Field (9CH160)**	UGA's 2022 Field School. Unit A-1 ^{14}C dated to AD 880–1030, Late Woodland/Early Mississippian Period (Parbus et al. 2023:280).
9CH160-D1-LVL4-S1	Op. D1, Level 4	9CH160-A-1-3-S1	Unit A-1, Level 3
9CH160-D1-LVL4-S2	Op. D1, Level 4	9CH160-A-1-3-S2	Unit A-1, Level 3
9CH160-D1-LVL4-S4	Op. D1, Level 4	9CH160-A-1-3-S3	Unit A-1, Level 3
9CH160-FI-LVL4-S1	Op. FI, Level 4	9CH160-A-1-3-S4	Unit A-1, Level 3
9CH160-D1-LVL5-S1	Op. DI, Level 5	9CH160-A-1-3-S5	Unit A-1, Level 3
9CH160-E1-LVL2-S1	Op. E1, Level 2	9CH160-A-1-3-S6	Unit A-1, Level 3
9CH160-E1-LVL2-S2	Op. E1, Level 2	9CH160-A-1-3-S7	Unit A-1, Level 3
9CH160-D1-LVL2-S1	Op. D1, Level 2	9CH160-A-1-3-S9	Unit A-1, Level 3
9CH160-D1-LVL3-S1	Op. D1, Level 3	9CH160-A-1-3-S10	Unit A-1, Level 3
9CH160-D1-LVL3-S2	Op. D1, Level 3	9CH160-A-1-3-S11	Unit A-1, Level 3
9CH160-D1-LVL3-S3	Op. D1, Level 3		
9CH160-C1-LVL2-S1	Op. C1, Level 2		
9CH160-C4-LVL2-S1	Op. C4, Level 2		

Table 2. Provenience of samples, second half.

Sample ID	Context	Sample ID	Context
Finley's Pond (9CH204)	UGA's 2016 Field School. Unit A-1 broadly Mississippian (presence of Irene type ceramics). Unit B-1 ^{14}C dated to AD 1445–1490, Late Mississippian (Garland et al. 2023:358).	**South End (9CH155)**	Site reconnaissance by A. Roberts Thompson at eroding bluff edge of Newell Creek. Plantation in operation from AD 1849–1861 (documentary evidence).
9CH204-A-1-4-S2	Unit A-1, Level 4, Feature 1	9CH155-S1	Enslaved family's residential shell pit
9CH204-B-1-2-S2	Unit B-1, Level 2	9CH155-S2	Enslaved family's residential shell pit
9CH204-B-1-2-S3	Unit B-1, Level 2	9CH155-S3	Enslaved family's residential shell pit
9CH204-B-1-3-S1	Unit B-1, Level 3	9CH155-S4	Enslaved family's residential shell pit
9CH204-B-1-3-S3	Unit B-1, Level 3	9CH155-S5	Enslaved family's residential shell pit
9CH204-B-1-4-S2	Unit B-1, Level 4	9CH155-S6	Enslaved family's residential shell pit
9CH204-B-1-5-S3	Unit B-1, Level 5	9CH155-S7	Enslaved family's residential shell pit
9CH204-B-1-6-S1	Unit B-1, Level 6	9CH155-S8	Enslaved family's residential shell pit
9CH204-B-1-6-S2	Unit B-1, Level 6		
9CH204-B-1-6-S3	Unit B-1, Level 6		

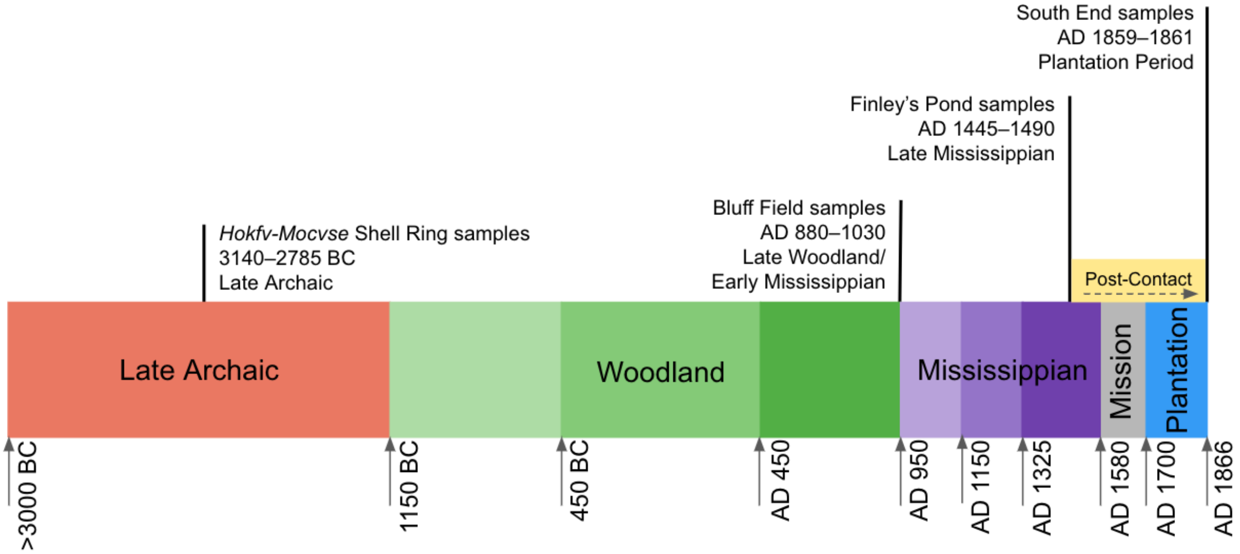


Figure 18. Highly simplified timeline of samples based on radiocarbon dates (or exact dates in the case of South End) at each site. Figure made by S. Forbes.

3.1.3 Limitations

Sclerochronology provides an estimation of season of capture and water salinity (Thompson and Andrus 2013). Oysters precipitate their shells near, not at, isotopic equilibrium with ambient water (Surge et al. 2001). Sources of error for interpreting season of capture may include unknown climatic and environmental changes and oyster growth variation during the oysters' lifetimes and sampling resolution and misinterpretation of data by the author (Thompson and Andrus 2013). Sources of error in estimating water salinity may include unknown climate and environmental changes during the oysters' lifetimes, including changes in local hydrology and error in the construction of the equations used (Thompson and Andrus 2013). Furthermore, the selected samples may not be representative of each cultural site as they were not randomly selected. See Andrus (2011) and Twaddle and colleagues (2016) for further discussion of the limitations of the method.

3.2 Oyster Archaeobiology

Oyster shell size and shape is influenced by oyster age, ambient growing conditions, and human harvesting pressures (Bartol et al. 1999; Crook 1992; Kennedy et al. 1996; Lawrence 1988). In archaeological studies, change in oyster shell morphology through time is used as a proxy for oyster reef management practices on the assumption that sustainably managed reefs produce healthier oysters with larger shells and overharvested reefs produce smaller oysters (e.g., Garland et al. 2024; Lulewicz et al. 2017; Rick et al. 2016; Savarese et al. 2016; Thompson et al. 2020). Lulewicz and colleagues (2017) measured shell height (LVH) and shell length (LVL) of intact left oyster valves randomly sampled from the Late Woodland (Unit A-1) shell pit (n=606) and Late Mississippian (Unit B-1) shell midden (n=1224) at Finley's Pond. Following the same methods as Lulewicz and colleagues (2017), Garland and colleagues (2024) measured LVH and LVL of intact left oyster valves randomly sampled from multiple Late Archaic proveniences at *Hokfv-Mocvse* (n=145) and the Late Woodland/Early Mississippian component of Bluff Field (n=498). The results of these analyses are reported in Chapter 4 and are used to contextualize the sustainability of Indigenous oyster harvesting practices.

CHAPTER 4

RESULTS

Here, I present the results of the incremental stable oxygen ($\delta^{18}O$) isotope analysis on oyster samples from *Hokfv-Mocvse* Shell Ring, a Late Archaic Period shell ring (n=13), Bluff Field, a Late Woodland/Early Mississippian Period shell midden mound (n=10), Finley's Pond, a Late Mississippian Period shell midden mound (n=10), and South End, a Plantation Period shell pit (n=8). From this data, I address the two guiding research questions: 1. During which seasons were oysters harvested?; and 2. From which estuarine zones were oysters harvested? I also present the results of Lulewicz and colleagues' (2017) and Garland and colleagues' (2024) oyster archaeobiology analyses in order to contextualize the findings in the discussion.

4.1 Seasons of Harvest

This research investigates how oysters were harvested by Indigenous and enslaved communities on Ossabaw Island over a five millennia period by answering two guiding research questions. The first research question seeks to determine when oysters were harvested. Were they harvested year-round or only during specific seasons? At all Indigenous sites, the majority of oysters were harvested during the winter (>50%), with lower percentages of collection occurring in other seasons (see Figures 19 and 20). At *Hokfv-Mocvse* Shell Ring, oysters were harvested in the winter (n=7, 53.8%), fall (n=3, 23.1%), summer (n=2, 15.4%), and spring (n=1, 7.7%) (Garland et al. 2024:11). At Bluff Field, oysters were harvested in the winter (n=8, 80%) and summer (n=2, 20%). At Finley's Pond, oysters were harvested in the winter (n=7, 70%), summer (n=2, 20%), and spring (n=1, 10%). At South End, enslaved individuals harvested oysters equally in the winter (n=4, 50%) and spring (n=4, 50%).

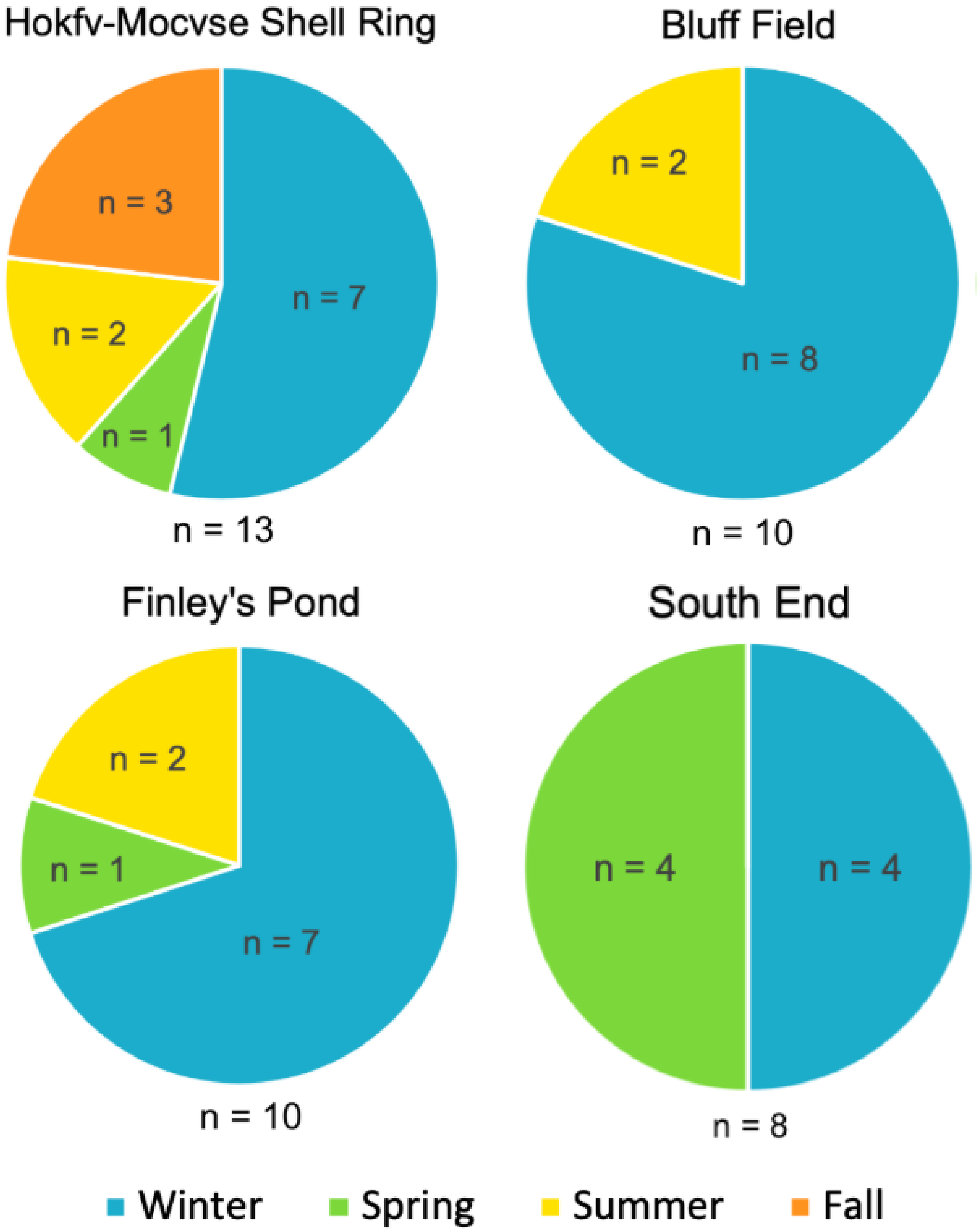


Figure 19. Season of harvest of oysters at four studied sites. Figure made by S. Forbes.

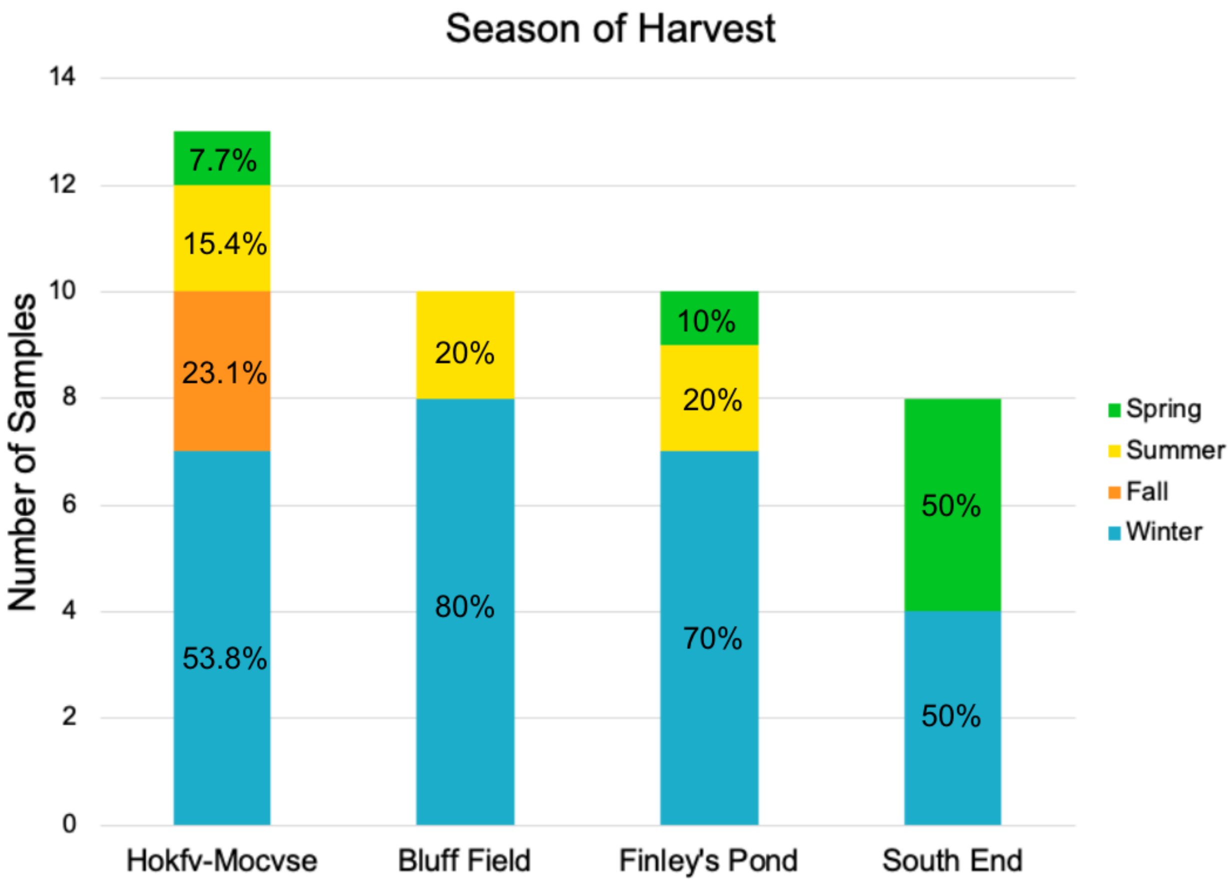


Figure 20. Season of harvest of oysters with percentages harvested in each season. Figure made by S. Forbes.

4.2 Estuarine Zones of Harvest

The second guiding research question seeks to determine where oysters were harvested. More specifically, from which estuarine zones were oysters harvested? Were Indigenous and enslaved communities harvesting from a wide range of oyster reefs within the estuarine system, or only nearby reefs? Oysters are euryhaline species that tolerate a wide range of salinities. Generally, they can tolerate salinity ranges between 5 to 37 psu, but have also been reported to survive in salinities above and below that range, including lower than 3.5 psu and up to 40 psu (Bartol et al. 1999; Butler 1952; Galtsoff 1964; La Peyre et al. 2009).

Estuarine waters can be divided by salinity into oligohaline (0.5 to 5 psu), mesohaline (5 to 18 psu), polyhaline (18 to 30 psu), and euhaline (>30 psu) zones (McLusky 1993:491). Generally, oligohaline water occurs in the upper reaches of the estuary, mesohaline in the inner estuary, polyhaline in the middle to lower reaches of the estuary, and euhaline water at the mouth of the estuary, or the open ocean (McLusky 1993:491; Reitz 2021:86). Therefore, through estimated salinities, general statements about the estuarine zones where oysters were harvested can be made.

At all Indigenous sites, the majority of oysters were harvested from polyhaline salinities, or the middle to lower reaches of estuaries. Additionally, oysters harvested by Indigenous individuals were harvested across a range of salinities (15+ psu) (see Figures 21 and 22). At *Hokfv-Mocvse*, oysters were harvested from polyhaline (n=10, 76.9 %) and euhaline (n=3, 23.1%) estuarine zones, from 21 to 36 psu (Garland et al. 2024:11-12). At Bluff Field, oysters were harvested from mesohaline (n=1, 10%), polyhaline (n=6, 60%), and euhaline (n=3, 30%) estuarine zones, from 17 to 40 psu. At Finley’s Pond, oysters were harvested from mesohaline (n=1, 11.1%), polyhaline (n=6, 66.7%), and euhaline (n=2, 22.2%) estuarine zones, from 13 to 34 psu. One oyster at Finley’s Pond fell below the reported salinity tolerance for oysters at 2.9 psu and was excluded from this analysis. At South End, oysters were harvested from a narrower range of salinities (33 to 41 psu), and from exclusively euhaline (n=8, 100%) estuarine zones, which occur in the mouth of estuaries or the open ocean. The average estimated salinity from South End oysters is 37 psu, substantially more saline than the average estimated salinities from any of the Indigenous sites (such as *Hokfv-Mocvse*, 27 psu; Bluff Field, 29 psu; and Finley’s Pond, 25 psu).

A Chi Squared Test of Independence suggests that there is no relationship between season of harvest and estuarine zone of harvest; i.e., at all sites, oysters harvested in a particular season were harvested across the range of estuarine zones represented at that site, and vice versa. As the *p*-value of each dataset was greater than 0.05 (*Hokfv-Mocvse* Shell Ring: $p = 0.754$; Bluff Field: $p = 0.054$; Finley's Pond: $p = 0.782$; South End: observed values equaled expected values), it was found that the relationship between season of harvest and estuarine zone of harvest had no statistical significance.

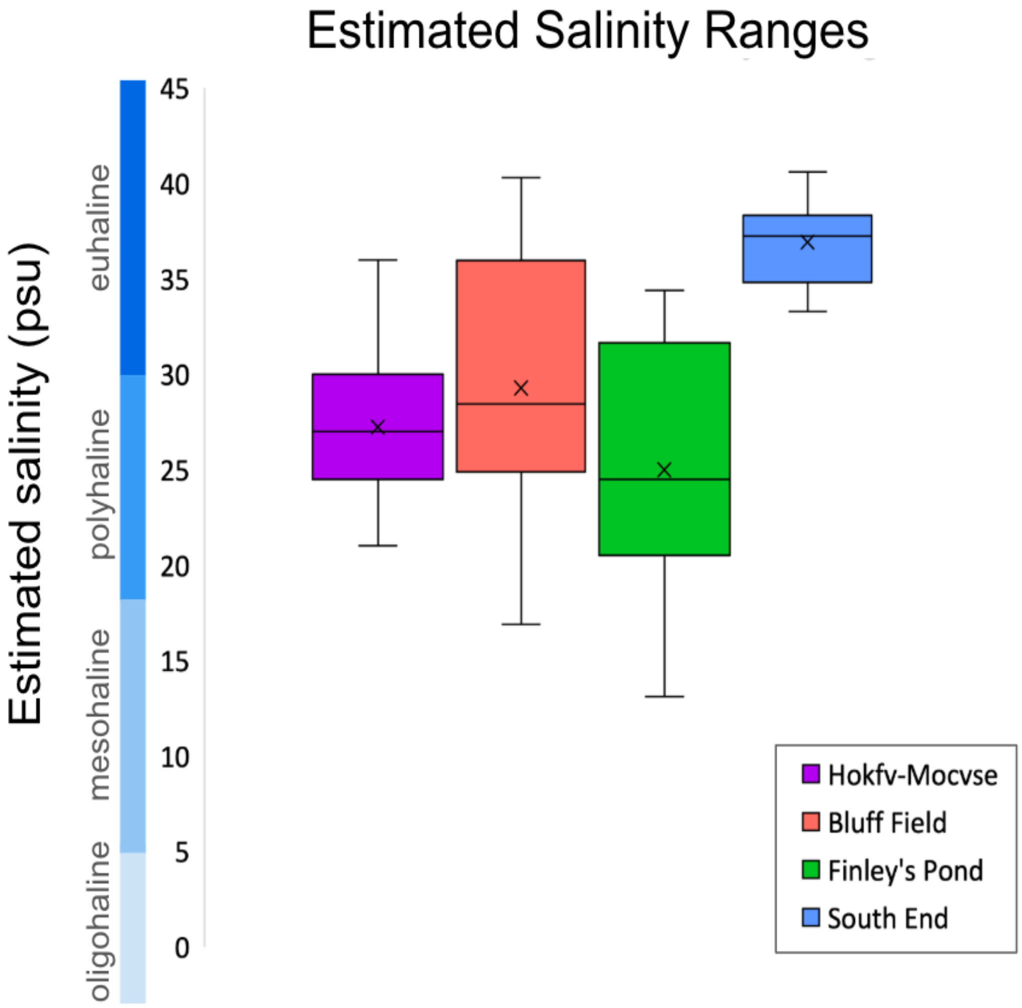


Figure 21. Estimated salinity ranges of oysters from *Hokfv-Mocvse* Shell Ring, Bluff Field, Finley's Pond, and South End. *Hokfv-Mocvse* Shell Ring data from Garland et al. (2024). Figure made by S. Forbes.

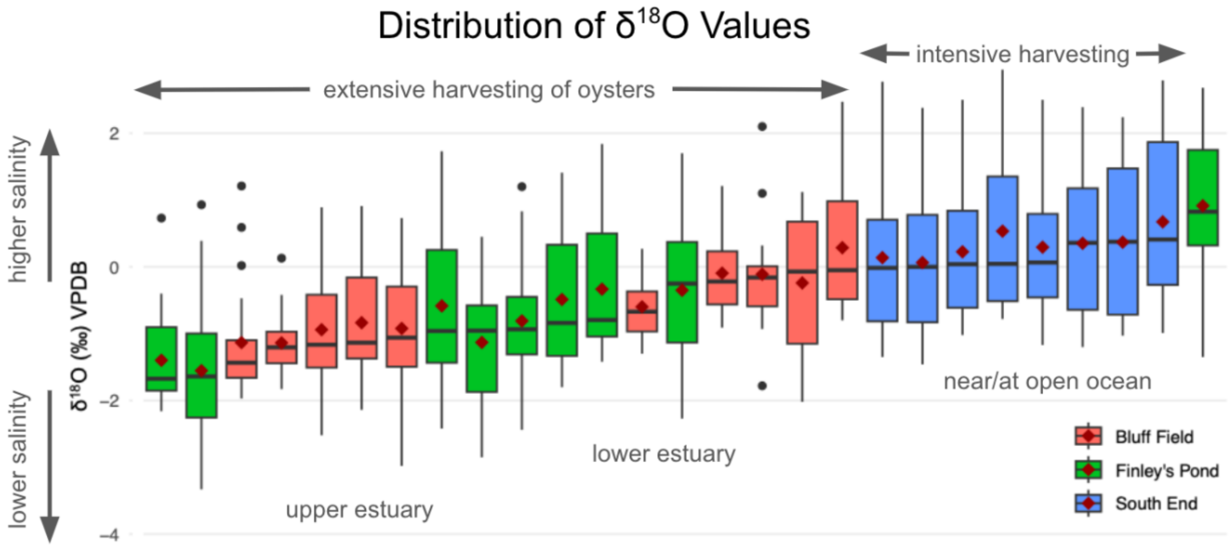


Figure 22. Distribution of δ^{18}O values of newly sampled oysters in this study. Figure made by C. J. Garland and S. Forbes.

4.3 Oyster Archaeobiology Results

Garland and colleagues (2024) measured shell height (LVH) and shell length (LVL) of intact left oyster valves randomly sampled from multiple Late Archaic Period proveniences at *Hokfv-Mocvse* Shell Ring (n=145) and the Late Woodland/Early Mississippian Period component of Bluff Field (n=498). Lulewicz and colleagues (2017) measured shell height (LVH) and shell length (LVL) from the Late Woodland Period (Unit A-1) shell pit (n=606) and Late Mississippian Period (Unit B-1) shell midden (n=1224) at Finley's Pond. In comparing data from the three sites, Garland and colleagues (2024:12) found that the shells from all sites were not statistically different in height or length ($p < 0.01$) (see Figure 23).

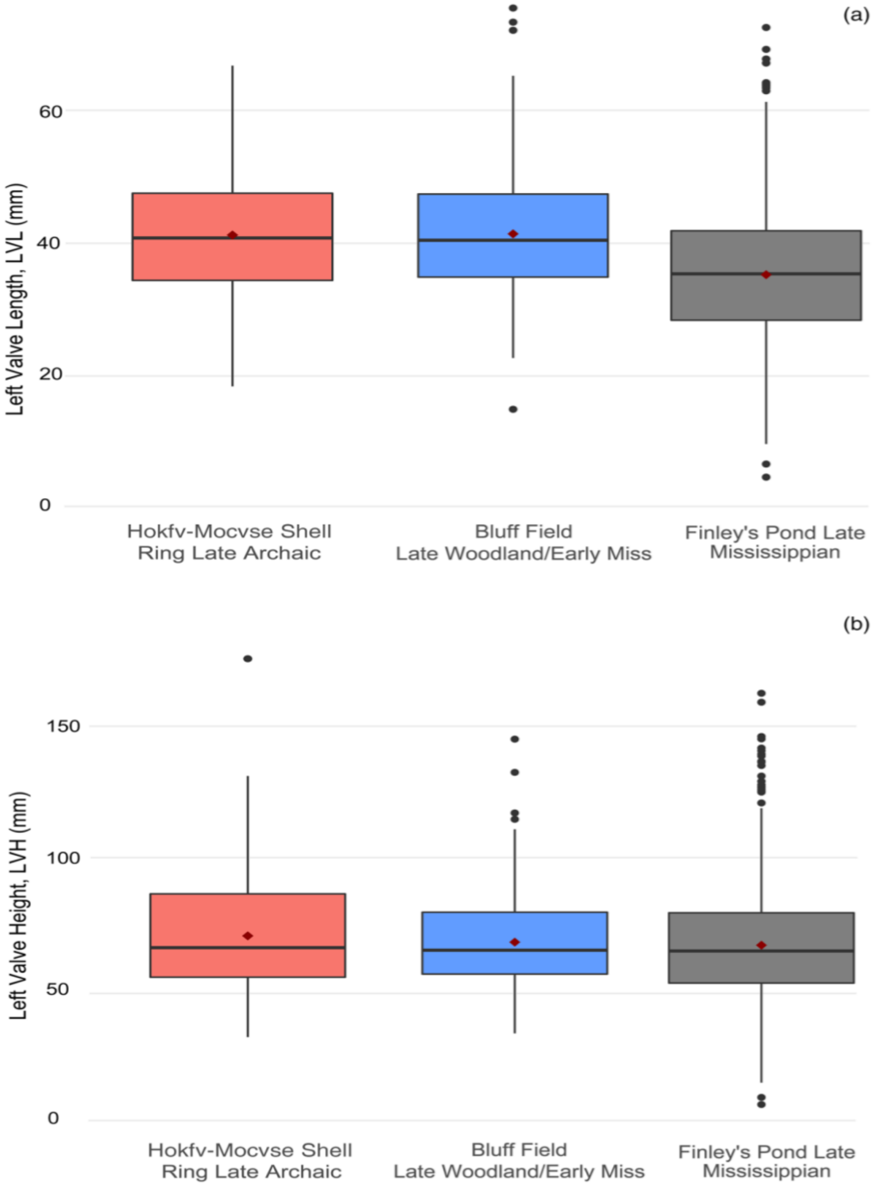


Figure 23. Comparison of range of shell height (a) and shell length (b) of oysters, edited to only display samples from *Hokfv-Mocvse* Shell Ring, Bluff Field, and Finley's Pond. From Garland et al. (2024), figure 7.

CHAPTER 5

DISCUSSION AND CONCLUSIONS

5.1 Discussion of Major Findings

After determining when and where communities on Ossabaw Island harvested oysters, it is possible to ask the following research questions: a. How were Indigenous groups harvesting oysters from their landscape? Was there change or continuity in harvesting practices from the Late Archaic Period to the Late Mississippian Period?; b. How were enslaved communities harvesting oysters from their surrounding landscape during the Plantation Period?; c. Were there differences in oyster harvesting practices between Indigenous and enslaved communities?; and d. How does this information fit with previously collected data on oyster harvesting practices in the South Atlantic Bight and Gulf Coast, including sclerochronological data and oyster archaeobiological data? By exploring these research questions, I am able to make statements about oyster resource management practices over the *longue durée* on Ossabaw Island, providing information about the sustainable socioecological system of Indigenous oyster harvesting and contextualizing modern oyster reef fishery collapse by investigating Post-Contact (enslaved community) oyster harvesting practices.

5.1.1 Indigenous Oyster Harvesting: Seasonality

Indigenous inhabitants of Ossabaw primarily harvested oysters in the winter across all time periods, a trend that is seen throughout the South Atlantic Bight and Gulf Coast (Garland and Thompson 2023; Holland-Lulewicz et al. 2020; Thompson and Andrus 2013; Thompson et al. 2015, 2024a). At all sites, oysters were also harvested in the summer (at the least), pointing to year-round occupation and multi-season oyster harvesting (see Table 3).

Table 3. Table summarizing previous eastern oyster and hard clam shell midden sclerochronology research in the South Atlantic Bight and Gulf Coast regions.

Site	Context	Seasons	Salinity
Sapelo Island Shell Ring Complex, GA (Andrus and Thompson 2012; Thompson and Andrus 2011)	Late Archaic n = 17 oysters	n/a	**4 to 36 psu**
Sapelo Island Shell Ring Complex, GA (Garland and Thompson 2023)	Late Archaic n = 16 oysters	**81% winter (n=13)** 19% summer (n=3)	**12 to 36 psu**
Composite from shell ring sites in GA and SC (Thompson et al. 2024a)	Late Archaic n = 206 oysters and clams	**54% winter (n=112)** 27% summer (n=55) 11% (n=23) 8% spring (n=16)	**4 to 46 psu**
Garden Patch Site, FL (Holland-Lulewicz et al. 2020)	Middle Woodland n = 10 oysters	**40% winter (n=4)** 20% fall/winter (n=2) 20% summer/fall (n=2) 10% fall (n=1) 10% summer (n=1)	n/a
Crystal River Site, FL (Thompson et al. 2015)	Middle/Late Woodland n = 19 oysters	**47% winter (n=9)** 16% summer (n=3) 16% spring (n=3) 11% fall (n=2) 5% fall/winter (n=1) 5% spring/summer (n=1)	n/a
Roberts Island Shell Mound Complex, FL (Thompson et al. 2015)	Middle/Late Woodland n = 26 oysters	**46% winter (n=12)** 19% spring (n=5) 15% summer (n=4) 12% winter/fall (n=3) 8% fall (n=2)	n/a
Crystal River Site and Roberts Island Shell Mound Complex, FL (Lulewicz et al. 2018)	Middle/Late Woodland n = 46 oysters	n/a	**1 to 43 psu**
Pumpkin Hammock, GA (Thompson and Andrus 2013)	Late Mississippian/ Contact n = 13 oysters	**38% winter (n=5)** 23% fall (n=3) 15% summer (n=2) 15% winter/spring (n=2) 8% spring (n=1)	**17 to 24 psu**

While a seasonal preference for harvesting oysters in the winter is observed throughout the South Atlantic Bight, the reason for this patterning remains somewhat elusive. One idea is that Indigenous inhabitants turned towards harvesting oysters in the winter when other seasonal resources were no longer available (Colclasure et al. 2023:5). Although oysters have been traditionally conceptualized as nonideal fallback resources (for discussion see Thomas 2014a), archaeological data and modern ethnographic accounts demonstrate that oysters were an important resource for the Indigenous groups of the region (Colaninno 2010; Reeder-Myers et al. 2022; Reitz 1988, 2014, 2021; Reitz et al. 2009; Thomas 2008, 2014a). For example, in faunal assemblages from cultural sites across the South Atlantic Bight, non-seasonal, small-bodied fishes and shellfish comprise the majority of taxa, whereas seasonal fishes and terrestrial fauna like deer, turtle, birds, and small mammals occur in low numbers (Colaninno 2010; Reitz 1988, 2014, 2021; Reitz et al. 2009). This demonstrates that oysters were an important part of Indigenous subsistence.

Another idea is that more intensive oyster harvesting occurred during winter ceremonial feasts resulting in higher quantities of oysters harvested in the winter and deposition in shell rings and middens (Holland-Lulewicz et al. 2020; Lulewicz et al. 2018; Thompson and Andrus 2011, 2013; Thompson et al. 2015). Even in the present day, there is a belief that eating oysters in warmer months is dangerous; bacteria, viruses, and parasites harbored in raw oysters can cause illness, hence the modern Georgia oystering season beginning in October; and oysters left sitting in the hot sun could spoil faster (Gallant 2018; Klein 2017; Virginia Department of Health 2018). Additionally, oysters spawn multiple times in the summer (and for portions of the spring and fall in the waterways surrounding Ossabaw Island), discharging egg and sperm, which gives the flesh a ‘snotty’ texture (Berrigen et al. 1991; Breuer 1962; Durant 1970; Gallant 2018; Kennedy et al. 1996; Klein 2017:para. 8).

However, the Indigenous inhabitants of *Hokfv-Mocvse* Shell Ring, Bluff Field, and Finley’s Pond harvested oysters in the summer, spring, and fall (Garland et al. 2024); at Bluff Field and Finley’s Pond, summer was the only other season oysters were harvested. Commenting on the same seasonality pattern seen across 14 Late Archaic shell ring sites in the South Atlantic Bight, Thompson and colleagues (2024a:4) hypothesize that Indigenous groups may have harvested more oysters in the winter simply due to “culinary preferences”. Overall, the reason(s) Indigenous inhabitants chose to harvest oysters primarily in the winter is still up for speculation.

In terms of the other seasons in which oysters were collected at the Indigenous sites, oysters from *Hokfv-Mocvse* Shell Ring were harvested from all four seasons, whereas oysters from Bluff Field were harvested in winter and summer, and from Finley’s Pond from winter, spring, and summer. This may be due to the depositional history of the features in which the oysters were deposited. *Hokfv-Mocvse* is a large shell ring village, and oyster shells were likely accumulated in household middens before being re-deposited into a larger shell ring structure; therefore, the samples from this site represent an extended view of oyster harvesting over a longer period of time and between multiple households within a village (Thompson and Andrus 2011). Conversely, the Bluff Field and Finley’s Pond oyster samples were taken from shell midden mounds, which are likely middens associated with one or a small number of households, and capture the oyster harvesting practices of this small group of individuals over roughly 25 years (V. D. Thompson, pers. comm. 2023).

5.1.2 Indigenous Oyster Harvesting: Estuarine Zones

Indigenous inhabitants harvested oysters over a large range of salinities for over 4 millennia. This extensive harvesting pattern is a trend that is seen throughout the South Atlantic Bight and Gulf Coast (Andrus and Thompson 2012; Garland and Thompson 2023; Lulewicz et al. 2018; Thompson and Andrus 2011, 2013; Thompson et al. 2024a). The most restricted Indigenous range of harvesting occurred during the Late Archaic, represented by the oyster samples from *Hokfv-Mocvse* Shell Ring. During the Late Archaic, oyster reef fisheries around Ossabaw Island became viable for intensive shellfishing following sea level rise, prompting mobile fisher-hunter-gatherers to settle on the island year-round in shell ring villages, the first villages in Eastern North America (Garland et al. 2024; Thompson et al. 2024a, 2024b).

It may be that Indigenous groups harvested oysters over the most restricted range of salinities during the Late Archaic Period because sea level was still ca. 4 m below present, and oyster reefs may have only occurred in polyhaline and euhaline estuarine zones at the time as increasing sea level may have outweighed freshwater input (Turck and Thompson 2019). While groups were sedentary, evidenced in part by oysters that were captured from multiple seasons (e.g., Garland et al. 2024), they were also highly mobile in the landscape in terms of resource procurement, a pattern of movement Thompson and colleagues (2024b:3) refer to as “tethered mobility.” This data indicates that Indigenous groups on Ossabaw Island continued to be highly mobile within the estuarine system, even potentially traveling further upstream and out into the open ocean to harvest oysters during the Late Woodland Period and Late Mississippian Period as demonstrated by the wider range of estimated salinities from the oysters sampled from Bluff Field and Finley’s Pond.

In terms of the differences in salinity ranges between Bluff Field and Finley's Pond oysters (i.e., Finley's Pond oysters were harvested from slightly lower salinities on average than Bluff Field oysters), this may be due to fluctuating sea level. During the end of the Late Archaic and into the Early Woodland Period, sea level dropped ca. 3.3 m below the Late Archaic high stand; whereas, during the Middle and Late Woodland, sea level rebounded quickly at a rate of ca. 1 cm per year, surpassing Late Archaic sea level by ca. 3 m (Thompson and Turck 2009; Turck and Thompson 2019:170-175). During the Mississippian Period, sea level remained relatively stable, rising at a negligible rate (Thompson and Turck 2009; Turck and Thompson 2019:183). It may be that the dramatically rising sea level during the Woodland Period skewed the estimated salinity ranges of the oysters from Bluff Field upwards—stated in another way, the differences in the average salinity between the Bluff Field and Finley's Pond samples may simply be due to climatic changes rather than any difference in Indigenous harvesting patterns.

As stated earlier, the 5,000 years of Indigenous history on the Georgia coast are characterized by 1. "near-continuous and accelerating population growth" and 2. "significant shifts in political organization and settlement organization" (Garland et al. 2023:351) which occurred within the context of 3. dramatic environmental change, largely in the form of sea level fluctuations that impacted estuarine resources (DePratter and Howard 1981; DePratter and Thompson 2013; Thompson and Turck 2009; Turck and Thompson 2016, 2019). It is significant that, throughout dramatic demographic, political, social, and environmental change, oyster harvesting remained an extensive foraging practice, if not an activity that increased in range through time. Additionally, Garland and colleagues (2024:12) argue that the maintenance of oyster shell height and length from the Late Archaic to the Late Mississippian indicates that Indigenous inhabitants were sustainably harvesting oysters throughout their multi-millennia history on Ossabaw Island (see also Thompson et al. 2020) (see Figure 23). How is it that Indigenous communities continued to intensively, yet sustainably, harvest oysters, a common pool resource prone to overharvesting, despite significant changes in nearly every sphere of life?

In order to more fully capture the scope and complexities of human-environmental interactions, it is beneficial to take a socioecological systems approach, which recognizes social and ecological subsystems as coupled, impacting the other through reciprocal relationships and changing together coevolutionarily (Norgaard 1994; Olmos-Martínez and Ortega-Rubio 2020:4). Resiliency is the capacity of a system to respond to disturbances (Adger 2000:349). Resiliency can take many forms, such as adaptive change, in which the system responds to a disturbance through modification while preserving its essential attributes (Olmos-Martínez and Ortega-Rubio 2020:6; Redman 2005; Salas-Zapata et al. 2012). In this way, the socioecological system of Indigenous oyster harvesting on Ossabaw Island can be thought of as resilient, as the importance of oysters, mode of harvesting (i.e., extensively), and intensity and magnitude of shellfishing did not change significantly through time.

Adger (2000:348) argues that institutions are a central component that link social and ecological subsystems. Using this perspective, institutions can be thought of as the lynchpin that holds together a socioecological system: either the institution is effective at managing the connection between the two subsystems, and the system as a whole can thrive, or it is unsuccessful. Institutions are effective when there is a socioecological fit, or when the institution’s structure and rules are internally aligned and coordinated to the characteristics of the social and ecological subsystems (Bodin 2017; Cumming et al. 2006). Socioecological fit needs to occur both horizontally and vertically for an institution to be successful (Bodin 2017) (see Figure 24). For example, if individuals within an institution are competing against each other to harvest a resource instead of working together, horizontal misfit occurs in the social subsystem, which may result in overharvesting and depletion of the resource, decreasing net outcomes (Bodin 2017). Socioecological fit in the vertical dimension is best conceptualized as scale matching (Cumming et al. 2006). Scale occurs in spatial, temporal, and functional forms within the subsystems (Cumming et al. 2006). Fit in the vertical dimension occurs when the scales of the social and ecological subsystems are matched, resulting in effective resource management (Bodin 2017; Cumming et al. 2006). For example, if an institutional rule allows for a resource to be harvested every year, but it takes the resource many years to regenerate, vertical misfit occurs in the functional scale, again decreasing net outcomes (Bodin 2017; Cumming et al. 2006). If resiliency and sustainability of socioecological systems are necessarily maintained by well-matched institutions which mediate the connection between the social and ecological subsystems, then which institutions upheld the Indigenous oyster harvesting system on Ossabaw Island (Reitz 2014; Thompson et al. 2024a)?

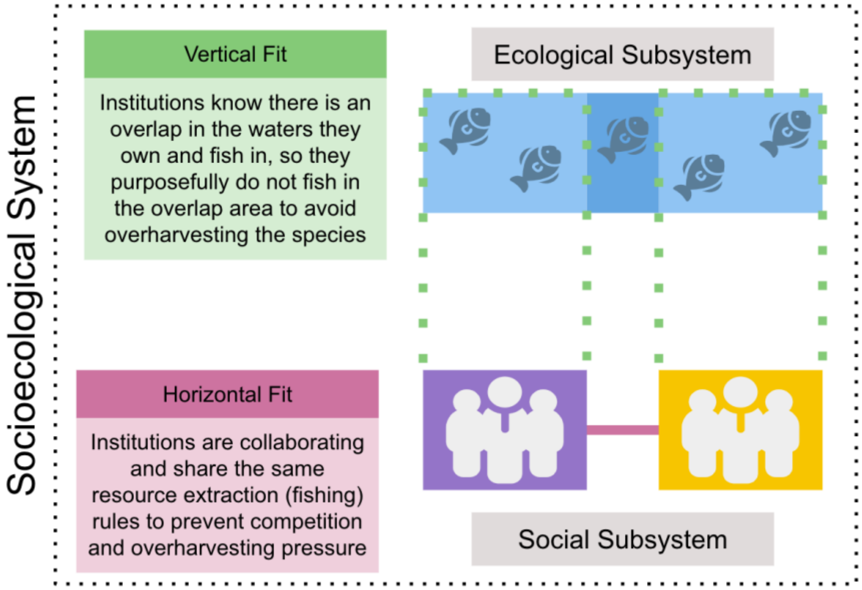


Figure 24. Simplified graphic depicting an example of socioecological fit in the horizontal and vertical dimensions. Figure made by S. Forbes.

Many researchers have proposed explanations as to the extensive pattern of Indigenous oyster harvesting observed in the archaeological record, seen at sites along the South Atlantic Bight and Gulf Coast (see Table 3). This pattern of traveling long distances from residential sites, including into the upper reaches of estuaries and into the open ocean, eschews traditional optimal foraging theory explanations. Crook (1992), drawing from ethnographic accounts of shellfishing, speculates that Indigenous women and children harvested oysters at locations that were accessible by foot near settlements as part of their typical foraging routine, whereas men opportunistically harvested oysters while on hunting or fishing excursions by boat (see also Thomas 2014a). As oyster reefs are essential habitats for juvenile and adult fish and attract a wide variety of other organisms, it is possible that oyster reefs were targeted for a range of resources and oysters were incidentally harvested as part of other foraging excursions (Bahr and Lanier 1981; Coen et al. 1999). Thompson and Andrus (2013:204) state that canoe technology and knowledge of tides facilitated long-distance movement throughout the estuarine system, which allowed access to oyster reefs that could be located 20+ km away from residential sites (Andrus 2008; Andrus and Thompson 2012).

Thompson and colleagues (2020; 2024a) posit that a common pool resource management system in the form of territoriality or proprietorship governed oyster harvesting; in this model, reefs were not freely accessible to individuals, and the management system directed harvesting practices from intensive to extensive in nature perhaps in part to promote oyster reef productivity (see also Thomas 2014a). Bettinger and colleagues (1997:896) found that ‘depleted’ Californian big mussel colonies, or colonies that humans had harvested mussels from in the recent past, were more productive (in terms of meat content relative to weight) than ‘pristine’ colonies, as ‘depleted’ colonies had more room for larger mussels to grow. Eastern oyster reefs on the

Georgia coast grow in a similar clumped fashion, therefore it is likely that extensively harvesting oysters throughout the estuarine system was a choice Indigenous people made that was designed to increase the productivity of multiple reefs (Crook 1992; Thompson et al. 2020, 2024a). In this way, increasing oyster reef productivity through extensive harvesting may have had an epiphenomenal conservationist effect (Alvard 1993; Thomas 2014b), such that oyster reefs were thinned enough to increase reef productivity while also maintaining enough reef substrate for oyster regeneration, which represents a socioecological fit in the vertical dimension (i.e., the scales of management and ecological processes match) (Cumming et al. 2006:3).

Additionally, Garland and Thompson (2023) speculate that village layout (i.e., houses arranged in a circle enclosing a central plaza, in the case of shell ring villages) and intervillage feasting ceremonies enhanced resource management efforts by promoting distribution of oysters and resource management cooperation within and between villages and discouraging overharvesting and free riders (see also Thompson and Moore 2015; Thompson 2018). This would represent a horizontal fit in the social subsystem.

It is worth noting that none of the above proposed explanations for the extensive oyster harvesting pattern seen in the data are mutually exclusive. Further, there is ethnographic evidence that many of these practices occur simultaneously within shellfishing societies (see Thomas 2014b for an example of resource sharing and reciprocal territorial access; see Lepofsky et al. 2017 for an example of proprietorship, mariculture or habitat enhancement, and traditions linked to sustainable resource management).

Adger's (2000:348, 351) definition of institutions includes both 'informal' aspects, such as habitual behavior, rules, and norms ("socialized behavior"), as well as 'formal' institutions ("structures of governance or law"). Traditional gendered divisions of labor (e.g., Crook 1992), canoe technology and knowledge of tides (e.g., Thompson and Andrus 2013), culturally acceptable behavior surrounding harvesting, sharing, and cooperation, and ceremonial feasting activity (e.g., Garland and Thompson 2023; Thompson 2018; Thompson and Moore 2015) can all be conceptualized as forms of Traditional Ecological Knowledge (TEK) (Poe et al. 2013; Ziker et al. 2016). Traditional Ecological Knowledge is a knowledge-practice-belief system: knowledge is generated by observations of the local environment and this knowledge is encoded into resource management practices (for the purposes of this study) supported by beliefs about the natural world (Berkes et al. 2000:1252). Traditional Ecological Knowledge is adaptive in that it accumulates gradually through modifications to practice based on outcomes as well as continued observation of environmental conditions (Berkes et al. 2000:1252). In this way, the spatial, temporal, and functional scales of ecological processes are known and monitored and can inform institutional management to create socioecological fit.

Traditional Ecological Knowledge, broadly, is a type of socialized behavior that falls under the umbrella of ‘informal’ institutions *sensu* Adger (2000). Reef proprietorship and village layout are arguably more formalized institutions. It is possible that both ‘informal’ and ‘formal’ institutions promoted the resiliency and sustainability of the Indigenous oyster harvesting socioecological system on Ossabaw Island. Poe and colleagues (2013) argue that only by incorporating cultural dimensions can resource management be successful; this further supports the idea that socioecological resource management systems need to leverage both ‘informal’ and ‘formal’ institutions for optimal outcomes. The integration of both types of institutions into the management of oyster reefs likely allowed Indigenous communities to maintain the essential attributes of the oyster harvesting socioecological system and continue sustainably harvesting oysters on Ossabaw Island through fluctuations in demography, social and political structure, and environmental change for 4,500 years. Further, there is archaeological evidence for these institutions changing over time, such as oyster reef proprietorship becoming more hierarchical during the Mississippian Period as hierarchical sociopolitical institutions emerged, further supporting the idea that Indigenous communities maintained the socioecological system's resiliency through adaptive change, or the development of the system in response to external fluctuations (Thomas 2014a; Thompson et al. 2020:3).

5.1.3 Enslaved Community Oyster Harvesting

Whereas Indigenous communities harvested oysters primarily in the winter, secondarily in the summer, and sparsely in the fall and spring across a wide range of salinities, the oysters from a shell pit associated with an enslaved community's residential area on the South End Plantation break from this pattern. Enslaved individuals harvested oysters during the winter/spring transition from a restricted range of salinities associated with the open ocean. This is the first sclerochronological data of its kind from a Plantation Period and/or Gullah-Geechee context in the South Atlantic Bight, so there are few datasets for comparison. Additionally, the disparate institutional and cultural contexts dividing Indigenous and enslaved community lifeways (namely, the institutions of chattel slavery and colonialism) makes comparisons of the two datasets tenuous. One dataset that approaches similarity in contexts is Colclasure and colleagues' (2023) study on Indigenous oyster harvesting practices during the Mission Period (ca. AD 1565–1680) at Pueblo Santa Catalina de Guale on St. Catherine's Island, Georgia. During this period, Indigenous people were conscripted to provide labor for Spanish missions underneath the *repartimiento* drafted labor system (Colclasure et al. 2023). Explaining the seasonality pattern in oyster harvesting at the site, Colclasure and colleagues (2023:5, 16) posit the intensification of maize agriculture through missionization spurred Indigenous individuals to harvest oysters almost exclusively in winter/spring. Heightened agricultural activity during the summer underneath the *repartimiento* labor system did not allow much freedom for oyster harvesting, which the authors interpreted as a disruption to traditional Indigenous subsistence patterns (Colclasure et al. 2023:5, 16).

Similarly to the *repartimiento* labor system, enslavement within the Plantation task system restricted the times and locations that enslaved individuals were able to harvest oysters (Roberts Thompson 2020). The task system was the preferred mode of enslaved labor organization on the Georgia coast (Roberts Thompson 2020 citing Crook 2001; Floyd Smith 1985; Joseph 1987; Morgan 2010; Singleton 2010). This system grouped time into tasks assigned by the plantation owner and overseers that occurred at specific times and locations, and time outside of the completion of those tasks in which enslaved individuals had relatively more autonomy that was still constrained within the system of slavery (Roberts Thompson 2020:3 citing Crook 2001).

Singleton (2010:174) states that most unscheduled time was used by enslaved individuals as labor for themselves, such as procuring and preparing food. Oyster harvesting likely occurred during unscheduled time as enslaved individuals sought to procure food from the estuarine landscape for themselves and their families; this is further evidenced by the fact that oysters were not included in issued rations (Reitz, Gibbs, and Rathbun 1987:166; Roberts Thompson 2020:75). Roberts Thompson (2020:298) states that enslaved individuals’ unscheduled time fluctuated seasonally, decreasing during crop harvests. South End was primarily a Sea Island cotton plantation (Roberts Thompson 2020). Sea Island cotton planting occurred in March and April, and harvesting took place from August to December, with weeding, hoeing, and thinning taking place between planting and harvesting (Kovacik and Mason 1985:85-86). After harvest, enslaved individuals further processed cotton for market, such as through drying, removing debris, ginning, and packaging (Kovacik and Mason 1985:86). As the bulk of Sea Island cotton planting, harvesting, and processing occurred from mid-spring to early winter, it is logical that enslaved individuals had more unscheduled time to harvest oysters during the winter/spring transition. It is also likely that enslaved individuals harvested oysters from the area closest to their quarters, which would be the tidal creek and open ocean adjacent to the South End plantation core. There is some documentary evidence in the South End plantation journals and diaries that enslaved men were assigned the task of fishing and collecting oysters on scheduled time within the task system, but it seems as though this task was for the purpose of procuring food for the plantation owner and overseer rather than provisioning for ones' self and other enslaved individuals (Roberts Thompson 2020:268).

Is this change in oyster harvesting practices due to the collapse of the sustainable socioecological system governing oyster harvesting and loss of Indigenous TEK, or rather the result of the constraints imposed upon enslaved individuals underneath the plantation system? The answer is that both processes occurred independently of the other and impacted oyster reef fisheries on different timescales and in different ways. European contact terminated the sustainable Indigenous oyster harvesting system, which was a background process with ramifications playing out over longer timescales, arguably into the present day. Conversely, the institution of slavery directly impacted the enslaved community's oyster harvesting practices for the shorter period in which enslaved people harvested oysters on Ossabaw Island. The plantation task system limited enslaved individuals' freedom of time and space; while unscheduled time existed in the task system, the bulk of this time was still spent completing personal or familial labor. Additionally, there were not many opportunities available for enslaved individuals to pilot watercraft. The only recorded instances of enslaved individuals operating boats at South End are during assigned tasks (Roberts Thompson 2020). It is unlikely that enslaved individuals were able to own boats, rafts, or canoes, or have access to them during unscheduled time, to restrict their movements and prevent escape. Therefore, the plantation system significantly curtailed the enslaved community's ability to harvest oysters, both in time and place.

In general, the time after Indigenous groups fled Ossabaw Island ca. AD 1550 and when the island was colonized by Euroamericans marks a break in resource management from sustainable, place-based and observation-informed practices to oyster harvesting practices that were unsustainable, not based upon local knowledge, and characterized by the Euroamerican culture of exploitation. That is not to say that enslaved individuals exploited oysters on Ossabaw Island, as there is no evidence for that. Rather, when Ossabaw came under Euroamerican ownership, oysters were another resource that came under Euroamerican exploitative resource extraction. This data on the oyster harvesting practices of enslaved individuals on Ossabaw Island from AD 1849–1861 provides new details that further contextualize oyster harvesting practices leading up to the oyster reef fishery collapse of the 19th and 20th centuries and the sustained oyster reef fishery collapse we experience today. Below, I trace the history of oyster harvesting in North America in general and on the Georgia coast in particular to illustrate this sea change in oyster harvesting and the consequences for the health of the oyster reef fisheries.

5.2 Connecting Indigenous and Enslaved Community Data to Contemporary Collapse

The Eastern oyster first became commercially fished in the Eastern Atlantic region in the 1600s, soon after Euroamerican colonization (Kirby 2004:13097). Oysters were initially harvested by hand or using tongs (see Figure 25) before machinery was invented at the turn of the 18th century to dredge oysters, or drag a metal net across the river bottom or seafloor to pull up clumps of oysters, damaging reefs in the process (Drake 1891:205; Felver 2019) (see Figure 26). Dredging was done by sailboat before the invention of the steamboat; this combined with further mechanization of the dredging process throughout the 1800s accelerated oyster fishermen's ability to harvest oysters and damage oyster reefs (Tabb 2018). During the late 1800s, commercial oyster exploitation facilitated by new harvesting technology led to oyster reef fishery collapse in New England, driving oyster harvesting pressure down the eastern seaboard towards less-exploited reefs, a process Kirby (2004:13096) refers to as "fishing down the coast" (Crook 1992; Thompson et al. 2020) (see Figures 27). In response to the growing demand for southern oysters, the Oemler Oyster Company opened the first oyster cannery along the Georgia coast on Wilmington Island in the late 1880s (Towler 1990). New canning technology intersected with the growing demand for Georgia oysters and privatization of oyster reefs, accelerating the exploitation of oysters for commercial export (Hackle 2023; Know the Connection, n.d.; Tabb 2018).

Figure 25. Child laborer using oyster tongs in the early 20th century in Apalachicola, Florida. From Hine (1909).

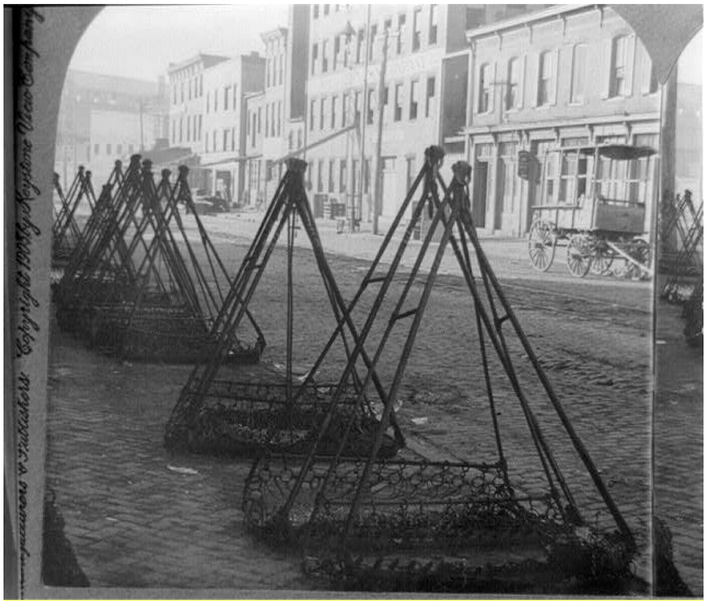


Figure 26. Metal oyster dredgers used to harvest oysters via sailboat lined up in the street in Baltimore, Maryland in the early 20th century. From *Dredgers* (ca. 1905).

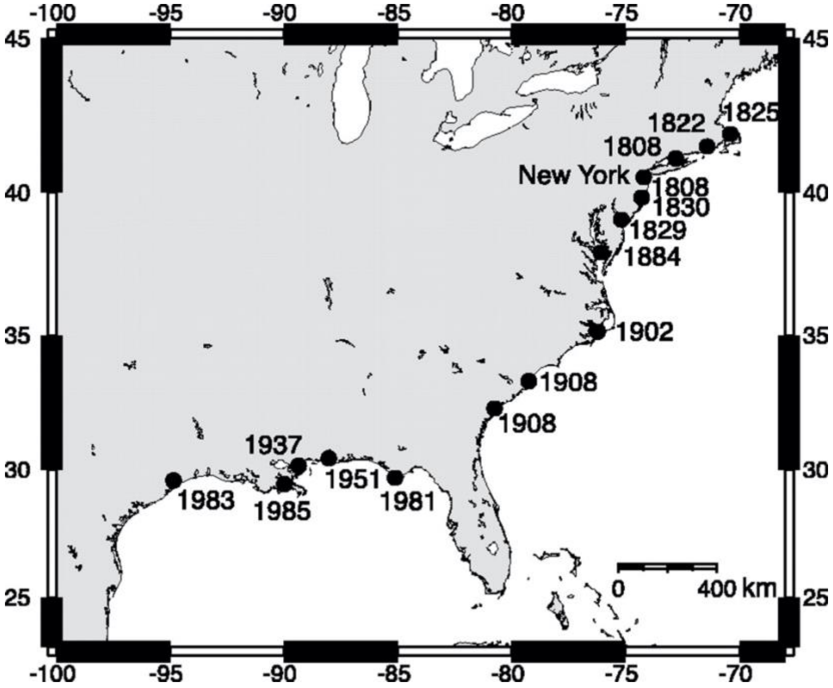


Figure 27. Fishing down the coast: map showing linear progression of oyster reef degradation southwards through time with earliest date for reef degradation marked. From Kirby (2004), figure 2.

Evidently, the pressure to overharvest oysters swiftly led to oyster reef fishery decline in Georgia. In 1889, J. C. Drake, a U.S. Navy ensign, undertook a 5-month survey of the Georgia coast estuaries to assess oyster reef conditions (Crook 1992; Drake 1891; *Science* 1891). Based on Drake's findings, an article in *Science* (1891:155) stated that Georgia oysters were "much depleted from over-fishery," and oysters were "extinct or fast becoming so". That same year, the Georgia Legislature's Oyster Commission outlawed oyster harvesting from May to August and promoted shell planting or seeding, a process by which shucked oyster shells are restored to reefs to increase habitat for juveniles (Drake 1891:205). The simultaneous increase in demand for oysters and decline in the oyster reef fisheries combined with new laws restricting appropriate oyster harvesting behavior brough the 'Oyster Wars' and 'oyster pirates' of the Chesapeake Bay to the Georgia coast (Hackle 2023; Kimmel 2008; Oemler 1894) (see Figure 28).

Figure 28. Illustration of oyster pirates using dredgers to capture oysters by night in the Chesapeake Bay, illustrated for *Harper's Weekly*. From Schell and Hogan (1884).

Despite these early and dramatic signs of overharvesting, the Georgia oyster canning business continued to expand in the early 20th century. Oyster landings (total weight of meat harvested in a year) peaked in Georgia in 1908, at 8 million pounds (Harris 1980:1; Kirby 2004:13097). Only two years later, in 1910, landings had decreased by more than half to only 3 million pounds (Harris 1980:1) (see Figure 29).

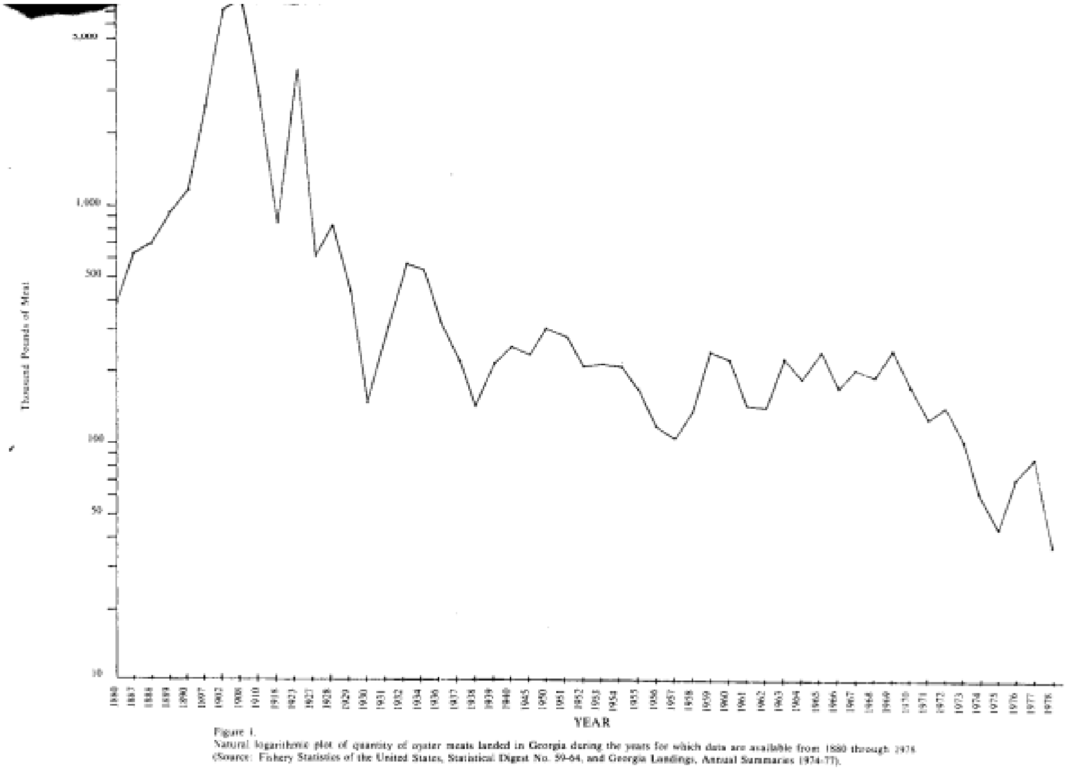


Figure 29. Oyster landings in Georgia from 1880 to 1978. From Harris (1980), figure 1.

In 1919, there were 18 oyster canneries operating in Georgia, of which 14 were located along the coast, as well as multiple wholesale dealers in raw oysters (Smith 1921:7). During this time, oyster canning and the commercial seafood industry in general became the economic backbone of coastal Gullah-Geechee communities, including Pin Point, which was a community of descendants of individuals formerly enslaved on Ossabaw Island (Ingram 2022; Rodgers 2010; Worley 2021). At least two canneries were owned by members of the Gullah-Geechee community (e.g., Ben Bond and John Anderson Seafood in Pin Point, and Timmons Oyster Factory in Harris Neck), but many factories were owned by European immigrants or Euroamericans who employed Gullah-Geechee people in subpar working conditions (e.g., A. S. Varn and Sons Oyster and Crab Factory, L. P. Maggioni and Company, Oemler Oyster Company) (Hackle 2023; Ingram 2022). Men would harvest oysters while women and children shucked and canned oysters in the factory, both difficult jobs that sometimes paid below minimum wage (Holmes 2018; Pinckney 2020) (see Figure 30). As oyster landings dropped due to reef overexploitation, Gullah-Geechee oystermen became a scapegoat for problems ultimately caused by European and Euroamerican companies that commercially harvested oysters for exportation outside of the Georgia coast (Ingram 2022; see Braje 2025 for parallel case in California). In 1894, A. Oemler, owner of Oemler Oyster Company, wrote this about the degrading state of the oyster reef fisheries:

> *The colored oystermen (there is not a single white man now engaged in the precarious occupation of tonging oysters in Chatham County, although a few had assisted in the process of depletion) fill their boats…indiscriminately with oysters, loose shells, and other débris of the beds, and while drifting homewards they cull their loads…and all the empty shells, so indispensable as collectors to replenish the beds, are thrown overboard…or when the culling process has not been completed in transit, they are as effectually destroyed by being cast upon the shell heap at home. Thus, the oyster beds are bodily removed…and an area which might give employment and sustenance to their descendants vanishes forever as a source of food for the public* (pg. 265).

Conventionally, the end of Georgia's oyster industry boom is placed in the 1930s-1950s (Kenworthy 2015; UGA Marine Extension and Sea Grant n.d., a). By the 1970s, the areal extent of oyster beds in Georgia estuaries had decreased by 87% since Drake's 1889 survey; by 2018, only 8% of the beds recorded in 1889 supported live oysters (Crook 1992:484 citing Harris 1980; Thompson et al. 2020:7 citing Alexander 2018). Overharvesting played a large role in the decline of oyster reefs, alongside pollution, fluctuating salinity, drought, and parasitic infections (Gallant

2018). Despite oyster reef fishery collapse, oyster harvesting remained a way of life for Gullah-Geechee people; the A. S. Varn & Son Oyster and Crab Factory operated in Pin Point until 1985, after which it was converted into the Pin Point Heritage Museum, highlighting the role estuarine resources, and especially the oyster, play in the Gullah-Geechee culture (Lowcountry Gullah LLC 2019; Mobley 2011; Worley 2021).

Figure 30. Example of child labor used in oyster shucking and canning business at the Maggioni Canning Company at Port Royal, South Carolina. From Hine (1912).

5.3 How Archaeological Data Can Inform Contemporary Reef Management

Currently, oyster reefs along the Georgia coast are the focus of multiple reef conservation and restoration initiatives, as oysters have been recognized for their importance in maintaining the health and productivity of estuarine systems, including increasing biodiversity, enhancing water quality, protecting coastlines from erosion and storms, and sequestering carbon, among other human and ecosystem benefits (Georgia Southern University Press Release 2023; Southeastern Fisheries Science Center 2022; UGA Marine Extension and Georgia Sea Grant n.d., b). A large portion of this motivation is economic, as 1. oyster reefs provide habitat for commercial, recreational, and sport fish species, which draw money to the state through commercial fishing, tourism, and state licenses; 2. oysters themselves are of commercial value in Georgia; and 3. coastal erosion mitigation projects costs the state of Georgia millions per year, inter alia (Beeson n.d.; Kenworthy 2015; Jones 2024; Landry et al. 2003; UGA Marine Extension and Georgia Sea Grant n.d., b). Therefore, there is a desire for the state of Georgia to promote the long-term viability of oysters and oyster reef habitat.

The Georgia Department of Natural Resources, Coastal Resources Division currently manages two oyster reef enhancement and nine oyster reef restoration projects (Georgia Department of Natural Resources, Coastal Resources Division n.d., b), and the GDNR partners with many organizations and institutions to restore oyster reefs: Savannah State University students build artificial reef habitat for oysters and monitor and map wild and manmade oyster reefs (Southeastern Fisheries Science Center 2022), and Georgia Southern University students and professors also build reef habitat (Georgia Southern University Press Release 2023; Jones 2023). The University of Georgia Marine Extension and Georgia Sea Grant manage oyster reef mapping, bioremediation, and artificial reef restoration projects, including the Generating Enhanced Oyster Reefs in Georgia’s Inshore Areas (G.E.O.R.G.I.A) Project, in which discarded oyster shells from restaurants and community roasts are recycled to create more reef substrate (UGA Marine Extension and Georgia Sea Grant n.d., a). Currently, there are eight oyster shell recycling centers on the Georgia coast where shells are collected for the G.E.O.R.G.I.A Project

(Georgia Department of Natural Resources, Coastal Resources Division n.d., b). Shell to Shore is an Athens, Georgia-based nonprofit organization that partners with The University of Georgia to also recycle discarded oyster shells by collecting shells from inland restaurants for shoreline and oyster reef restoration projects and for oyster aquaculture substrate (Atkins 2024; Butterman 2022; Shell to Shore n.d.).

Figure 31. UGA Shellfish Research Laboratory oyster hatchery. From Kenworthy (2015).

The state of Georgia's first oyster hatchery opened in 2015, emerging out of collaboration between the GDNR Coastal Management Program, the Georgia Department of Agriculture, UGA Marine Extension, and the Georgia Shellfish Growers Association, and managed by the UGA Shellfish Research Laboratory, with the goal to "develop a sustainable oyster aquaculture industry in Georgia", allowing shellfishers in the state to enter the half-shell market that wild-grown oysters are unsuitable for (Beeson n.d.; Kenworthy 2015) (see Figure 31). In 2019, the Georgia Legislature began allowing floating cages for commercial oyster aquaculture, which has ramped up in subsequent years (Jones 2024). This diversification into aquaculture is a potential avenue to keep wild oysters from human harvesting pressures, while still allowing Georgians to engage in the oyster market. The oyster shellfishing business (and livelihood) comes with its own diversity of stakeholders, bringing together politicians, marine scientists, entrepreneurs, and the unique watermen culture of the Georgia coast documented recently by Gallant (2018).

How can archaeological data inform contemporary oyster reef management? Oyster sclerochronology and archaeobiology data demonstrate that it was possible for Indigenous communities on Ossabaw Island to sustainably harvest wild oysters for millennia, providing a case study proving that sustainable, yet intensive oyster reef management is possible for the state of Georgia to achieve. However, translating this data into coastal resource management policy recommendations proves difficult.

Arguably, Georgia's oyster reefs are currently in a no-analog scenario, as there is a legacy of 1. intensive, yet sustainable Indigenous management of oyster reefs for 4.5 millennia that was abruptly released at Contact (ca. BC 3000–AD 1550), 2. seemingly less intensive oyster harvesting for approximately 300 years (ca. AD 1550–1880), 3. rapid commercial overharvesting by Euroamericans for approximately 100 years (ca. AD 1880–1980) leading to near-complete oyster reef collapse, and 4. a period of relative quiescence, during which the ramifications of earlier overexploitation are still felt and the system is in a state of reorganization (ca. AD 1980–present) (see Cuddington 2011 for discussion of human legacy effects; see Rick et al. 2008 for parallel case in California) (see Figure 32). Creating effective coastal resource management policies for the novel state of oyster reefs in the present and future will require creative solutions. One avenue of creativity may be found in institutional *bricolage*. Cleaver (2007:229) defines institutional *bricolage* as the process by which preexisting, culturally contextual norms, practices, and relationships are drawn upon in the creation of institutional structures and rules, which ensures institutions are socioculturally appropriate. This idea brings back the notion that ‘informal’ and ‘formal’ institutions promoted the resiliency and sustainability of the Indigenous oyster harvesting socioecological system.

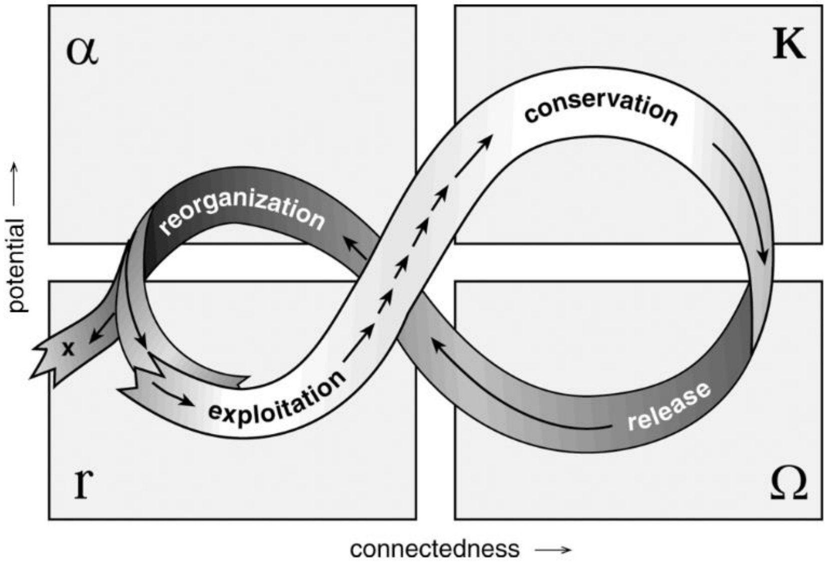


Figure 32. The adaptive cycle of socioecological systems. From Holling and Gunderson (2002).

As a general suggestion, I recommend that oyster shellfishers are consulted in the creation of the state of Georgia’s coastal resource management policies and in the state’s oyster reef restoration and enhancement activities (which has already happened to varying degrees, see Gallant 2018). To give one specific suggestion, I recommend that Georgia increases the quantity of oyster reefs managed by shellfishers. Currently, commercial wild oyster harvesting is done on a lease system in which the state of Georgia leases out sections of oyster reef to licensed shellfishers (Gallant 2018). In theory, the current system *could* leave leased reefs prone to overharvesting pressures and later collapse if shellfishers continuously harvest from the same reef season after season and do not leave enough reef substrate or mature adults for adequate oyster regeneration. In actuality, as shellfishers’ livelihoods depend on the productivity of their leased reefs, there is no evidence that they overharvest reefs below regenerative capacities;

instead, their long-term commitment to one leased reef drives them to carefully manage and actively improve their reefs through reef expansion (Gallant 2018; V. D. Thompson, pers. comm. 2025). It may be that the shellfishers' productive reef management practices could be leveraged in support of the state of Georgia's oyster reef enhancement and restoration goals by increasing the quantity of reefs that are leased to commercial shellfishers, extending the benefits of reef management to a greater quantity of reefs. Another possibility is that the state of Georgia could modify the lease system to allow for rotating reef plots, another way of extending the management of oyster reefs by shellfishers over a larger area.

5.4 Conclusions

The Indigenous inhabitants of Ossabaw Island harvested oysters primarily during the winter and extensively across the estuarine landscape for 4.5 millennia, a pattern that is observed across the South Atlantic Bight and Gulf Coast. Preservation of these essential oyster harvesting characteristics and the importance of oysters (both functionally and culturally) and the maintenance of oyster shell size despite dramatic demographic, social, political, and environmental change indicates that traditional oyster harvesting was a resilient and sustainable system. This socioecological system was possibly maintained by both 'informal' and 'formal' institutions, such as TEK, oyster reef proprietorship, and village layout, which likely developed through time in response to the aforementioned changes occurring on the coast, which is adaptive change. Conversely, enslaved inhabitants of South End Plantation harvested oysters during the winter/spring transition from a restricted range of salinities, likely the marsh and open ocean adjacent to their residences located at the plantation core. Enslaved individuals likely had more time to harvest oysters during the winter/spring as Sea Island cotton, the staple product of South End Plantation, was planted and harvested from March to December.

Oysters remain culturally important to the descendants of the Indigenous and enslaved inhabitants of Ossabaw Island: the Muscogee (Creek) people and Gullah-Geechee communities. This study provides Muscogee people with more information about their relationship to the environment via oyster harvesting and resource management. It also explores the often-unrecorded lifeways of the enslaved ancestors of Gullah-Geechee people. This archaeological data can be used to bridge the gap between documentary records to trace the history of oyster reef fishery collapse along the Georgia coast and provide insight for future oyster reef management efforts.

5.5 Future Research

There are still many questions left to be answered about how Indigenous and enslaved communities harvested oysters on Ossabaw Island and throughout the South Atlantic Bight in general. Firstly, in order to continue investigating the socioecological system of Indigenous oyster harvesting, there needs to be a shift in focus to the institutions that governed oyster harvesting, rather than the effects of this governance (i.e., oysters themselves). What is the materiality of these institutions in the archaeological record? The archaeological correlates of 'informal' and 'formal' institutions governing oyster harvesting need to be defined and explored (*sensu* Tushingham 2020). For example, following Garland and Thompson's (2023) assertion that circular shell ring village layout may have promoted sharing and cooperation and discouraged overharvesting and free riders during the Late Archaic Period, future researchers can explore village layout during the Woodland or Mississippian Periods to determine if village layouts changed, and if changes may have impacted resource management cooperation. Some institutions may have no physical trace in the archaeological record, such as TEK; however, ethnohistoric accounts and interviews of Muscogee (Creek) people may help bridge this gap.

Taking a political ecology approach to this topic and researching the power structures of these institutions is another perspective that will help researchers understand how this sustainable socioecological system operated.

The oyster harvesting practices of enslaved communities is just beginning to be explored. Practical next steps include conducting more sclerochronological analyses on oysters from enslaved community contexts at Plantation sites, both within the South Atlantic Bight and beyond, to broaden the dataset for comparisons and recognition of salient trends. Another method would be to measure oyster shell valve height and length from Mission and Plantation Period sites (*sensu* Garland et al. 2024; Lulewicz et al. 2017) and compare this data to Indigenous-harvested oysters to determine if there is a reduction in oyster shell size through time, which would point to overharvesting. Combining fine-grained radiocarbon dating on short-lived organic samples and Bayesian analysis with oyster archaeobiology may be used as a proxy to determine when oyster harvesting became unsustainable, and to what degree.

Other exciting avenues of research include investigating how freedmen's communities harvested oysters (e.g., Holland-Lulewicz et al. 2024), as well as comparing the oyster harvesting practices of enslaved individuals to the consumption of oysters by Euroamerican plantation owners or overseers (e.g., Reitz, Gibbs, and Rathbun 1987). Documentary evidence could also be used to fill the gap; records of oyster harvesting laws, landings, and menu prices could be used as proxies for oyster reef collapse, too (*sensu* Braje 2016, 2025; Daniel 2015). Overall, there is a need to bridge the gap between Indigenous and Post-Contact or enslaved, freedmen, and Euroamerican archaeology and to investigate the transition from sustainable to unsustainable oyster harvesting to better inform modern day resource management practices.

REFERENCES

Adger, W. N. (2000). Social and ecological resilience: Are they related? *Progress in Human Geography 24*(3).

Alagona, P. S., Sandlos, J., and Wiersma, Y. F. (2012). Past imperfect. *Environmental Philosophy 9*(1), 49–70.

Alexander, C. R. (2018). *Geospatial integration to advance management in coastal Georgia*. Georgia Department of Natural Resources.

Alvard, M. S. (1993). Testing the "ecologically noble savage" hypothesis: Interspecific prey choice by Piro hunters of Amazonian Peru. *Human Ecology 21*, 355–387.

Anderson, D. G. (1994). *The Savannah River Chiefdoms: Political Change in the Late Prehistoric Southeast.* University of Alabama Press, Tuscaloosa.

Anderson, J. R. (1929). The genesis of Georgia: A historical sketch. *The Georgia Historical Quarterly 13*(3), 229–283.

Andrus, C. F. T. (2011). Shell midden sclerochronology. *Quaternary Science Reviews 30*(21-11), 2892–2905.

Andrus, C. F. T., and Crowe, D. (2000). Geochemical analysis of Crassostrea virginica as a method to determine season of capture. *Journal of Archaeological Science 27*, 33-42.

Andrus, C. F. T., and Crowe, D. (2008). Chapter 18: Isotope analysis as a means for determining season of capture for *Mercenaria*. In D. H. Thomas (Ed.), *Native American Landscapes of St. Catherine's Island, Georgia, Vol. II*. Anthropological Papers of the American Museum of Natural History. New York.

Andrus, C. F. T., and Thompson, V. D. (2012). Determining the habitats of mollusk collection at the Sapelo Island shell ring complex, Georgia, USA using oxygen isotope sclerochronology. *Journal of Archaeological Science 39*(2), 215–228.

Arana, L. R. (1964). The Alonso Solana map of Florida, 1683. *The Florida Historical Quarterly 42*(3), 258–266.

Atkins, I. (2024, March 14). *From waste to waves: How Shell to Shore is working with restaurants to save Georgia's coastline through oysters.* Grady Newsource. Accessed online at https://gradynewsource.uga.edu/from-waste-to-waves-how-shell-to-shore-is-working-with-restaurants-to-save-georgias-coastline-through-oysters/.

Bahr, L. M., and Lanier, W. P. (1981). *The ecology of intertidal oyster reefs of the South Atlantic coast: A community profile*. [Report]. U.S. Fish and Wildlife Service.

Balée, W. (2006). The research program of historical ecology. *Annual Review of Anthropology 35*, 75–98.

Bartol, I. K., Mann, R., and Luckenbach, M. (1999). Growth and mortality of oysters (*Crassostrea virginica*) on constructed intertidal reefs: Effects of tidal height and substrate level. *Journal of Experimental Marine Biology and Ecology 237*(2), 157–184.

Beeson, L. (n.d.). The pearl on the Georgia coast. [Newspaper article]. *University of Georgia Exposure.* Accessed online at https://universityofgeorgia.exposure.co/revitalizing-georgias-oyster-industry.

Berkes, F., Colding, J., and Folke, C. (2000). Rediscovery of Traditional Ecological Knowledge as adaptive management. *Ecological Applications 10*(5), 1251–1262.

Berrigen, M., Candies, T., Cirino, J., Dugas, R., Dyer, C., Gray, J., Herrington, T., Keithly, W., Leard, R., Nelson, J. R., and Van Hoose, M. (1991). *The Oyster Fishery of the Gulf of*

Mexico, United States: A Regional Management Plan. [Report]. Gulf States Marine Fisheries Commission.

Bettinger, R. L., Malhi, R., and McCarthy, H. (1997). Central place models of acorn and mussel processing. *Journal of Archaeological Science 24*(10), 887–899.

Black, B. A., Andersson, C., Butler, P. G., Carroll, M. L., DeLong, K. L., Reynolds, D. J., Schöne, B. R., Scourse, J., van der Sleen, P., Wanamaker, A. D., and Witbaard, R. (2019). The revolution of crossdating in marine palaeoecology and palaeoclimatology. *Biology Letters 15*(1).

Bodin, Ö. (2017). Collaborative environmental governance: Achieving collective action in social-ecological systems. *Science* 357(6352).

Braje, T. (2016). *Shellfish for the Celestial Empire: The Rise and Fall of Commercial Abalone Fishing in California*. University of Utah Press, Salt Lake City.

Braje, T. (2025, January 22). *How Chinese Immigrants Built and Lost a Shellfish Industry: Social and Environmental Lessons from California History.* [Presentation].

Brehmer, M., Lee, B., Bach, B., Riche, N. H., and Munzner, T. (2017). Timelines revisited: A design space and considerations for expressive storytelling. *Institute of Electrical and Electronics Engineers Transactions on Visualization and Computer Graphics 23*(9), 2151–2164.

Breuer, J. P. (1962). An ecological survey of the lower Laguna Madre of Texas, 1953–1959. *Publications of the Institute of Marine Science, University of Texas 8*(15), 3–183.

Buchanan, B., Kilby, J. D., LaBelle, J. M., Surovell, T. A., Holland-Lulewicz, J., and Hamilton, M. J. (2022). Bayesian modeling of the Clovis and Folsom radiocarbon records indicates a 200-year multigenerational transition. *American Antiquity 87*(3).

Butler, P. A. (1952). Growth and mortality rates in sibling and unrelated oyster populations. *Proceedings of the Gulf and Caribbean Fisheries Institute 4*(71).

Butler, P. G., Freitas, P. S., Burchell, M., and Chauvaud, L. (2019). Chapter 21: Archaeology and sclerochronology of marine bivalves. In A. C. Smaal, J. G. Ferreira, J. Grant, J. K. Petersen, and Ø. Strand (Eds.), *Goods and Services of Marine Bivalves*, (pg. 413–444). Springer.

Butterman, E. (2022). *Sustainability is a shore thing: Alumnus Zachary Brendel helps recycle oyster shells from farm to shore.* The University of Georgia College of Agriculture & Environmental Sciences. Accessed online at https://discover.caes.uga.edu/sustainability-is-a-shore-thing/index.html.

Browning-Mullis, S. (2020, May 4). *Why we use "enslaved"*. [Blog post]. Telfair Museums. Accessed online at https://www.telfair.org/article/why-we-use-enslaved/.

Cajigas, R., Sanger, M. C., Semon, A. M., Thompson, V. D., Garland, C. J., Blair, E. H., and Thomas, D. H. (2024). Sequential villages and settling down on the Southeast U.S. coast. *Frontiers in Human Dynamics 6*.

Chapman, J. T. J. (2022). *Using radiocarbon measurements to assess the historical impacts of archaeological sites on Ossabaw Island, GA*. [Master's thesis]. University of Georgia.

Cleaver, F. (2007). Understanding agency in collective action. *Journal of Human Development 8*(2), 223–244.

Coen, L. D., Brumbaugh, R. D., Bushek, D., Grizzle, R., Luckenback, M. W., Posey, M. H., Powers, S. P., and Tolley, S. G. (2007). Ecosystem services related to oyster restoration. *Marine Ecology Progress Series 341*, 303–307.

Coen, L. D., Luckenback, M. W., and Breitburg, D. L. (1999). The role of oyster reefs as essential fish habitat: A review of current knowledge and some new perspectives. *American Fisheries Society Symposium 22*, 438–454.

Colaninno, C. E. (2010). *Zooarchaeological analysis of vertebrate remains from five Late Archaic shell rings on the Georgia Coast, USA*. [Doctoral dissertation]. University of Georgia.

Colclasure, C. B., Andrus, C. F. T., and Blair, E. H. (2023). Of missions and marshes: Stable isotope analysis of Mission-Era Guale oyster harvesting on St. Catherines Island, Georgia. *The Journal of Island and Coastal Archaeology*.

Crook, M. R., Jr. (1992). Oyster sources and their prehistoric use on the Georgia coast. *Journal of Archaeological Science 19*, 483–496.

Crook, R. (2001). Gullah and the task system. *Anthropology of Work Review 22*(2), 24–28.

Cuddington, K. (2011). Legacy effects: The persistent impact of ecological interactions. *Biological Theory 6*, 203–210.

Cumming, G. S., Cumming, D. H. M., and Redman, C. L. (2006). Scale mismatches in social-ccological systems: Causes, consequences, and solutions. *Ecology and Society 11*(1).

Dame, R. F. (1993). *Bivalve Filter Feeders in Estuarine and Coastal Ecosystem Processes*. NATO Advanced Science Institute Series, Series G. Springer Verlag.

Dame, R. F. (1996). *Ecology of Marine Bivalves: An Ecosystem Approach*. CRC Press.

Daniel, L. B., III. (2015, March 1). *The History of Oyster Management over the Past Century.* North Carolina Division of Marine Fisheries. Accessed online at https://www.nccoast.org/wp-content/uploads/2015/03/01-The-N.C.-Experience_-The-History-of-Oyster-Management-Over-the-Past-Century.pdf.

Dearing, J. A., Battarbee, R. W., Dikau, R., Larocque, I., and Oldfield, F. (2006). Human–environment interactions: Towards synthesis and simulation. *Regional Environmental Change 6*, 115–123.

DePratter, C.B. (1974). *An archaeological survey of Ossabaw Island, Chatham County, Georgia: A preliminary report.* [Unpublished manuscript]. Laboratory of Archaeology, University of Georgia, Athens.

DePratter, C. B. (1991). *W.P.A. Archaeological Excavations in Chatham County, Georgia: 1937–1942*. Laboratory of Archaeology, University of Georgia, Athens.

DePratter, C. B., and Howard, J. D. (1981). Evidence for a sea level lowstand between 4500 and 2400 years BP on the southeast coast of the United States. *Journal of Sedimentary Research 51*(4), 1287–1295.

DePratter, C. B., and Thompson, V. D. (2013). Past shorelines of the Georgia coast. In V. D. Thompson and D. H. Thomas (Eds.), *Life Among the Tides: Recent Archaeology on the Georgia Bight.* Anthropological Papers of the American Museum of Natural History.

Dorsey, A. (2010). "The Great Cry Of People Is Land!": Black settlement and community development on Ossabaw Island, Georgia, 1865–1900. In *African American Life in the Georgia Lowcountry: The Atlantic World and the Gullah Geechee*, P. D. Morgan (Ed.), pp. 224–252. University of Georgia Press, Athens.

Drake, J. C. (1891). *On the sounds and estuaries of Georgia, with reference to oyster culture* [Report]. United States Coast and Geodetic Survey.

Drake's Report on the Georgia oyster-beds. (1891). *Science 17*(242),155.

Dredgers used on sailing craft, Baltimore, Md., U.S.A. (ca. 1905). [Photograph]. Retrieved from the Library of Congress, https://www.loc.gov/item/2002723690/.

Duncan, R. (1986). *Freedom's Shore: Tunis Campbell and the Georgia Freedmen*. University of Georgia Press, Athens.

Durant, J. E. (1970). The effects of temperature and salinity upon the gonadal cycle of *Crassostrea virginica* (Gmelin) in Georgia waters. In T. L. Linton (Ed.), *Feasibility study of methods for improving oyster production in Georgia.* Georgia Game and Fish Commission.

Elliott, D. T. (2005). *North End Plantation, Ossabaw Island, Georgia. Preliminary Archaeological Investigations*. LAMAR Institute Publication Series Report Number 76, Savannah.

Elliott, D. T. (2007). *Archaeological Investigations at Tabbies 1 and 2, North End Plantation, Ossabaw Island, Georgia*. LAMAR Institute Publication Series, Savannah.

Elliot, D. T. (2008). South of hell's gate: Life at the North End Plantation, Ossabaw Island. *Early Georgia* 36(1), 23–42.

Elliott, D. T. (2009). *Archaeological Investigations at 9CH155*. Georgia Department of Natural Resources, Historic Preservation Division, Stockbridge.

Elliott, D. T. (2009). *Archaeological Investigations at 9CH155*. Georgia Department of Natural Resources, Historic Preservation Division, Stockbridge.

Erlandson, J. M. (2001). The archaeology of aquatic adaptations: Paradigms for a new millennium. *Journal of Archaeological Research 9,* 287–350.

Erlandson, J. M., and Rick, T. C. (2010). Archaeology meets marine ecology: The antiquity of maritime cultures and human impacts on marine fisheries and ecosystems. *Annual Review of Marine Science 2*, 231–51.

Erlandson, J. M., Rick, T. C., Ainis, A. F., Gill, K. M., Jew, N. P., and Reeder-Myers, L. A. (2019). Shellfish, geophytes, and sedentism on Early Holocene Santa Rosa Island, Alta California, USA. *The Journal of Island and Coastal Archaeology 15*(4), 504–524.

Esri. (2024, February 6). "World Imagery" [Basemap]. Scale Not Given. ArcGIS.

Feinman, G. M. and Neitzel, J. E. (2020). Excising culture history from contemporary archaeology. *Journal of Anthropological Archaeology 60*.

Felver, R. (2019, January 31). *Dredging up a debate: a controversial oyster practice is still making waves*. Chesapeake Bay Program. Accessed online at https://www.chesapeakebay.net/news/blog/dredging-up-a-debate#:~:text=By%20the%20start%20of%20the,play%20in%20the%20Chesapeake%20Bay.

Floyd Smith, J. (1985). *Slavery and Rice Culture in Low Country Georgia, 1750–1860*. University of Tennessee Press, Knoxville.

Ford, A., and Nigh, R. (2009). Origins of the Maya Forest Garden: Maya resource management. *Journal of Ethnobiology 29*(2), 213–236.

Frank, A. K. (2019 [2002]). *Mary Musgrove*. New Georgia Encyclopedia.

Gallant, A. J. (2018). *A High Low Tide: The Revival of a Southern Oyster*. University of Georgia Press.

Galtsoff, P. S. (1964). The American oyster, *Crassostrea virginica gmelin*. *U.S. Fisheries Bulletin 64*, 1–480. U.S. Government Printing Office.

Garland, C. J., Ritchison, B. T., Tucker, B., and Thompson, V. D. (2023). A preliminary consideration of craft production and settlement expansion on Ossabaw Island, Georgia, USA. *The Journal of Island and Coastal Archaeology 18*(2).

Garland, C. J., and Thompson, V. D. (2023). Collective action and shellfish harvesting practices among Late Archaic villagers of the South Atlantic Bight. *Journal of Anthropological Archaeology 69*.

Garland, C. J., Thompson, V. D., Sanger, M. C., Smith, K. Y., Andrus, C. F. T., Lawres, N. R., Napora, K. G., Colannino, C. E., Compston, J. M., Jones, S., Hadden, C. S., Cherkinsky, A., Maddox, T., Deng, Y., Lulewicz, I. H., and Parsons, L. (2022). A multi-proxy assessment of the impact of environmental instability on Late Holocene (4500-3800 BP) Native American villages of the Georgia coast. *PLoS ONE 17*(3).

Garland, C. J., Thompson, V. D., Howland, M. D., Gragson, T. L., Andrus, C. F. T., Demyan, M., and Parbus, B. (2024). Stable isotope analysis and chronology building at the Hokfv-Mocvse cultural site, the earliest evidence for South Atlantic shell-ring villages. *American Antiquity*.

Gayes, P. T., Scott, D. B., Collins, E. S., Nelson, D. D. (1992). A Late Holocene sea-level fluctuation in South Carolina. In C. H. Fletcher, III, and J. F. Wehmiller (Eds.), *Quaternary Coasts of the United States: Marine and Lacustrine Systems*, (pp. 155–160). SEPM Society for Sedimentary Geology, Tulsa.

Georgia Department of Natural Resources, Coastal Resources Division. (n.d., a). *Oyster Restoration Reefs.* Accessed online at https://coastalgadnr.org/oysterreefs.

Georgia Department of Natural Resources, Coastal Resources Division. (n.d., b). *GA Oyster Shell Recycling Locations.* [ArcGIS map]. https://coastalgadnr.org/ShellRecycling.

Georgia Department of Natural Resources, Wildlife Resources Division. (n.d.). *Ossabaw Island: WMA Richmond Hill.* Accessed online at https://georgiawildlife.com/ossabaw-island-wma.

Georgia Southern University Press Release. (2023, October 2). *Georgia Southern University restoring coastline with oyster habitats*. [Newspaper article]. Accessed online at https://ww2.georgiasouthern.edu/news/2023/10/02/georgia-southern-university-restoring-coastline-with-oyster-habitats/.

Gosselin, M., Dupont, C., Poulain, C., Le Coz, X., Marchand, G., Paillard, C., Paulet, Y., Pustoc'h, F., and Gruet, Y. (2023). Sclerochronological and geochemical study of the carpet shell *Ruditapes decussatus* in archaeological contexts: A potential tool for season of collection and coastal paleo-temperature. *Journal of Archaeological Science: Reports 48*.

Gullah Geechee Cultural Heritage Corridor Commission. (2012). *Gullah Geechee Cultural Heritage Corridor management plan.* [Report]. National Park Service, Denver Service Center.

Hackle, A. (2023, January 26). RHHS grad raking up history of Georgia oysters at GSU. [Newspaper article]. *Bryan County News*. Accessed online at https://www.bryancountynews.com/news/RHHS-grad/.

Hadden, C. S., Hutchinson, I., and Martindale, A. (2023). Dating marine shell: A guide for the wary North American archaeologist. *American Antiquity 88*(1), 62–78.

Harris, C. D. (1980). *Survey of the intertidal and subtidal oyster resources of the Georgia coast.* [Report]. Georgia Department of Natural Resources, Coastal Resources Division.

Helama, S., and Hood, B. C. (2011). Stone Age midden deposition assessed by bivalve sclerochronology and radiocarbon wiggle-matching of *Arctica islandica* shell increments. *Journal of Archaeological Science 38*(2), 452–460.

Hine, L. W. (1909). *A young oyster fisher. Others smaller employed in busy season. Apalachicola, Fla. Randsey Summerford says he starts out at 4 A.M. one day, is out all night in the little oyster boat and back next day some time. Gets a share of the proceeds. Said he was 16 years old and been at it 4 years. Lives in Georgia and is here 6 months a year. Location: Apalachicola, Florida.* [Photograph]. Retrieved from the Library of Congress, https://www.loc.gov/pictures/item/2018675064/.

Hine, L. W. (1912). *Henry, 10 year old oyster shucker who does five pots of oyster sic a day. Works before school, after school, and Saturdays. Been working three years. Maggioni Canning Co. Location: Port Royal, South Carolina*. [Photograph]. Retrieved from the Library of Congress, https://www.loc.gov/item/2018674544/.

Holland-Lulewicz, J., Holland-Lulewicz, I., Roberts Thompson, A., and Forbes, S. (November 2024). *Expanding Shell Midden Studies to Gullah-Geechee Sites along the Southeastern Atlantic Coast: An Example from Ossabaw Island, Georgia*. [Conference presentation]. Southeastern Archaeological Conference, Williamsburg, Virginia.

Holland-Lulewicz, J., and Roberts Thompson, A. D. (2022). Incomplete histories and hidden lives: The case for social network analysis in historical archaeology. *International Journal of Historical Archaeology 26*, 1025–1053.

Holland-Lulewicz, I., Wallis, N. J., and Thompson, V. D. (2020). Exploring the season of mound building through oxygen isotope geochemistry at the Garden Patch site, Gulf Coast Florida, USA. *Southeastern Archaeology 39*(1), 16–28.

Holling, C. S., and Gunderson, L. H. (2002). Resilience and adaptive cycles. In L. H. Gunderson and C. S. Holling (Eds.), *Panarchy: Understanding transformation in human and natural systems*, pp. 25–62. Island Press, Washington, D. C.

Holmes, R. (2018, January 4). Pin Point's American story: From a Gullah community to the Supreme Court. [Newspaper article]. *NWF Daily News.* Accessed online at https://www.nwfdailynews.com/story/opinion/columns/2018/01/04/on-road-with-rick-holmes-pin-points-american-story-from-gullah-community-to-supreme-court/16358331007/.

Honerkamp, N., Crook, R., and Kroulek, O. (2007). *Pieces of Chocolate: Site Structure and Function at Chocolate Plantation(9MC96), Sapelo Island, Georgia*. Jeffrey L. Brown Institute of Archaeology, University of Tennessee at Chattanooga.

Honerkamp, N. (2011). *Pedestrian Survey of the South End Riverbank, Ossabaw Island, Georgia (A-1)* and *Supplemental Pedestrian Survey of the South End Riverbank, Ossabaw Island (B-1)*. Georgia Department of Natural Resources, Historic Preservation Division, Stockbridge.

Honerkamp, N. (2013). *Riverbank Erosion and Cultural Features, South End (9CH155)*. Georgia Department of Natural Resources, Historic Preservation Division, Stockbridge.

Howard, C. B. DePratter, and R. W. Frey (eds.)*, Excursions to Southeastern Geology: The Archaeology-Geology of the Georgia Coast* (pp. 179–191). Georgia Geologic Survey.

Höpker, S. N., Wu, H. C., Müller, P., Barusseau, J., Vernet, R., Lucassen, F., Kasemann, S. A., Westphal, H. (2019). Pronounced northwest African monsoon discharge during the Mid- to Late Holocene. *Frontiers in Earth Science 7*.

Ingram, S. (2022, September 27). *Georgia's Oyster Industry*. [ArcGIS Storymap]. Accessed online at https://storymaps.arcgis.com/stories/a0284dd5668c4db7b8eb0a68e55ab959.

Jackson, J. B. C., Kirby, M. X., Berger, W. H., Bjorndal, K. A., Louis W. Botsford, L. W., Bourque, B. J., Bradbury, R. H., Cooke, R., Erlandson, J., Estes, J. A., Hughes, T. P., Kidwell, S., Lange, C. B., Lenihan, H. S., Pandolfi, J. M., Peterson, C. H., Steneck, R. S., Tegner, M. J., and Warner, R. R. (2001). Historical overfishing and the recent collapse of coastal ecosystems. *Science 293*(5530), 629–637.

Jefferies, R. W. and Moore, C. R. (2013). Mission San Joseph de Sapala: Mission Period archaeological research on Sapelo Island. In V. D. Thompson and D. H. Thomas (Eds.), *Life among the tides: Recent archaeology on the Georgia Bight*, (pp. 345–374). New York: Anthropological Papers of the American Museum of Natural History, No. 98.

Jenkins, J. A., and Gallivan, M. D. (2024). The oyster revolution: shell middens, shell temper, and settling down in North America's Chesapeake region. *Frontiers in Human Dynamics 6*.

Jenkins, J. A., and Gallivan, M. D. (2020). Shell on earth: oyster harvesting, consumption, and deposition practices in the Powhatan Chesapeake. *Journal of Island Coastal Archaeology 15,* 384–406.

Jew, N. P., Erlandson, J. M., Watts, J., and White, F. J. (2013). Shellfish, seasonality, and stable isotope sampling: δ18O analysis of mussel shells from an 8,800-year-old shell midden on California's Channel Islands. *Journal of Island and Coastal Archaeology 8*(2).

Jones, E. (2023, November 21). *Rebuilding oyster reefs along the Georgia coast could help fight climate change*. WABE. Accessed online at https://www.wabe.org/rebuilding-oyster-reefs-along-the-georgia-coast-could-help-fight-climate-change/.

Jones, T. (2024, January 23). *Georgia's first floating-cage grown oysters reach restaurants in major milestone.* Georgia Department of Natural Resources, Coastal Resources Division. Accessed online at https://coastalgadnr.org/Coastlines/January2024/Oysters.

Joseph, J. W. (1987). Highway 17 revisited: The archaeology of task labor. *South Carolina Antiquities 19*(1-2), 29–34.

Keene, D. A. (2004). Reevaluating Late Prehistoric coastal subsistence and settlement strategies: New data from Grove's Creek Site, Skidaway Island, Georgia. *American Antiquity 69,* 671–688.

Kennedy, V. S., Newell, R. I. E., and Eble, A. F. (1996). *The Eastern Oyster: Crassostrea virginica*. National Oceanic and Atmospheric Administration, Oceanic and Atmospheric Research. Maryland Sea Grant College, College Park.

Kenworthy, E. (2015, December 15). *UGA Marine Extension launches state's first oyster hatchery.* UGA Marine Extension and Sea Grant. Accessed online at https://gacoast.uga.edu/uga-marine-extension-launches-states-first-oyster-hatchery/.

Kimmel, R. M. (2008). *Oyster wars: The historic fight for the bay's riches*. The Maryland Natural Resource. Accessed online at https://dnr.maryland.gov/Documents/Oyster-Wars.pdf.

Kirby, M. X. (2004). Fishing down the coast: Historical expansion and collapse of oyster fisheries along continental margins. *Proceedings of the National Academy of Sciences 101*(35), 13096–13099.

Klein, J. (2017, May 9). Oysters, despite what you've heard, are always in season. [Newspaper article]. *The New York Times*. Accessed online at https://www.nytimes.com/2017/05/05/science/oysters-summer-safe-r-months.html.

Know the Connection (n.d.). *Georgia Oyster History*. Georgia Department of Natural Resources, Coastal Resources Division. Accessed online at https://coastalgadnr.org/sites/default/files/crd/KTC/files/GeorgiaOysterHistory.pdf.

Kollock, G. J. (1866). Letter to Susan Kollock, May, Letters, 1791–1906, Kollock family papers. Georgia Historical Society, Savannah.

Kovacik, C. F. and Mason, R. E. (1985). Changes in the South Carolina Sea Island cotton industry. *Southeastern Geographer 25*(2), 77–104.

Kumar, V. and Verma, K. (2021). Chapter 8: Geological records of climate change. In S. Singh, P. Singh, S. Rangabhashiyam, and K. K. Srivastava (Eds.), *Global Climate Change* (pg. 175–185). Elsevier.

Lawrence, D. R. (1988). Oysters as geoarchaeologic objects. *Geoarchaeology 3*(4), 267–274.

Landry, C. E., Keeler, A. G., and Kriesel, W. (2003). An economic evaluation of beach erosion management alternatives. *Marine Resource Economics 18*(2).

La Peyre, M. K., Gossman, B., and La Peyre, J. F. (2009). Defining optimal freshwater flow for oyster production: Effects of freshet rate and magnitude of change and duration on Eastern oysters and *Perkinsus marinus* infection. *Estuaries and Coasts 32*, 522–534.

Lepofsky, D., Smith, N. F., Cardinal, N., Harper, J., Morris, M., (Elroy White), G., Bouchard, R., Kennedy, D. I. D., Salomon, A. K., Puckett, M., and Rowell, K. (2015). Ancient shellfish mariculture on the Northwest Coast of North America. *American Antiquity 80*(2), 236–259.

Lowcountry Gullah LLC. (2019, August 2). *Pin Point Heritage Museum*. Accessed online at https://lowcountrygullah.com/pin-point-museum/.

Lulewicz, I. H., Thompson, V. D., Cramb, J., and Tucker, B. (2017). Oyster paleoecology and Native American subsistence practices on Ossabaw Island, Georgia, USA. *Journal of Archaeological Science 15*, 282–289.

Lulewicz, I. H., Thompson, V. D., Pluckhahn, T. J., Andrus, C. F. T., and Das, O. (2018). Exploring oyster (Crassostrea virginica) habitat collection via oxygen isotope geochemistry and its implications for ritual and mound construction at Crystal River and Roberts Island, Florida. *The Journal of Island and Coastal Archaeology 13*(3), 388–404.

Manning, S. W., Birch, J., Conger, M. A., Dee, M. W., Griggs, C., Hadden, C. S., Hogg, A. G., Bronk Ramsey, C., Sanft, S., Steier, P., and Wild, E. M. (2018). Radiocarbon re-dating of contact-era Iroqouian history in northeastern North America. *Science Advances 4*(12).

Marquardt, W. H. (2017). Shell mounds in the Southeast: Middens, monuments, temple mounds, rings, or works? *American Antiquity 75*(3).

Martino, J. C., Fowler, A. J., Doubleday, Z. A., Grammer, G. L., and Gillanders, B. M. (2019). Using otolith chronologies to understand long-term trends and extrinsic drivers of growth in fisheries. *Ecosphere 10*(1).

McLusky, D. S. (1993). Marine and estuarine gradients - An overview. *Netherlands Journal of Aquatic Ecology 27*, 489–493.

Milner, N. (2013). Human impacts on oyster resources at the Mesolithic-Neolithic transition in Denmark. In V. D. Thompson and J. C. Waggoner, Jr. (Eds.), *The Archaeology and Historical Ecology of Small Scale Economies* (pp. 19–40). University Press of Florida, Gainesville.

Mobley, C. (2011, June 26). Heritage museum to bridge Pin Point's past and future. [Newspaper article]. *Savannah Now/Savannah Morning News.* Accessed online at https://www.savannahnow.com/story/news/2011/06/26/heritage-museum-bridge-pin-points-past-and-future/13428974007/.

Moore, C. B. (1897). Certain aboriginal mounds of the Georgia Coast. *Journal of the Academy of Natural Sciences of Philadelphia*, 11.

Morgan, P. D. (2010). *African American Life in the Georgia Lowcountry: The Atlantic World and the Gullah Geechee*. University of Georgia Press, Athens.

Norgaard, R. B. (1994). *Development Betrayed: The End of Progress and a Co-Evolutionary Revisioning of the Future* (1st ed.). Routledge.

Odum, W. E. (1971). *Fundamentals of Ecology*. W. B. Saunders, Philadelphia.

Odum, W. E. (1990). Chapter 6: Internal processes influencing the maintenance of ecotones: Do they exist? In H. Décamps and R. J. Naiman (Eds.), *The Ecology and Management of Aquatic-Terrestrial Ecotones* (pp. 91–102). UNESCO.

Oemler, A. (1894). *The Past, Present, and Future of the Oyster Industry of Georgia*. [Report]. Bulletin of the United States Fish Commission, World's Fisheries Congress.

Olmos-Martínez, E. and Ortega-Rubio, A. (2020). Chapter 1: Socioecology. In A. Ortega-Rubio (Ed.), *Socio-ecological studies in natural protected areas* (pp. 3–17). Springer.

Parbus, B., Thompson, V. D., Garland, C. J., and Tucker, B. (2023). Bluff Field (9CH160) ceramics and radiocarbon dating and their implications for chronology building on Ossabaw Island and the Georgia coast. *Southeastern Archaeology 42*(4), 272–289.

Pauly, D. (1995). Anecdotes and the shifting baselines syndrome of fisheries. *Trends in Ecology and Evolution 10*, 430.

Pearson, C. E. (1975). *Locational Analysis of Late Prehistoric Sites on Ossabaw Island, Georgia*. University of Georgia, Laboratory of Archaeology, Athens.

Pearson, C. E. (1977). *Analysis of Late Prehistoric Settlement on Ossabaw Island, Georgia*. University of Georgia, Laboratory of Archaeology, Athens.

Pearson, C. E. (1979). *Patterns of Mississippian Period adaptation in coastal Georgia* [Doctoral dissertation]. University of Georgia.

Pearson, C. E. (1980). Late prehistoric settlement systems on Ossabaw Island, Georgia. In J. D. Howard (Ed.), *Excursions in southeastern geology: The archaeology-geology of the Georgia coast* (pp. 179–191). Department of Natural Resources, Environmental Protection Division, Georgia Geologic Survey, Atlanta.

Pearson, C. E. (2014). *Prehistoric Settlement and Sites on Ossabaw Island, Georgia: An Atlas.* University of Georgia, Laboratory of Archaeology, Athens.

Peharda, M., Schöne, B. R., Black, B. A., and Corrège, T. (2021). Advances of sclerochronology research in the last decade. *Palaeogeography, Palaeoclimatology, Palaeoecology 570*.

Pinckney, R. (2020, December 11). Oysters in the blood. [Newspaper article]. *South Magazine*. Accessed online at https://www.southmag.com/oysters-in-the-blood/.

Poe, M, R., Norman, K. C., and Levin, P. S. (2013). Cultural dimensions of socioecological systems: key connections and guiding principles for conservation in coastal environments. *Society for Conservation Biology, Conservation Letters 7*(3), 166–175.

Price, G. (2007). *Mapping and Systematic Shovel Testing at Middle Place Plantation (9CH158)*. Georgia Department of Natural Resource, Historic Preservation Division, Stockbridge.

Price, T. D., and Brown, J. A. (1985). Aspects of hunter–gatherer complexity. In T.D. Price and J. A. Brown (Eds.), *Prehistoric Hunters-Gatherers: The Emergence of Cultural Complexity* (pp. 3–20). Elsevier, Orlando.

Redman, C. L. (2005). Resilience theory in archaeology. *American Anthropologist 107*(1), 70–77.

Reeder-Myers, L. Braje, T. J., Hofman, C. A., Elliott Smith, E. A., Garland, C. J., Grone, M., Hadden, C. S., Hatch, M., Hunt, T., Kelley, A., LeFebvre, M. J., Lockman, M., McKechnie, I., McNiven, I. J., Newsom, B., Pluckhahn, T., Sanchez, G., Schwadron, M., Smith, K. Y., Smith, T., Spiess, A., Tayac, G., Thompson, V. D., Vollman, T., Weitzel, E. M., and Rick, T. C. (2022). Indigenous oyster fisheries persisted for millennia and should inform future management. *Nature Communications 13*.

Reitz, E. J., Gibbs, T., and Rathbun, T. (1987). Archaeological evidence for subsistence on coastal plantations. In T. A. Singleton (Ed.), *The archaeology of slavery and plantation life*. Academic Press, Orlando

Reitz, E. J. (1988). Evidence for coastal adaptations in Georgia and South Carolina. *Archaeology of Eastern North America 16*, 137–158.

Reitz, E. J. (2014). Continuity and resilience in the central Georgia Bight (USA) fishery between 2760 BC and AD 1580. *Journal of Archaeological Science 41*, 716-731.

Reitz, E. J. (2021). A case study in the longevity of a regional estuarine fishing tradition: The central Georgia Bight (USA). *Archaeological and Anthropological Sciences 13*.

Reitz, E. J., Quitmyer, I. R., and Marrinan, R. A. (2009). What are we measuring in the zooarchaeological record of prehispanic fishing strategies in the Georgia Bight, USA? *The Journal of Island and Coastal Archaeology 4*(1), 2–36.

Ribble, D. B. (2005). Etymology of place names in Georgia's Golden Isles. *Research Reports of Kochi University 54*, 39–49.

Rick, T. C. (2023a). Shell midden archaeology: Current trends and future directions. *Journal of Archaeological Research 32*, 309–366.

Rick, T. C. (2023b). Coastal archaeology and historical ecology for a changing planet. *Journal of Anthropological Research 79*(2), 153–175.

Rick, T. C., Erlandson, J. M., Braje, T. J., Estes, J. A., Graham, M. H., and Vellanoweth, R. L. (2008). Historical ecology and human impacts on coastal ecosystems of the Santa Barbara Channel region, California. In T. C. Rick and J. M. Erlandson (Eds.), *Human impacts on ancient marine ecosystems: A global perspective*, (pp. 77-101). University of California Press.

Rick, T. C., and Lockwood, R. (2013). Integrating paleobiology, archeology, and history to inform biological conservation. *Conservation Biology 27*(1), 45–54.

Rick, T. C., Reeder-Myers, L. A., Hofman, C. A., Breitburg, D., Lockwood, R., Henkes, G., Kellogg, L., Lowery, D., Luckenback, M. W., Mann, R., Ogburn, M. B., Southworth, M., Wah, J., Wesson, J., and Hines, A. H. (2016). Millennial-scale sustainability of the Chesapeake Bay Native American oyster fishery. *Proceedings of the National Academy of Sciences 113*(23), 6568–6573.

Ritchison, B. T. (2018). Exploring a Bayesian method for examining the regional ceramic sequence along the Georgia coast. *Southeastern Archaeology 37*(1), 12–21.

Ritchison, B. T. (2019). *The downstream effects of abandonment: 14th century AD immigration and settlement response on the Georgia coast, USA*. [Doctoral dissertation]. University of Georgia.

Ritchison, B. T., and Anderson, D. G. (2022). Vacant quarters and population movements: Legacy data and the investigation of a large-scale emigration event from the Savannah River Valley to the Georgia coast. In R. A. Cook and A. R. Comstock (Eds.), *Following* *the Mississippian spread: Climate change and migration in the Eastern US (ca. AD 1000-1600)* (pp. 257–299). Springer International Publishing.

Ritchison, B., Roberts Thompson, A. D., Thompson, V. D., Porter, M. E., and Tucker, B. (2018). *Survey and Mitigation of the South End Site (9CH155), Ossabaw Island, Georgia*. Georgia Department of Natural Resources, Historic Preservation Division, Stockbridge.

Roberts Thompson, A. (2020). *People, place, and taskscapes of enslavement: African American life on the South End Plantation, Ossabaw Island, Georgia, 1849–1861*. [Doctoral dissertation]. University of York.

Roberts Thompson, A., Thompson, V. D., Garland, C. J., Butler, R. A., deBeaubien, D., Panther, M., Hunt, T., Wendt, L., Fontenot, R., Langley, L., Schenk, K. L., Porter Freeman, M. E., Auerbach, C., and Saunders, C. (2023). The NAGPRA nexus, institutional integrity, and the evolving role of archaeological laboratories. *Advances in Archaeological Practice 11*(2), 232–245.

Rodgers, P. (2010, December 14). A part of Pin Point. [Newspaper article]. *Connect Savannah*. Accessed online at https://www.connectsavannah.com/community/a-part-of-pin-point-2134194.

Rogers, R. (2002). *Archaeological Investigations at 9CH155 (The Newell Creek Site), 2001–2002, Ossabaw Island, Chatham County, Georgia*. Georgia Department of Natural Resources, Historic Preservation Division, Stockbridge.

Rogers, R. (2003). *Archaeological Investigations at the Newell Creek Site (9CH155), Ossabaw Island, Georgia, 2003 Season*. Georgia Department of Natural Resources, Historic Preservation Division, Stockbridge.

Salas-Zapata, W. A., Ríos-Osorio, L. A., and Álvarez-Del Castillo, J. (2012). Marco conceptual para entender la sustentabilidad de los sistemas socioecológicos. *Ecología Austral 22*(1).

Savarese, M., Walker, K. J., Stingu, S., Marquardt, W. H., and Thompson, V. D. (2016). The effects of shellfish harvesting by aboriginal inhabitants of Southwest Florida (USA) on productivity of the eastern oyster: Implications for estuarine management and restoration *Anthropocene 16*, 28–41.

Schell and Hogan (1884, March 1). The oyster war in Chesapeake Bay. [Drawing]. *Harper's Weekly*, pg. 136. Retrieved from the Library of Congress, https://www.loc.gov/item/2002698359/.

Shell to Shore (n.d.). *Birkley Heynen internship program*. Accessed online at https://www.shelltoshore.com/uga-internships.

Singh, M., and Glowacki, L. (2021). Human social organization during the Late Pleistocene: Beyond the nomadic-egalitarian model. *Evolution and Human Behavior 43*(5), 418–431.

Singleton, T. A. (2010). Reclaiming the Gullah-Geechee past: Archaeology of slavery in Coastal Georgia. In P. D. Morgan (Ed.), *African American life in the Georgia lowcountry: the Atlantic World and the Gullah Geechee* (pp. 151–187). University of Georgia Press, Athens.

Smith, H. M. (1921). *Report of the United States Commissioner of Fisheries for the Fiscal Year 1919 with Appendices.* [Report]. U.S. Bureau of Fisheries, Washington Government Printing Office.

Southeastern Fisheries Science Center. (2022, July 27). *Oyster reef habitat restoration to protect Georgia's coast.* National Oceanic and Atmospheric Administration Fisheries. Accessed online at https://www.fisheries.noaa.gov/feature-story/oyster-reef-habitat-restoration-protect-georgias-coast.

State Archaeologist Office. (2004). *Preliminary Archaeological Investigations of the Historic Component, Middle Place Site, Ossabaw Island, Chatham County, Georgia*. Georgia Department of Natural Resources, Historic Preservation Division, Stockbridge.

Surge, D. M., Lohmann, K. C., Dettman, D. L. (2001). Controls on isotopic chemistry of the American oyster, *Crassostrea virginica*: Implications for growth patterns. *Palaeogeography Palaeoclimatology, Palaeoecology 172*, 283–296.

Surge, D. M., Lohmann, K. G., and Goodfried, G. A. (2003). Reconstructing estuarine conditions: Oyster shells as recorders of environmental change, Southwest Florida. *Estuarine, Coastal and Shelf Science 57*(5–6), 737–756.

Tabb, K. (2018, August 29). *Our coast's history: NC's oyster war*. [Newspaper article]. Coastal Review. Accessed online at https://coastalreview.org/2018/08/our-coasts-history-ncs-oyster-war/.

Thomas, D. H. (2008). *Native American Landscapes of St. Catherine's Island, Georgia, Vol. I—III*. Anthropological Papers of the American Museum of Natural History. New York.

Thomas, D. H. (2014a). The shellfishers of St. Catherine's island: Hardscrabble foragers or farming beachcombers? *The Journal of Island and Coastal Archaeology 9*(2), 169–182.

Thomas, F. R. (2014b). Shellfish gathering and conservation on low coral islands: Kiribati perspectives. *The Journal of Island and Coastal Archaeology 9*(2), 203–218.

Thompson, V. D. (2018). Chapter 2: Collective action and village life during the Late Archaic on the Georgia coast. In J. Birch and V. D. Thompson (Eds.), *The Archaeology of Villages in Eastern North America*, (pp. 20–35). University of Florida Press, Gainesville.

Thompson, V. D., and Andrus, C. F. T. (2011). Evaluating mobility, monumentality, and feasting at the Sapelo Island Shell Ring Complex. *American Antiquity 76*(2), 315–344.

Thompson, V. D., and Andrus, C. F. T. (2013). Using oxygen isotope sclerochronology to evaluate the role of small islands among the Guale (AD 1325 to 1700) of the Georgia coast, USA. *The Journal of Island and Coastal Archaeology 8*(2), 190–209.

Thompson, V. D., and Moore, C. R. (2015). The sociality of surplus among Late Archaic hunter-gatherers of coastal Georgia. In C. T. Morehart and K. De Lucia (Eds.), *Surplus: The politics of production and the strategies of everyday life*, (pp. 245–266). University Press of Colorado, Denver.

Thompson, V. D., Pluckhahn, T. J., Das, O., and Andrus, C. F. T. (2015). Assessing village life and monument construction (cal. AD 65–1070) along the Central Gulf coast of Florida through stable isotope geochemistry. *Journal of Archaeological Science Reports 4*, 111–123.

Thompson, V. D., Rick, T., Garland, C. J., Thomas, D. H., Smith, K. Y., Bergh, S., Sanger, M., Tucker, B., Lulewicz, I., Semon, A. M., Schalles, J., Hladik, C., Alexander, C., and Ritchison, B. T. (2020). Ecosystem stability and Native American oyster harvesting along the Atlantic coast of the United States. *Science Advances 6*(28).

Thompson, V. D., Sanger, M., Smith, K. Y., Garland, C. J., Howland, M. D., Andrus, C. F. T., Holland-Lulewicz, I., Hadden, C., Alexander, C., Cajigas, R., Blair, E., Semon, A., and Thomas, D. H. (2024a). Shellfishing, sea levels, and the earliest Native American villages (5000-3800 yrs. BP) of the South Atlantic coast of the U.S. *Scientific Reports 14*, 22322.

Thompson, V. D., Smith, K. Y., Sanger, M., Garland, C. J., Pluckhahn, T. J., Napora, K., Bedell, J. D., Hadden, C., Cherkinsky, A., Cajigas, R., Blair, E. H., Semon, A. M., Thomas, D.

H. (2024b). The dynamics of fishing villages along the South Atlantic Coast of North America (ca. 5000–3000 years BP). *Scientific Reports 14*, 4691.

Thompson, V. D., and Turck, J. A. (2009). Adaptive cycles of coastal hunter-gatherers. *American Antiquity 74*(2), 255–278.

Thompson, V. D., and Turck, J. A. (2010). Island Archaeology and the Native American Economies (2500 B.C.–A.D. 1700) of the Georgia Coast. *Journal of Field Archaeology 35*(3), 283–297.

Thompson, V. D., Turck, J. A., and DePratter, C. B. (2013). Cumulative actions and the historical ecology of islands along the Georgia coast. In V. D. Thompson and J. C. Waggoner, Jr. (Eds.), *The archaeology and historical ecology of small economies* (pp. 79–96). University of Florida.

Thompson, V. D., and Worth, J. E. (2011). Dwellers by the sea: Native American adaptations along the southern coasts of Eastern North America. *Journal of Archaeological Research 19*, 51–101.

Towler, W. J., Jr. (1990). Armenius Oemler (1827–1897). (1990). *Savannah Biographies, Volume 19.* Armstrong Atlantic State University.

Tucker, B., and Thompson, V. D. (2018). *Preliminary Investigations at Bluff Field (9CH160) on Ossabaw Island, Georgia.* 75th Southeastern Archaeological Conference. Augusta, Georgia.

Turck, J. A. (2011). *Geoarchaeological analysis of two back-barrier islands and their relationship to the changing landscape of coastal Georgia, U.S.A.* [Doctoral dissertation]. University of Georgia.

Turck, J. A., and Thompson, V. D. (2016). Revisiting the resilience of Late Archaic hunter-gatherers along the Georgia coast. *Journal of Anthropological Archaeology 43*, 39–55.

Turck, J. A., and Thompson, V. D. (2019). Human-environmental dynamics of the Georgia coast. In L. Reeder-Myers, J. A. Turck, and T. C. Rick (Eds.) *The archaeology of human-environmental dynamics of the North American Atlantic coast* (pp. 164–198). University of Florida.

Tushingham, S. (2020). Chapter 3: The ordered anarchy frontier: Storage, sedentism, and the evolution of plank house villages on the southern Pacific Northwest coast. In R. S. Bakhtiary, T. L. Jones, and M. G. Delacorte (Eds.), *Cowboy Ecologist: Essays in Honor of Robert L. Bettinger*, (pg. 49–69). University of California, Davis.

Twaddle, R. W., Ulm, S., Hinton, J., Wurster, C. M., and Bird, M. I. (2015). Sclerochronological analysis of archaeological mollusc assemblages: Methods, applications and future prospects. Archaeological and Anthropological Sciences 8, 359–379.

UGA Marine Extension and Sea Grant. (n.d., a). *Oyster reefs in Georgia.* Accessed online at https://gacoast.uga.edu/outreach/programs/oyster-reefs-georgia/.

UGA Marine Extension and Sea Grant. (n.d., b). *Oyster restoration project*. Accessed online at https://gacoast.uga.edu/education/adult-education/oyster-restoration/.

Virginia Department of Health. (2018, September). *Epidemiology fact sheet: Risk of eating raw oysters and clams*.

Waselkov, G. A. (1987). Shellfish gathering and shell midden archaeology. *Advances in Archaeological Method and Theory 10*, 93–210.

Williams, M., and Thompson, V. D. (1999). A guide to Georgia Indian pottery types. *Early Georgia 27*(1), 1–167.

Will, M., Kandel, A. W., and Conard, N. J. (2019). Midden or molehill: The role of coastal adaptations in human evolution and dispersal. *Journal of World Prehistory 32*, 33–72.

Worley, S. (2021, September 1). Pin Point Heritage Museum. [Review]. *Condé Nest Traveler*. Accessed online at https://www.cntraveler.com/activities/savannah/pin-point-heritage-museum.

Yamazaki, T. and Oda, S. (2009). Changes in shell gathering in an early agricultural society at the head of Ise Bay, Japan. *Journal of Archaeological Science 36*(9), 2007–2011.

Ye, F., Crippa, G., Angiolini, L., Brand, U., Capitani, G., Cusack, M., Garbelli, C., Griesshaber, E., Harper, E., and Schmahl, W. (2018). Mapping of recent brachiopod microstructure: A tool for environmental studies. *Journal of Structural Biology 201*(3), 221–236.

Ziker, J. P., Rasmussen, J., and Nolin, D. A. (2016). Indigenous Siberians solve collective action problems through sharing and traditional knowledge. *Sustainability Science 11*, 45–55.

APPENDIX A

SHELL ISOTOPE PROFILES

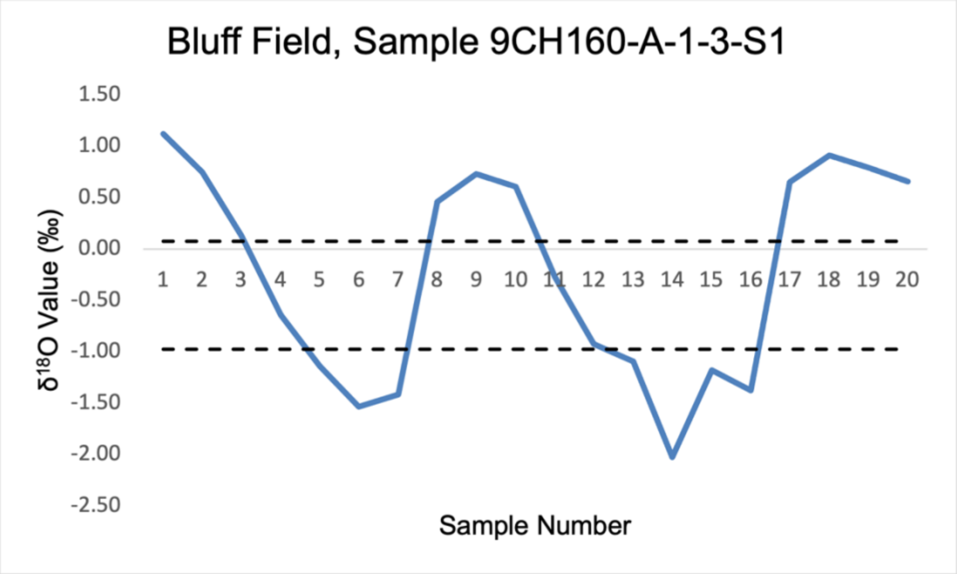


Figure 1. Bluff Field, Sample 9CH160-A-1-3-S1 (Bluff Field #1) shell isotope profile.

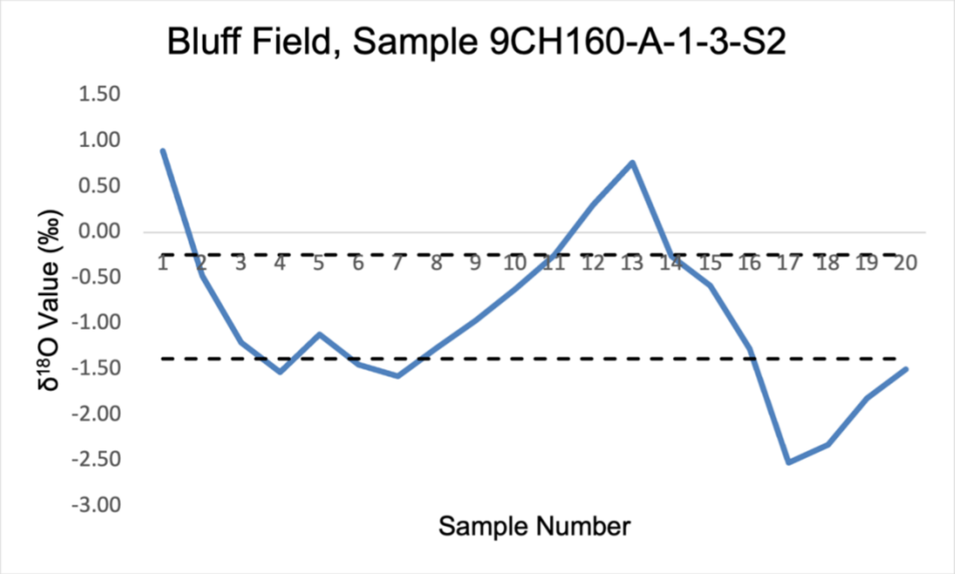


Figure 2. Bluff Field, Sample 9CH160-A-1-3-S2 (Bluff Field #2) shell isotope profile.

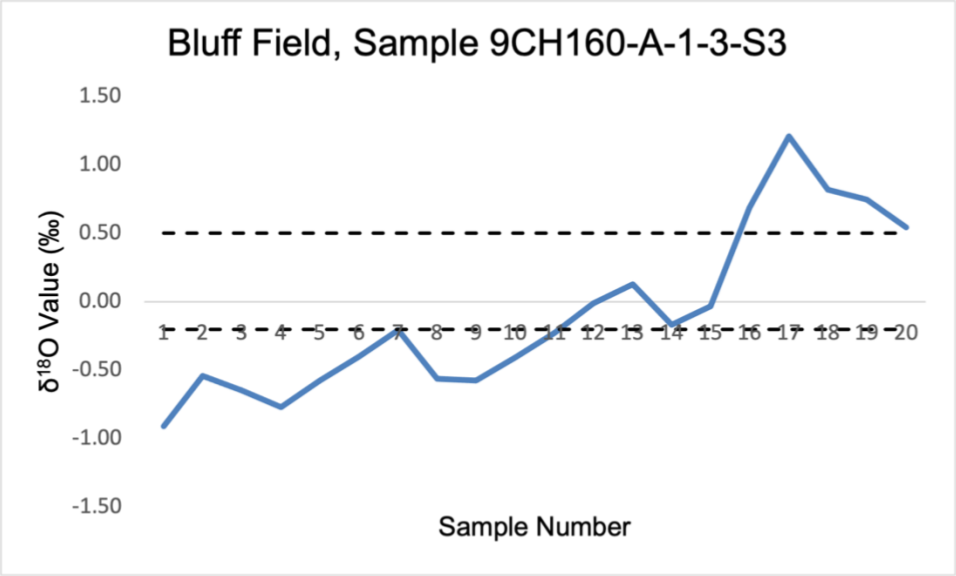


Figure 3. Bluff Field, Sample 9CH160-A-1-3-S3 (Bluff Field #3) shell isotope profile.

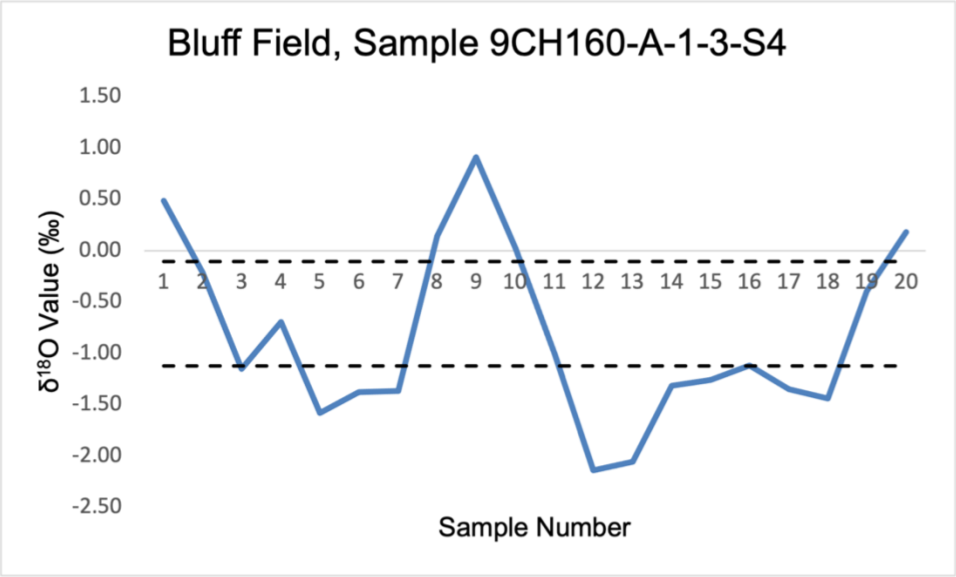


Figure 4. Bluff Field, Sample 9CH160-A-1-3-S4 (Bluff Field #4) shell isotope profile.

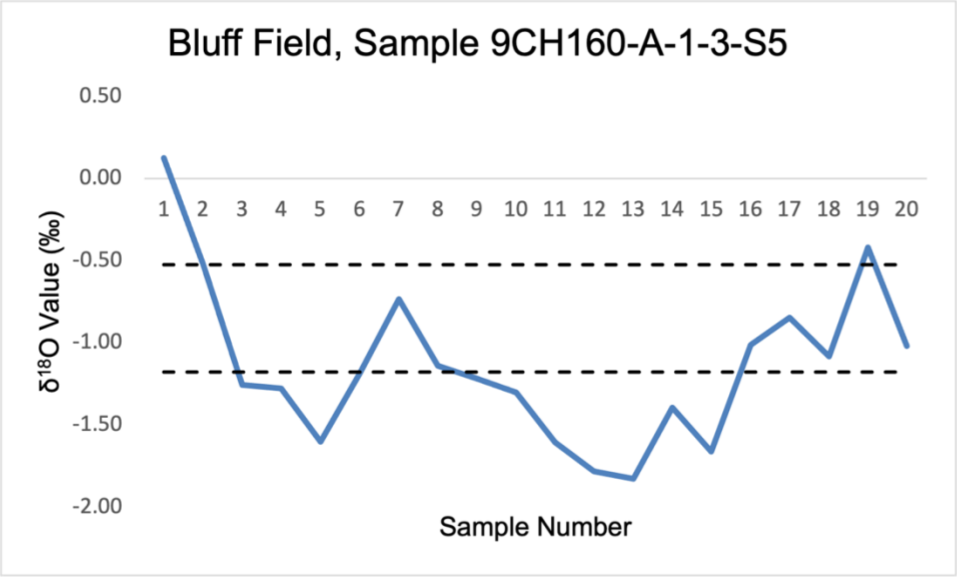


Figure 5. Bluff Field, Sample 9CH160-A-1-3-S5 (Bluff Field #5) shell isotope profile.

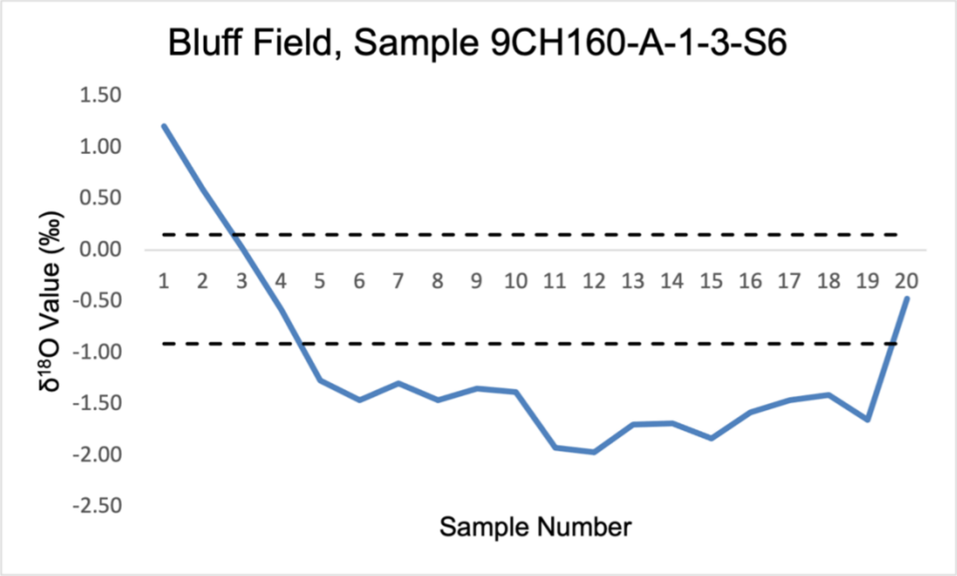


Figure 6. Bluff Field, Sample 9CH160-A-1-3-S6 (Bluff Field #6) shell isotope profile.

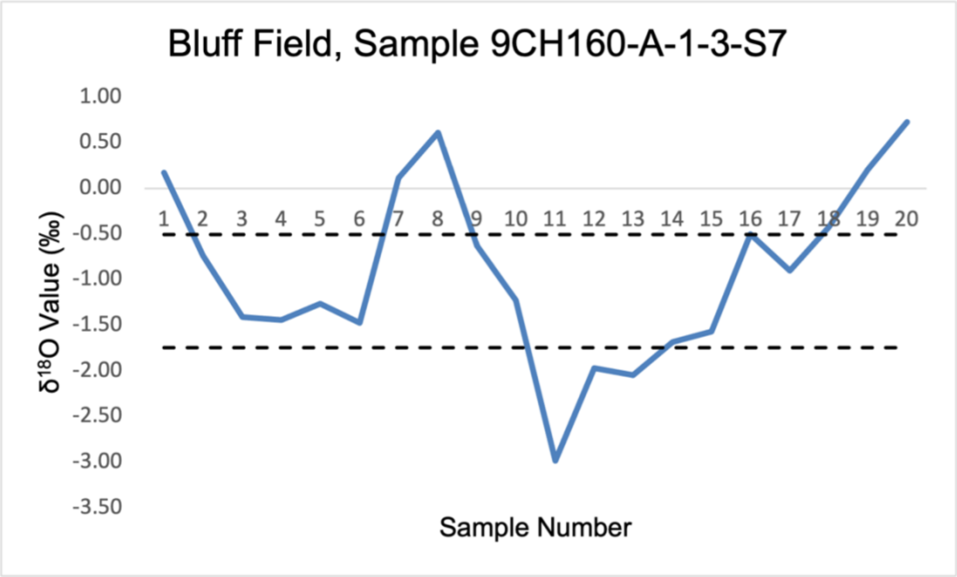


Figure 7. Bluff Field, Sample 9CH160-A-1-3-S7 (Bluff Field #7) shell isotope profile.

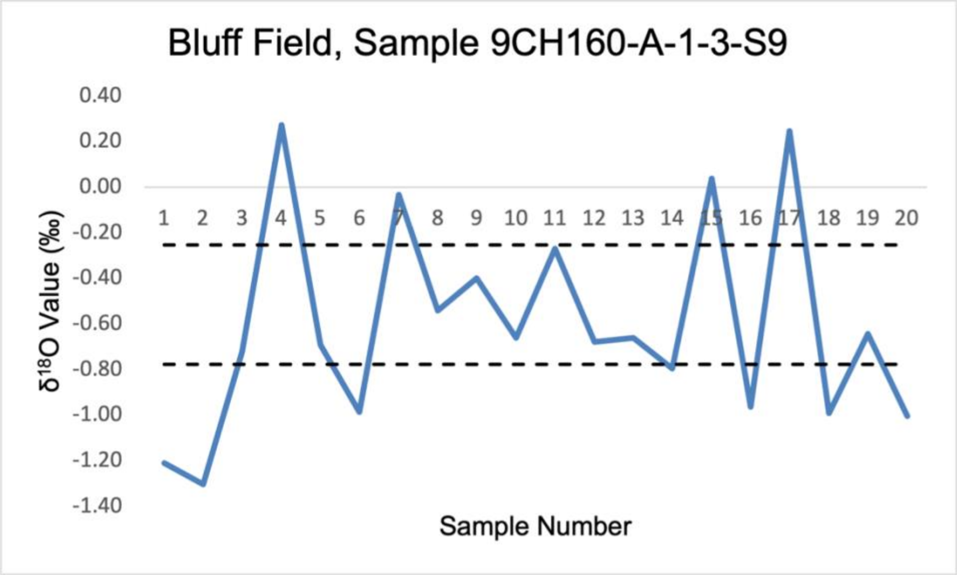


Figure 8. Bluff Field, Sample 9CH160-A-1-3-S9 (Bluff Field #8) shell isotope profile.

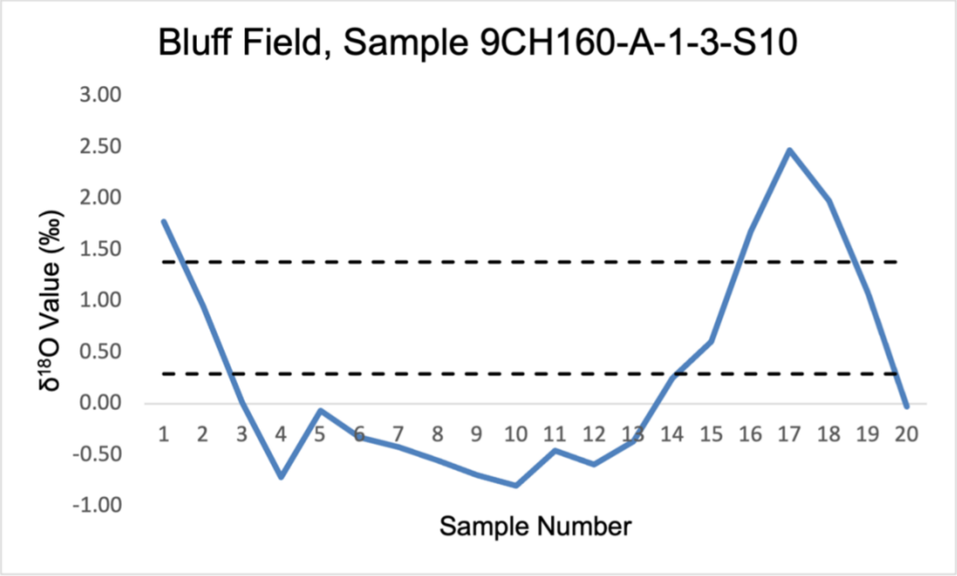


Figure 9. Bluff Field, Sample 9CH160-A-1-3-S10 (Bluff Field #9) shell isotope profile.

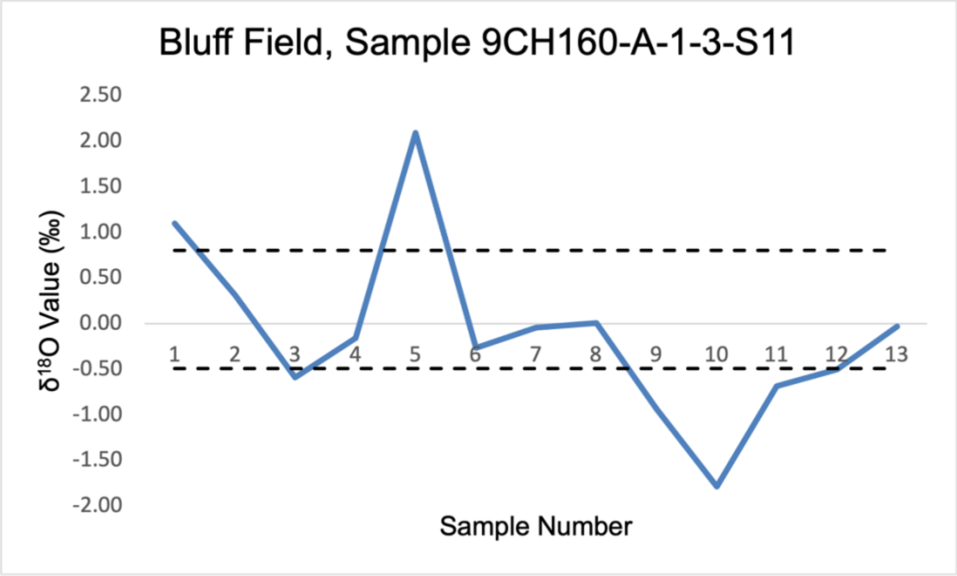


Figure 10. Bluff Field, Sample 9CH160-A-1-3-S11 (Bluff Field #10) shell isotope profile.

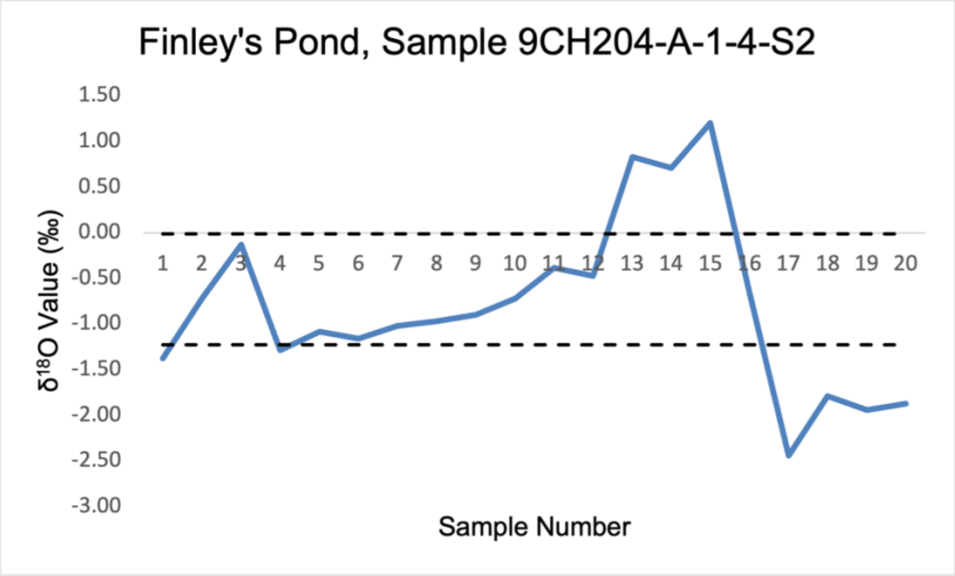


Figure 11. Finley's Pond, Sample 9CH204-A-1-4-S2 (Finley's Pond #1) shell isotope profile.

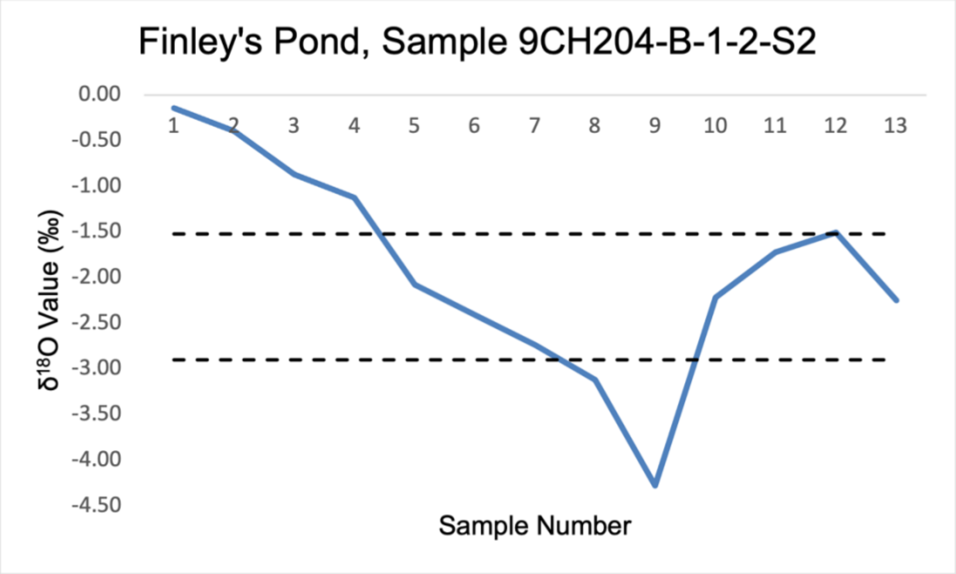


Figure 12. Finley's Pond, Sample 9CH204-B-1-2-S2 (Finley's Pond #2) shell isotope profile.

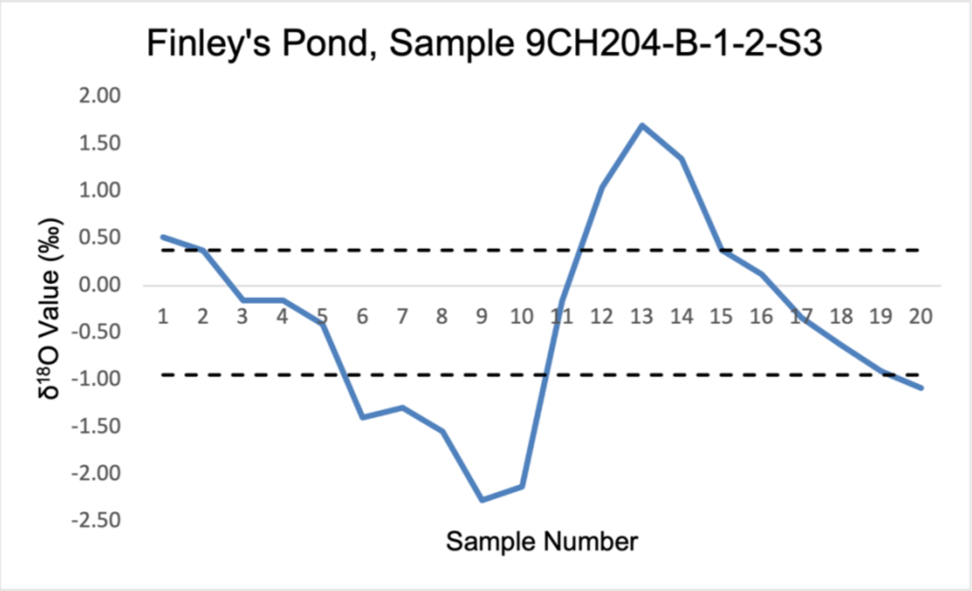


Figure 13. Finley's Pond, Sample 9CH204-B-1-2-S3 (Finley's Pond #3) shell isotope profile.

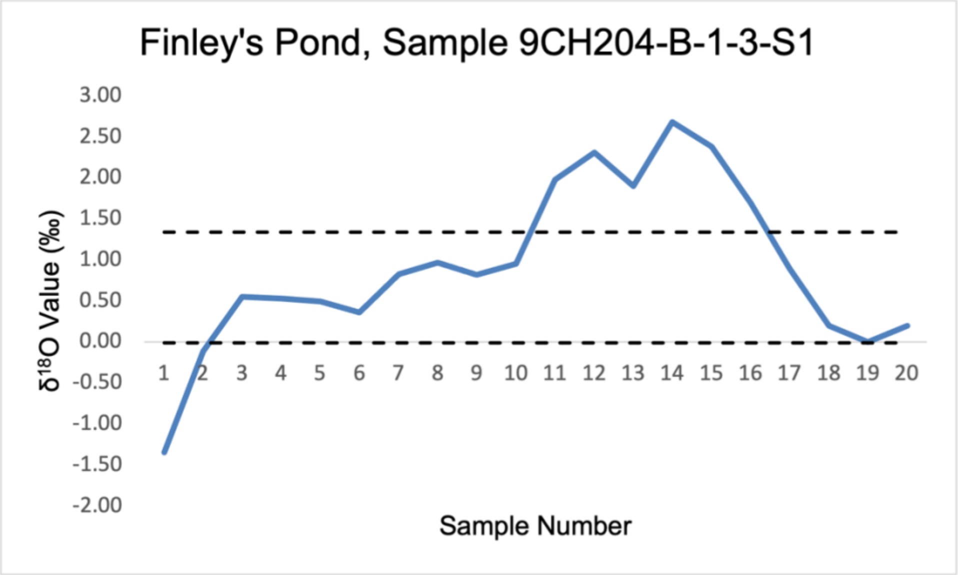


Figure 14. Finley's Pond, Sample 9CH204-B-1-3-S1 (Finley's Pond #4) shell isotope profile.

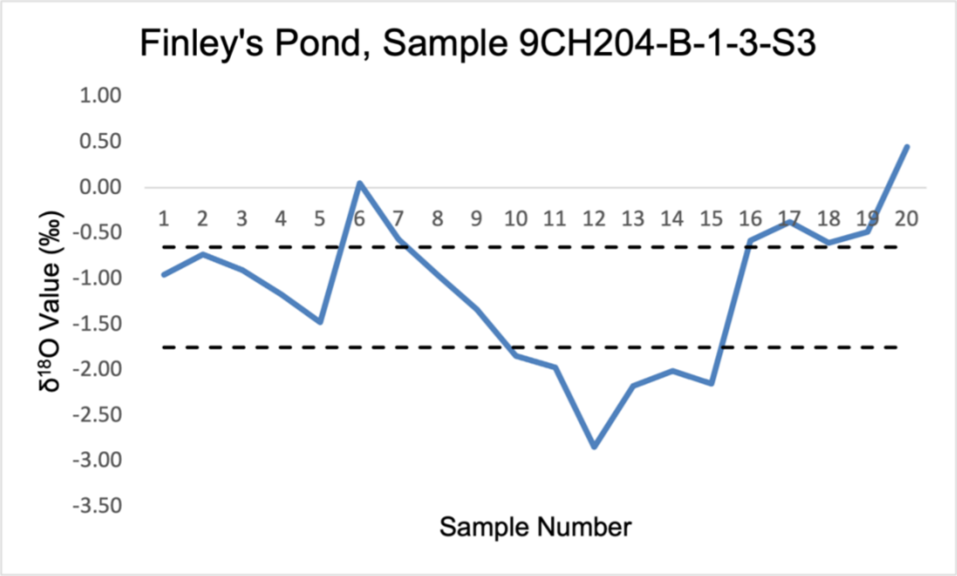


Figure 15. Finley’s Pond, Sample 9CH204-B-1-3-S3 (Finley’s Pond #5) shell isotope profile.

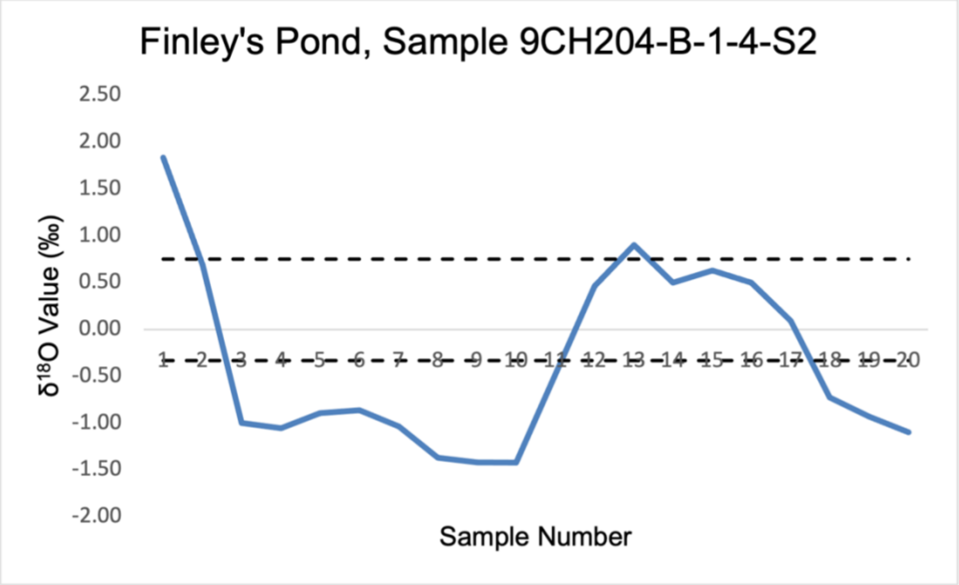


Figure 16. Finley’s Pond Sample 9CH204-B-1-4-S2 (Finley’s Pond #6) shell isotope profile.

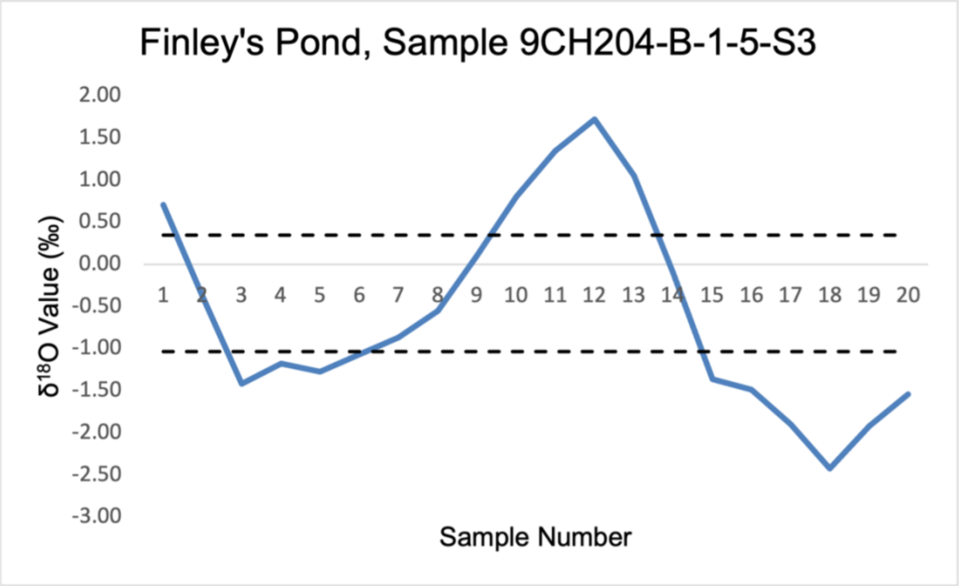


Figure 17. Finley's Pond, Sample 9CH204-B-1-5-S3 (Finley's Pond #7) shell isotope profile.

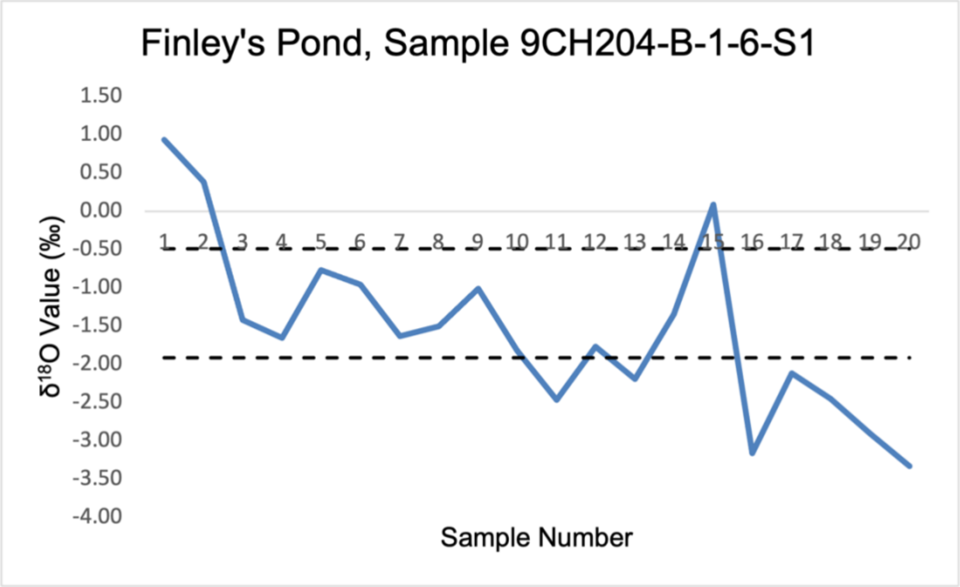


Figure 18. Finley's Pond, Sample 9CH204-B-1-6-S1 (Finley's Pond #8) shell isotope profile.

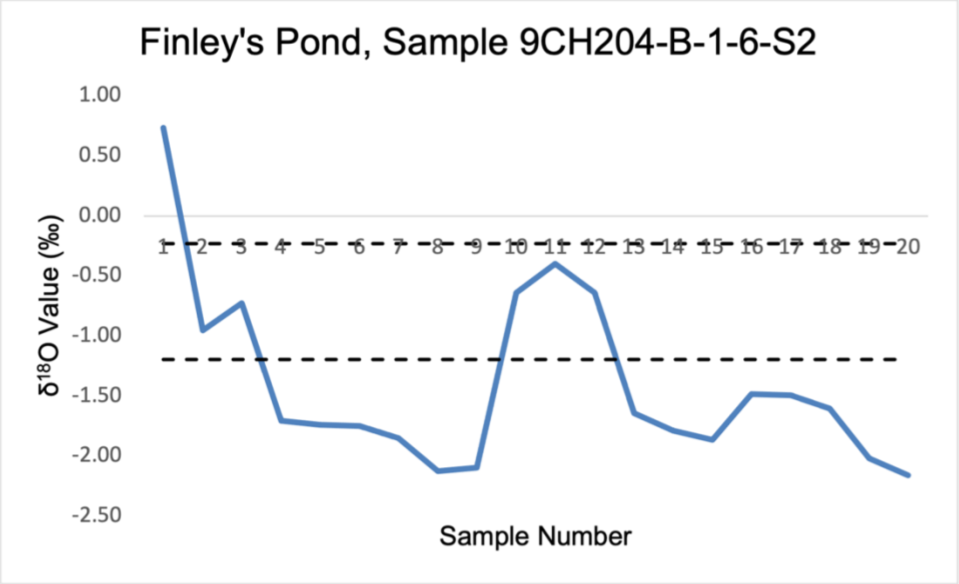


Figure 19. Finley’s Pond, Sample 9CH204-B-1-6-S2 (Finley’s Pond #9) shell isotope profile.

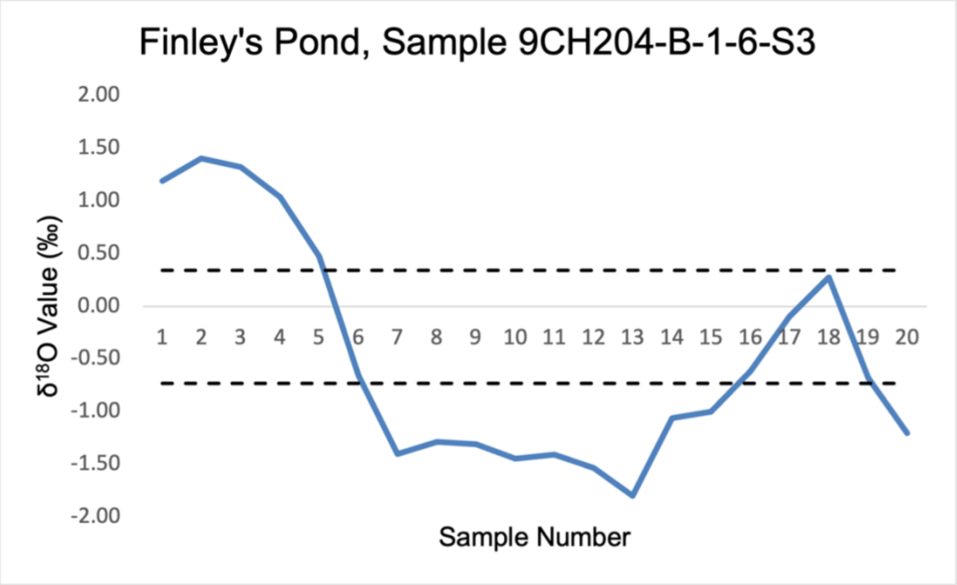


Figure 20. Finley’s Pond, Sample 9CH204-B-1-6-S3 (Finley’s Pond #10) shell isotope profile.

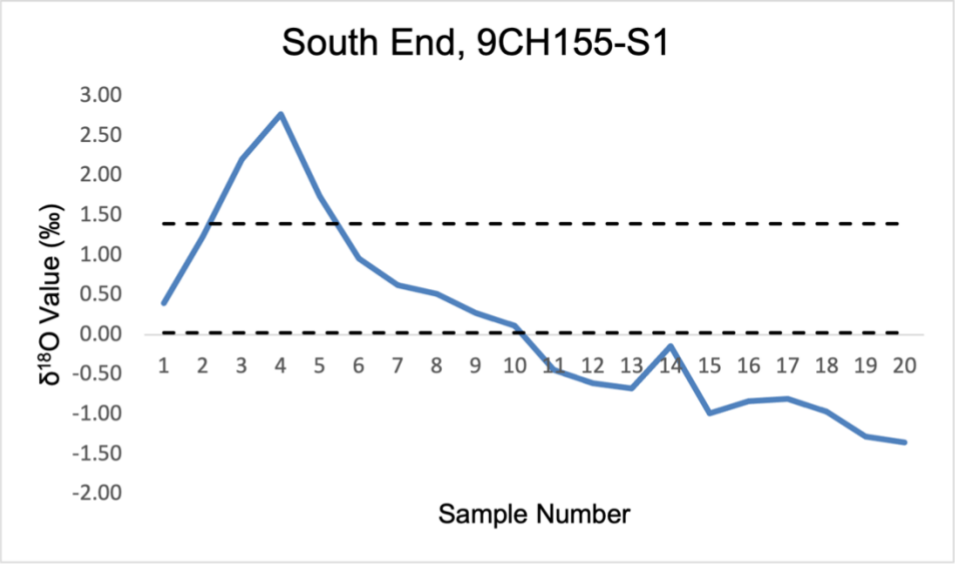


Figure 21. South End, Sample 9CH155-S1 (South End #1) shell isotope profile.

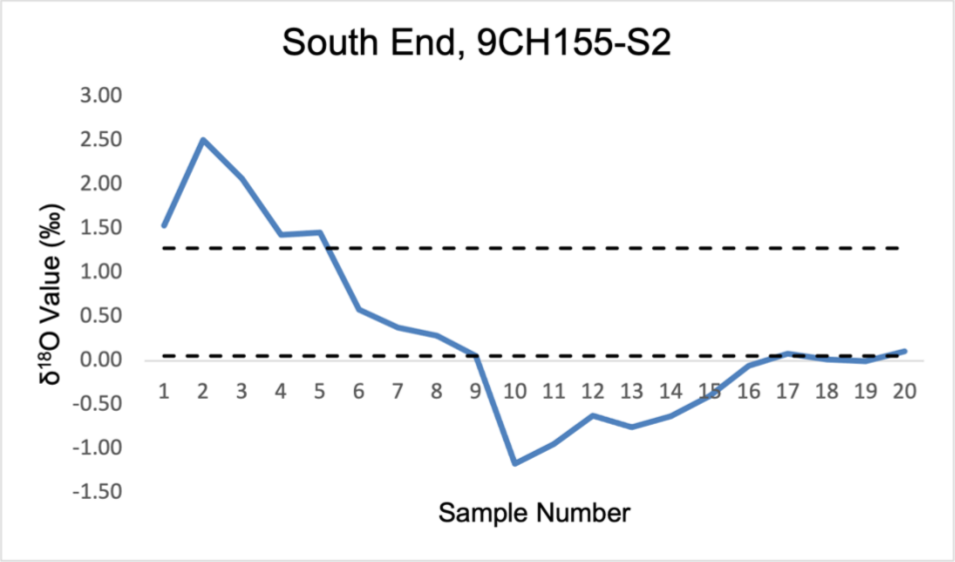


Figure 22. South End, Sample 9CH155-S2 (South End #2) shell isotope profile.

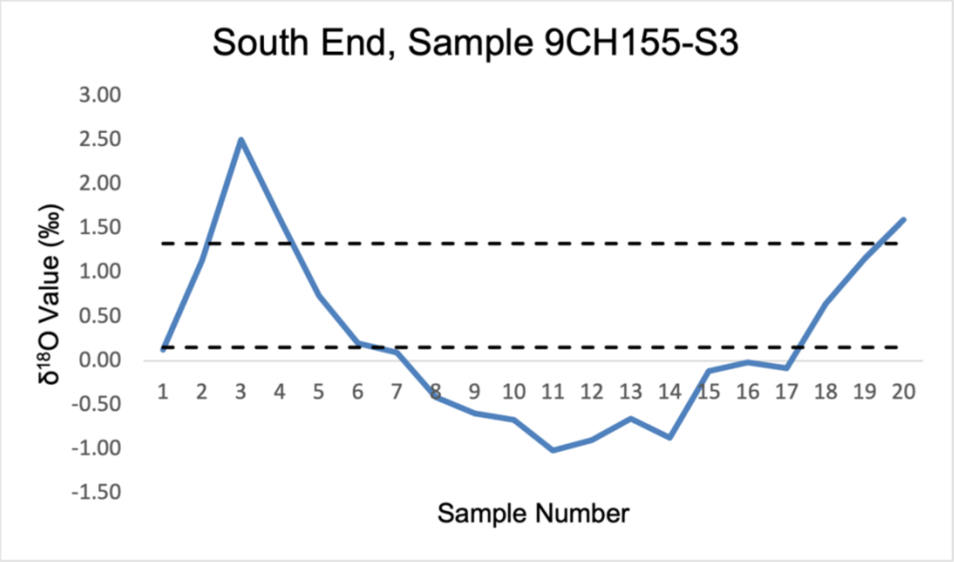


Figure 23. South End, Sample 9CH155-S3 (South End #3) shell isotope profile.

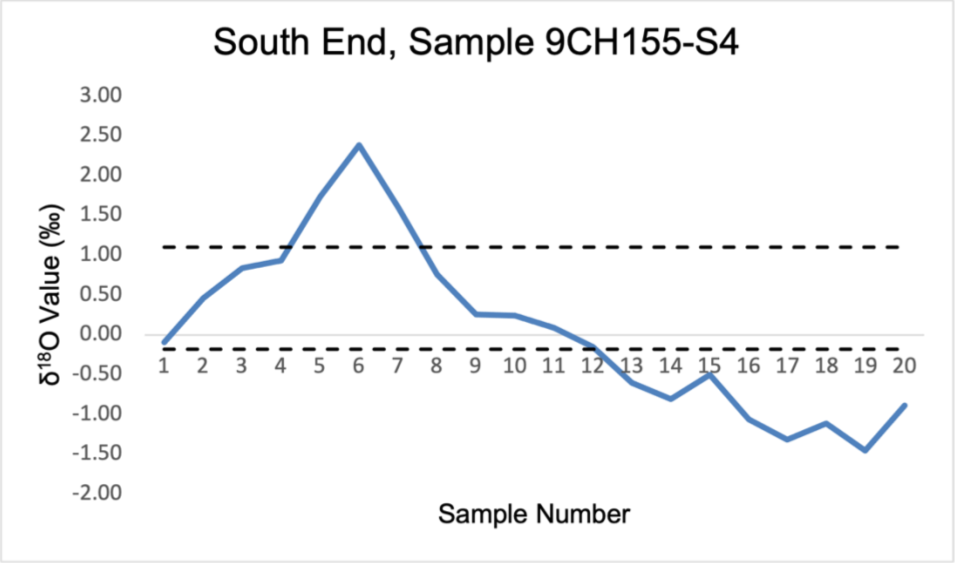


Figure 24. South End, Sample 9CH155-S4 (South End #4) shell isotope profile.

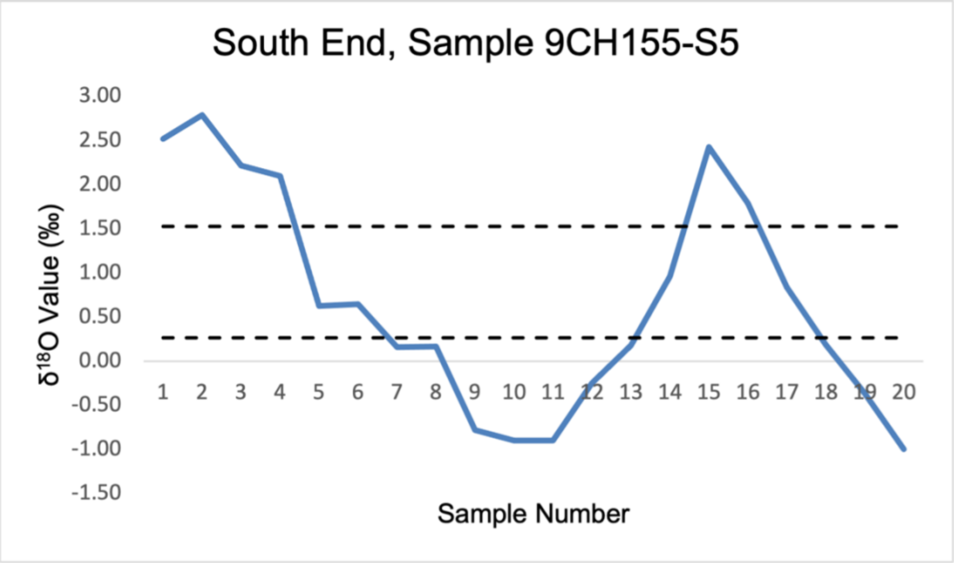


Figure 25. South End, Sample 9CH155-S5 (South End #5) shell isotope profile.

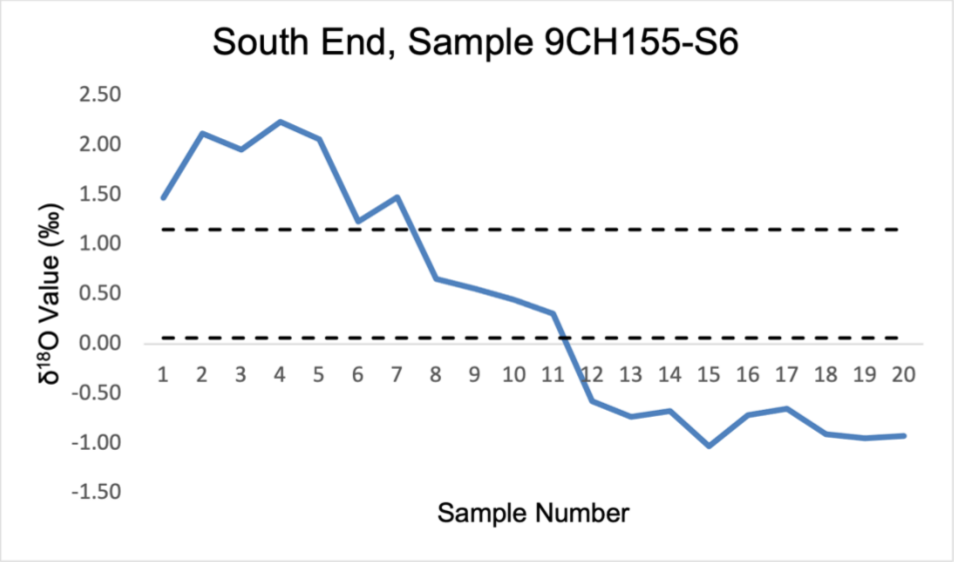


Figure 26. South End, Sample 9CH155-S6 (South End #6) shell isotope profile.

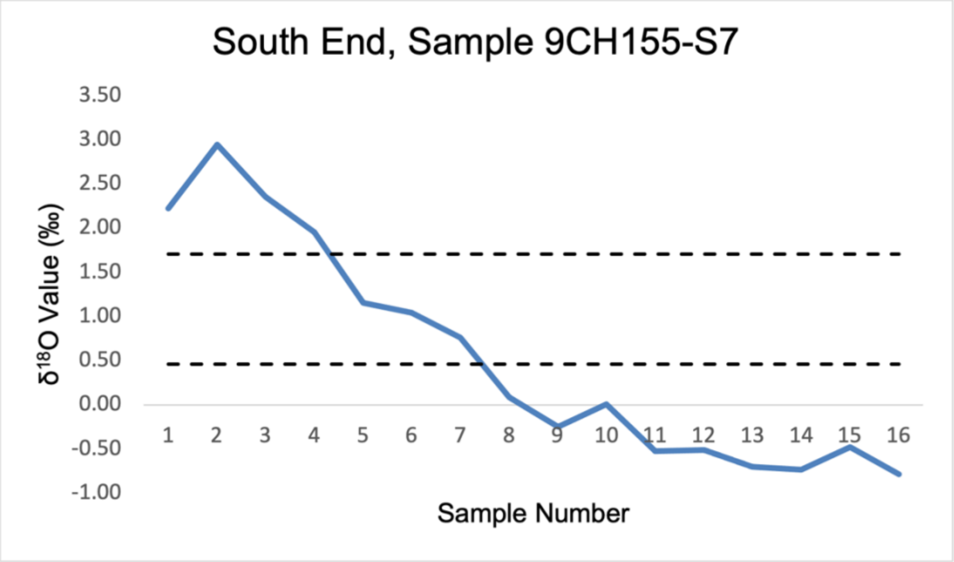


Figure 27. South End, Sample 9CH155-S7 (South End #7) shell isotope profile.

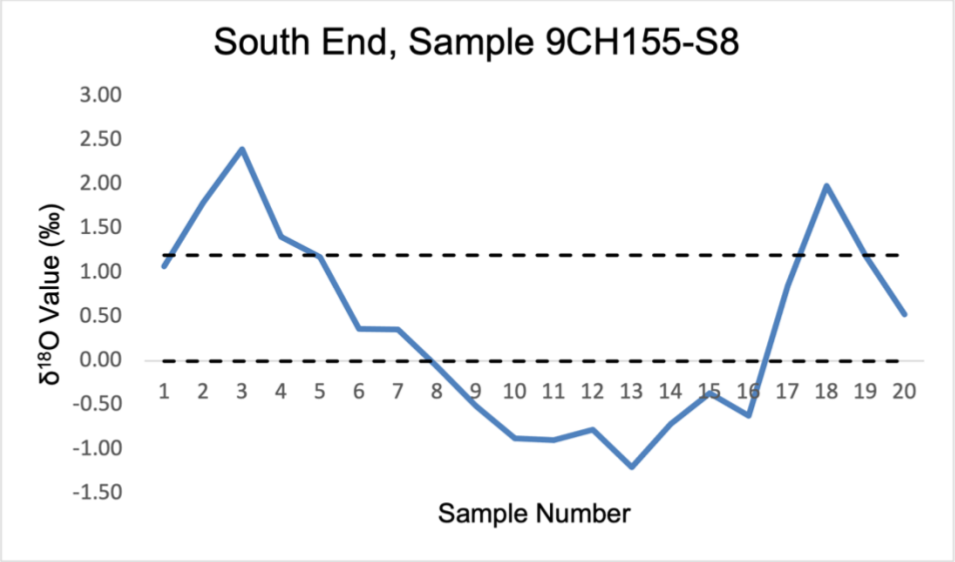


Figure 28. South End, Sample 9CH155-S8 (South End #8) shell isotope profile.

APPENDIX B

PROVENIENCE DATA TABLES

Table 1. *Hokfv-Mocvse* Shell Ring data summary (adapted from Garland et al. 2024, table 2).

Sample ID	Context	Estimated Season	Estimated Salinity (ppt)
***Hokfv-Mocvse* Shell Ring (9CH160)**	UGA's 2022 Field School Shell ring construction ^{14}C dated to 3140–2785 BC, Late Archaic (Garland et al. 2024:1, 7-8)		
9CH160-D1-LVL4-S1	Op. D1, Level 4	Winter	26
9CH160-D1-LVL4-S2	Op. D1, Level 4	Summer	24
9CH160-D1-LVL4-S4	Op. D1, Level 4	Winter	28
9CH160-FI-LVL4-S1	Op. FI, Level 4	Winter	21
9CH160-D1-LVL5-S1	Op. DI, Level 5	Fall	31
9CH160-E1-LVL2-S1	Op. E1, Level 2	Fall	26
9CH160-E1-LVL2-S2	Op. E1, Level 2	Winter	25
9CH160-D1-LVL2-S1	Op. D1, Level 2	Winter	31
9CH160-D1-LVL3-S1	Op. D1, Level 3	Summer	27
9CH160-D1-LVL3-S2	Op. D1, Level 3	Winter	22
9CH160-D1-LVL3-S3	Op. D1, Level 3	Spring	28
9CH160-C1-LVL2-S1	Op. C1, Level 2	Winter	36
9CH160-C4-LVL2-S1	Op. C4, Level 2	Fall	29

Table 2. Bluff Field data summary.

Sample ID	Context	Estimated Season	Estimated Salinity (psu)
Bluff Field (9CH160)	UGA's 2022 Field School Unit A-1 ^{14}C dated to AD 880–1030, Late Woodland/Early Mississippian (Parbus et al. 2023:280)		
9CH160-A-1-3-S1	Unit A-1, Level 3	Winter	27.2
9CH160-A-1-3-S2	Unit A-1, Level 3	Winter	21.8
9CH160-A-1-3-S3	Unit A-1, Level 3	Summer	39.1
9CH160-A-1-3-S4	Unit A-1, Level 3	Winter	25.9
9CH160-A-1-3-S5	Unit A-1, Level 3	Winter	29.2
9CH160-A-1-3-S6	Unit A-1, Level 3	Winter	27.7
9CH160-A-1-3-S7	Unit A-1, Level 3	Winter	16.9
9CH160-A-1-3-S9	Unit A-1, Level 3	Summer	34.9
9CH160-A-1-3-S10	Unit A-1, Level 3	Winter	40.3
9CH160-A-1-3-S11	Unit A-1, Level 3	Winter	29.8

Table 3. Finley’s Pond data summary.

Sample ID	Context	Estimated Season	Estimated Salinity (psu)
Finley’s Pond (9CH204)	UGA’s 2016 Field School Unit A-1 broadly Mississippian (presence of Irene type ceramics) Unit B-1 ^{14}C dated to AD 1445–1490, Late Mississippian (Garland et al. 2023:358)		
9CH204-A-1-4-S2	Unit A-1, Level 4, Feature 1	Summer	22.7
9CH204-B-1-2-S2	Unit B-1, Level 2	Winter	2.9
9CH204-B-1-2-S3	Unit B-1, Level 2	Winter	24.5
9CH204-B-1-3-S1	Unit B-1, Level 3	Summer	34.4
9CH204-B-1-3-S3	Unit B-1, Level 3	Spring	18.3
9CH204-B-1-4-S2	Unit B-1, Level 4	Winter	33.7
9CH204-B-1-5-S3	Unit B-1, Level 5	Winter	22.9
9CH204-B-1-6-S1	Unit B-1, Level 6	Winter	13.1
9CH204-B-1-6-S2	Unit B-1, Level 6	Winter	25.7
9CH204-B-1-6-S3	Unit B-1, Level 6	Winter	29.6

Table 4. South End data summary.

Sample ID	Context	Estimated Season	Estimated Salinity (psu)
South End (9CH155)	Site reconnaissance by A. Roberts Thompson at eroding bluff edge of Newell Creek Plantation in operation from AD 1849–1861(documentary evidence)		
9CH155-S1	Enslaved family’s residential shell pit feature	Spring	34.4
9CH155-S2	Enslaved family’s residential shell pit feature	Winter	36.5
9CH155-S3	Enslaved family’s residential shell pit feature	Spring	38.1
9CH155-S4	Enslaved family’s residential shell pit feature	Spring	33.3
9CH155-S5	Enslaved family’s residential shell pit feature	Winter	38.4
9CH155-S6	Enslaved family’s residential shell pit feature	Winter	38.0
9CH155-S7	Enslaved family’s residential shell pit feature	Winter	40.6
9CH155-S8	Enslaved family’s residential shell pit feature	Spring	36.1

APPENDIX C

GAS BENCH DATA

Table 5. Bluff Field, Sample 9CH160-A-1-3-S1 (Bluff Field #1).

Sample ID	$\delta^{18}O$ corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH160-A-1-3-S1A	1.12			
9CH160-A-1-3-S1B	0.75			
9CH160-A-1-3-S1C	0.13			
9CH160-A-1-3-S1D	-0.64			
9CH160-A-1-3-S1E	-1.14			
9CH160-A-1-3-S1F	-1.54			
9CH160-A-1-3-S1G	-1.42			
9CH160-A-1-3-S1H	0.46			
9CH160-A-1-3-S1I	0.73			
9CH160-A-1-3-S1J	0.60			
9CH160-A-1-3-S1K	-0.27			
9CH160-A-1-3-S1L	-0.93			
9CH160-A-1-3-S1M	-1.09			
9CH160-A-1-3-S1N	-2.02	0.45	0.43	27.2
9CH160-A-1-3-S1O	-1.18			
9CH160-A-1-3-S1P	-1.38			
9CH160-A-1-3-S1Q	0.65			
9CH160-A-1-3-S1R	0.91			
9CH160-A-1-3-S1S	0.79			
9CH160-A-1-3-S1T	0.66			

Table 6. Bluff Field, Sample 9CH160-A-1-3-S2 (Bluff Field #2).

Sample ID	$\delta^{18}O$ corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH160-A-1-3-S2A	0.89			
9CH160-A-1-3-S2B	-0.47			
9CH160-A-1-3-S2C	-1.21			
9CH160-A-1-3-S2D	-1.53			
9CH160-A-1-3-S2E	-1.12			
9CH160-A-1-3-S2F	-1.45			
9CH160-A-1-3-S2G	-1.57			
9CH160-A-1-3-S2H	-1.27			
9CH160-A-1-3-S2I	-0.97			
9CH160-A-1-3-S2J	-0.62			
9CH160-A-1-3-S2K	-0.25			
9CH160-A-1-3-S2L	0.30			
9CH160-A-1-3-S2M	0.76			
9CH160-A-1-3-S2N	-0.26			
9CH160-A-1-3-S2O	-0.59			
9CH160-A-1-3-S2P	-1.28			
9CH160-A-1-3-S2Q	-2.52	-0.05	-0.07	21.8
9CH160-A-1-3-S2R	-2.33			
9CH160-A-1-3-S2S	-1.82			
9CH160-A-1-3-S2T	-1.50			

Table 7. Bluff Field, Sample 9CH160-A-1-3-S3 (Bluff Field #3).

Sample ID	$\delta^{18}O$ corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH160-A-1-3-S3A	-0.91	1.56	1.54	39.1
9CH160-A-1-3-S3B	-0.54			
9CH160-A-1-3-S3C	-0.65			
9CH160-A-1-3-S3D	-0.77			
9CH160-A-1-3-S3E	-0.58			
9CH160-A-1-3-S3F	-0.40			
9CH160-A-1-3-S3G	-0.21			
9CH160-A-1-3-S3H	-0.56			
9CH160-A-1-3-S3I	-0.57			
9CH160-A-1-3-S3J	-0.40			
9CH160-A-1-3-S3K	-0.23			
9CH160-A-1-3-S3L	-0.01			
9CH160-A-1-3-S3M	0.13			
9CH160-A-1-3-S3N	-0.17			
9CH160-A-1-3-S3O	-0.03			
9CH160-A-1-3-S3P	0.69			
9CH160-A-1-3-S3Q	1.21			
9CH160-A-1-3-S3R	0.82			
9CH160-A-1-3-S3S	0.75			
9CH160-A-1-3-S3T	0.54			

Table 8. Bluff Field, Sample 9CH160-A-1-3-S4 (Bluff Field #4).

Sample ID	$\delta^{18}O$ corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH160-A-1-3-S4A	0.49			
9CH160-A-1-3-S4B	-0.22			
9CH160-A-1-3-S4C	-1.15			
9CH160-A-1-3-S4D	-0.69			
9CH160-A-1-3-S4E	-1.58			
9CH160-A-1-3-S4F	-1.38			
9CH160-A-1-3-S4G	-1.37			
9CH160-A-1-3-S4H	0.14			
9CH160-A-1-3-S4I	0.91			
9CH160-A-1-3-S4J	0.02			
9CH160-A-1-3-S4K	-1.00			
9CH160-A-1-3-S4L	-2.14	0.33	0.31	25.9
9CH160-A-1-3-S4M	-2.05			
9CH160-A-1-3-S4N	-1.32			
9CH160-A-1-3-S4O	-1.26			
9CH160-A-1-3-S4P	-1.12			
9CH160-A-1-3-S4Q	-1.35			
9CH160-A-1-3-S4R	-1.44			
9CH160-A-1-3-S4S	-0.39			
9CH160-A-1-3-S4T	0.18			

Table 9. Bluff Field, Sample 9CH160-A-1-3-S5 (Bluff Field #5).

Sample ID	δ^{18}O corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH160-A-1-3-S5A	0.13			
9CH160-A-1-3-S5B	-0.53			
9CH160-A-1-3-S5C	-1.25			
9CH160-A-1-3-S5D	-1.28			
9CH160-A-1-3-S5E	-1.60			
9CH160-A-1-3-S5F	-1.19			
9CH160-A-1-3-S5G	-0.73			
9CH160-A-1-3-S5H	-1.14			
9CH160-A-1-3-S5I	-1.22			
9CH160-A-1-3-S5J	-1.30			
9CH160-A-1-3-S5K	-1.60			
9CH160-A-1-3-S5L	-1.78			
9CH160-A-1-3-S5M	-1.83	0.64	0.62	29.2
9CH160-A-1-3-S5N	-1.39			
9CH160-A-1-3-S5O	-1.66			
9CH160-A-1-3-S5P	-1.01			
9CH160-A-1-3-S5Q	-0.85			
9CH160-A-1-3-S5R	-1.08			
9CH160-A-1-3-S5S	-0.42			
9CH160-A-1-3-S5T	-1.02			

Table 10. Bluff Field, Sample 9CH160-A-1-3-S6 (Bluff Field #6).

Sample ID	δ^{18}O corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH160-A-1-3-S6A	1.21			
9CH160-A-1-3-S6B	0.59			
9CH160-A-1-3-S6C	0.02			
9CH160-A-1-3-S6D	-0.58			
9CH160-A-1-3-S6E	-1.27			
9CH160-A-1-3-S6F	-1.46			
9CH160-A-1-3-S6G	-1.30			
9CH160-A-1-3-S6H	-1.46			
9CH160-A-1-3-S6I	-1.35			
9CH160-A-1-3-S6J	-1.38			
9CH160-A-1-3-S6K	-1.92			
9CH160-A-1-3-S6L	-1.97	0.5	0.48	27.7
9CH160-A-1-3-S6M	-1.70			
9CH160-A-1-3-S6N	-1.69			
9CH160-A-1-3-S6O	-1.83			
9CH160-A-1-3-S6P	-1.58			
9CH160-A-1-3-S6Q	-1.46			
9CH160-A-1-3-S6R	-1.41			
9CH160-A-1-3-S6S	-1.65			
9CH160-A-1-3-S6T	-0.47			

Table 11. Bluff Field, Sample 9CH160-A-1-3-S7 (Bluff Field #7).

Sample ID	$\delta^{18}O$ corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH160-A-1-3-S7A	0.17			
9CH160-A-1-3-S7B	-0.74			
9CH160-A-1-3-S7C	-1.41			
9CH160-A-1-3-S7D	-1.44			
9CH160-A-1-3-S7E	-1.27			
9CH160-A-1-3-S7F	-1.47			
9CH160-A-1-3-S7G	0.11			
9CH160-A-1-3-S7H	0.61			
9CH160-A-1-3-S7I	-0.63			
9CH160-A-1-3-S7J	-1.22			
9CH160-A-1-3-S7K	-2.98	-0.51	-0.53	16.9
9CH160-A-1-3-S7L	-1.97			
9CH160-A-1-3-S7M	-2.05			
9CH160-A-1-3-S7N	-1.68			
9CH160-A-1-3-S7O	-1.57			
9CH160-A-1-3-S7P	-0.50			
9CH160-A-1-3-S7Q	-0.90			
9CH160-A-1-3-S7R	-0.43			
9CH160-A-1-3-S7S	0.21			
9CH160-A-1-3-S7T	0.73			

Table 12. Bluff Field, Sample 9CH160-A-1-3-S9 (Bluff Field #8).

Sample ID	$\delta^{18}O$ corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH160-A-1-3-S9A	-1.21			
9CH160-A-1-3-S9B	-1.30	1.17	1.15	34.9
9CH160-A-1-3-S9C	-0.72			
9CH160-A-1-3-S9D	0.27			
9CH160-A-1-3-S9E	-0.69			
9CH160-A-1-3-S9F	-0.99			
9CH160-A-1-3-S9G	-0.03			
9CH160-A-1-3-S9H	-0.54			
9CH160-A-1-3-S9I	-0.40			
9CH160-A-1-3-S9J	-0.66			
9CH160-A-1-3-S9K	-0.27			
9CH160-A-1-3-S9L	-0.68			
9CH160-A-1-3-S9M	-0.66			
9CH160-A-1-3-S9N	-0.79			
9CH160-A-1-3-S9O	0.04			
9CH160-A-1-3-S9P	-0.96			
9CH160-A-1-3-S9Q	0.25			
9CH160-A-1-3-S9R	-0.99			
9CH160-A-1-3-S9S	-0.64			
9CH160-A-1-3-S9T	-1.00			

Table 13. Bluff Field, Sample 9CH160-A-1-3-S10 (Bluff Field #9).

Sample ID	$\delta^{18}O$ corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH160-A-1-3-S10A	1.77			
9CH160-A-1-3-S10B	0.95			
9CH160-A-1-3-S10C	0.01			
9CH160-A-1-3-S10D	-0.72			
9CH160-A-1-3-S10E	-0.07			
9CH160-A-1-3-S10F	-0.33			
9CH160-A-1-3-S10G	-0.43			
9CH160-A-1-3-S10H	-0.56			
9CH160-A-1-3-S10I	-0.70			
9CH160-A-1-3-S10J	-0.80	1.67	1.65	40.3
9CH160-A-1-3-S10K	-0.46			
9CH160-A-1-3-S10L	-0.59			
9CH160-A-1-3-S10M	-0.37			
9CH160-A-1-3-S10N	0.25			
9CH160-A-1-3-S10O	0.61			
9CH160-A-1-3-S10P	1.68			
9CH160-A-1-3-S10Q	2.47			
9CH160-A-1-3-S10R	1.98			
9CH160-A-1-3-S10S	1.08			
9CH160-A-1-3-S10T	-0.03			

Table 14. Bluff Field, Sample 9CH160-A-1-3-S11 (Bluff Field #10).

Sample ID	$\delta^{18}O$ corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH160-A-1-3-S11A	1.10			
9CH160-A-1-3-S11B	0.32			
9CH160-A-1-3-S11C	-0.59			
9CH160-A-1-3-S11D	-0.16			
9CH160-A-1-3-S11E	2.10			
9CH160-A-1-3-S11F	-0.26			
9CH160-A-1-3-S11G	-0.04			
9CH160-A-1-3-S11H	0.01			
9CH160-A-1-3-S11I	-0.93			
9CH160-A-1-3-S11J	-1.78	0.69	0.67	29.8
9CH160-A-1-3-S11K	-0.68			
9CH160-A-1-3-S11L	-0.50			
9CH160-A-1-3-S11M	-0.03			

Table 15. Finley’s Pond, Sample 9CH204-A-1-4-S2 (Finley’s Pond #1).

Sample ID	$\delta^{18}O$ corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH204-A-1-4-S2A	-1.37			
9CH204-A-1-4-S2B	-0.71			
9CH204-A-1-4-S2C	-0.13			
9CH204-A-1-4-S2D	-1.29			
9CH204-A-1-4-S2E	-1.08			
9CH204-A-1-4-S2F	-1.16			
9CH204-A-1-4-S2G	-1.02			
9CH204-A-1-4-S2H	-0.97			
9CH204-A-1-4-S2I	-0.90			
9CH204-A-1-4-S2J	-0.72			
9CH204-A-1-4-S2K	-0.39			
9CH204-A-1-4-S2L	-0.47			
9CH204-A-1-4-S2M	0.83			
9CH204-A-1-4-S2N	0.71			
9CH204-A-1-4-S2O	1.20			
9CH204-A-1-4-S2P	-0.67			
9CH204-A-1-4-S2Q	-2.44	0.03	0.01	22.7
9CH204-A-1-4-S2R	-1.79			
9CH204-A-1-4-S2S	-1.94			
9CH204-A-1-4-S2T	-1.87			

Table 16. Finley's Pond, Sample 9CH204-B-1-2-S2 (Finley's Pond #2).

Sample ID	$\delta^{18}O$ corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH204-B-1-2-S2A	-0.14			
9CH204-B-1-2-S2B	-0.39			
9CH204-B-1-2-S2C	-0.87			
9CH204-B-1-2-S2D	-1.13			
9CH204-B-1-2-S2E	-2.07			
9CH204-B-1-2-S2F	-2.41			
9CH204-B-1-2-S2G	-2.74			
9CH204-B-1-2-S2H	-3.12			
9CH204-B-1-2-S2I	-4.28	-1.81	-1.83	2.9
9CH204-B-1-2-S2J	-2.21			
9CH204-B-1-2-S2K	-1.72			
9CH204-B-1-2-S2L	-1.51			
9CH204-B-1-2-S2M	-2.25			

Table 17. Finley’s Pond, Sample 9CH204-B-1-2-S3 (Finley’s Pond #3).

Sample ID	$\delta^{18}O$ corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH204-B-1-2-S3A	0.51			
9CH204-B-1-2-S3B	0.37			
9CH204-B-1-2-S3C	-0.15			
9CH204-B-1-2-S3D	-0.16			
9CH204-B-1-2-S3E	-0.41			
9CH204-B-1-2-S3F	-1.40			
9CH204-B-1-2-S3G	-1.29			
9CH204-B-1-2-S3H	-1.55			
9CH204-B-1-2-S3I	-2.27	0.2	0.18	24.5
9CH204-B-1-2-S3J	-2.13			
9CH204-B-1-2-S3K	-0.16			
9CH204-B-1-2-S3L	1.04			
9CH204-B-1-2-S3M	1.70			
9CH204-B-1-2-S3N	1.35			
9CH204-B-1-2-S3O	0.38			
9CH204-B-1-2-S3P	0.12			
9CH204-B-1-2-S3Q	-0.34			
9CH204-B-1-2-S3R	-0.63			
9CH204-B-1-2-S3S	-0.91			
9CH204-B-1-2-S3T	-1.08			

Table 18. Finley's Pond, Sample 9CH204-B-1-3-S1 (Finley's Pond #4).

Sample ID	$\delta^{18}O$ corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH204-B-1-3-S1A	-1.35	1.12	1.1	34.4
9CH204-B-1-3-S1B	-0.11			
9CH204-B-1-3-S1C	0.55			
9CH204-B-1-3-S1D	0.53			
9CH204-B-1-3-S1E	0.49			
9CH204-B-1-3-S1F	0.36			
9CH204-B-1-3-S1G	0.83			
9CH204-B-1-3-S1H	0.97			
9CH204-B-1-3-S1I	0.82			
9CH204-B-1-3-S1J	0.96			
9CH204-B-1-3-S1K	1.98			
9CH204-B-1-3-S1L	2.31			
9CH204-B-1-3-S1M	1.90			
9CH204-B-1-3-S1N	2.68			
9CH204-B-1-3-S1O	2.38			
9CH204-B-1-3-S1P	1.70			
9CH204-B-1-3-S1Q	0.90			
9CH204-B-1-3-S1R	0.20			
9CH204-B-1-3-S1S	0.00			
9CH204-B-1-3-S1T	0.20			

Table 19. Finley’s Pond, Sample 9CH204-B-1-3-S3 (Finley’s Pond #5).

Sample ID	δ^{18}O corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH204-B-1-3-S3A	-0.95			
9CH204-B-1-3-S3B	-0.73			
9CH204-B-1-3-S3C	-0.90			
9CH204-B-1-3-S3D	-1.17			
9CH204-B-1-3-S3E	-1.47			
9CH204-B-1-3-S3F	0.05			
9CH204-B-1-3-S3G	-0.57			
9CH204-B-1-3-S3H	-0.96			
9CH204-B-1-3-S3I	-1.33			
9CH204-B-1-3-S3J	-1.84			
9CH204-B-1-3-S3K	-1.97			
9CH204-B-1-3-S3L	-2.85	-0.38	-0.4	18.3
9CH204-B-1-3-S3M	-2.17			
9CH204-B-1-3-S3N	-2.01			
9CH204-B-1-3-S3O	-2.15			
9CH204-B-1-3-S3P	-0.58			
9CH204-B-1-3-S3Q	-0.38			
9CH204-B-1-3-S3R	-0.60			
9CH204-B-1-3-S3S	-0.48			
9CH204-B-1-3-S3T	0.45			

Table 20. Finley’s Pond, Sample 9CH204-B-1-4-S2 (Finley’s Pond #6).

Sample ID	$\delta^{18}O$ corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH204-B-1-4-S2A	1.84			
9CH204-B-1-4-S2B	0.69			
9CH204-B-1-4-S2C	-1.00			
9CH204-B-1-4-S2D	-1.05			
9CH204-B-1-4-S2E	-0.89			
9CH204-B-1-4-S2F	-0.86			
9CH204-B-1-4-S2G	-1.04			
9CH204-B-1-4-S2H	-1.37			
9CH204-B-1-4-S2I	-1.42			
9CH204-B-1-4-S2J	-1.42	1.05	1.03	33.7
9CH204-B-1-4-S2K	-0.47			
9CH204-B-1-4-S2L	0.46			
9CH204-B-1-4-S2M	0.90			
9CH204-B-1-4-S2N	0.50			
9CH204-B-1-4-S2O	0.63			
9CH204-B-1-4-S2P	0.50			
9CH204-B-1-4-S2Q	0.09			
9CH204-B-1-4-S2R	-0.73			
9CH204-B-1-4-S2S	-0.93			
9CH204-B-1-4-S2T	-1.10			

Table 21. Finley's Pond, Sample 9CH204-B-1-5-S3 (Finley's Pond #7).

Sample ID	$\delta^{18}O$ corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH204-B-1-5-S3A	0.71			
9CH204-B-1-5-S3B	-0.38			
9CH204-B-1-5-S3C	-1.42			
9CH204-B-1-5-S3D	-1.17			
9CH204-B-1-5-S3E	-1.28			
9CH204-B-1-5-S3F	-1.06			
9CH204-B-1-5-S3G	-0.86			
9CH204-B-1-5-S3H	-0.55			
9CH204-B-1-5-S3I	0.10			
9CH204-B-1-5-S3J	0.81			
9CH204-B-1-5-S3K	1.35			
9CH204-B-1-5-S3L	1.73			
9CH204-B-1-5-S3M	1.05			
9CH204-B-1-5-S3N	-0.09			
9CH204-B-1-5-S3O	-1.36			
9CH204-B-1-5-S3P	-1.48			
9CH204-B-1-5-S3Q	-1.90			
9CH204-B-1-5-S3R	-2.42	0.05	0.03	22.9
9CH204-B-1-5-S3S	-1.92			
9CH204-B-1-5-S3T	-1.54			

Table 22. Finley’s Pond, Sample 9CH204-B-1-6-S1 (Finley’s Pond #8).

Sample ID	$\delta^{18}O$ corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH204-B-1-6-S1A	0.93			
9CH204-B-1-6-S1B	0.39			
9CH204-B-1-6-S1C	-1.42			
9CH204-B-1-6-S1D	-1.65			
9CH204-B-1-6-S1E	-0.76			
9CH204-B-1-6-S1F	-0.96			
9CH204-B-1-6-S1G	-1.63			
9CH204-B-1-6-S1H	-1.51			
9CH204-B-1-6-S1I	-1.01			
9CH204-B-1-6-S1J	-1.82			
9CH204-B-1-6-S1K	-2.46			
9CH204-B-1-6-S1L	-1.77			
9CH204-B-1-6-S1M	-2.19			
9CH204-B-1-6-S1N	-1.35			
9CH204-B-1-6-S1O	0.09			
9CH204-B-1-6-S1P	-3.16			
9CH204-B-1-6-S1Q	-2.11			
9CH204-B-1-6-S1R	-2.45			
9CH204-B-1-6-S1S	-2.90			
9CH204-B-1-6-S1T	-3.33	-0.86	-0.88	13.1

Table 23. Finley's Pond, Sample 9CH204-B-1-6-S2 (Finley's Pond #9).

Sample ID	δ^{18}O corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH204-B-1-6-S2A	0.73			
9CH204-B-1-6-S2B	-0.96			
9CH204-B-1-6-S2C	-0.73			
9CH204-B-1-6-S2D	-1.71			
9CH204-B-1-6-S2E	-1.74			
9CH204-B-1-6-S2F	-1.75			
9CH204-B-1-6-S2G	-1.85			
9CH204-B-1-6-S2H	-2.12			
9CH204-B-1-6-S2I	-2.10			
9CH204-B-1-6-S2J	-0.64			
9CH204-B-1-6-S2K	-0.40			
9CH204-B-1-6-S2L	-0.64			
9CH204-B-1-6-S2M	-1.64			
9CH204-B-1-6-S2N	-1.79			
9CH204-B-1-6-S2O	-1.86			
9CH204-B-1-6-S2P	-1.49			
9CH204-B-1-6-S2Q	-1.49			
9CH204-B-1-6-S2R	-1.60			
9CH204-B-1-6-S2S	-2.02			
9CH204-B-1-6-S2T	-2.16	0.31	0.29	25.7

Table 24. Finley's Pond, Sample 9CH204-B-1-6-S3 (Finley's Pond #10).

Sample ID	δ^{18}O corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH204-B-1-6-S3A	1.19			
9CH204-B-1-6-S3B	1.41			
9CH204-B-1-6-S3C	1.33			
9CH204-B-1-6-S3D	1.04			
9CH204-B-1-6-S3E	0.48			
9CH204-B-1-6-S3F	-0.66			
9CH204-B-1-6-S3G	-1.40			
9CH204-B-1-6-S3H	-1.28			
9CH204-B-1-6-S3I	-1.31			
9CH204-B-1-6-S3J	-1.45			
9CH204-B-1-6-S3K	-1.41			
9CH204-B-1-6-S3L	-1.53			
9CH204-B-1-6-S3M	-1.80	0.67	0.65	29.6
9CH204-B-1-6-S3N	-1.06			
9CH204-B-1-6-S3O	-1.00			
9CH204-B-1-6-S3P	-0.61			
9CH204-B-1-6-S3Q	-0.10			
9CH204-B-1-6-S3R	0.28			
9CH204-B-1-6-S3S	-0.68			
9CH204-B-1-6-S3T	-1.20			

Table 25. South End, Sample 9CH155-S1 (South End #1).

Sample ID	δ^{18}O corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH155-S1A	0.40			
9CH155-S1B	1.24			
9CH155-S1C	2.21			
9CH155-S1D	2.77			
9CH155-S1E	1.74			
9CH155-S1F	0.96			
9CH155-S1G	0.62			
9CH155-S1H	0.51			
9CH155-S1I	0.27			
9CH155-S1J	0.11			
9CH155-S1K	-0.43			
9CH155-S1L	-0.61			
9CH155-S1M	-0.67			
9CH155-S1N	-0.14			
9CH155-S1O	-0.99			
9CH155-S1P	-0.83			
9CH155-S1Q	-0.81			
9CH155-S1R	-0.97			
9CH155-S1S	-1.28			
9CH155-S1T	-1.35	1.12	1.1	34.4

Table 26. South End, Sample 9CH155-S2 (South End #2).

Sample ID	$\delta^{18}O$ corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH155-S2A	1.53			
9CH155-S2B	2.50			
9CH155-S2C	2.07			
9CH155-S2D	1.43			
9CH155-S2E	1.45			
9CH155-S2F	0.58			
9CH155-S2G	0.38			
9CH155-S2H	0.29			
9CH155-S2I	0.05			
9CH155-S2J	-1.17	1.31	1.29	36.5
9CH155-S2K	-0.95			
9CH155-S2L	-0.63			
9CH155-S2M	-0.75			
9CH155-S2N	-0.63			
9CH155-S2O	-0.40			
9CH155-S2P	-0.05			
9CH155-S2Q	0.08			
9CH155-S2R	0.02			
9CH155-S2S	-0.01			
9CH155-S2T	0.10			

Table 27. South End, Sample 9CH155-S3 (South End #3).

Sample ID	δ^{18}O corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH155-S3A	0.13			
9CH155-S3B	1.14			
9CH155-S3C	2.50			
9CH155-S3D	1.61			
9CH155-S3E	0.74			
9CH155-S3F	0.20			
9CH155-S3G	0.10			
9CH155-S3H	-0.41			
9CH155-S3I	-0.60			
9CH155-S3J	-0.66			
9CH155-S3K	-1.02	1.46	1.44	38.1
9CH155-S3L	-0.90			
9CH155-S3M	-0.65			
9CH155-S3N	-0.87			
9CH155-S3O	-0.11			
9CH155-S3P	-0.02			
9CH155-S3Q	-0.08			
9CH155-S3R	0.65			
9CH155-S3S	1.16			
9CH155-S3T	1.60			

Table 28. South End, Sample 9CH155-S4 (South End #4).

Sample ID	$\delta^{18}O$ corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH155-S4A	-0.09			
9CH155-S4B	0.46			
9CH155-S4C	0.83			
9CH155-S4D	0.93			
9CH155-S4E	1.73			
9CH155-S4F	2.38			
9CH155-S4G	1.60			
9CH155-S4H	0.76			
9CH155-S4I	0.26			
9CH155-S4J	0.24			
9CH155-S4K	0.09			
9CH155-S4L	-0.15			
9CH155-S4M	-0.60			
9CH155-S4N	-0.81			
9CH155-S4O	-0.50			
9CH155-S4P	-1.07			
9CH155-S4Q	-1.32			
9CH155-S4R	-1.11			
9CH155-S4S	-1.46	1.02	1	33.3
9CH155-S4T	-0.89			

Table 29. South End, Sample 9CH155-S5 (South End #5).

Sample ID	δ^{18}O corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH155-S5A	2.52			
9CH155-S5B	2.79			
9CH155-S5C	2.22			
9CH155-S5D	2.10			
9CH155-S5E	0.63			
9CH155-S5F	0.65			
9CH155-S5G	0.16			
9CH155-S5H	0.17			
9CH155-S5I	-0.78			
9CH155-S5J	-0.90			
9CH155-S5K	-0.90			
9CH155-S5L	-0.24			
9CH155-S5M	0.19			
9CH155-S5N	0.96			
9CH155-S5O	2.43			
9CH155-S5P	1.79			
9CH155-S5Q	0.84			
9CH155-S5R	0.19			
9CH155-S5S	-0.36			
9CH155-S5T	-0.99	1.49	1.47	38.4

Table 30. South End, Sample 9CH155-S6 (South End #6).

Sample ID	δ^{18}O corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH155-S6A	1.47			
9CH155-S6B	2.12			
9CH155-S6C	1.95			
9CH155-S6D	2.24			
9CH155-S6E	2.06			
9CH155-S6F	1.24			
9CH155-S6G	1.48			
9CH155-S6H	0.66			
9CH155-S6I	0.56			
9CH155-S6J	0.44			
9CH155-S6K	0.31			
9CH155-S6L	-0.57			
9CH155-S6M	-0.73			
9CH155-S6N	-0.67			
9CH155-S6O	-1.03	1.45	1.43	38.0
9CH155-S6P	-0.71			
9CH155-S6Q	-0.65			
9CH155-S6R	-0.91			
9CH155-S6S	-0.95			
9CH155-S6T	-0.93			

Table 31. South End, Sample 9CH155-S7 (South End #7).

Sample ID	$\delta^{18}O$ corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH155-S7A	2.23			
9CH155-S7B	2.95			
9CH155-S7C	2.35			
9CH155-S7D	1.96			
9CH155-S7E	1.15			
9CH155-S7F	1.04			
9CH155-S7G	0.76			
9CH155-S7H	0.09			
9CH155-S7I	-0.25			
9CH155-S7J	0.00			
9CH155-S7K	-0.52			
9CH155-S7L	-0.51			
9CH155-S7M	-0.70			
9CH155-S7N	-0.74			
9CH155-S7O	-0.48			
9CH155-S7P	-0.78	1.7	1.68	40.6

Table 32. South End, Sample 9CH155-S8 (South End #8).

Sample ID	$\delta^{18}O$ corrected vs VPDB	$\delta^{18}O_{water}$ vs VPDB	$\delta^{18}O_{water}$ vs VSMOW	Salinity (psu)
9CH155-S8A	1.07			
9CH155-S8B	1.79			
9CH155-S8C	2.39			
9CH155-S8D	1.41			
9CH155-S8E	1.17			
9CH155-S8F	0.36			
9CH155-S8G	0.36			
9CH155-S8H	-0.07			
9CH155-S8I	-0.51			
9CH155-S8J	-0.88			
9CH155-S8K	-0.90			
9CH155-S8L	-0.78			
9CH155-S8M	-1.20	1.28	1.26	36.1
9CH155-S8N	-0.71			
9CH155-S8O	-0.37			
9CH155-S8P	-0.62			
9CH155-S8Q	0.85			
9CH155-S8R	1.98			
9CH155-S8S	1.19			
9CH155-S8T	0.52			