The Econfina Paleochannel Sites: Detecting and locating submerged coastally adapted cultural landscapes in Apalachee Bay, Florida, Gulf of Mexico, U.S.A.

By

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ABSTRACT

This study underscores the significant contribution of Inverse Detection Analysis (IDA) and scientific SCUBA surveys to the field of submerged archaeological sites, particularly within the Apalachee Bay area. The efficacy of the IDA method in accurately predicting the location of sediment-starved cultural sites was established with the successful detection and verification of several archaeological sites dating from the terminal Pleistocene to the Late Holocene. In doing so, a crucial understanding of these sites' characteristics, purpose, and variable occupation was unveiled. The application of scientific SCUBA surveys enabled a comprehensive analysis of these sites, leading to contextual variability between the sites despite the geographical similarity. Integrating these methodologies resulted in a more refined and accurate understanding of ancient cultures' relationships and adaptation to their environments.

IDA is emerging as an improved method over conventional offshore diving methodologies. Its high-resolution landform identification significantly enhances the object classification capability, making it a valuable tool for future submerged cultural landscape exploration and anthropological research. The findings of this study endorse the broader application of IDA beyond the scope of the Apalachee Bay area, pointing to its potential to transform the exploration and analysis of submerged cultural landscapes, perhaps globally. As such, this aligns seamlessly with anthropological research endeavors to better comprehend humanity's historical trajectory and advocate for its preservation. The role played by technological advancements like IDA in archaeology is now paramount; its importance is undeniable in the quest to grapple with the intricacies of historical landscapes submerged in the depths of time.

The utilization of Inverse Detection Analysis (IDA) and scientific SCUBA surveys in examining submerged archaeological sites in the Apalachee Bay area, Gulf of Mexico, has yielded insights into past human activities and occupancies. The differential functions observed between the high-activity Newton McGann and Econfina Channel sites, as compared to the limited findings at the Ochlocknee Shoals, underscore the complexity of ancient

cultures and their nuanced adaptation strategies to similar geographical contexts. The high-resolution landform identification potential of IDA and the meticulous human touch of SCUBA surveys have provided a significant advancement over traditional offshore diving methodologies, particularly in locating historic shipwrecks thus far.

The results obtained here hold not only local but global implications for the field of maritime archaeology in shallow water sediment-starved environments. They demonstrate how such technological advancements enable efficient, minimally invasive, accurate, and potentially cost-effective investigation of submerged archaeological sites, thereby contributing to the preservation of cultural heritage.

DECLARATION

I certify that this thesis:

1. does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university

2. and the research within will not be submitted for any other future degree or diploma without the permission of Flinders University; and

3. to the best of my knowledge and belief, does not contain any material previously published or written by another person except where due reference is made in the text.

Signed... ....

Date....... ....

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The Econfina Channel Site Project is a Finders University, Masters of Maritime, archaeological thesis research investigation by Nathan Hale, supported by Principal Supervisor Jonathan Benjamin. The research was conducted at the Econfina Channel Site (8TA139) in Apalachee Bay, Florida, United States (US). Institutions that assisted in the research were the Aucilla Research Institute (ARI), of which Nathan Hale is a current Research Assistant, and the Georgia Florida Aviation Search Team (G-FAST).

Assisting Institutions

Located in Monticello, Florida, ARI is a non-profit organization that supports researchers and students at archaeological, geographical, paleontological, and ecological sites throughout the Big Bend region of Florida. ARI provides research support to researchers at inundated and terrestrial sites, with access to the ARI laboratory for material analysis and curation facilities. ARI has decades of dive experience in the Gulf of Mexico and the black-water rivers of the Big Bend. ARI's Dive Team follows AAUS dive standards.

G-FAST is a non-profit search and rescue team in the Big Bend of northern Florida. The organization can deploy rescue teams locally, domestically, and internationally to aid in search and rescue operations, volatile situations, evacuations, and emergencies. G-FAST is comprised of pilots, boat captains, divers, formal law enforcement personnel, military officers, and entrepreneurs. The G-FAST Dive Team consists of personnel who have formerly served in the US Armed Services and are certified dive masters, rescue divers, and instructors. They are trained in shallow, deep, and ship and cave rescue searches.

Special thanks to the following organizations located in Tallahassee, Florida: the US National Park Service (NPS) and the Southeastern Archaeological Center (SEAC), who gave extra diver and boat support, while the Florida Bureau of Archaeological Research (FBAR) issued the required permits and provides sample storage.

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1.0 INTRODUCTION

Submerged paleolandscapes is a term that focuses on the geophysical and paleoenvironmental reconstruction of past environments and geomorphic processes on a broader geophysical scale. When used in maritime archaeology, it moves attention away from individual archaeological deposits or sites (Bailey et al. 2017:8), visualizing contextualization with a wider lens when approaching anthropological questions or concepts. Maritime cultural landscapes are defined by Ben Ford (2011) as "all of the evidence of how people interacted with watery places both on land and underwater." While maritime archaeology is a unique branch of archaeology that focuses on studying humanity's relationship with water and its influence on our history, over the years, it has expanded to include not just the examination of historical shipwrecks but also entire maritime cultural landscapes (Robinson 2020:1). Gately and Benjamin (2017) define maritime archaeology as "the discipline and activities devoted to the study of all aspects of the human past through the evidence-based inquiry and interpretation of material and physical remains, which pertain to aquatic bodies, past and present."

Human populations have favored coastal areas for millennia, and possibly our hominid ancestors did as well (Nunn and Reid 2015:4; Benjamin et al. 2021:2). Not only do coastal regions typically have more diverse resources, such as plants and animals, but freshwater springs were likely to be abundant (Bailey et al. 2017:1; Faure et al. 2002:54). Hence, potentially higher population densities occurred in coastal regions. People prefer coastal sites to hinterlands, especially during arid climates during glacial periods (Bailey et al. 2017:1, 2). We know people lived along coastlines from the terminal Pleistocene (14,500-11,700 calibrated years before present (cal BP)) to the beginning of the Late Holocene (4200 cal BP) because, in most cases, the conditions were favorable (Bailey and Flemming 2008:2153). So, where is the archaeological evidence?

A significant problem in finding terminal Pleistocene and Holocene (11,700–4200 cal BP) archaeological sites is that the large-scale amount of land that was once potentially utilized by people in the Late Pleistocene (129,000–11,700 cal BP). is now submerged on the continental shelf (Clarkson

2017:306; Wiseman 2022:1). At least 20 million km^2 of coastlines on a global scale were once available to human populations (Bailey et al. 2017:1; Benjamin 2010:254). At the end of the Last Glacial Maximum (LGM) (20,000), the marine transgression from approximately 19,000–6000 years before the present (BP) increased from -120 meters (m) Below Modern Sea Level (bmsl) to the Modern Sea Level (msl), broadly generalized globally or eustatic sea-level change (Bailey and Flemming 2008:2153). Today's sea level is among the highest in the Quaternary, with only one higher stand of 6 m above msl, during the Last Interglacial or Marine Isotope Stage (MIS) 5, at approximately 130,000 BP. Over the last million years, sea levels were lower, averaging 40-50 m bmsl and isolating for short periods between low stands of -100 m and high stands such as today. Thus, many Pleistocene and Holocene archaeological coastal landscapes and deposits are currently inundated (Bailey et al. 2017:1, 2; Erlandson 2001:300). Offshore archaeological landscapes had to endure at least one marine transgression.

Submerged archaeological landscapes are a global phenomenon, with research centers in Europe and North America leading innovative research programs and methods (Bittmann et al. 2022:1, 2; Elkin et al. 2023:83; Gaffney et al. 2007:1). Despite this, detecting and mapping submerged cultural sites remain challenging, partly because surveys focusing on these sites are mainly based on topographical/bathymetrical prediction (Grøn et al. 2021:903). As demonstrated in Denmark, these surveys typically detect less than 1% of the submerged archaeological sites that would be present in similarly surveyed areas on land.

Thus, the need for more efficient and accurate methodologies in maritime archaeology is crucial (Benjamin 2020:2; Elkin et al. 2023:83). To effectively prospect submerged archaeological sites, it is essential to understand site formation processes. This was demonstrated in the Southern North Sea, where a 3D deep seismic survey gathered by the oil industry was used to model a vast submerged landscape Mesolithic Europeans would have occupied (Bittmann et al. 2022:1, 2; Gaffney et al. 2007:1,2: Fitch et al. 2005:185). While submerged archaeological landscapes represent a significant opportunity to advance our understanding of past human activities, they present challenges unique to their underwater context

(Benjamin 2010:259). There have been many advances in methodologies that have influenced the way submerged environments are studied. Predictive modeling, environmental reconstruction, and geomorphological and geoarchaeological approaches have influenced governmental agencies such as cultural heritage management departments, where critical planning decisions for conserving submerged archaeological sites are implemented (Faught 2014:38).

Detecting submerged cultural landscapes is particularly significant as it provides valuable insights into past human activities and the historical significance of these landscapes (Bailey and Flemming 2008:2153). Efficient mapping and recording of submerged cultural sites that may contain evidence of intensive shellfish harvesting and lithic knapping technology constitute a central archaeological challenge (Benjamin 2020:262; Grøn et al. 2021:454). Submerged cultural deposits may be well preserved and intact if quickly buried. However, they can also be challenging to detect and map through surveys that identify bathymetrical/topographical settlement indicators (Benjamin 2020:260; Gagliano et al. 1982:2; Grøn et al. 2021:454; Pearson et al. 1989:6). Aspects related to offshore sites matter, because they are mostly either unknown, not completely understood, or cannot be compared to other sites because the data sets to assess patterns are too small. Therefore, the development of a precise predictive model methodology that can map submerged cultural sites directly and efficiently, including buried sites, will significantly contribute to maritime archaeology. (Benjamin 2010:261; Gagliano 1982:2)

This thesis project focused on systematic scientific self-contained underwater breathing apparatus (SCUBA) diving and exploration of submerged archaeological sites in Apalachee Bay, Florida, Gulf of Mexico, US, with the goal of ground truthing detected anomalies that are potential anthropogenic sites, dating from the terminal Pleistocene through the Early to Late Holocene. These anomalies or targets were processed and identified using three bathymetric Light Detection and Ranging (LiDAR) data sets (from Apalachee Bay), which were converted into a form of machine intelligence using a semi-automated method called inverse detection analysis (IDA) to detect submerged archaeological characteristics, which require further investigation (Cook Hale et al. 2023:928). The LiDAR datasets included Ochlocknee Shoals, the Aucilla paleochannel, and the Econfina paleochannel (Figure 1).

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Figure 1. Bathymetric LiDAR data sets of (clockwise) Ochlocknee Shoals (left), Aucilla paleochannel (top), Econfina paleochannel (right) (Image by Jessica Cook Hale 2022).

This method utilizes machine learning algorithms to analyze image features and classify objects based on predetermined criteria (Cook Hale et al. 2023:928). This study's initial blind test utilizing the IDA method detected documented archaeological sites in Apalachee Bay (within 50 m accuracy) and identified numerous anomaly targets that required ground-truthing (Figures 3, 13, 14). Through the ground-truthing process using diver survey, the predictive accuracy of the IDA method was evaluated at Ochlocknee Shoals and the Econfina Channel site. Through this evaluation, the IDA method accurately predicted and located a sediment-starved, shallow-water cultural site in Apalachee Bay. Diver survey confirmation of one target (archaeological site) in a single day indicates that this methodology could contribute to identifying other submerged cultural landscapes globally. Most bathymetric LiDAR data sets in archaeological research have been used to locate historic-era shipwrecks and architecture, not earlier cultural deposits (Cook Hale et al. 2023:928, 929).

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Figure 2. Map of documented archaeological sites and bathymetric LiDAR survey areas in Apalachee Bay, Florida, US. (Image from Cook Hale et al. 2021:929).

This research addresses questions concerning how maritime archaeologists can refine methods for locating shallow submerged sites, what the environmental and cultural characteristics of the landscapes in the shallow submerged Econfina River (paleochannel) are, and how they compare to other survey areas in Apalachee Bay, Florida. Additionally, this remote sensing methodology has the potential to identify landforms at a much faster rate than offshore diving methodologies can currently provide. This high-resolution landform identification is necessary for discussing cultural landscapes or the totality of human, non-human, and environmental features that shaped past human activities. This information is crucial because it will allow researchers to confidently use the IDA predictive model to identify other areas of interest that may have gone undiscovered.

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Figure 3. Archaeological locales along the Aucilla paleochannel (left) and Econfina paleochannel system (right) as of 2022 were re-identified by this study. The newly identified site along the Econfina paleochannel is labeled as the Newton McGann site (Map from Cook Hale et al. 2023:938).

This study demonstrates the accuracy and effectiveness of the IDA method as a predictive model for detecting previously unknown or undetected archaeological sites submerged in shallow water. The study relies on remote sensing methods generated from processed bathymetric LiDAR data, including using a semi-automated analysis method called IDA in conjunction with the SCUBA surveys by trained archaeologist divers. The goal of the research was to relocate the Econfina Channel site midden and then dive nearby (100-200 m distance) possible anthropogenic targets produced by IDA methods and compare the results to the Ochlocknee Shoals research results (Figure 4).

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Figure 4. Bathymetric LiDAR image with plotted target locations for diver survey around the Econfina Channel site (Map from Cook Hale 2022b:3).

The Econfina River paleochannel sites, which include several shell middens, serve as a critical case study for this research (Figure 5). This study aims to compare the Econfina paleochannel sites to determine if there are any indications that these submerged landscapes had different purposes. By comparing various archaeological and geoarchaeological features, the study seeks to understand if the sites had similar or different occupational purposes and activities. Through various investigations and analyses, the study intends to understand the characteristics of these sites and their broader implications for understanding human occupational activities during the Middle to Late Holocene (8,200–4,200 cal BP). The Econfina River paleochannel sites share similarities with other submerged cultural sites in Apalachee Bay, such as the J&J Hunt site on the Aucilla paleochannel, indicating that they may have served similar purposes and activities in the past (Cook et al. 2023:933).

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Figure 5. Bathymetric LiDAR of project area showing and locations of documented sites/features at the Econfina Channel and Ward Morgan sites (Map from Cook Hale 2022b:1).

Researchers aim to better understand the archaeological record, specifically through the analysis of their respective shell middens. Researchers hope to determine whether the Econfina Channel site is a stand-alone or represents intensive coastal development that can be detected elsewhere in the Apalachee Bay. Overall, this research will help clarify some environmental and cultural characteristics of submerged cultural landscapes in Apalachee Bay, Florida. This study explores how maritime archaeologists can improve methods for locating shallow submerged cultural landscapes. Furthermore, this research will ground truth the IDA predictive model at Ochlocknee Shoals and the Econfina Channel site to provide more accurate data for future studies.

Finally, this study addresses the knowledge gaps in Apalachee Bay's archaeological record. As noted by Faught and Donoghue (1997), there are potentially many other submerged archaeological sites that have yet to be discovered or investigated. Using modern technology and advanced analytical techniques such as the IDA method, researchers hope to locate additional cultural sites that provide further insight into the cultural and environmental characteristics of coastal cultural landscapes in Apalachee Bay during the terminal Pleistocene to Late Holocene period.

These submerged landscape studies are becoming increasingly relevant as rising sea levels threaten coastal sites and nearshore development booms (McDonald et al. 2020:16; Bittmann et al. 2022:1, 2). By increasing the control points to understand the Holocene landscape evolution of the study area, geoarchaeological surveys have been integrated with remote sensing methods, allowing for a more detailed reconstruction of changing environmental conditions. It is important to note that the results of this study have implications not only for understanding the history and past culture of coastally adapted peoples in Apalachee Bay but also for developing strategies to mitigate the impacts of climate change and rising sea levels on coastal communities (Li et al. 2019:8; Adityawitari et al. 2020:1, 2).

This research project has several objectives that contribute to a more comprehensive understanding of submerged cultural landscapes in Apalachee Bay during the Middle to Late Holocene period. With advanced analytical techniques, researchers aim to locate and investigate submerged archaeological sites in Apalachee Bay that have yet to be explored. Furthermore, by studying the sedimentary deposits and shell middens of these sites, researchers can gain insights into the environmental conditions and cultural practices that existed at that time (Anderson et al. 2017:16). While this research project has several objectives that contribute to a more comprehensive understanding of maritime cultural landscapes in Apalachee Bay, there is still much that remains unknown about this area and its history.

1.1 Background

Shell mounds made by humans date back 130,000–100,000 years in South Africa (Hinshelwood et al. 2011:1 Thompson and Andrus 2011:316). Most shell mounds consist of different materials people deposit, including animal bones, artifacts, and sometimes burials. Some shell mounds were simply sheet middens, where people discarded materials, while others were intentionally built and maintained. Most shell mounds that have a significant size are found to be ritual landscapes rather than kitchen middens (Saunders 2017:2). Today, archaeologists around the world debate whether particular shell mounds were built for ceremonial purposes, living quarters, village areas, social gathering places, or were used only as an area where people threw their trash, even though some mounds contain burials (Russo 2010:156). Archaeologists have also discussed how some shell mounds can have combinations of uses, even all of the above, with different sorts of activities occurring at different times (Sanger 2021:752). Some shell mounds are monument building, particularly in significant accumulations, indicating a specific cultural activity (Gamble 2017:446, 447). However they were formed, shell mounds can provide archaeologists with a wide range of information about past Indigenous cultures, such as foraging and hunting tactics, reliance on resource types, and the various environmental and ecological factors impacting people's lives (Reitz 2016:2).

The documented submerged shell middens in Hjarnø Vesterhoved, Denmark; Apalachee Bay, Florida, US; and Saga, Japan, are evidence of people utilizing coastal areas before sea-level stability (Astrup 2021:106854; Faught 2004a:283; Faught 2004b:276; Higashimyo 2007:2, 5). Submerged shell middens are rarely located. The recent use of bathymetric LiDAR analysis that was processed using machine learning techniques (semi-automated analysis) and diver survey methods, however, successfully located an undocumented shell midden site during the thesis research in Apalachee Bay, Florida.

The newly located submerged shell midden named Newton McGann (Florida Master Site File number not assigned at time of thesis completion) is situated 970 meters (m) northeast of the Econfina Channel shell midden site (Figure 3). The Econfina Channel site has been investigated since the late 1980s (Cook et al. 2023:937). The submerged site is comprised of multiple features, including a large (> 30 meters across) shell midden, a lithic quarrying zone, and at least one freshwater spring feature. Past excavations and analyses have yielded diagnostic artifacts and radiocarbon dates from approximately 5,200–2,500 cal BP (Cook Hale et al. 2019:18; Faught and Donoghue 1997:22).

The Econfina Channel site is within the geological context of the Woodville Karst Plain of the Florida panhandle (Garrison and Cook Hale 2019:179). Apalachee Bay is a part of the West Florida Shelf, a low-gradient continental shelf primarily made of limestone. The karst landscape comprises dissolution features such as sinkholes, collapsed features, and chert (a siliceous cryptocrystalline material ideal for tool making) nodule inclusions within the bedrock.

Following a government-funded research project in the mid-1970s involving remote sensing and coring off the continental shelf in the northern Gulf of Mexico, intensive offshore archaeological investigations, which included diver surveys in Apalachee Bay, began in the 1980s under Dunbar and Faught. Their predictive site model extended archaeological trends from onshore submerged archaeological sites such as the Aucilla River into the offshore region (Anuskiewicz 1988:1; Anuskiewicz and Dunbar 1993:2, 39; Faught 2004a:275; Faught 2004b:286; Webb 2006:2, 39). The offshore investigations sought to determine if sites of similar antiquity could be detected in the Gulf of Mexico as those being investigated onshore. Notably, these investigations focused on terminal Pleistocene and Early Holocene occupations representing inland rather than coastal adaptations. Thus, details of Middle to Late Holocene shell middens must be thoroughly researched (Cook Hale 2023:929).

Submerged shell midden sites are challenging to locate, which appears to be a global phenomenon (Davis et al. 2021). However, they have the potential to provide a wealth of knowledge about past settlement histories. Submerged shell middens can have slight variations in composition compared to terrestrial shell middens, and they can have better preservation, depending on site formation processes (Benjamin and Ulm 2021:4). Thus, there is the potential to learn more precise details about past people by studying anthropogenic submerged shell mounds. Research documenting the Econfina paleochannel shell-midden cultural sites in Apalachee Bay, Florida, has added critical cultural data for the area.

1.2 Previous Apalachee Bay Investigations

Investigations have been conducted in Apalachee Bay on Indigenous submerged sites for over 40 years. Multidisciplinary offshore submerged archaeological site investigations involving diver surveys began in 1986, spearheaded by Michael Faught, a graduate student at the University of Arizona, and James Dunbar (Florida Bureau of Archives, History, and Records Management). The site prediction model derived from these investigations was based on the Page-Ladson (8Je591) site discoveries, the oldest pre-Clovis site in the southeastern US, dating to 14,550 cal. BP is located 13.5 km from the Econfina Channel site on the Aucilla River (Dunbar 2006:133; Halligan et al. 2016:1).

Once they located sites known to collectors on the Aucilla River, they extended research from the Aucilla River to Apalachee Bay, targeting now submerged paleo-river channels (paleochannels) consisting of sinkhole sites, spring features and chert outcrops offshore (Garrison and Cook Hale 2020:8; Faught 2004:279a). The research revealed fifteen submerged Indigenous sites or artifact scatters in Apalachee Bay (Figure 6). The five most notable include Ray Hole Springs (8TA171), Ontolo (8JE1577), J&J Hunt (8JE740), Fitch site (8JE739), and the Econfina Channel site (8TA139) (Faught and Donoghue 1997:441; Faught 2004b:278). The research provided foundational methods and data that made further investigations possible and approachable.

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Figure 6. Map the research area locations of sites and artifact encounters (filled circles) and survey locations without artifacts (open circles). J&J Hunt (8JE740) and Ontolo (8JE1577) are indicated as triangles around the segment of the Aucilla paleochannel. This map was made from bathymetric data published on the NOAA navigational chart of Apalachee Bay, Florida (Chart number 11405) (Faught 2004b:279).

Apalachee Bay research efforts on submerged pre-contact Indigenous sites were renewed in 2014 at the Econfina Channel site. The research conducted focused on the assessment of site formation processes and site integrity (Cook Hale et al. 2018:17). The research also delineated the boundaries of the site and associated site area, including the discovery of two nearby shell middens and a lithic quarry named Ward Morgan site (Cook Hale et al. 2021:5). Current Econfina Channel site research analyzes the impact of two tropical cyclone systems at the site (Cook Hale et al. 2022).

In May of 2022, Aucilla Research Institute (ARI) conducted the first part of our dive research at Ochlocknee Shoals Apalachee Bay, Florida. The research involved SCUBA dives to ground truth potential archaeological targets generated from bathymetric LiDAR data with applied semi-automated analysis using IDA methods. In the initial IDA blind test, known archaeological sites in Apalachee Bay were detected as targets, along with abundant anomaly targets that need ground-truthing (Cook Hale 2023:933, 934). In the Ocholocknee Shoals area, diver surveys were conducted at various locations, revealing that only one location demonstrated minimal sediment cover conditions (sediment starved), typically observed on the eastern side of Apalachee Bay. This location, known as Station 9 (out of bathymetric LiDAR detection range), displayed coarse to very coarse sands and fine shelly gravels along with intermittent carbonate chert outcrops and hard bottom reef ledges, indicating higher energy marine contexts and paleochannel features. At Station 9, one lithic item was recovered near scattered carbonate and chert outcrops (Figure 7). The lithic item appeared to have surficial evidence of flake scarring, suggesting possible human modification (Figure 8). However, its shape did not match any known tool types from the region (Cook Hale 2023:940).

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Figure 7. IDA analysis identified targets in the Ocholocknee Shoals for archaeological potential, showing those visited during diver surveys in May and June 2022 (Cook Hale et al. 2023:135).

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Figure 8. Possible culturally modified lithic material recovered from Station 9 in Ocholocknee Shoals in June 2022. (Image from Cook Hale et al. 2023).

The second part of the diving research continued at the Econfina Channel site in August 2022, where the author participated. The research results suggest significant broad impacts for submerged site detection, relocation, and preservation. While insights into cultural adaptation and subsistence procurement activities during the Middle to the late Holocene are on a focused area, they suggest these findings challenge the idea of a singularly purposed archaeological site and promote the concept of cultural landscapes. Research continues at the Econfina paleochannel midden sites by Cook Hale and colleagues.

1.3 Research Goals

This study aims to investigate the accuracy and effectiveness of the IDA method in detecting submerged archaeological sites in shallow water. The study uses remote sensing methods from processed bathymetric LiDAR data and a semi-automated analysis method called IDA. The primary goal of the research is to relocate the Econfina Channel site midden and subsequently dive near potential anthropogenic targets identified by the IDA method to compare the results with the Ochlocknee Shoals research findings.

1.4 Primary Question

How do the environmental and cultural characteristics of the shallow submerged sites and their articulations and associations across cultural landscapes inform us about humans using the landscape in the survey areas of Apalachee Bay during the Middle to Late Holocene (8,200–4,200 cal. BP)?

1.4.1 Methods

This thesis will use the following methods to answer the primary question. It will:

- Analyze the results of ground-truthing the IDA predictive model at Ochlocknee Shoals and the Econfina Channel site;
- Assess the accuracy of the IDA methodology at Ochlocknee Shoals and the Econfina Channel site;
- Delineate the newly discovered midden Newton McGann contribute to the archaeological record of Apalachee Bay; and
- Investigate how the Econfina Paleochannel sites relate to each other.

1.5 Limitations

- GPS equipment- typically hard-to-find sites in Apalachee Bay with past GPS units.
- This study was a self-funded project that supplied equipment, air tank refills, food, and lodging but not radiocarbon dating.

- No radiocarbon dates from the new site or diagnostic tool contexts were obtained, so temporal associations are based exclusively on diagnostic forms and established seriations.
- Original fieldwork operations were scheduled for two weeks in July 2023. The author could not secure a Dive Master for the duration of dive operations, a Flinders University requirement. Fieldwork was limited to four days, with one day of operations canceled due to inclement weather. Thus, the opportunity to ground truth more targets was impossible once we located the Newton McGann site on the first day of dive operations.
- The IDA confirmation of the presence of previously recorded archaeological sites in the sediment starved Econfina and Aucilla paleochannels was within 50 meters of accuracy.
- Results of the research the author participated in in August 2022 were published in January 2023 during mid-thesis writing, narrowing the original research scope for the author.

1.6 Approval (Regulatory)

1.6.1 US Federal Regulations: NEPA and NHPA, Section 106 and Section 110.

In the United States, heritage values are determined, in part, by the *National Historic Preservation Act of 1966* (NHPA) to incorporate events, viewsheds, and other “intangibles” of the archaeological and historical record.

The National Park Service (NPS) determines what is eligible for the National Register of Historic Places (NRHP) using NHPA guidelines. State and local historical preservation councils and commissions also base their significance/values standards on the NHPA. Preservation is determined by their cultural and historical significance and integrity. These values must meet the qualifications under the NHPA criteria. Archaeological sites in the region of Apalachee Bay likely meet the criteria A and D under Historical Sites, Rural Historic Landscapes, and Traditional Cultural Property established by the NRHP.

If Indigenous Peoples’ burial remains are found during archaeological investigations, the State Historic Protection Officers (SHPO) associated with the ancestral lands on which the remains were found must adhere to the laws of the *Native American Graves Protection and Repatriation Act (*NAGPRA) of 1990 (Pub.L.101-601; 25 USC 3001-3013; 104 Stat. 3048-3058), while consulting with the correct designated Indigenous Nation (Sec. 106 36 CRF 800.6(a).

1.6.2 Florida State Law:

Florida's antiquities law (Chapter 267, *Florida Statutes*) and administrative rules (Chapters 1A-31 and 1A-32, *Florida Administrative Code)* govern publicly owned archaeological and historical resources on state property, land, and water. Administered by the Florida Division of Historical Resources, the law establishes programs and policies to encourage the preservation of historic resources for the public benefit. State-owned aquatic resources are located on the bottom of navigable rivers, streams, lakes, bays, and offshore (in the Gulf of Mexico, out to 9 nautical miles (nm), and in the Atlantic, out to 3 nm).

The project research is in Florida's sovereign submerged lands. Florida requires the archaeological research permit application 1A-32 to be submitted to the Division of Historical Resources (DHR) before investigating submerged sovereign lands. DHR approved the project request and permit 2122.048 was issued in May 2022. No formal ethics approval is needed before research begins in August of 2022.

In May of 2023, Indigenous engagement for future submerged landscape projects in Florida began with communications between the Seminole Nation, Smithsonian National Museum of the American Indian (NMAI), Archaeological and Forensic Sciences at Bradford University, UK (AFSB), and Florida State University (FSU).

1.7 Significance/Justification

This thesis project's methodology and success in detecting submerged cultural landscapes may significantly improve the accuracy of archaeological surveys focused on identifying bathymetrical/topographical settlement indicators (Benjamin et al. 2020:26). Using advanced technology such as inverse detection analysis combined with scientific diver ground-truthing surveys have the potential to be more efficient and accurate means of detecting submerged archaeological sites. Additionally, these methods can be cost-effective in areas where LiDAR data is taken and accessible. This new approach potentially represents a significant step towards more efficient and accurate underwater archaeological research, which may contribute significantly to our understanding of past human activities and the historical significance of submerged landscapes globally.

2.0 RELATED RESEARCH – LITERATURE REVIEW

This chapter reviews the relevant contexts of maritime archaeology methodology, geological settings, environmental description, marine transgression, paleoclimate, and cultural context.

2.1 Maritime Archaeology and Advances in Methodology

Maritime archaeology has a long and fascinating history that spans several centuries. It was only in the mid-20th century, however, that maritime archaeology emerged as a distinct discipline with unique methodologies (Ford 2006:ix). One of the earliest methods used in maritime archaeology was dive surveys, which involved professional diving to investigate underwater sites. Early dive surveys included techniques such as hand fanning to expose sections of middens and stratigraphy of sediments and shell matrices (Faught 2004b:278; Green 2004:142).

As technology developed, new methods were introduced, such as photography, photogrammetry, artifact sampling, soil sampling, and mapping (Bass 1972: 8, 11; Benjamin et al. 2020:2; Gagliano et al. 1977:v, 3, 5; Garrison 1992:97, 102; Grøn et al. 2021:454). These innovations have allowed for more detailed documentation and analysis of underwater sites, enhancing our understanding of maritime cultural heritage (Garrison and Cook Hale 2020:8; Mattei et al. 2018:1). By the 1970s, the incorporation of remote sensing technology, such as side-scan sonar and sub-bottom profilers, allowed for systematic surveys of large areas, leading to the discovery and analysis of previously unknown underwater cultural landscapes (Gagliano et al. 1977:3, 5; Singh et al. 2000:320). The more recent integration of GIS and 3D modeling technologies has helped to improve accuracy in the recording and analysis of data, making it easier to share information with researchers around the world and create more detailed visual representations of submerged landscapes (Georgiou 2021:2; Hoffmeister et al. 2014:173). Moreover, maritime cultural landscapes have expanded to include individual shipwrecks, entire regions, and their maritime history (Henderson 2019:3).

Advances in methodologies have greatly expanded the scope and precision of maritime archaeology. These advances have enabled a more comprehensive understanding of maritime cultures and landscapes while promoting and preserving this important cultural heritage (Henderson 2019:4; Trakadas 2019:154). As maritime archaeologists continue to improve techniques and technologies, discoveries will undoubtedly be made that shed further light on our past and help us better comprehend the vital role of the sea in shaping our history, culture, and landscapes.

2.2.1 Underwater Cultural Heritage

Locating preserved offshore cultural landscapes, such as shell middens, has been a continual issue in maritime archaeology (Benjamin 2010:262). Researchers trying to locate these types of sites can be impeded by a lack of funding, access to data, and available time. Locating and ground-truthing offshore human landscapes is vital for many reasons. Archaeological sites may inform researchers about past peoples' dietary choices, degree of sedentism, exchange systems, cultural signatures, and how they responded to climate change (Bailey and King 2011:2, 3). These aspects related to offshore sites are mostly either unknown, not completely understood, or cannot be compared to other sites because the data sets to assess patterns are too small. Because of their infrequency and potential value, submerged maritime archaeological sites or underwater cultural heritage (UCH) are vulnerable to looting or misconduct. Therefore, a standard code of ethics is essential for maritime archaeologists to follow.

The historical and methodological foundation of UCH was solidified in 2001. Over sixty countries follow the codes of the 2001 United Nations Education, Scientific, and Cultural Organization (UNESCO) Convention as their benchmark for protecting underwater cultural heritage, including the UK, the US, and Australia (although the United States, as of the finalization of this thesis, is not currently a UNESCO member country). The UNESCO Article 1-Definitions states that "Underwater cultural heritage" means all traces of human existence having a cultural, historical, or archaeological character which have been partially or totally under water, periodically or continuously, for at least 100 years such as: sites, structures, buildings, artifacts, and human remains, together with their archaeological and natural context and objects of prehistoric character. The UNESCO rules concerning activities directed at UCH are listed in the annex under general principles. Rule 1 states that *in situ* preservation is the first consideration. However, activity authorization can be given if the purpose significantly protects knowledge or enhances underwater cultural heritage.

The 2001 UNESCO codes for UCH are frameworks or guidelines that more countries are beginning to follow. The guidelines recommend leaving UCH sites *in situ* unless the cultural heritage is threatened or if the justifications of an archaeological excavation would significantly contribute to protecting knowledge or enhancing underwater cultural heritage. If maritime archaeologists are involved in excavating an underwater cultural heritage site, protocols must be a part of the project design specifically tailored for each underwater cultural heritage site. Part of a project design is background research. Hence, maritime archaeologists are aware of certain situational aspects of the site, such as preservation conditions, jurisdiction, and what laws may be in effect. During the Paleo Econfina Channel Project, the 2001 UNESCO codes for UCH were followed.

2.2 Methodological Advances of Submerged Landscape Research in the Northern Gulf of Mexico

There have been many advances in methodologies that have influenced the way submerged cultural landscapes are studied. Coastal Environments, Inc. (CEI) (1977) conducted the first regional, large-scale, multidisciplinary research in the Gulf of Mexico with a focus on collecting and analyzing bathymetric data to detect cultural deposits (Figure 9) (Garrison and Cook Hale 2020:8). Archaeological site predictive modeling, environmental reconstruction, and geomorphological and geoarchaeological approaches influenced governmental agencies such as cultural heritage management departments, where critical planning decisions concerning how submerged archaeological site protections are implemented (Garrison and Cook Hale 2020:8). The CEI authors (Gagliano et al. 1977) continued research in the Gulf Coast. They refined their methods (Gagliano 1982). Without using any diver survey methods, CEI influenced how archaeological researchers approached submerged cultural landscapes on the Outer Continental Shelf

(OCS) offshore in Apalachee Bay and the Atlantic coast of Florida (Cook Hale et al. 2019:3; Dunbar et al.1989:25; Faught and Donoghue 1997:427, 431; Garrison and Cook Hale 2020; Marks 2006:57; Murphy 1990:2)

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Figure 9. CEI's analysis of bathymetric data in the Gulf of Mexico (CEI Plate 2 Gagliano et al. 1977) (Photo of Plate 2 by Nathan Hale).

2.2.1 Predictive Model

In 1970, The US Department of the Interior implemented energy and mineral prospection guidelines on the OCS. The guidelines stipulated that it was mandatory to conduct maritime archaeological surveys of all leasing blocks before any development and to avoid any areas with archaeological potential. Prior actions to extract mineral resources resulted from irreversible damage to offshore Indigenous cultural landscapes and post-European contact historical shipwrecks (Gagliano et al. 1977:2). Remote sensing-focused research was conducted in the Gulf of Mexico (from the Rio Grande River to the Florida Keys), directed by Sherwood Gagliano (Gagliano et al. 1977:v), to determine the best procedures to predict and locate possible submerged cultural heritage areas. There was pressure from industries and governmental branches to work quickly, but published submerged site prediction models were non-existent, especially on such a large scale.

First, a literature review and a data study of the available seismic data were conducted to analyze the geology of the continental shelf and coastal zone. The coastal zone was divided into 13 different coastal systems. The geomorphology in each system was researched, including sedimentation, tectonics, and sea-level fluctuations. Second, a literature and data study of pre-European contact Indigenous cultural periods and locations were investigated. The research focused on site morphologies, content index artifacts, characteristic artifact assemblages, and zooarchaeological remains of extinct Pleistocene animals. Third, to help identify shipwrecks, a literature review of ships used in the Gulf from colonial exploration through World War II was conducted. The review included a systematic analysis of historical reports of shipwrecks, archival records, literature, charts, maps, and sailing routes (Gagliano et al. 1977:3, 5). A submerged cultural site predictive model was made from the study results.

By comparing analyzed seismic data sets to terrestrial landforms, which people generally prefer, and to known archaeological sites, the model demonstrated that various relic landforms, such as riverine terraces, survived the marine transgression and were likely to contain evidence of Indigenous occupations. Landforms ideal for human occupation were identified and mapped in the Gulf of Mexico. However, predicted landforms ideal for occupation needed to be tested, and standardized methods had to be developed to avoid archaeological sites. Two pilot studies were conducted in the 80s, starting with sediment coring methodologies.

2.2.2 Geoarchaeology

The premise of the sediment core analysis research was to create a field book for archaeologists to compare offshore cores to terrestrial ones. A geological approach was needed to solve an archaeological problem (Gagliano et al. 1982:2). The process involved hand coring of known anthropogenic sites (including a control) at eight types of terrestrial, coastal landforms in Texas, Louisiana, and Mississippi for use in as analogs for offshore sediment cores. A standardized method of core handling, recording, and logging was designed. Sedimentological and geochemical testing was conducted to identify and define the characteristics of cultural deposits. Although the study had a small sample size, it set a standard for determining if offshore cores contained paleosols or were retrieved from a natural environment. The second pilot study focused on testing offshore landscapes for cultural signatures.

2.2.3 Ground Truthing

The subsequent study, spearheaded by Charles Pearson, selected a research area of 2580 mi^2 offshore named the Sabin Valley in western Louisiana and eastern Texas (Figure 10). The research was conducted in two phases. The first phase reviewed and evaluated collected seismic data, borehole data, and recovered archaeological and geological samples/materials (Figure 10). The second phase involved collecting high-resolution seismic data of the study area, and 76 vibro-cores were extracted at five specific target areas to ground-truth potential submerged archaeological sites (Figures 11, 12). Samples were analyzed for pollen, foraminifera, grain size, particle size, and geochemical composition. Radiocarbon dates were collected from vibro-core samples (Pearson et al. 1986:1-5).

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Figure 10. The study area shoreline filled and submerged Sabine Pass (Pearson et al. 1989:7).

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Figure 11. A clean view of features identified from bathymetric data in lease block six (Figure 10) shows vibro-core line transects (Pearson et al. 1989:8).

Results of the study showed that 1 out of 5 of the predicted sites produced strong evidence of Indigenous occupation. Two vibro-cores from Sabine Pass 6 had inclusions of a Holocene shell midden dating to 8,055 BP. The submerged midden rested on a terrace between two adjacent tributary streams. The vibro-cores contained burned and unburned shells, fish bones, small mammal bones, bird bones, amphibian bones, reptile bones, and plant seeds. No indication of burning was found in any of the other cores, ruling out a wildfire. The study results showed that pre-transgressive deposits could remain intact or minimally disturbed.

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Figure 12. The geologic cross section in lease block five is interpreted from Vibro-cores (Pearson et al. 1989:10).

It was determined that during early periods of sea-level rise, surfaces within deep stream valleys could be covered in estuarian muds, deposits that protected shorefront wave activity (Pearson et al. 1986:94,148). Although this study had success, positive ground-truthing percentages were low, and the testing areas were in the shallowest areas of the seismic surveys. Choosing Holocene landscapes gave the study a higher chance of success because Pleistocene landscapes are more challenging to locate. The primary methods used in this study are still used today for offshore cultural heritage management planning. Detected submerged cultural landscapes of high archaeological potential in developing lease zones are declared avoidance areas to protect cultural landscapes.

2.2.4 Bathymetric LiDAR and Applied IDA Applications

Light Detection and Ranging (LiDAR) is an aerial remote sensing method that records data in wavelengths within the near-infrared spectrum of 1064-1550 nm, which is useful when surveying terrestrial areas with heavy vegetation. While the utilization of green or bathymetric LiDAR can scan surfaces below shallow water, recording wavelengths of 532nm (Davis et al. 2021:1). Using terrestrial LiDAR data in 2021, researchers conducted a study that covers three coastal counties in the state of South Carolina, US (Davis et al. 2021:1). The goal was to detect more shell rings and mounds using existing data. The study argues that shell rings and mound sites were prevalent, not rare, during the Late Archaic Period (provide the accepted date range for the Late Archaic) (Davis et al. 2021:1). Research suggests that these types of sites were not only used as ritual spaces, but they were common in everyone’s daily lives as well.

The study utilized LiDAR, synthetic aperture radar (SAR), and multispectral data from known shell rings and mounds; then, new analytic methods were applied. When working with LiDAR, the researchers applied data sets to a created model composite multiband raster (Mask R-CNN) in ArcGIS Pro computer software. This model was trained to detect sites. Deep learning methods were used to increase true positives while reducing false-positive results, then ground-validated their results. The researchers found over 100 unknown shell rings on the coast of South Carolina (Davis et al. 2021:10). This method is an excellent example of how to get the most information possible from remote sensing data sets. An expanded version of these methods has been applied by Davis to recent Apalachee Bay bathymetric

LiDAR data, including the Econfina Channel site area, with impressive results (Cook Hale et al. 2023:933).

The bathymetric LiDAR data was contracted by the Aucilla Research Institute between 2016 and 2021 in Apalachee Bay, focusing on Ochlocknee Shoals, the Aucilla, and the Econfina paleochannels. Then, in 2022, Davis converted the data into machine intelligence using deep learning or machine learning methods. The method was a semi-automated analysis that detects potential archaeological targets. The targets generated from the LiDAR data involved a method related to object-based image analysis (OBIA) called inverse detection analysis (IDA). The IDA method has quickly advanced remote sensing techniques and influenced the study of submerged landscapes (Doneus et al. 2015:103). In a blind test by Davis, the method securely selected known archaeological deposits in Apalachee Bay within a 50 m radius (Figures 13, 14) (Cook et al. 2023:935). The other generated targets must be confirmed by deploying maritime archaeological diver surveys.

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Figure 13. Bathymetric LiDAR processed data sets with the applied IDA method. The Aucilla (left) and Econfina (right) paleochannels. Highlighted red areas are IDA targets, and the black circles are known submerged cultural sites (Map by Jessica Cook Hale and Dylan Davis, 2022).

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Figure 14. Zoomed in images of (Figure 13) IDA predicted targets and known sites: Aucilla paleochannel (left) and Econfina paleochannel (right).

In May of 2022, the Aucilla Research Institute (ARI) conducted the first part of this study’s maritime archaeological diver survey research at Ochlocknee Shoals in Apalachee Bay. The research involved dive surveys to ground-truth potential archaeological targets generated from the LiDAR data using the applied IDA method. The second part of the diving research continued at the Econfina Channel site in August 2022, where the author was involved. The research results suggest significant implications for submerged archaeological site preservation of global submerged cultural landscapes (Cook Hale et al. 2022:941).

2.3 Geological Getting/Environmental Description

Apalachee Bay in the northeastern Gulf of Mexico has a low gradient, low energy, and a sediment-starved coastline with minimal wave, current, and tide action (Cook Hale et al. 2022:3; Hine et al. 1988:567). The region is known as the “Big Bend,” where the peninsula of Florida meets the panhandle of Florida. The modern coast has little development because there are no ports and minimal beachlines on the coastline, such as the Saint Marks Lighthouse area, which is rare in Florida. Thus, it is often called the Forgotten Coastline. This coastal area has rich vegetation forested by pine *(Pinus* sp.*)*, oak *(Quercus* sp.*),* and cypress (*Taxodium* sp.), which are abundant near wetlands and freshwater sources (Faught 2004:279).

Apalachee Bay is a part of the West Florida Shelf, a low-gradient continental shelf primarily made of limestone. The karst landscape is characterized by dissolution features such as sinkholes, collapsed features, and chert (cryptocrystalline silicate) that is ideal for tool making within the bedrock (Anuskiewicz and Dunbar 1993:4). The Florida coastline tends to have excellent archaeological site preservation. Thus, geological processes must be comprehended so that other congruent formations may yield submerged sites.

2.3.1 Bedrock Geology

The Florida basement rock formation primarily consists of crystalline igneous and metamorphic rock. The formation was a part of the first massive continent named Gondwana that formed during the Late Proterozoic Eon, 700 million years ago (Hine et al. 2017:462; Parker and Cooke 1944:18). The Gondwana and Laurasia tectonic plates collided approximately 300 million years ago becoming part of the mega continent Pangea. Once Laurasia (now North America) separated from Pangea, the Florida basement rock formation was surrounded by seawater 160 million years ago.

The exposed formation likely withstood heavy erosion due to intense thunderstorms before it was submerged by sea transgression for a million years during the Late Jurassic Period to the Early Tertiary Period (150–50 ma), except for intermittent exposure during times of marine regression (Hine et al. 2017:462, 463, 464). Carbonate organisms such as coral flourished, developing the Florida mega platform from accumulated carbonate sediments that covered the Florida basement formation. This low-gradient carbonate rock formation contains the Florida aquifer and the above karst features. (Hine et al. 2017:465; Missimer and Maliva 2017:1847; Parker and Cooke 1944:18). Apalachee Bay consists of Oligocene Suwannee limestone on the eastern part, which grades to younger Miocene St. Marks limestone to the west.

The Suwannee Straits was a seaway or channel that separated the shallowly submerged Florida platform from the Appalachian Mountain lowlands to the north. During the Paleocene Epoch through the mid-Holocene (between 66 and 56 million years ago), rivers flowing southeast carried siliciclastic sediment loads from the mountain range, which infilled the Suwannee Straits and were predominantly deposited onto the Florida panhandle and the northwestern peninsula (Missimer and Maliva 2017:1847, 1848).

2.3.2 Quaternary Geology/Stratigraphy

The Cody Escarpment, or Cody Scarp, is a geological feature developed from two Pleistocene sea-level high stands north of Apalachee Bay. The escarpment has up to 30 m of relief and topographically divides the Northern Highlands, the Gulf Coast Lowlands, or the Woodville Karst Plain along the coastline (Figure 15) (Upchurch 2007:4; Webb 2006:29).

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Figure 15. The approximate location of the Cody Scarp (Image from Upchurch 2007:4)

A visible example of a Cody Scarp Pleistocene peak marine terrace deposit can be seen at the southern edge of downtown Tallahassee, Florida. Pliocene (5.33-2.58 million years ago) and Pleistocene shoreline development and fluvial karst erosional effects left thin, surficial, poorly developed soil of Quaternary sediment deposits (Upchurch 2007:). The sediment deposits primarily consist of sand and clay, which conform on top of the bedrock onshore and offshore (Garrison and Cook Hale 2019:179).

The dissolution of carbonate rocks caused by streams and groundwater and the erosional effects by stream headwaters resulted in the karstic landscape that becomes more prominent south towards the coastline (Figure 16) (Upchurch 2007:9, 10).

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Figure 16. Model for Cody Scarp retreats with a summary of geologic processes in each geomorphic domain (Image from Upchurch 2007:10).

2.3.3 Geomorphology/Hydrology

Much of the Big Bend is a karst landscape and is dominated by geomorphic features such as sinkholes, springs, swales, natural bridges, cavernous underground drainage systems, and disappearing streams and rivers (Figure 17) (Donoghue 2006:34: Rupert 1988:2). Karst features are caused by extensive dissolution of limestone by acidic groundwater that become more prominent in areas that have little to no surface deposits, high precipitation, a susceptibility to eustatic sea-level fluctuations, and abundance of marshes and wetlands in the region (Donoghue 2006:33: Rupert 1988:2). Evidence of heavy solutional erosion is found where rocky outcrops occur (Parker and Cooke 1944:27). The Big Bend has all these attributes although the groundwater is only mildly acidic.

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Figure 17. Karst fluvial examples (Image from Upchurch 2007:11).

The absence of any or the presence of a relatively thin layer of deposition overlying the limestone in the Big Bend leaves the Floridan aquifer unconfined. The position of the current sea level and the convergence with the Florida aquifer gives rivers such as the Econfina River constant flow for 20 km inland. River channels and springs further upstream are affected by precipitation rates in the region (Thulman 2009:246). During the terminal Pleistocene, sea levels were lower, and the climate was arid. Areas further inland without flowing rivers made the freshwater springs attractive to animals.

The Aucilla River, originating north of the Cody Scarp, and the Econfina River, beginning below the escarpment, only cross the Florida lowlands and are both fully karst-controlled drainage systems. The outcome results in fewer sediment loads deposited offshore than St. Marks/Wakulla River and the Ochlocknee River to the west, which crosses the Florida highlands and lowlands, making the rivers both alluvial and karst-controlled drainage systems (Cook Hale 2017:16, 17; Faught 2004b:423).

2.4 Marine Transgression and Relative Sea-Level Curves in the Gulf of Mexico

At the end of the Last Glacial Maximum (LGM) (25,000–20,000 BP), the earth's ice sheets began to melt, and sea levels began to rise. The LGM began the Holocene marine transgression period, which ended at approximately 5,000 BP. During this period, the eustatic change in sea levels increased from -130 m below its present level. The Continental Shelf was extensive but lost 40% of its landmass (Figure 18) (Davidson-Arnott 2010:19, 43; Hine et al. 2017:473; Stanford 2011:196).

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Figure 18. Approximate Florida coastline positions per millennia (Map from Joy 2019:109).

However, the relative sea level on the coast of Florida was -130 to -125 m below the modern sea level at 22,000 cal BP (Balsillie and Donoghue 2011:57; Joy 2019:109). In Florida, the relative sea-level curve is not affected by glacio-isostatic rebound effects. Joy (2019) produced a sea-level curve focusing on the US Gulf of Mexico. Another regional sea-level curve study by Balsillie and Donoghue (2004) has been the standard curve used by researchers in the Gulf of Mexico since publication. Joy (2019) calculates the highest sea level mark at approximately 8 m below the modern shoreline by 7,200 cal BP, leaving the area of the Econfina Channel sites still unsubmerged. However, the relative sea-level curve is unclear after 7,000 cal. BP, Joy estimates that between 4,000–2,500 cal BP sea levels stabilized on the state of Florida coastlines, establishing the local modern sea level (Joy 2019:7). Due to the marine transgression, an extensive amount of archaeological material documenting coastal adaptations before the LGM is now underwater (Bailey and Flemming 2008:10; Saunders and Russo 2011:48).

Offshore archaeological landscapes were subjected to at least one transgression. Others had undergone multiple sea transgressions and regressions, subjecting them to possible intense erosional factors, especially those at the shoreface. Heavy erosional wave action can obliterate *in situ* sites (Erlandson 2001:300). Organic matter such as bone, shell, and lithic tools may be left behind in a lag deposit. Once artifacts are removed from protective paleosols by natural or human forces, they are subjected to weathering and corrosion.

2.5 Paleoclimate

2.5.1 Terminal Pleistocene Climate, Ecology, and Sea Level Position

The terminal Pleistocene is marked between the end of the LGM (approximately 20,000 BP) and the beginning of the Early Holocene (11,700 BP), at the termination of the Younger Dryas stadial (ca. 12,890-11,700 cal BP). During this period, the climate fluctuated as sea levels rose from approximately -130 m to -40 m in Florida. Florida was much cooler and drier than it is today (Joy 2019:109; Clark et al. 2012:1137). Temperatures warmed as glaciers continued to melt, and the sea transgression continued to inundate Florida’s terrestrial environment, impacting plants and animals (Hine et al. 2017:476).

Florida had a mixed parkland environment consisting mainly of species of oak and pine trees. As temperatures began to increase, birch (*Betula* sp.), spruce (*Picea* sp.), and hickory (*Carya* sp.) species took hold. Ragweed (*Ambrosia* sp.) was the predominant grass throughout the southeast

(Garrison et al. 2012:180; Hine et al. 2017:476; Watts et al. 1992:1062). By 12,000 BP, the climate became more temperate, and the mixed parkland changed to mixed forests, dominated by oak and hickory (Delcourt and Delcourt 1984:272, 274; Hine et al. 2017:276). The landscape change and environmental conditions profoundly affected Florida's plants and animals. These changes played a role in the extinction of megafauna species such as mammoth (*Mammuthus columbi* sp.), *mastodon* (*Mammut Americanum* sp.), bison (*Bison antiquus* sp.), tapir (*Tairus veroensis* sp.), and the giant ground sloth (*Megatherium* sp.) (Dunbar 2016:26).

2.5.2 Early Holocene to Middle Holocene Climate, Ecology, and Sea Level Position

High-amplitude fluctuations characterized the Holocene climate. During the Early Holocene (11,700–8,200 BP) in Florida, sea levels rose from -40 m to -18 m below the modern sea level (bmsl) (Joy 2019:109). As sea levels rose, so did the water tables. Springs, streams, and rivers began to flow. The climate was warmer and more arid, but a significant increase in precipitation caused regular flooding (Halligan 2016:2, 4; Hine et al. 2017:476; Otvos and Price 2001:4, 5). Smaller browsers, such as white-tailed deer, replaced the significant megafauna browsers (Anderson 2001:156).

Sea level increased from -18m to -10m bmsl during the Middle Holocene (provide a date range). The relative sea-level curves stabilized after 7,000 cal BP (Joy 2019:109). As marine transgression increased and inundated more coastal areas, temperate forests replaced the mixed forests (Hansen 2006:169).

2.5.3 Late Holocene/Modern Climate, Ecology, and Sea Level Position

By the beginning of the Late Holocene (4,200 BP), the sea level began to equalize, and the climate began to resemble that of modern Florida. Humans had adapted to climate change but were still reacting to changing coastline positions. The sea level rose to current levels no later than 2,500 cal. BP (Joy 2019:109). The Econfina Channel site dates during the Middle and Late Holocene transition.

2.6 Cultural Context

The archaeological terms such as Paleoindian and Archaic periods have been imposed on Indigenous cultural developments in the Southeast from the terminal Pleistocene onward (Sanger and Barnett 2021:196, 197). It is essential to acknowledge that these do not reflect Indigenous perspectives on cultural development. However, these terms will be used to describe the current state of knowledge. These period terms are temporal identifiers that allow us to talk about regional phenomena that are broadly similar across the geographic extent of the Southeast. The correlation between these cultural terms and climate conditions will be indicated.

2.6.1 Paleoindian Period

The Paleoindian period in Florida (14,400–11,700 cal BP) correlates to the terminal Pleistocene. Exactly how and when the initial populations arrived in North America is unknown. There is a strong possibility that multiple wave migrations occurred across Beringia, a land bridge connecting northeastern Asia with northwestern North America (Braje et al. 2020:3). The first migration of people likely used watercraft or a combination of watercraft and walking along the Pacific coastlines (Davis et al. 2019:895). The earliest and most solid archaeological evidence of human activity in the Americas comes from the Cooper's Ferry site in the Pacific Northwest, dating to 16,000 cal BP (Davis et al. 2019:891). Some of the oldest Paleoindian sites are in the Big Bend region, such as Page-Ladson (Figures 19, 20) (14,500 cal BP) (Halligan et al. 2016:4). Page-Ladson and Sloth Hole (8JE121) provide examples of people accessing resources in the region along karst river channel sinkholes where springs/cenotes were flowing, and which attracted wildlife and humans. People chose sinkholes with nearby rocky outcrops made of chert to utilize accessible tool stones (Dunbar 2016:30; Halligan et al. 2016:1).

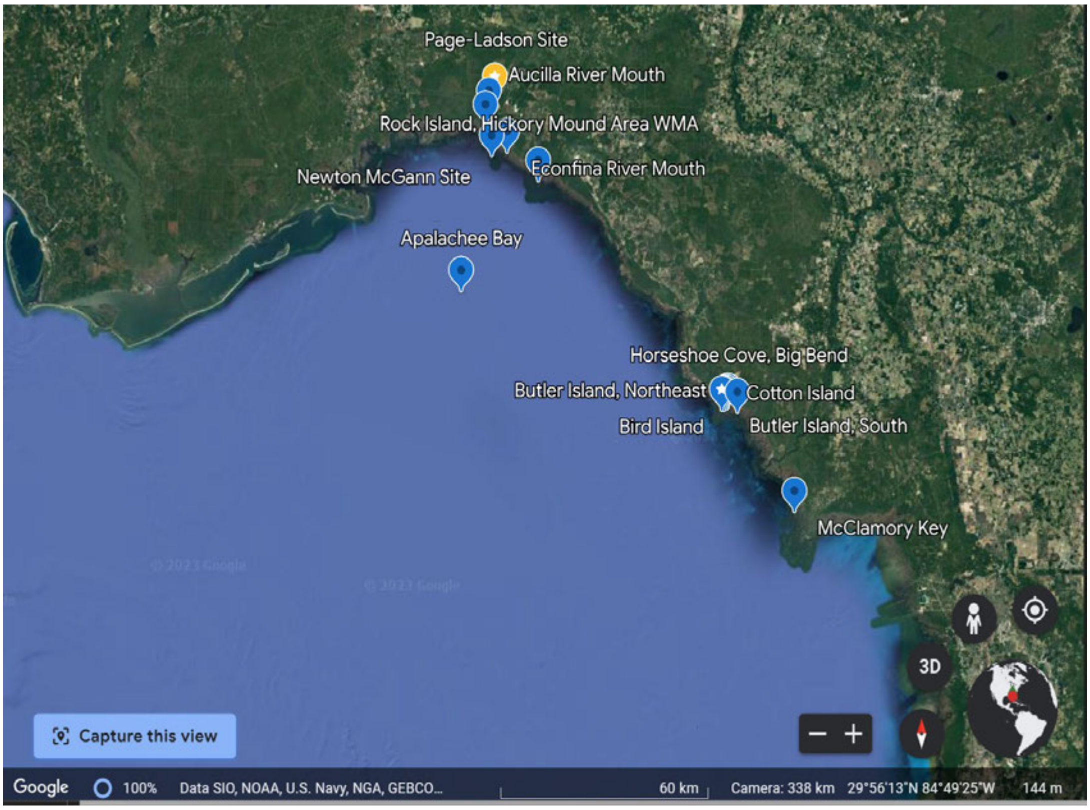

Figure 19. The Big Bend, Florida, with included topic points (Map by Nathan Hale from Google Earth, 2023)

Paleoindian sites are recognized by their large bifacial lanceolate projectile points/knives and blade tool technology that were a part of their toolkits. The Clovis toolkit (13,300–12,750 cal. BP) had the most widely spread tool kit during the terminal Pleistocene, stretching across North America utilizing chert, animal bone, ivory, and wood (Bradley et al. 2010:1, 114; Dunbar 2016:184, 208; Halligan et al. 2016). These projectile points/knives (bifaces) were likely used for hunting now-extinct megafauna. Significant bifacial lanceolate points, including ochre, are commonly found in single cremation burials during this period and are rarely located (Dunbar 2016:245; Owsley et al. 2001:115).

Sifts in burial practices are seen at the southeastern Sloan Site in Arkansas, US. The Sloan site is an example of a Paleoindian dune cemetery where people were buried with only hypertrophic points (more significant than average), Dalton points, and caches (Morse 2018:141, 142). The Dalton tool kit replaced the Paleoindian Clovis tool kit as arguably North America's most successful tool point (Smallwood et al. 2019:226). Dalton was distinct from Clovis and was the first diagnostic form with distinct regionalization appearing at appropriately (11,700 cal BP). It appears at the long-term Paleoindian occupational sites such as the Harley Flats site north of Tampa, Florida, and the big bend at the Page-Ladson site (Morse 2018:138).

2.6.1.1 Page-Ladson

Two significant Paleoindian sites located in the 1980s are Page-Ladson and Sloth Hole, which are submerged sinkhole/cenote sites that contain rocky outcrops in the river channel of the Aucilla River (Figure 20). The Page-Ladson site is a confirmed pre-Clovis site with evidence of use throughout the Middle Archaic period (Dunbar 2016:140). The earliest occupation dates to 14,500 cal BP, making it one of the oldest archaeological sites in the Southeast.

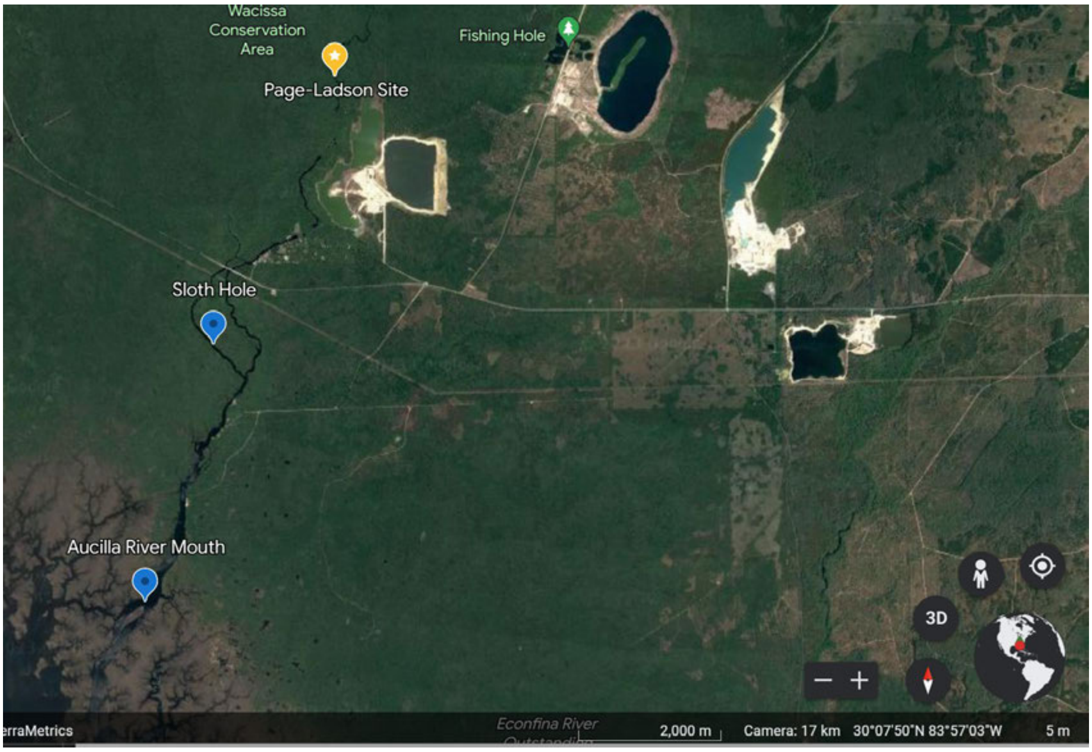

Figure 20. The Aucilla River is the location of Sloth Hole and Page-Ladson (Map by Nathan Hale from Google Earth, 2023).

The site was abandoned because of flooding due to the rising sea level, which also affected inland fluvial systems (Dunbar 2006:412; Halligan et al. 2016:1, 2, 4). The submerged sinkhole site with a diameter of 60 m is located 11.5 km inland from the modern-day mouth of the Aucilla River. Dunbar, Faught, and colleagues surveyed paleo-river channels of Apalachee Bay, looking for offshore site analogs (rocky outcrops and sinkholes/cenotes) that potentially could predate the Page-Ladson site (Faught and Donoghue

1997:423). The method proved successful, resulting in the successful location of most known archaeological sites in Apalachee Bay.

2.6.1.2 Indigenous Paleoindian Cultural Sites in Apalachee Bay, FL.

Efforts to extend the Page-Ladson site predictive model into Apalachee Bay resulted in the identification of five submerged sites where most research was focused: Ray Hole Springs (8TA171), Ontolo (8JE1577), J&J Hunt (8JE740), Fitch site (8JE739), and the Econfina Channel site (8TA139), along with multiple less well-defined archaeological locales or artifact scatters (Faught and Donoghue 1997:441; Faught 2004b:278) (Figure 21). During the terminal Pleistocene, the Ontolo and J&J Hunt submerged sites have evidence of Paleoindian occupational activities in the form of diagnostic point technology on the Aucilla (River) paleochannel margins near sinkholes. Megafauna bones were found at J&J Hunt and Fitch, but no evidence of human butchering was obtained (Faught 2004b:283, Faught and Donoghue 1997:442). The artifacts are evidence of activity which indicates that Indigenous people likely utilized coastal resources during the terminal Pleistocene when the sea level was -40 m bmsl (Faught 2004a:276; Joy 2019:7).

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Figure 21. Map of past research in Apalachee Bay, FL. (Faught 2004a:278).

Ontolo and J&J Hunt have finished the production of diagnostic Paleoindian tool typologies. At the same time, Fitch indicates an intensive quarrying site where only primary tool coring technologies were used, and no formal tools were recovered (Donoghue 1997:442). A Suwannee point (ca. 12,500–11,500 cal BP) was located at Ontolo, and at J&J Hunt, a Suwannee point base and a Suwannee preform were recovered (Farr 2006:42; Faught 2004b:284; Marks 2006:31) The three sites show human activity through the Middle Archaic period (7,240–4,200 cal BP) until submerged by sea transgression. Human activity at Ray Hole Springs was likely, although there is no concrete evidence, while at the Econfina Channel site, there was no occupational activity (Cook Hale 2017:23).

2.6.2 Early Archaic Period

Florida’s Early Archaic period was between 11,500 and 8,900 cal BP and correlated to the onset of the Early Holocene, immediately post-Younger Dryas stadial. The sea level at 10,900 cal BP was -40 m below the current sea level. By 10,500 cal BP, the sea level was -20. That is a sea transgression of 20 m in 400 years (Joy 2019:109). As the sea transgression continued, the effects must have been profound to the people and their habitats. As the sea level continued to rise, so did the water tables. Rivers, streams, and springs began to flow, and the climate was warmer and more humid. An increase in varied social and subsistence behaviors becomes visible in the archaeological record (Anderson 2001:157) (Figure 22).

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Figure 22. Study area with site locations by period, coastline positions, and all fluvial features. Sites are taken from southeastern state master site file databases and include sites assigned to the Early Archaic (11,500–8,900 cal BP, n = 500) and Middle Archaic periods (n = 1,160, 8,900–5,800 cal BP) (Map from Garrison and Cook Hale 2019:3).

Because of the extreme change in environmental conditions due to the collapse of the Laurentide ice sheet, people adapted to different subsistence strategies. People shifted their hunting and gathering patterns to contend with changes in types of species. People's social boundaries were diffuse, suggesting that the movement of goods, people, and ideas was more open during this period, even though residential sites increased (Anderson and Hanson 1988:262). These groups preferred high-quality chert stones for the ease of resharpening instead of remaking (Cook Hale 2022b:40). Cultural differentiation has been detected in the region specifically by Thulman (2006), who argued that ratios of bifacial Bolen, Kirk side-notch, and Kirk corner-notch points (11,100–9,250 cal BP) on either side of the Suwannee River indicate a division between cultural groups that has nothing to do with subsistence patterns or natural context (Figure 23) (Farr 2006:68).

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Figure 23. (A) Sloan (B) Simpson (C) Suwannee (D) Bolen (E) Kirk (Image A from- AAS https://archeology.uark.edu/learn-discover/current-research/what-is-a-sloan-point/; and Images B-E from- https://projectilepoints.net/Search/Florida_Search.html) (Image by Nathan Hale and KC Graham Jones).

Ties to ancestors in Florida at the Harley Flats site (8Hi407) are indicated with Late Paleoindian Simpson and Suwannee point types in the same occupation surface, arguing for continual occupation from Paleoindian to Early Archaic periods (Dunbar 2006:406; Cook Hale 2022b:31). Regional burial traditions shifted during the Early Archaic when multiple burials became more common.

2.6.2.1 Early Archaic Sites in Apalachee Bay, FL.

During the Early Archaic period in the Big Bend, Indigenous activity can be recognized by tool types represented at Ray Hole Springs, Ontolo, and J&J Hunt (Cook Hale 2019b:212; Dunbar et al. 1989:28; Faught 2004b:285). Ray Hole Springs lies 30 km offshore in 12.6 m of water. The excavated sinkhole is approximately 7.5 m along its longest axis, showing Indigenous activity from the Early Archaic to the Middle Archaic periods. The tools collected by Dunbar et al. during excavations in 1986 were heavily corroded and determined to be “pseudo tools.” Further lithic analysis by Cook Hale (2019) demonstrated Early and Middle Archaic signatures that agree with the radiocarbon dates 11,400–8600 cal BP (Auskiwicz et al. 1993:5, 6). Five Bolen side-notched points were excavated from J&J Hunt, along with an adze (axe) bit and unifacial Hendrix scrapers associated with Bolen technology. In contrast, at Ontolo, a rare Kirk serrated (11,100–9250 cal BP) and a Hendrix scraper were recovered (Farr 2006:68). Indications of increased site use in Apalachee Bay are more evident during the Middle through Late Archaic periods (Figure 24).

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Figure 24. Located Apalachee Bay diagnostic points, including Florida Archaic, stemmed point examples (Image from Fought 2004b:284).

2.6.3 Middle Archaic Period (8,900–5,800 cal BP)

The choices people made in choosing lithic tool materials and their production shifted to local and expedient (Cook Hale 2022b:36). Points change in design and increase in size, from the Kirk-Stemmed type to a less formal broad blade hafted biface known as the Florida Archaic Stemmed (Farr 2006:79, 87). The climate was cool and dry, with a 6-8 m drop in water tables. People living inland stayed near water sources, such as rivers, springs, and ponds. Thus, a higher population density occurred in coastal regions while shellfish exploitation flourished (Anderson 2001:58, 59; Bailey and Flemming 2008:2153). The mortuary pond burial tradition began in Florida at the end of the Early Archaic through the Middle Archaic periods (Figure 25).

2.6.3.1 Early-to-Middle Archaic Mortuary Pond in Florida, US.

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Figure 25. Photo of the Windover Pond (Image by Dr. Ben Brotemarkle 2012).

Indigenous pond burials are unique to Florida in the southeastern US during the Late Archaic through the Middle Archaic periods (Randall 2015:145). However, most archaeological evidence of mortuary pond activity falls within the Middle Archaic period. There are six documented mortuary ponds, or “wet cemeteries,” in North America, all located in Florida. Mortuary ponds are small bodies of water used as interment sites (Randall 2015:145). The burial ponds were used for up to a thousand years, indicating tangible, long-term ties to the landscape, making the entire region a cultural landscape. The preservation is outstanding due to layers of peat matrix (Adovasio 2001:2, 5). Archaeological evidence shows that mortuary pond burials happened within 48 hours after death. In most cases, people were wrapped in woven burial shrouds with grave goods in a flexed position and buried in the peat of the pond, under approximately 1 m of water. Long stakes were pierced through the woven wrap into the peat and tied together above the water as a marker (Randall 2016:145, 146, 147) (Figure 26).

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Figure 26. Illustration of pond burials. The image does not show people buried in the peat. (Image from Wentz 2012:8)

There are archaeological issues with all the sites. Warm Mineral Springs (8SO19) suggests Early Archaic association (10,000-8,500 BP) (Royal and Clark 1960), and Little Salt Springs (8SO18) suggest Early, Middle, and Late Archaic occupations (9,200–5,200 BP) (Clausen et al. 1979) were excavated by an amateur underwater archaeologist in the 1950s and mostly lack provenience information. Republic groves (8CR200) Middle and Late Archaic. (7,000–5,000 BP) (Milanich 1994) and Bay West (8BR246) Middle and Late Archaic (6,900–6,000 BP) (Beriault et al.1981) were salvage excavations that lacked provenance because construction crews had disturbed the sites before salvage began. Manasota Key Offshore (8,849–8,200 BP) (Duggins and Price 2016) has had no peer-reviewed publications since its discovery in 2016. Windover (8BR246) (8,120–6,990 BP) (Doran 2002) is the only published, well-controlled excavation of a mortuary pond (Figure 27). Excavations were conducted before the Native American Graves Protection and Repatriation Act (NAGPRA) of 1991 was enacted by the US government. Thus, no Indigenous engagement was involved.

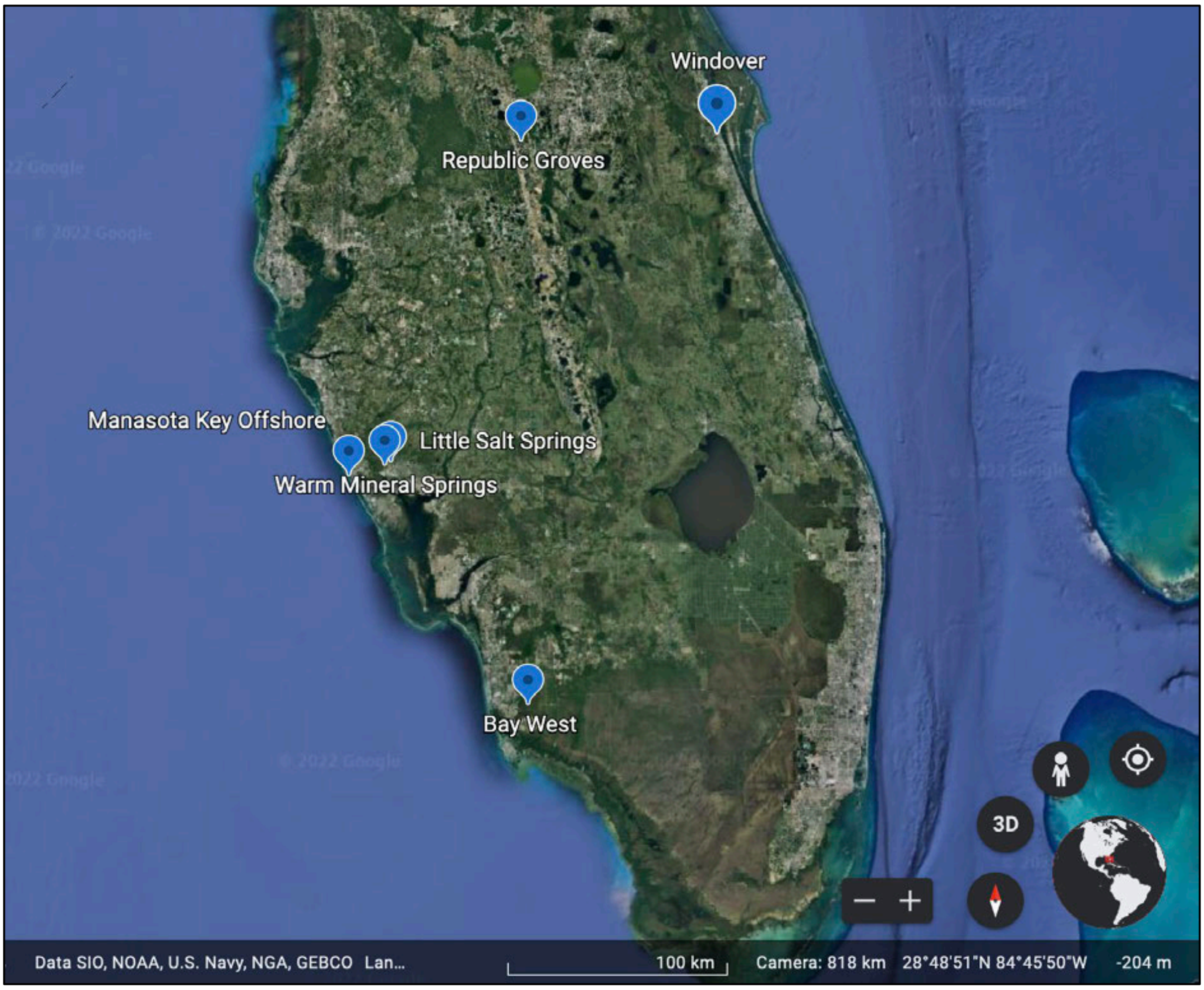

Figure 27. Archaic Period mortuary ponds listed clockwise: Republic Groves, Windover, Bay West, Manasota Key Offshore, Warm Mineral Springs, and Little Salt Springs (Map by Nathan Hale from Google Earth 2022).

The Windover site was discovered in 1982, and excavations began at the site, which uncovered 168 minimum individuals and indicated that people were buried there for 1,000 years. Windover is famously known for its preservation of human bones and brain tissues; other preserved site materials, such as textiles and wood tools, help shed light on a period in Florida that was once obscure (Adovasio et al. 2001:1). Only six projectile points were recovered in association with burials. However, carved wood posts or effigies were also located and associated with graves in various locations at the site (Wentz 2012:249). Other recovered artifacts include decorative shells, beads, and tools made of wood, antler, shell, and bone (Figure 28) (Randall 2015:145, 146; Wentz 2012).

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Figure 28. (Left) Windover shell and wooden tools. (Right) Windover woven material (Images from Wentz 2012:248,253).

Fabrics removed from the Windover mortuary pond site are the oldest textiles from the Southeast and show the complexity of woven materials the society made. Eighty-seven artifacts recovered were fabric and cordage items, including baskets, open twined mats, a hood, bags, a bag with a drawstring, and mortuary shrouds (Adovasio et al. 2001:1, 16). The cordage was spun, twisted, or braided and was made primarily from cabbage palmetto (*Sabal* sp.) Four different weave types, the most intricate, were used in burial shrouds (Figure 29). This practice indicates the organization and division of labor, subsistence practice, personal status, and a continual evolution based on ancient roots (Adovasio et al. 2001:1, 16, 75).

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Figure 29. Windover weave examples: (Left) Balanced Plain Weave, Type 4; (Middle) Open Simple Twisting, Paired S and Z Twist Wefts, Type 4; (Right) Close Diagonal twining, paired S Twist Weft, Type 3. (Images from Brevard Museum of history and natural Sciences). https://www.nbbd.com/godo/BrevardMuseum/WindoverPeople/index.html

There are indications that the people of Windover placed care for one another as of high social importance. Care at Windover is represented in how people were buried and treated towards one group member during their lives. An example is the care people gave to an 18-year-old boy who suffered from a long terminal illness. Showing he was well taken care of for a long time rather than abandoned (Wentz 2012).

2.6.3.2 Offshore Early-to-Middle Archaic Mortuary Pond in Florida US.

In 2016, amateur divers found human remains below 9 meters of water, 200 m off the coast of Florida, in the Gulf of Mexico. The Florida Bureau of Archaeological Resources investigated the report. The archaeologists discovered that Indigenous human remains eroded from an inundated mortuary pond, dating to 8,949–8,200 BP, named Manasota Key Offshore. It was determined that the area was once a small island with a spring (Gannon 2018). One unit was excavated to confirm their hypothesis. The cemetery is $25{,}000^2$ m and is estimated to have approximately 100 individuals (Figure 30). The Seminole Tribe of Florida, which has jurisdiction in Florida over Indigenous burial rights, was notified, and the decision was made to leave the graves undisturbed. It has been estimated that the burial site is losing 1 m along the exterior length per year due to erosion, and six graves were looted in one year alone.

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Figure 30. (Left) Photo of the Manasota Key Offshore excavation. (Right) Photo of a carved stake in a unit (Images from) https://www.gulfcoastcf.org/our-initiatives/arts-and-culture/manasota-key-offshore-archaeological-site.

The Douglass Beach site is in 2 m to 3 m of water, and documented artifact finds range between 100 m to 300 m offshore along the 550 m coastline of Hutchinson Island in the Atlantic Ocean (Murphy 1990:5, 37). Douglass Beach is a multiple-component site with well-preserved Archaic Period sedimentation layers with a 1715 CE Spanish Plate Fleet shipwreck component above (Murphy 1990:51, 52). Although the Indigenous component of the Douglass Beach site has yet to be officially designated a mortuary pond burial site, evidence such as a wooden stake dating to the Late Archaic Period suggests the possibility.

Human bones, including a cranium, and a line of wooden stakes at a linear feature were found driven into sediments (Murphy 1990:36). A recovered 3 x 20 cm stake showed that it was sharpened on one end and battered on the other. The stake dates to 4,630 BP, which indicates that the mortuary pond burials may have continued into the Late Archaic (Murphy 1990:27). Late Paleoindian through Middle Archaic occupations are represented by the points that were recovered from the site, which are Suwannee (12,700–11,500 cal BP), Bolen (11,500–11,000 cal BP), and Newnan's Lake Point

(Newnan's) (7,000–6,500 cal BP) (Cook Hale 2019:200; Farr 2006:42, 66, 94). These points have been associated with a Florida terrestrial shell burial mound at Tick Island and the Florida pond burial sites of Little Salt Springs and Bay West (Clausen et al. 1979:612; Farr 2006:94; Murphy 1990:36). The same point types have been located at submerged sites in Apalachee Bay.

2.6.3.3 Middle Archaic Period Coastal Adaptations

Shellfish exploitation by Archaic period hunter-gatherers started as early as 9,000 years ago and intensified between 7,500–3,200 cal BP in the Florida panhandle, northeast Florida, and southwest Florida (Randall and Sassaman 2017:10; Saunders 2017:1). Current data that account for past and present environmental conditions suggest Middle Archaic people could have flourished year-round on the southeast coast of the US, foraging solely on marine and estuarine resources (Thomas 2014:170). This data argues against Flannery and Marcus (2012), who suggested that people need agriculture for sedentism, population, and cultural growth.

Coastal shellfish, especially oysters, are very adaptable even in waters that change salinity, temperature, and turbidity (Saunders and Russo 2011:48). The dominant Eastern oyster (*Crassostrea virginica* sp.) of the region can thrive in subtidal and intertidal zones, withstanding salinity levels of a wide range (~5-35 ppt) (Sassaman 2016:5) These data support the adaptability of shellfish in changing environments and means that there should have been plenty of shellfish resources available, even at rising sea levels. This evidence indicates that hunter-gatherers were capable of sustaining themselves, and they also flourished during this time. Coastal sustainability could have been done without going deep inland for food sources (Thomas 2014:70). However, because of rising sea levels, it would have been necessary to relocate further inland due to encroachment. Oysters in subtidal conditions with higher salinity become subject to parasites, such as oyster drills and sponges (Sassaman 2016:5).

There is supporting data on how Middle and Late Archaic people would have flourished year-round on the southeast coast of the US, foraging solely on their access to marine and estuarine resources (Thomas 2014:170). Data from Saunders and Russo 2011, and Thomas 2014, account for past and present environmental conditions and argue against the idea that people need agriculture for sedentism, population, and cultural growth (Flannery and Marcus 2012). Coastal shellfish, especially oysters, are very adaptable even in waters that change salinity, temperature, and turbidity (Saunders and Russo:48). The adaptability of shellfish in changing environments would mean that there should have been plenty of shellfish resources available, even at rising sea levels. It is possible that hunter-gatherers were not only capable of sustaining themselves but could also flourish during this time. Coastal resilience could have been accomplished without going inland for food sources (Thomas 2014:70).

The intensification of shellfish exploitation by Archaic people started at least 7,000 BP in the Florida panhandle, northeast Florida, and southwest Florida. Two of the oldest shell mounds are in some of the highest topographic areas in Florida. This suggests that there should be more shell mound sites off the coast of Florida that were submerged during the Last Glacial Maximum sea-level rise (Saunders and Russo:48).

2.6.3.4 Middle Archaic Period Ceremonial Mounds of Florida

Indigenous ceremonial shell mound-building can be traced back to Florida before 7,000 BP, during the Middle Archaic period (8,900–5,800 cal BP) (Randall and Sassaman 2017:12; Russo 2004:102). These mounds tend to be large, sub-circular, oblong, or linear in shape and have complex depositions, including human burials (Figure 31). Most shell mounds that have a significant size are found to be ritual landscapes rather than kitchen middens (Saunders 2017:2).

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Figure 31. Location of Florida mound sites and submerged sites: 1. Elliotts Point sites around Choctawhatchee Bay; 2. Mitchell River sites; 3. Apalachicola River sites; 4. J&J Hunt site, Ray Hole Spring; 5. Hill Cottage site; 6. Venice Beach site; 7. Useppa Island; 8. Horrs Island/Bonita Shell Ring sites; 9. Ten Thousand Islands area/Everglades; 10. Joseph Reed Shell Ring site; 11. Tick Island site; 12. Tomoka Mounds site; 13. Summer Haven site; 14. Guana River Shell Ring site; 15. Spencer's Midden site; 16. McGundo Midden site; 17. Rollins Shell Ring site; 18. Oxeye Island site (Map from Saunders and Russo 2017:43).

The highest concentration of Floridian Middle Archaic period shell mounds is in the northeastern St. Johns River valley, approximately 55 km from the Atlantic coastline. Two of the oldest Middle Archaic period shell mound sites in Florida are Silver Glen Springs (6,400 cal BP), on the St. Johns River, and Horr's Island (Mound B) (7,200 cal BP), on the southwest coast of Florida (Figure 32) (Randall and Sassaman 2017:18; Saunders 2017:17). Both sites have adjacent Late Archaic period (5,800–3,200 cal BP) shell mounds/rings that are U-shaped and have burial pits that were deposited in a range of 500 to 2,000 years after their initial constructions. In Florida, Late Archaic shell ring sites razed near or adjacent to older shell mounds were common, and the trend of reusing older shell mounds continued into the Woodland Period (Figure 32) (3,200–1,000 cal BP).

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Figure 32. (Right) Reconstructed topography (c 1872) of the Silver Glen Springs watershed showing the location of shell mounds, a sand mound, villages, and midden deposits (Image from Randall and Russo 2017:34, 36). (Left) Shaded relief topographic maps of the Fig Island Shell Ring site, Rollins Shell Ring site, and Horr's Island Ring complex (Map from Saunders and Russo 2017:46).

Some Middle Archaic shell mound sites were considered essential to small non-sedentary populations. They were places of feasting and ceremonial rituals (Sassaman 2016:53). Six different Florida Archaic shell mound sites date between 7,200–6,000 BP, with fewer burials associated with them than in later periods (Randall 2015:118). Because of fewer burials, no pottery, and perhaps the lack of distinctive geometric shell mound shapes, many archaeologists have looked at the period as less sophisticated and significant (Milner and Jefferies 1998); this is far from an accurate description.

2.6.3.5 Submerged Middle Archaic Period sites in Apalachee Bay, Florida.

All the most intensely researched sites in Apalachee Bay, Ray Hole Springs, Ontolo, Fitch, J&J Hunt, and the Econfina Channel sites show evidence of the Middle Archaic occupation. J&J Hunt is likely the most significant submerged site in Apalachee Bay, indicating hunter-gatherer utilization of resources from the terminal Pleistocene throughout the Middle Holocene. Assemblages recovered are late Pleistocene mammoth faunal remains, diagnostic tool types, two oak tree stumps, and evidence of shell middens

(Faught 2004b:285). An oak tree stump's radiocarbon date is 7,240 BP, suggesting a terrestrial landscape until 6,000 BP when more brackish or marshy conditions occur, evidenced by oyster shell and charcoal radiocarbon dates (Faught 2004a:438). Although archaeological surveys at J&J Hunt were not focused on Middle Holocene cultural material, Faught (2004b) indicates the "possible" presence of mid-Holocene shell middens. However, the study did have strong evidence of midden materials in three test pits, which contained disarticulated oyster (*Crassostrea virginica* sp.) shells, faunal bones, and charcoal, which are all shell midden indicators (Faught 2004a:285) (Figure 33).

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Figure 33. Map of the J&J Hunt site, the three red circles indicate shell-midden deposits that were excavated (Map from Faught 2004b:281).

Dunbar, Faught, and colleagues securely demonstrated the existence of terminal Pleistocene and Middle Holocene archaeological deposits in Apalachee Bay. Coastal adaptations were explored relatively little, aside from recording shell deposits at multiple sites, including the potential presence of a shell midden at the Econfina Channel site (Figure 34).

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Figure 34. (Left) Profile view drawing of excavation TT991 at J&J Hunt showing shell deposit layers, with possible shell-midden materials shaded in grey. The black dots indicate mammoth bones (Image from Faught 2004a:287). (Right) Photo of the Econfina Channel site midden excavation profile view, indicating the different depositional layers (Image from Cook Hale et al. 2018:7).

2.6.3.6 Middle-to-Late Archaic Period submerged shell midden in Apalachee Bay, FL.

The Econfina Channel site (8TA139) is located 3 km offshore, approximately due southeast of the Econfina River mouth, and is currently submerged in -2 to -4 m (MSL), depending on the tides. The Econfina Channel site has been proven to be anthropogenic, with a significant accumulation of shells showing evidence that indicates heavy occupational use throughout the late Middle and Late Archaic periods (Cook Hale 2018:17). The Econfina Channel Site comprises multiple features, including a large (> 30 m across) shell midden, a lithic quarrying zone, and at least one freshwater spring feature. Past excavations and analyses have yielded diagnostic lithic artifacts, a variety of faunal remains (fish species undocumented), and four radiocarbon dates that show the shell-midden materials were deposited during human activities from 5,200–4,200 cal BP, with one outlier dating 2,500 cal BP (Cook Hale et al. 2022:6, 18; Faught and Donoghue 1997:444) (Figure 35).

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Figure 35. Econfina Channel Site map including Ward Morgan site features showing the spring, quarry, midden zones, areas of excavation, and sediment sample collection (Map (right) from Cook Hale et al. 2022a:4; Map (left) from Cook Hale 2022b:6).

The geoarchaeological methods helped differentiate between nonhuman post-depositional processes and the cultural material remains left by humans at the site. These methods included sediment analysis, mapping, bulk sediment sampling, and excavation (Cook Hale et al. 2018, 5, 6, 11). Laboratory research teased out the evidence for human activities by examining several aspects. Sediment can be examined for anthropogenic inclusions and geochemistry. Special attention is paid to traces of human activities like artifacts, debitage (waste from stone tool production), charcoal, and geochemical traces (Cook Hale et al. 2018:11). The examination of these aspects of analysis, the researchers provided supporting evidence by determining sediments were anthropogenic. Cook Hale et al. (2018) also determined that submerged offshore sites experience post-depositional forces significantly different from those in terrestrial contexts. These include erosion or deflation of sediments and degradation of artifacts or features caused by the marine environment. These forces can significantly affect the preservation and interpretation of archaeological data from these sites.

The geoarchaeological analysis by Cook Hale et al. (2022) of the Econfina Channel site sediment samples taken before and after the passage of each hurricane, Hermine and Irma, contributed to submerged coastal site preservation studies. The research shows observable changes due to the hurricanes; the larger-sized archaeological materials were minimally displaced horizontally. Vertical deflation occurred as finer sand fractions were removed by storm activity (Cook Hale et al. 2022:14). The study indicates that powerful weather events cause some alterations. Significant horizontal displacement of larger artifacts is unlikely. This understanding is crucial for interpreting human activities associated with these materials and preserving submerged archaeological sites.

In 2017, a new set of midden and quarry features were identified near the Econfina Channel site and named Ward Morgan (Florida Master Site File not given) (Figure 36). Ward Morgan is located on the northern side of the Econfina paleochannel, approximately 150 m north of the Econfina Channel site. Like the Econfina Channel, the Ward Morgan site has shell-midden features and a lithic quarrying zone. No radiocarbon dates have been processed, nor have diagnostic artifacts been recovered from the site (Cook Hale et al. 2018:4).

The recent IDA analysis results have recognized known features of the Econfina Channel and Ward Morgan sites, such as the shell middens, the lithic quarries/rocky outcrops, and the freshwater spring. The analysis also indicated nine new potential target areas to investigate within 200 m or less of the Econfina Channel site. The targets show signatures consistent with the different known features at the Econfina site (Davis et al. 2021:9). These signatures appear to show the presence of three freshwater springs, a rocky outcrop, and five possible shell deposits that may be anthropogenic.

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Figure 36. Bathymetric LiDAR of the Econfina paleochannel with plotted black circles indicating site features and stars indicating predicted anthropogenic deposits (map by Jessica Cook Hale and Dylan Davis 2022).

The Econfina Channel and Ward Morgan sites are two submerged archaeological sites that yielded significant evidence of heavy occupational use during the late Middle and Late Archaic periods when monumental shell mound and shell ring sites were part of the cultural landscape of the region (Russo 2010:156; Gamble 2017:446, 447). The presence of large shell deposits found at both sites indicates that Indigenous people once utilized these areas for subsistence purposes, likely harvesting and consuming the abundant marine resources of the region (Saunders 2017:2). These sites lie between terrestrial shell mound sites on the coast. This evidence suggests that the Econfina Channel site could yield evidence that the shell deposits are more than middens but were intentionally built shell mounds before being submerged by marine transgression. These sites are particularly interesting to archaeologists because they provide insight into past communities' material culture, social organization, and subsistence practices on the landscape. New data suggest that the area near the Econfina Channel and Ward Morgan sites may contain undocumented anthropogenic shell deposits or other archaeological features, making them promising areas for future research.

2.6.4 Late Archaic Period (5,800–3,200 cal BP.)

2.6.4.1 Late Archaic shell rings of the Southeastern US and shell mound sites of the Big Bend, Florida

The monumental shell ring building tradition existed during the Late Archaic Period (5,800–3,200 cal BP) on the coast of the southeastern US (Sanger 2021:751). These structures are some of the earliest large-scale architectures found in the US and are evidence of the first intensive occupations to appear on the US coastlines (Russo 2006:8). Shell rings are a particular type of shell mound, defined as being circular, semicircular/C-shaped, and U-shaped with little to no shell in the center, generally known as a plaza (Russo 2006:15, 2010:156; Thompson and Andrus 2011:316) (Figure 37). Shell ring matrices consist primarily of oysters and, to a lesser degree, hard clams, and other marine bivalves. A smaller percentage of shell ring matrices comprise various faunal remains. In contrast, shell middens tend to have more faunal accumulation and less variety in exotic faunal remains (Colaninno 2012:5).

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Figure 37. Shell rings in Florida, South Carolina, and Georgia (Saunders and Russo 2011:45).

In Florida, U-shaped shell rings dominate, and ring size varies from 77-250 m in diameter and 4.2-0.3 in height (measured from the plaza floor) (Russo 2006:24). There are gaps in extant shell rings along the northwest coast of Florida from the Buck Bayou (8WL90) site to the Hill Cottage (8S02) site. This gap could be the low gradient Western Florida Shel (Figure 38). Apalachee Bay would have been one of the first areas submerged on the Florida coastline. This gap suggests that there should be more shell rings in this area that were submerged during the Holocene marine transgression (Saunders and Russo 2011:48).

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Figure 38. Shell ring sites on the coastal Southeast show the gap of shell ring sites in the Big Bend (Russo 2010:60).

During the Middle-to-Early Late Archaic periods, the complexity involving Indigenous peoples' reactions to sea level rise and the importance of their ancestors' burial sites show signs of significance. During this time, people adapted and relocated inland away from the encroaching sea line. On the Gulf Coast of Florida, from 5,000–1,800 cal BP, evidence suggests that people were relocating to their ancestors' human-modified U-shaped dune burial site mounds made of sand, shell, or a combination of both. After their ancestors' remains were relocated further inland, the mounds became places of ritual gathering and centers of settlements. (Randall and Sassaman 2017:11).

Shell mound sites McClamory Key (8LV228), Bird (8DI52), and Butler (8DI50 and 8DI97) Islands provide insights into significant details about coastally adaptive cultures during the environmental transition from terrestrial to a marsh to open marine conditions and insights into the mortuary practices during the Late Archaic from two eroding shell mound cemeteries

(McFadden 2014:180; Sassaman 2015:1). The shell mound sites are located north and south of the Suwannee River Delta in the Big Bend (Figure 39).

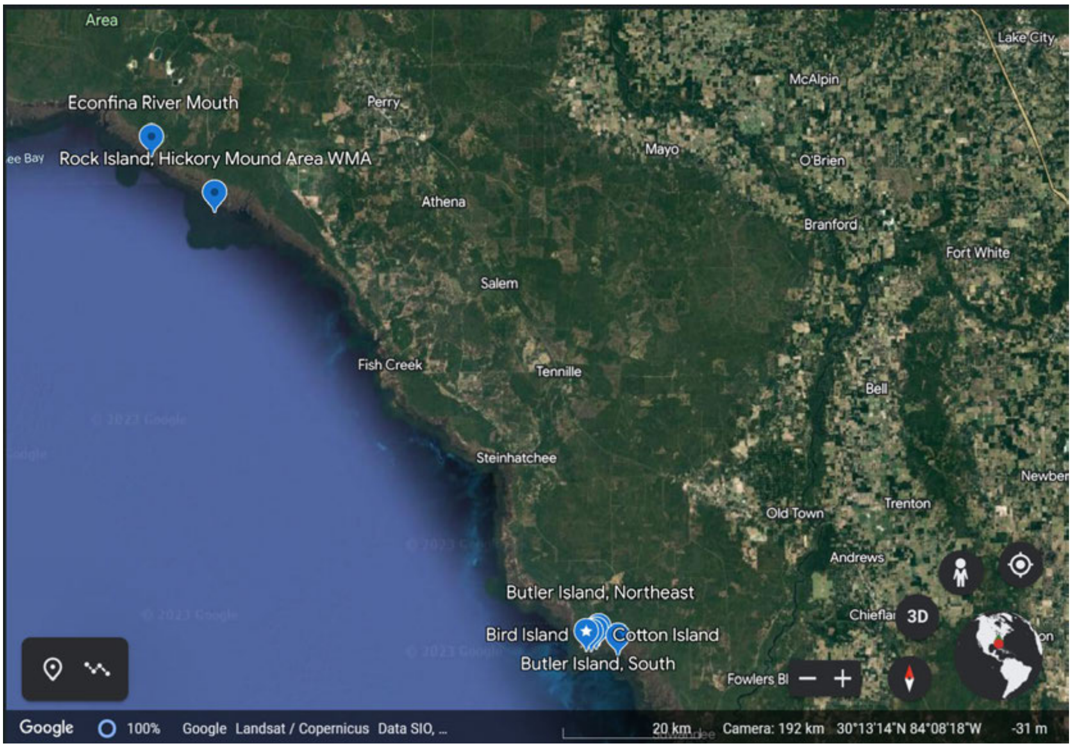

Figure 39. A map of Big Bend shell mounds showing the gap of 90 km SE from the Econfina River mouth to Bird Island (Map by Nathan Hale and from Google Earth).

Associated artifacts at the shell mound burial sites at Bird Island and McClamory Key place some of the burials chronologically from 5,000–4,500 cal BP (McFadden 2014:180; Sassaman 2015:82). Artifacts consisted of shell tools, pottery, lithic points, beads, and soapstone imported from the Appalachian Mountains. 23 minimum to a maximum of 32 individual human remains were rescued and repatriated at McClamory Key in 2013, while at Bird Island, there is consistent monitoring of the shell mound burials (McFadden 2014:194; Sassaman 2015:6) (Figure 40).

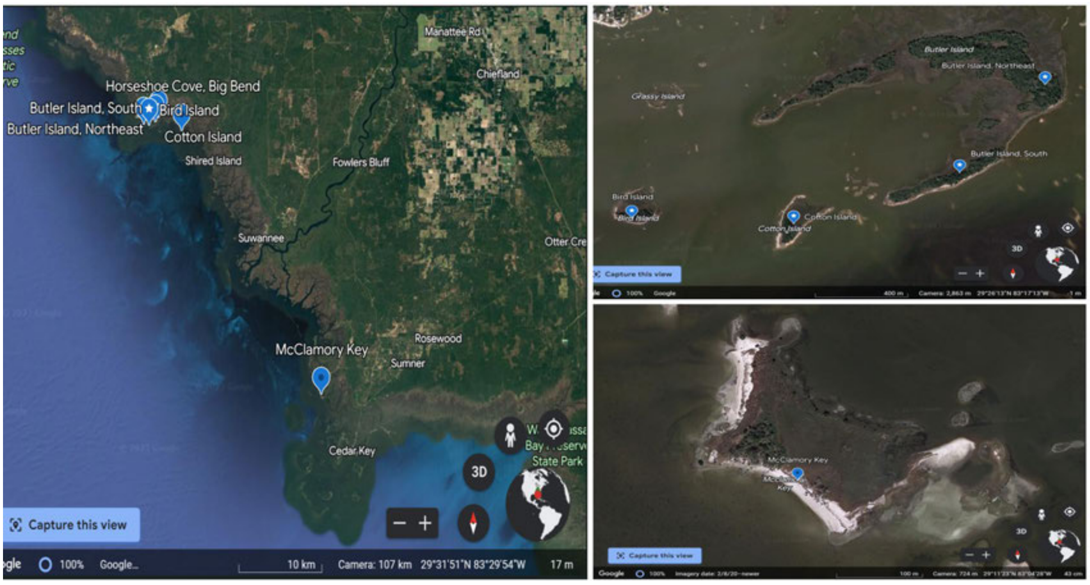

Figure 40. Shell mound sites near the Suwannee Delta (left). Bird Island and Butler sites (top right) and McClamory Key (bottom right) (Images by Nathan Hale from Google Earth).

The sediment cores collected contained evidence of several environmental shifts linked to the region's past landscape changes. The site began as a terrestrial environment and transitioned into a salt marsh over time before becoming an open marine environment. This progression reflects fluctuations in sea levels over time. These environmental shifts were directly related to archaeological data from Butler Island and provided insights into the effects of the changing environment on human activities and occupancy in the region (McFadden 2014:191, 192, 193).

An intact mound in the hammocks of McClamory Key and the mainland mound village complex Garden Patch (8DI4) just northeast of Butler Island date to the later cultural periods (650–770 cal BP) and (1,160–1,260 cal BP). Evidence shows the record of abandonment and resettlement, offering clues about ancient population movements. Despite environmental shifts and their resultant isolation from the mainland, the continual human reoccupation of these islands suggests their cultural importance (McFadden 2014:191; Sassaman 2015:9) (Also see Shell Mound and Palmetto Mound sites- Randall and Sassaman 2017:23, 24).

If this trend existed for at least 3,000 years, it supports the possibility of submerged shell mound/shell ring sites. This means that some undefined depositional areas of sites in Apalachee Bay could be highly complicated if they are well preserved. Because of the lack of any documented submerged monumental shell mound sites, archaeologists are caught in a dilemma: do they assume Indigenous people built shell monuments during the terminal Pleistocene and Early Holocene at paleo-coastlines before and during the sea transgression, or do they instead assume shell ring formation did not begin until sea-level stabilization occurred during the Middle and Late Holocene?

2.6.4.2 Poverty Point

The Poverty Point National Monument, located in northeast Louisiana, US, is also a UNESCO World Heritage Site. Its name is derived from a nearby 19th-century settler plantation (UNESCO 2014). Built-in stages, Poverty Point or Bird Mound, is a unique Late Archaic period (5,800 to 3,200 cal BP) effigy earthen works complex (consisting of earth and stone), consisting of six mounds, six concentric embankments or ridges, and timber circles (likely used as calendars) in the plaza (Howe 2014:82; Sassaman 2010:57). The embankments and the mounds were created at the end of the Late Archaic period between 3,600 and 3,200 cal BP (Figure 41, 42).

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Figure 41. Map of the Poverty Point or Bird Mound, plaza, embankments, and associated mounds, with an inset map of the Lower Mississippi Valley showing

locations of Poverty Point and Middle Archaic mound complexes (Image from Sassaman 2005:339).

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Figure 42. LiDAR digital elevation model of Bird Mound (Map from Hargrave et al. 2021:193).

The Lower Jackson Mound (5,850 cal BP) was built approximately 2,000 years before the effigy complex. Mound D (1,100–1,150 BP) was built approximately 2,000 years after the effigy complex, demonstrating that people kept coming back to the site while it contained no burials (Hargrave et al. 2021:192; Kidder 2011:111; Sassaman 2010:57). Bird Mound is an example of large-scale scope of design, planning, engineering, and long-distance (e.g., Soapstone from the Appalachia Mountains), trade networks that the Late Archaic fishing, hunting, and collecting societies could manifest. This southeastern site is significant in its size and time scale—mounds date from 5,850 to 1,150. The Econfina Channel site thrived when large-scale Late Archaic earthworks construction occurred.

2.6.5 Terminal Late Archaic Period (3,500–2,500 cal BP)

The Late Archaic period in Florida was followed by the Woodland period (3,200–1,000 cal BP), and a highly debated time frame known as the Terminal Late Archaic period is approximately 3,500–2,500 cal BP. Some archaeologists (e.g., Miller 1998) argue that people became more mobile and only used shellfish resources for part of the year. During this time, there were fewer archaeological shell deposit sites in northwest and northeast Florida, but people likely stayed on the coastline during a marine regression (Russo 2010:157). A drop would have been followed by a rise in the sea level to the below modern sea level. That would indicate that underwater sites in Florida below sea level may have been reoccupied between 3,500 BP and 2,500 BP. However, no regression at that time has been demonstrated in the coastal geomorphological record.

3.7 Summary

This chapter intended to give crucial background information on maritime archaeology, methodology, geology, environment, hydrology, paleoclimate, and cultural contexts to give vital insight into the submerged Indigenous landscapes from the terminal Pleistocene to the time of contact in the study region.

3.0 MATERIALS AND METHODS

After an initial desktop study, this research utilized maritime archaeological, geoarchaeological, and scientific diver survey methods to examine and record the potential submerged archaeological sites in Apalachee Bay, followed by data analysis, documentation, and curation. The dive surveys aimed to confirm or deny if the produced Inverse Detection Analysis (IDA) targets were areas of past human activities and to use minimally invasive techniques to do so. In the research areas, it was necessary to remove some sediment and shell hash layers to reveal anthropogenic signatures. However, leaving materials in situ was a site and environmental preservation priority.

The diver survey methods included hand fanning, mapping, artifact sampling, soil sampling, photography, photogrammetry, videography, and recorded observations. These methods aid in identifying and analyzing underwater cultural materials while minimally disturbing the site. The desktop study, data analysis, and ground-truthing site-specific investigations provided insights into the geological, environmental, and anthropogenic preservation of the submerged archaeological sites in the Econfina paleochannel.

3.1 Desktop Data Processing, Research, and Planning

Background research and August 2022 fieldwork operations were conducted and planned by the author with boat and dive tank provisions assisted by Jessica Cook Hale. Bathymetric Light Detection and Ranging (LiDAR) data of the Econfina paleochannel, Aucilla Paleo Channel, and the Ochlocknee Shoals were collected through Aucilla Research Institute (ARI) grant funding and processed in 2016 and 2021 (Figure 1, 2). In 2022, the data were analyzed by Jessica Cook Hale and then sent to Dylan Davis for further processing using machine learning to generate potential anthropogenic targets in all the LiDAR data (Figures 3, 13, 14). The study's initial blind test utilizing the IDA method detected previously recorded archaeological sites (within 50 m accuracy) and identified numerous anomaly targets that need ground-truthing (Figures 3, 13, 14). The predictive accuracy of the IDA method was attempted first at Ochlocknee Shoals and evaluated after the ground-truthing survey. The desktop evaluation involved an examination of geologic features and the specific geomorphological processes in the study area and comparing them with those found in known submerged archaeological landscapes in Apalachee Bay (See 2.2.4).

3.2 On-Site Dive Survey Methods

Dive survey methods have contributed significantly to the advancement of maritime archaeology. Using SCUBA gear has allowed divers to access and explore previously inaccessible sites, while the introduction of underwater photography revolutionized documentation practices. Underwater photography, photogrammetry, artifact sampling, soil sampling, and mapping are some methods utilized during the research dive surveys. These methods aided in identifying and analyzing underwater cultural materials while maintaining minimal disruption to the site's integrity (Green 2009:139). The same methods the research dive team used have played crucial roles in developing maritime archaeology. It should be noted that only photography, minimal hand fanning, and site monitoring observations took place at the Econfina Channel Site.

3.2.1 Hand Fanning and Circle Search

Hand fanning is a simple technique to analyze the composition and arrangement of a site to gain insight into the communities that produced it (Green 2009:141). The research team conducted hand fanning in areas of interest, a manual technique where sediment and shell matrix are gently brushed aside to expose underlying features (Faught 2004b:278; Green 2009:142). This method was used to reveal minor artifacts or to expose stratigraphic layers in a controlled manner. This technique was helpful because it exposed layers of sediment to detect paleosols, artifacts, and anthropogenic features that are indicators of past occupational use.

A circle search is an efficient visual surveying technique for quickly locating features or collecting samples of an area that has not been well documented. This method is typically used in low-visibility dives (Green 2004:55). Divers will use a graduated line, or a metered tape reel fixed to the ground, moving away from the fixed point in five to ten meters increments, depending on the visibility. The divers will take a compass bearing and search in a 360° circle until completion. Divers will double the distance for the next search if nothing is found during the survey. Limitations of this survey are overlapping (surveying the same area multiple times) and the amount of distance covered because there will be too much slack in the line at some point, or the line may get hung up on an obstacle (Green 2009:101; Green 2004:55).

3.2.2 Photography, Photogrammetry, and Videography

The research dive team utilized photography, photogrammetry, and videography to document the sites. Photography involves capturing images of underwater artifacts, features, and the overall landscape using a camera in a waterproof housing. Specific camera settings, which vary depending on site conditions (Shortis 2019:11), are necessary for underwater photography. Photography provides visual documentation of site features, materials, and environmental conditions, aiding analytical processes. Six hundred forty-two survey photographs were captured with a Sony100, Olympus TG6 camera at Newton McGann and the Econfina Channel sites.

Photogrammetry can create high-resolution site plans for underwater sites. These site plans or surfaces can then be used to create 3D models and visualizations of the site, allowing for a more detailed analysis of its structure and layout (McCarthy and Benjamin 2014:96). Photogrammetry methods were used in three focused areas at the Newton McGann site, which involved taking multiple overlapping photographs of features. The images were processed to create a three-dimensional model or an orthophoto mosaic (ortho-mosaic) of an object or sediments at a site (McCarthy et al. 2019:4).

In order to render data sets into a quality 3D image using a software package, it is necessary to have 70% or greater image overlap horizontally and 50% vertically (McCarthy and Benjamin 2014:99). One out of the three areas where photogrammetry methods were used had enough photos to render a 3D mosaic (Figure 47). Videography techniques can also be used to create 3D images. Eighteen videos with 8.5 minutes were taken during the fieldwork at Newton McGann with a GoPro HERO10 camera and 49 additional photos. The videos were extremely valuable in interpreting the site, but unfortunately, no 3D rendering was possible.

3.2.3 Artifact and Soil Sampling

In addition to visual documentation, artifact and sediment sampling techniques were employed during the research. These samples can provide valuable insights into occupational practices along the Econfina paleochannel. Artifact sampling involves collecting small samples for analysis to determine their composition, age, use-wear, and origin. At the Newton McGann site, 14 artifact samples, mainly midden shells, were collected and contained in seawater inside gallon-sized zip-lock bags.

Sediment sampling involved collection at four locations of the visible/known shell midden area. Sediments were taken from the top of the sediment column to the seafloor bedrock, approximately 10 to 20 cm deep, for further study and evidence of past human occupational activities. Sediment analysis can provide evidence for determining human occupation, including the amount and type of occupational activities. Using various methods such as pollen analysis, partial size analysis (PSA), and statistical analysis of the PSA results, sediment analysis can reconstruct past environments, determine specific human activity zones, and determine local effects from tropical storms on submerged sites archaeological sites (Cook Hale et al. 2018:4; Cook Hale et al. 2022:2; Gagliano 1982:96).

3.3 Archaeological Site Field Work Overview

Post all data processing, target areas generated from IDA for dive surveys were selected within 100 to 200 meters of the Econfina Channel site. The targeted areas have the potential to indicate past human activities, such as lithic processing and the disposal of large quantities of shellfish. The Econfina Channel site was chosen because it is a known site. The recently located shell deposits (Ward Morgan) near the Econfina Channel site indicated more potential shell deposits. Global Positioning System (GPS) instruments have been unreliable in Apalachee Bay (personal experiences). Therefore, using a known submerged site would help as a visible maker.

Plans for targeted visual diver surveys were scheduled for August 9-12, 2022. The dive surveys were a collaborative effort between Flinders University, ARI, Georgia Florida Aviation Search Team (G-FAST), National Park Service (NPS), and students from Florida State University. Able participants gathered at the Econfina River boat ramp at 9:00 AM each morning, weather permitting, to load equipment aboard the boat/s and to be briefed on dive plans.

The research team’s objective was to relocate the Econfina Channel Site and secure a buoy to be used as a reference point, then dive on selected targets generated from the computer-aided analysis of the bathymetric LiDAR near the buoy marker. Once the dive boat was positioned above a target area, divers would be deployed to determine if the selected areas contained anthropogenic signatures indicative of human habitation. The goal was to conduct three to four dives on targeted areas daily. The anthropogenic areas would be documented using site mapping, image capture, sampling, and geolocation via GPS coordinates at areas of interest.

Relocating to the Econfina Channel site has often been challenging, dating back to when dive operations resumed in 2014 (personal observations). The area is not heavily developed; thus, cell reception is not always available. Experience with handheld GPS units in Apalachee Bay has had similar results, with inconsistent outcomes.

3.4 Post-Survey Methods

3.4.1 Mapping and Spatial Analysis

Mapping is a critical methodological component in documenting submerged cultural landscapes in maritime archaeology. Mapping techniques, such as hand drawing, can be performed during the survey (mud map) or from measurements, field notes, and photography images after completing the fieldwork. Immediately following the field survey research, a hand-drawing scale map of the Newton McGann site was made. The post-survey analysis involved creating a digital map. The hand-drawn scale map was recreated on PowerPoint and overlayed on the (ArcGIS) Econfina paleochannel site map. The spatial analysis involves studying patterns and relationships within these maps, including the distribution of artifacts, cultural features, and survey activity.

3.3.5 Artifacts, Sediments Samples, Data Collection Storage, and Conservation

Artifacts and sediment samples are stored at the Florida Bureau of Archaeological Research (FBAR) in Tallahassee, Florida, and available for further study. The Geographic Information Systems (GIS), LiDAR, and photography data are stored at ARI and with FBAR, including a final report. All data are also stored in multiple personal cloud accounts and hard drives.

3.4 Summary

During circle search surveys and other dives daily, several scientific dive research methods were used to document the site. These methods included hand fanning to expose sections of the midden and the stratigraphy of the sediments and shell matrix. Other methods included photography, photogrammetry, artifact sampling, soil sampling, mapping, and observations of geological, environmental, and anthropogenic contexts.

The discipline of maritime archaeology is a rapidly evolving and interdisciplinary area of study that utilizes a variety of advanced methodologies to explore, and document submerged cultural heritage (Bittmann et al. 2022:1, 2; Elkin et al. 2023:83; Gaffney et al. 2007:1). These methods can be used individually or in concert with other techniques to understand occupational histories at submerged sites better. Technological and methodological advances like GIS have become increasingly critical in maritime archaeological research. Non-invasive or in situ methods allow for documenting and analyzing submerged sites without disrupting their integrity.

4.0 RESEARCH RESULTS

4.1 Survey Overview

4.1.2 A New Archaeological Site Detected and Located

On the third diver survey of the first day, divers observed the limestone outcrops with exposed shells scattered on the edge of the paleochannel. Abundant disarticulated oyster and scallop shells were present, crown conch shells, and apple snails (Cook Hale et al. 2023:939) (Figure 43). With this evidence, including the observation of burnt shells, the research team mistakenly determined that the Econfina Channel shell-midden site was relocated.

Figure 43. (Left) Photo of the Newton McGann shell midden at the large wing-shaped rocky outcrop (Image by Justine Buchler). (Right) Author with a Burnt oyster shell west of the rocky outcrop (Photo by Jonathan Benjamin).

After reviewing the coordinates of the shell midden using the ArcGIS bathymetric database at the fieldhouse, it was determined that we had instead located a shell midden site that had not been documented. Its location was on the edge of a large target produced from the bathymetric Light Detection and Ranging (LiDAR) data sets. The Econfina Channel site (8TA139) lies 970 m south-southwest of the newly located site referred to as Newton McGann (Figure 44). Dive plans were made to return to Newton McGann for further documentation. On the last day of research, the researchers moved from the Newton McGann site and headed 970 m southwest at a bearing of 235° and confirmed the location of the Econfina Channel site (8TA139) in relation to the Newton McGann site.

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Figure 44. (Left) Photograph taken of the laptop screen after assessing the Econfina paleochannel midden coordinates on ArcGIS at the field house; the white dots on the left are the Econfina Channel and Ward Morgan site features, the blue center circle is the Newton McGann site, and the red circle on the right is a possible shell ring site noticed while making this image. (Right) image is the bathymetric LiDAR data sets with the applied IDA method; targets are indicated in dark red, black dots on the left are the Econfina Channel and Ward Morgan sites, center black dot is the Newton McGann site, and the target circled in black on the left is a possible shell ring feature (Image by Nathan Hale 2023, maps by Cook Hale and Davis 2022).

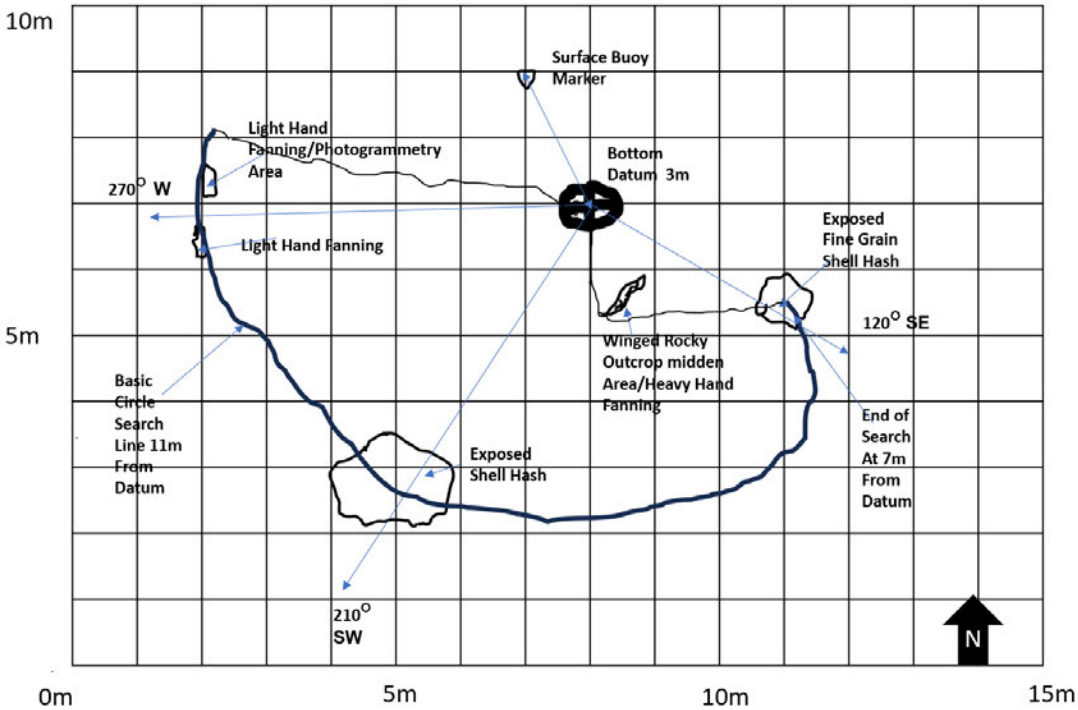

Figure 45. Map of the survey area at the Newton McGann site showing the site features, datum point, the area covered by a circle search, compass bearings, and the area where photogrammetry was used successfully (Image by Nathan Hale, 2023).

4.1.3 IDA Method Results

The survey conducted in August 2022 yielded several significant findings. A new method for analyzing bathymetric LiDAR data sets was presented in this study. Inverse detection analysis (IDA) was successfully used to identify one submerged archaeological deposit from the Holocene era efficiently, accurately, and (for the author) cost-effectively. While IDA analysis was influential in sediment-starved landscapes, it faced limitations in high sedimentation areas, as seen in the Ochlocknee study area, where dredging would be necessary to confirm anthropogenic deposits. However, the analysis successively confirmed previously recorded archaeological sites in the sediment-starved Econfina and Aucilla paleochannels within 50 meters of accuracy. It successfully detected one new archaeological midden deposit along the Econfina paleochannel. There are perhaps more archaeological sites in Apalachee Bay than have been accounted for. Considering the abundant targets produced by the IDA method, the team relocated an undocumented archaeological site on the first dive survey day, which suggests it is not random and there were more people on the landscape. Unfortunately, no radiocarbon dates were obtained, but site comparisons can be made.

4.1.4 Econfina Channel Site and Newton McGann Comparison

Locating the Newton McGann site is critical because it confirms the presence of at least two distinct sites along the Econfina paleochannel. These sites share similarities in their composition, as they both consist of shell-midden features along the margin of the Econfina paleochannel at similar depths and sediment profiles located within rocky outcrops and eelgrass beds. The sites with similar depths and less than a km apart would have experienced submergence from sea transgression at approximately the same time, indicating that both sites may have been occupied simultaneously or the Newton McGann site is an earlier deposit. Interestingly, aside from these similarities, there are also notable differences between the two sites. The differences include contrasts in the amount of lithic production, paleosol (preserved former ancient soil) color and texture, and variation in faunal assemblages.

The Econfina Channel site's lithic assemblage indicates all stages of reduction sequences in abundance, from primary core reduction evidence discarded in the quarry and freshwater seep zones to manufacturing, with tool retouch flake debitage scatter through the site (Cook et al. 2018:14; Garrison and Cook Hale:191) (Figure 46). On the other hand, the Newton McGann site showed no signs of lithic reduction, not even debitage scatter. Only one small unequivocal piece of chipped chert was recovered from within the midden materials. This difference is important because both sites had access to chert outcrops for making stone tools; only one of them shows evidence of tool production, and in the case of the Econfina Channel site, it was intensive compared to the degree of opposition (Cook Hale et al. 2018:6) (Figure 46).

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Figure 46. (Left). The located piece of chipped chert from the Newton McGann site. (Right) Lithic tools recovered from the Econfina Channel site: (a) debitage from a Bulk Sediment Sampling Station (BSSS), showing edge damage; (b) core from seep/spring feature with refitted blade tool recovered from U1 excavation; (c) multiuse unifacial tool recovered from a BSSS; (d) thumb scraper from a BSSS; scraper tool from a BSSS; (f) scraper tool recovered from surface of midden, near U1 excavation (Image from Cook Hale et al. 2018:8).

There is a notable difference in the color of the paleosols found at each site. These differences include variations in the color and texture of the paleosol. The paleosol at the landward, at the Newton McGann site, has a dark reddish-brown color, suggesting an indicative of a stream or spring margin experiencing tannic influences and freshwater, with slightly acidic conditions (Figure 47). The paleosol sediments at the Econfina Channel site are black, consistent with tidal marsh, and anoxic brackish water conditions (Cook Hale et al. 2018:12; Cook Hale et al. 2023:138, 139). The difference matters because it suggests that the locations may have been selected for different advantages or purposes, such as accessing different resources and more desirable living conditions (Binford 1980:18).

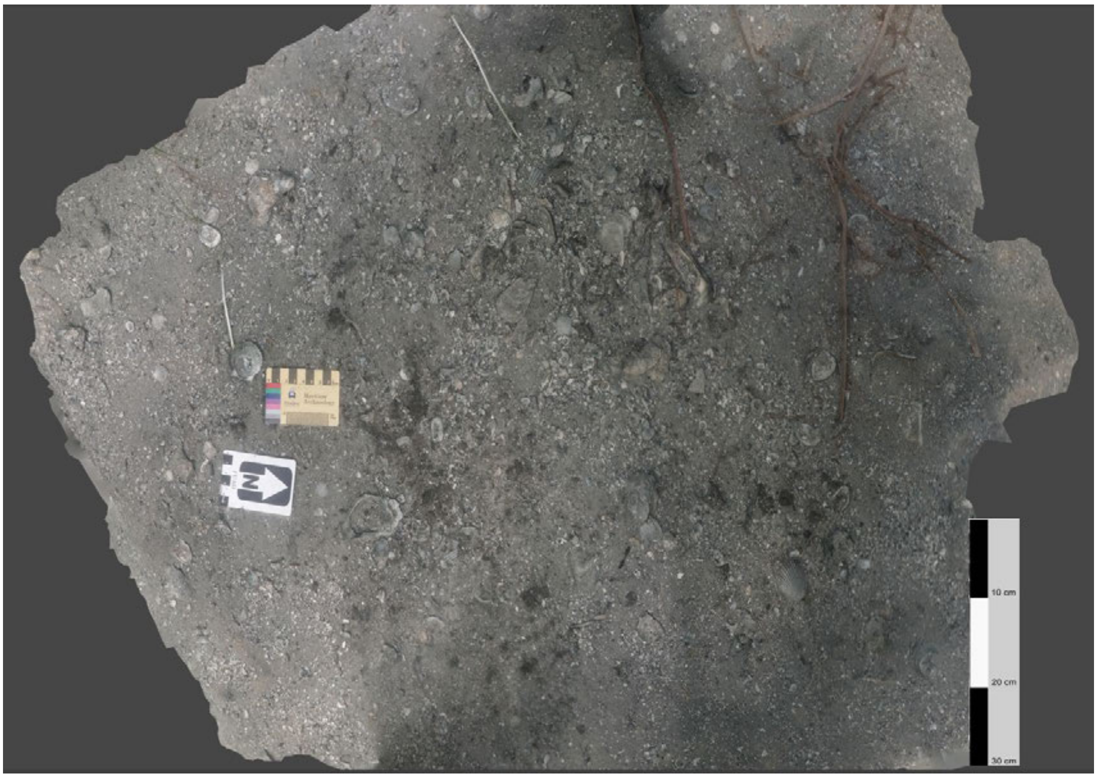

Figure 47. Newton McGann plain view of the rendered 3D vertical and horizontal mosaics 11m west of the datum beforehand fanning was done (Photos by Jonathan Benjamin 2022, image by Philippe Kermeen and Nathan Hale 2023).

The faunal assemblages observed at each site also provide insights into potential variations in subsistence procurement activities. The Econfina Channel site taxa are dominated by disarticulated oyster (*Crassostrea virginica* sp.), with scarce scallop (*Pecten sp*.), crown conch (*Melongena corona* sp.), and apple snails (*Ampullariidae* sp.) shells. In contrast, the taxa at the Newton McGann site contained abundant disarticulated oyster (*Crassostrea virginica* sp.) shells, tulip snails (*Fasciolaria tulip* sp.), limited bay scallop (*Argopecten irradians* sp.), moon snail (*Polinices duplicatus* sp.) shells, and one minor (~4 cm) sea biscuit (*Clypeaster rosaceus* sp.). Significantly, most of the oysters and the sea biscuit show indications of burning, including subsurface assemblages ruling out wildfires, while the Econfina Channel site does not have burnt taxa (Cook Hale et al. 2019:6; Cook Hale 2023:939) (Figure 48).

Figure 48. (Right) Burnt oyster shell samples (Images by Nathan Hale). (Left) Shell hash midden deposit (photo by Jonathan Benjamin).

The differences indicate the possibility of different procurement tasks being designated at these locations. The Newton McGann site possibly focused on cooking procurements, then what has been observed with Econfina Channel site taxa. This difference is interesting because the Econfina Channel site has an abundance of charcoal scattered throughout the midden and quarry zone indicated through the partial size and statical analyses, and it was determined to be likely from anthropogenic fires (Cook Hale 2018:17). The Econfina Channel site may have similarities to the Fitch site, where indications of intentional and controlled lithic tool heat treating occurred (Faught and Donoghue 1997:444).

These differences in lithic evidence, paleosol, and faunal assemblages indicate potential variations in the tasks and procurement carried out at each site. The abundance of lithic materials interdigitated with the shell-midden zones at the Econfina Channel site suggests that the site was used for multiple tasks or activities, such as tool and resource procurement, production, processing, and in a marshier environment less desirable as a living area. While the Newton McGann site showed fewer variations in tasks and perhaps had a focused one. The burnt disarticulated oyster shells and the sea biscuit suggest human subsistence production activities, possibly cooking and smoking food sources in an area that was more riverine and perhaps had more tree cover being further inland.

4.1.5 Summary

Overall, the survey results are significant, indicating that at least two separate sites along the Econfina paleochannel less than one kilometer apart exhibit similarities and differences in their characteristics. However, the differences are stark opposites of one another. One has indications of a residential base, and the other show clear signatures of heavy productivity in the procurement of tool and food resources and is akin to a workstation (Binford 1980:18). The choice of similar geographical contexts and depths suggests that both sites experienced submergence around the same time. However, they may have been used for different subsistence procurement tasks and not used contemporaneously. Suppose these sites were used at the same time by the same people. In that case, it is an excellent example of the concept of cultural landscapes because it shows a broader picture of how people made choices in the location of specific areas designed for optimal use across the landscape at that time instead of tethered to just one occupational area.

5.0 DISCUSSION

Integrating Inverse Detection Analysis (IDA) and trained scientific SCUBA (driver) archaeological surveys can potentially advance the study of submerged archaeological sites. By combining the semi-automated IDA method with detailed driver evaluations, researchers can accurately locate and verify archaeological anomalies detected in bathymetric light detection and range (LiDAR) data sets. Using these methods allows for a more comprehensive understanding of submerged cultural landscapes and provides valuable insights into past human activities and adaptations in coastal environments. The effectiveness of the IDA method in predicting the locations of sediment-starved, shallow-water cultural sites has some validation through this study. The successful detection of documented archaeological sites in Apalachee Bay with 50 m accuracy and the identification of an additional anomaly target, such as the Newton McGann site and the Econfina Channel site, demonstrate the potential of IDA as a predictive tool for identifying submerged cultural sites. The data set is small, and more testing is necessary.

This research has also shed light on the characteristics and purposes of these archaeological sites, revealing a contrast between high activity at the Newton McGann and Econfina Channel sites and limited findings at the Ochlocknee Shoals. These findings suggest that the purposes and tasks of site occupation can vary significantly within similar geographical contexts, offering new insights into how ancient cultures utilized and adapted to their environments. The high-resolution landform identification potential of IDA demonstrated in this study may surpass the capabilities of conventional offshore diving methodologies. By providing improved object classification capability, IDA potentially allows for more precise identification and analysis of submerged cultural features.

Integrating IDA and scientific diver surveys addresses several limitations and challenges traditional maritime archaeological methods face. For example, the IDA method enables researchers to analyze large bathymetric LiDAR data sets systematically and reproducibly (Davis et al. 2020:376). The IDA method reduces interobserver error and implicit biases in object detection procedures, leading to more reliable and consistent results (Davis et al. 2020:377). Additionally, diver surveys allow for direct and detailed examination of archaeological anomalies identified through IDA. Combining the efficiency of semi-automated data analysis with the detailed observations and documentation provided by divers can result in a comprehensive and accurate assessment of submerged archaeological sites.

The effectiveness and minimal destructiveness of this research approach make it a valuable tool for future exploration of submerged cultural landscapes and anthropological research to understand humanity's past and promote its preservation. This study highlights the potential applications of IDA and diver surveys in examining submerged archaeological sites. The integration of these methods has shown success in identifying and verifying archaeological anomalies, providing insights into site characteristics, purposes, and variations within similar geographical contexts. These findings emphasize the importance of utilizing advanced technological methods, such as IDA, to enhance our understanding of submerged cultural landscapes and their significance. In today's rapidly changing world, the significance of accurate and timely weather forecasts cannot be overstated.

Similarly, the significance of advanced methodologies like IDA cannot be understated in maritime archaeology and research on submerged cultural landscapes. These methodologies allow for more precise identification and analysis of submerged cultural features, improving our understanding of human history and cultural practices. Semi-automated methods like IDA and scientific SCUBA surveys can potentially address some of the limitations and challenges faced by traditional maritime archaeological methods, such as time-consuming manual analyses and limited accessibility to underwater sites (Davis et al. 2020:378). Integrating IDA and scientific SCUBA surveys in this study has demonstrated effectiveness in identifying archaeological anomalies and highlighted the potential for their broader application in future underwater archaeological research.

Upon examination of the Econfina Channel and the Newton McGann paleochannel sites, it becomes evident that although the two sites have notable similarities, perhaps due to submergence within the same geographical area and withstanding similar environmental conditions, their uses appear to diverge substantially based on lithic, paleosol, and faunal evidence. The analysis reveals that these two sites likely served different functions, perhaps even within the same culture. As Binford (1980) demonstrated in the forager collector spectrum, separate designated areas are often used for different subsistence strategies. This strategy is indicated at the Econfina paleochannel sites, showing a complex, nuanced landscape use, hinting at the socially and environmentally contextualized decisions the culture may have made.

Concerning the Econfina Channel site, the paleosol data suggests that it was in a marshier environment, indicated by black paleosol indicative of anoxic or brackish water conditions. The Econfina site has its unique place, discernible from the evidence of in-depth lithic production. It reveals an intensive use of the location, possibly as a "workstation" for toolmaking and resource procurement. The evidence of all stages of lithic reduction sequences and debitage scatter highlights the site's importance for tool manufacturing. Burnt shells are not found at the Econfina Channel site, but charcoal is abundantly found, indicating the potential for heat-treated lithic methods like the evidence found at the Fitch site. The Econfina Channel site must have played a critical role in the inhabitants' day-to-day life beyond a shell-gathering and shell-chucking area. The Ward Morgan site, approximately 175 m north, may likely have been another work area because it has a quarry zone near the paleochannel.

Conversely, with its reddish-brown paleosol, the Newton McGann site might have been influenced by fluvial or spring freshwater and tannic conditions, fitting a more human-friendly living area. The variation in paleosol color indicates differences in environmental conditions and resource accessibility, providing further insights into site selection and usage. The lack of lithic reduction at the Newton McGann site further supports the hypothesis that the site might have been more specialized, perhaps more for habitation and less for the function of an intensive workspace. It could also speak to a different temporal occupation, meaning the inhabitants of the Newton McGann site might not have been producing lithic tools at the time of their occupation. So, this variation potentially points towards a differential allocation of tasks and functions between sites. The Newton McGann site also provides evidence that leans more toward food procurement and preparation. Its faunal assemblages point towards broader subsistence activities. The presence of burnt oyster shells reinforces this premise, suggesting human activities related to food preparation, such as cooking or smoking.

Although no radiocarbon dates were obtained at the Newton McGann site, the Econfina Channel and the Newton McGann sites may have been used concurrently. They may yet portray a duality of human adaptation and utilization of the landscape seen through the shell midden features, proximity, and subsistence practices such as shellfish collection and consumption. If so, the inhabitants likely shared a cultural connection, understood their environment, and exploited it carefully, selecting suitable locations for specific activities. The preference for coastal-rich environments that would have been abundant in food resources and materials for toolmaking were optimally utilized before being abandoned due to sea transgression. Likely, the people did not just retreat from the Econfina Channel site to the Newton McGann site because both sites are at the same depths, and relocating to a higher elevation would have been a likely choice.

Significant parallels to these submerged sites can be seen when comparing them to the other terrestrial shell mounds in the Big Bend, such as Bird and Butler Islands, which gives a deeper understanding of how ancient cultures used, interacted, and adapted with their landscape. All these locations were important to people, and cultures prised and cherished these landscapes because they kept coming back. We know that the people relocated back to the shell mound sites at Bird and Butler Islands sites even when they were removed from the mainland, where new and protected areas were occupied (McFadden 2014:194). In the case of the Econfina Channel site, there was either a long-term occupation or people kept returning to the location many times over a long period. Either way, people were attracted to these locations, and this research located a meaningful one.

The IDA evaluation identified 30 locations of archaeological interest in the Econfina and 31 locations in the Aucilla paleochannel areas with 50 m accuracy. One has been investigated (Newton McGann) and is only on the edge of a significantly sized target/anomaly, possibly a village, furthering the necessity for more surveys. The implications indicate possible intensive human occupation and activities on a broadscale cultural landscape covering a lengthy timeline (terminal Pleistocene to the Late Holocene).

The semi-automated analysis of bathymetric LiDAR data proved to be a successful method for identifying previous submerged archaeological deposits with reasonable accuracy, and the diver survey methods are justified by locating one and collecting data from it, resulting in a significant analysis. This research was completed at a low cost (for the researchers), in less time, and in a minimally destructive manner compared to traditional maritime archaeological methods. Further research is scheduled in August 2023 to ground truth IDA targets on the Aucilla and the Econfina paleochannels using Scientific diver surveys.

6.0 CONCLUSION

The novel integration of these methodologies has showcased the potential for similarly innovative explorations in other geographic locations, furthering our collective understanding of cultural adaptations to underwater environments. With reasonable accuracy, the successful detection and verification of archaeological anomalies dating from the terminal Pleistocene to the Late Holocene may bear testament to the effectiveness of the Inverse Detection Analysis (IDA) method in predicting locations of sediment-starved, shallow-water cultural sites. This research has expanded the role of technologies like IDA beyond mere predictive toolkits to invaluable allies in academic and cultural endeavors to comprehend, conserve, and unpack the mysteries of our shared submerged historical landscapes. As such, the findings punctuate a potentially critical role of the IDA and similar technologies in shaping the future trajectory of archaeological exploration and reinforcing our shared commitment to cultural preservation.

Using Inverse Detection Analysis and trained scientific SCUBA (driver) archaeological surveys may prove more valuable in examining submerged archaeological sites, particularly in Apalachee Bay, Florida, and the Gulf of Mexico, US. By identifying and verifying anomalies detected from bathymetric LiDAR data sets, this study has successfully located and documented several significant archaeological sites dating from the terminal Pleistocene to the Late Holocene with acceptable accuracy. These findings validate the potential effectiveness of the IDA method in predicting the locations of sediment-starved, shallow-water cultural sites.

Integrating IDA with scientific diver surveys has provided a comprehensive understanding of these sites by examining their characteristics and purposes. This research has revealed a stark contrast in site occupation purposes and tasks within similar geographical contexts, shedding light on how ancient cultures adapted to their environments before and during periods of sea level change. This research is essential because there has been little focus on the earliest occupations in the region, which are likely submerged due to sea level rise. In conclusion, IDA's high-resolution landform identification potential demonstrated in this study may offer significantly improved object classification capability over conventional offshore diving methodologies. This research shows that the IDA method may be an invaluable tool for future exploration of submerged cultural landscapes and anthropological research in an efficient, precise, low-cost manner. The potential applications of Inverse Detection Analysis and scientific diver surveys extend far beyond the Apalachee Bay region.

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