

FORMATION PROCESSES OF SHIP SITES IN THE BLACKWATER
RIVER, SANTA ROSA COUNTY, FLORIDA

by

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ABSTRACT

FORMATION PROCESSES OF SHIP SITES IN THE BLACKWATER RIVER, SANTA ROSA COUNTY, FLORIDA

William Joseph Wilson, II

The Blackwater River in Santa Rosa County, Florida, is host to numerous ship sites, many of which relate to Pensacola's historic brick and lumber industry. Since the 1980s, the University of West Florida and Florida's Bureau of Archaeological Research have been documenting these sites, which are generally preserved well as a result of the low-speed hydrodynamics and high-tannin content of the river. In this thesis I examine the site formation processes of these sites, including a thorough analysis of natural and cultural forces. The data include previous historical and archaeological research, environmental data, side-scan sonar imagery, and diver reconnaissance. In addition to providing a greater understanding of sites in the Blackwater River, I hope this information plays an integral role in future site management strategies.

CHAPTER I

INTRODUCTION

Nautical archaeologists emphasize the study of formation processes and understanding the natural environments of the sites they are studying. Most notably, this approach has been used to understand the spatial relationships and presence or absence of artifacts (Muckelroy 1977). Although very useful for the interpretation of wreck sites, this approach leads to a focus on the end-product attributes of site formation rather than the processes, thus acting as mere descriptions of formation processes for use as explanatory devices (Ward et al. 1999:561). By focusing on the products, the analysis cannot be predictive; it merely describes the currently-observed state of the site. In order to make future projection of preservation and risks, other strategies must be employed.

Another methodology emerged years later which used a process-based (as opposed to a product-based) approach to site formation (Ward et al. 1999). This method divided the processes into four distinct (but interacting) groups: physical, biological, chemical, and anthropogenic. Each of these factors operates in some manner to affect the degradation of a site over time, but change in one can elicit change in another. The primary benefit to viewing formation through this model is that it can be predictive, which is invaluable for site management and monitoring. Additionally, this model can provide information about the initial formation of a site.

Site management is at the forefront of the nautical archaeological endeavors of state and federal agencies, as it is an important part of the responsible stewardship of sites. By using a process-based site formation approach, this research sought to provide a framework for managing several sites in the Blackwater River, as well as for understanding present and impending risks. This kind of work is imperative since noticeable degradation has been occurring

on sites in this area (Greg Cook 2012, pers. comm.). Underwater environments are incredibly complex, so understanding the environment and its relationship with submerged sites should be paramount. Thorough understanding of deteriorative factors and patterns is necessary for successfully mitigating their effects in the future.

Several questions framed this thesis. First, what was the state of preservation at each of the sites? What were the environmental conditions at each site? These questions are addressed by elaborating on the geography of the project area in Chapter 2. Projection of possible risks posed by environmental factors was also important. This was partially determined through examination of what happened to the sites since previous documentation efforts. Some changes were obvious, such as the disarticulation of structure or the movement (or removal) of large recorded artifacts from sites. Chapter 3 describes the previous archaeological work on these sites, and thus assists in indicating the amount of change over time. Chapter 4 answers what behavioral processes led to site creation and alteration by exploring the sites through a behavioral archaeological framework. Methods used and data collected during this study are presented in Chapter 5. Finally, Chapter 6 provides a discussion of all the information in this thesis, ending with a set of recommendations and conclusions.

How to proceed from the information gleaned in this research project was an important component of this study. In some situations, such as the raising of the CSS *Georgia* in 2015, emergency data recovery is warranted (Steve James 2015, pers. comm.). However, in most situations the proper course is in situ monitoring and preservation. All things tend towards degradation over time, but intervention is an option in slowing down that process. Strategies for conservation and protection of sites can be pursued as needed. Treatments must be prioritized according to the measures appropriate for the level of cultural significance attributed to each site.

To address the goals in this thesis, I relied on site formation analysis as a theoretical background. Site formation processes, at their most basic level, were originally broken down to “c-transforms” and “n-transforms” by Michael Schiffer (1976). This simple breakdown separates cultural processes of deposition and alteration (c-transforms) from natural (or non-cultural) processes (n-transforms) that have affected a site through time. Cultural processes include activities such as reuse of materials and the intentional destruction of structures. Natural processes are non-human actions: faunal, floral, geological, etc. Problems emerged from this model, however, since processes which might be considered natural such as sedimentation (or erosion) can sometimes be directly linked to human activities. This method was created to assist Schiffer in the development of his behavioral archaeology paradigm, and so his objective with site formation analysis was to improve interpretive power. However, the method lacks the ability to successfully ascertain risk factors working against the preservation of sites.

Nautical archaeologists have contributed much to the study of site formation processes (Muckelroy 1976, 1978; O’Shea 2002; Gibbs 2005:52, 2006), especially as it relates to the interpretation of archaeological scatters, which is probably due to the highly-dynamic nature of underwater environments. Muckelroy (1978) changed maritime archaeology with his studies on site formation processes, and he emphasized the importance of understanding the site within its environment. Instead of c- and n-transforms, he used “scrambling devices” and “extracting filters” as the mechanisms of site transformation. Scrambling devices are literally the forces which scramble materials, such as wave actions and water currents. Extracting filters include salvage and degradation, which remove things from a site. Interestingly, this approach ignored the human/non-human split established by Schiffer. Extractive forces and scrambling devices can be natural (e.g. the disintegration of perishable materials) or cultural. Like Schiffer, Muckelroy

was primarily interested in explaining the spatial relationships and patterns of artifacts at a site. His work has been very influential in this respect, but in order to better understand the processes at work on a site (and make predictions based on them), an improved framework was desirable.

David J. Stewart (1999) has more recently cautioned against oversimplifying marine site formation processes. Maritime archaeologists tended to focus only on site formation via the wrecking process of ships, relying heavily on Muckelroy's interpretations. Subsequently, many ignored the subsequent possible formation processes that can occur at submerged sites with regards to sediment deposition, biology, and anthropogenic activities such as dredging.

Out of this need to better understand site-altering forces was developed the process-oriented approach. Ingrid Ward, Piers Larcombe, and Peter Veth (1999) altered the natural vs. cultural process dichotomy into four groups that interact with each other: physical, chemical, biological, and anthropogenic factors. The authors' purpose was to shift the objective of site formation investigations from the descriptive, product-based strategy to a process-oriented one that could be used to predict the fate of sites. The approach was initially employed to study the wreck environment of HMS *Pandora* on the Great Barrier Reef, but this method was also effective in understanding arid and semi-arid sites in Northern Australia (Ward et al. 2003). This model was the most appropriate for my research since it could be used to understand ongoing processes and patterns of change at a site. Information resulting from this project informed recommendations for site management.

Those with backgrounds in geophysics have developed methods for monitoring sites over time through the use of side-scan sonar and multi-beam bathymetry (Quinn 2006; Quinn et al. 2007; Quinn et al. 2010; Bates et al. 2011). Although not all organizations have access to expensive remote-sensing technologies, they can be cost-effective means to make repeated site-

integrity assessments and track changes. Archaeologists with knowledge of the geosciences have made important developments in process-oriented site formation research. Quinn (2006:1419) brought attention to the relationship between a site's micro-environment and the outside forces which transport sediments, chemicals, animals, and other materials into and out of the environment. Quinn's time-lapse method of remote sensing was approximated in this study by comparing new data with earlier surveys from the Blackwater River. This provided an additional line of evidence for morphological changes to the sites through time.

In some cases, archaeologists have enlisted the help of experts in other fields to understand site formation processes. C&C Technologies investigated a deep-water shipwreck in the Gulf of Mexico with the assistance of marine biologists (Warren et al. 2004). The wreck, designated DKM U-166, was studied by employing an ROV, which took samples of rusticles (stalactite-like formations that occur in some marine environments when iron oxidizes) for analysis. In addition, an experiment was conducted by placing metal strips at the site for 48 hours in order to determine the on-site rate and types of bacterial growth. Interdisciplinary approaches to assessing site environments are useful for understanding the formation processes of submerged sites. This research project relied on consultation and prior research by other departments and agencies.

Chemical processes are a primary factor in the preservation of submerged sites, but archaeologists do not always incorporate chemical studies of on-site conditions into their analyses. Money, resources, and time are always issues, but the problem may also stem from a lack of understanding. Brian Jordan (2001) researched and compared several chemical aspects that affect the preservation of wood on submerged sites. He found the most important factors were dissolved oxygen (anaerobic environments are ideal), hydrogen-ion concentration (pH),

redox potential, and salinity. Chemical factors play a role in site dynamics in other ways as well. Salinity and dissolved oxygen determine what type of life can exist in a particular environment. Redox potential affects how much sediment (of particular grain sizes) can accumulate before oxygen is unable to reach lower levels of the sediment column, and therefore at what level anaerobic environments will form. The effects of pH on the corrosion potential of metals are well-established (Ammar and Riad 1958). These chemical aspects are in turn affected by physical processes such as the mixing rate at the water's surface due to wave action. Similarly, the mixing rate of the top levels in the sediment column due to hydrological regimes affect sediment chemistry. This illustrates the complex interplay of principal components at work in the submerged site environment.

This project involved the investigation of site formation processes at five submerged sites in the Blackwater River and Blackwater Bay. The Blackwater River begins in southern Alabama, and continues through Okaloosa County into Santa Rosa County, finally emptying into Blackwater Bay, which is a part of the Pensacola Bay System. Because of its location, this area of the river is affected by coastal tides and hydrological regimes. It is a tannin-rich, brackish-water environment, and the sites involved in this study had similar but differing on-site conditions. Bottom sediments ranged from fine to coarse grain depending on the location. This river was not selected because of its environment exclusively, but that was an important part of choosing this area for study. The other reason for its selection was the large number of sites located within it. This resulted from the importance of water-based infrastructure in local industries throughout the area's history.

Due to the complex nature of each site and the amount of data gathered, I chose to focus on five submerged sites (Figure 1). All had been surveyed, and some had undergone intense

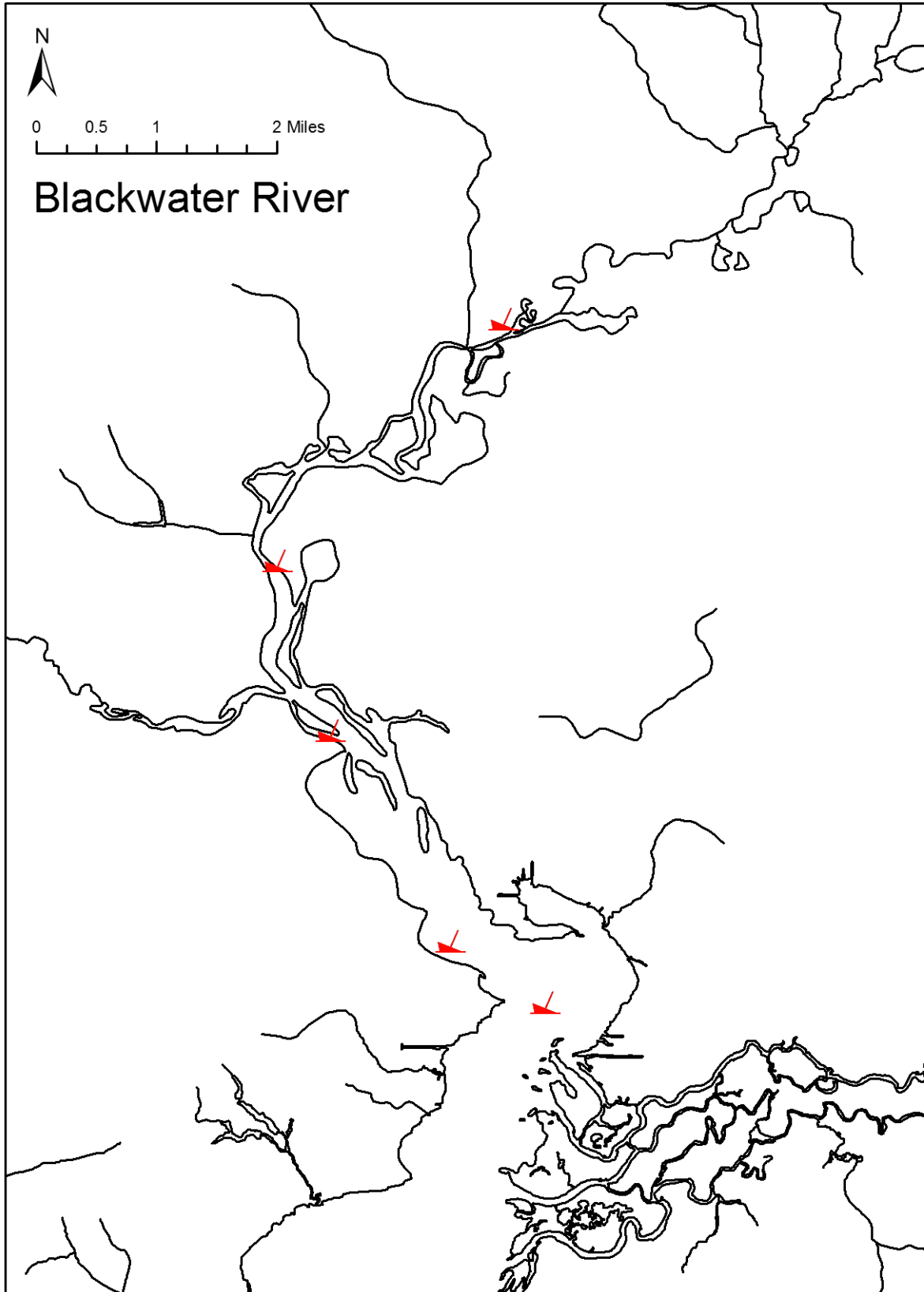


Figure 1. Map of sites. (Figure by author, 2015.)

documentation. These sites were selected based on two factors: historical/archaeological significance and location. Historical/archaeological significance was based on the integrity of the site itself or its importance historically. Location was a factor because I wanted to emphasize the variation in site environments from one location to another. Selecting sites side by side (such as the Shield's Point vessels) would have obscured the diverse settings that constitute this relatively small area of river and bay. Using previously investigated sites provided the additional benefit of adding previous baseline data from which to draw comparisons later in the analysis. These sites included the Bethune Schooner (8SR985), the Swingbridge Wreck (8ES1488), the Snapper Wreck (8SR1481), *Guanacaste* (8SR1492), and *City of Tampa* (8SR1490).

In terms of methodology, this research has broad implications for submerged sites in the region. When new sites are found in the Blackwater River, the results of this research can be used to recognize related environmental risks and preservation factors. Speaking more broadly, this information will be useful in understanding situations of similar site environments, as well as in providing comparative data for conditions at other sites. This research will serve as a reference for any study of the formation processes of submerged sites in this area, and will add to the general corpus of archaeological data on site formation processes.

The sites studied here are all of historical significance due to their roles in Pensacola's and the surrounding area's thriving industries based on nautical and riverine infrastructure. Preserving these sites is important for historians, archaeologists, and, particularly, area natives, whose identities are strongly linked to the histories represented by each of the sites. The ultimate goal is to assure the best management practices through considerations of risk factors and appropriate treatments. Enduring protection from anthropogenic factors (looting, dredging, boat traffic, etc.) through support of outside organizations will continue to be of vital importance.

CHAPTER II

GEOGRAPHICAL SETTING

The geography of the Blackwater River and its tributaries is a fundamental aspect of the formation and alteration of sites within it. In order to get an accurate view of a site or region, researchers must conduct some geographical background research. Examining an area geographically is a holistic way of studying many of its interacting forces, such as geology, ecology, the atmosphere, and hydrology. In relation to the Blackwater River, obvious factors play into the preservation of sites, such as the tannin-rich water and low currents in the southern portion of the river. Other components are more difficult to ascertain, such as occasional deleterious events (e.g. flooding, which produces sudden surges of current, and can create large shifts in the chemistry and ecology of the river environment). Included in this section is a map of the Pensacola Bay System and its location in Florida (Figure 2) and a map of the project area with the names of affiliated water bodies (Figure 3). This chapter discusses the streams and catchments as well as related fluvial processes.

The Blackwater River is a fluvial environment. Fluvial is a term that deals specifically with rivers or systems dominated by running water (Waters 1996:115), and are referred to generally as streams. In such systems, the term “stream” refers to channel-constrained water, and although the term is popularly used to describe a particular type of waterway that is usually smaller than a creek, streams in fluvial environments are not dependent upon size. For the purposes of this research, the word “stream” is used in the hydrographic sense, not the popular usage.

Fluvial environments are not only important as hydrological resources (providing food, water, and even a method of transportation), but are also the primary movers in changing the

shape of the landscape. They, more than any other geomorphological process, form the Earth's surface. Geomorphologists have noted not only the importance of rivers and other streams in altering environments, but also that humans place a disproportionate amount of focus on this particular geomorphic process (Doehring 1978:402). Activities such as channel dredging and damming (which can be used to create lakes and control the rate of flow) play a part in the management of rivers around the world, and dredging activities have likely impacted sites within the Blackwater River.

In order to understand the river, one must also understand the contributions of its surrounding environment, referred to as the catchment ecosystem, which affects the river's chemistry, biology, geology, and hydrology. The catchment (or watershed) is composed of all areas contributing to the river system which are isolated from other catchments topographically (Petts and Foster 1985:8). Anthropogenic formation processes factor in since changing landscape use caused erosion of sediments in the catchment system, which were subsequently deposited into the stream bed and along the banks. These anthropogenic contributors will be further explored in Chapter 4.

The project area starts about 3 miles northeast of Milton on the Blackwater River, after two of its main tributaries—Big Coldwater Creek and Big Juniper Creek—empty into it. Farther south, Pond Creek and Yellow River intersect with Blackwater, providing even greater flow. The river then discharges into Blackwater Bay, which merges with East Bay, a part of the greater Pensacola Bay System. The river level of the project area is thus highly affected both by the amount of rain in the river's catchment and tidal regimes. This mixing of the two forces (freshwater from upriver and saline water from the bay) creates an interface with warm, saltier water on the bottom and cool, freshwater on the surface, which is often observable by divers.

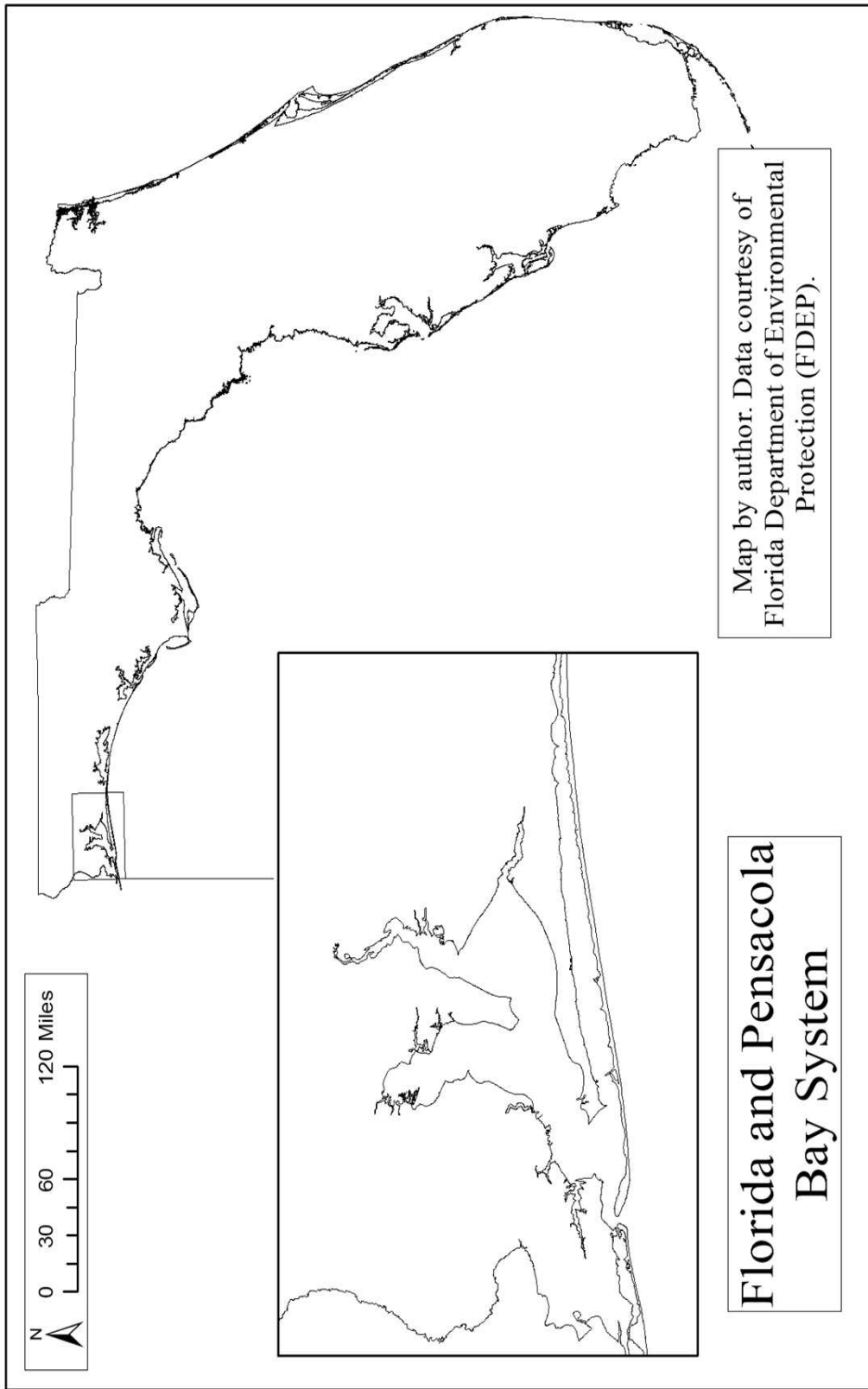


FIGURE 2. Map of Florida and Pensacola Bay System. (Figure by author, 2013.)

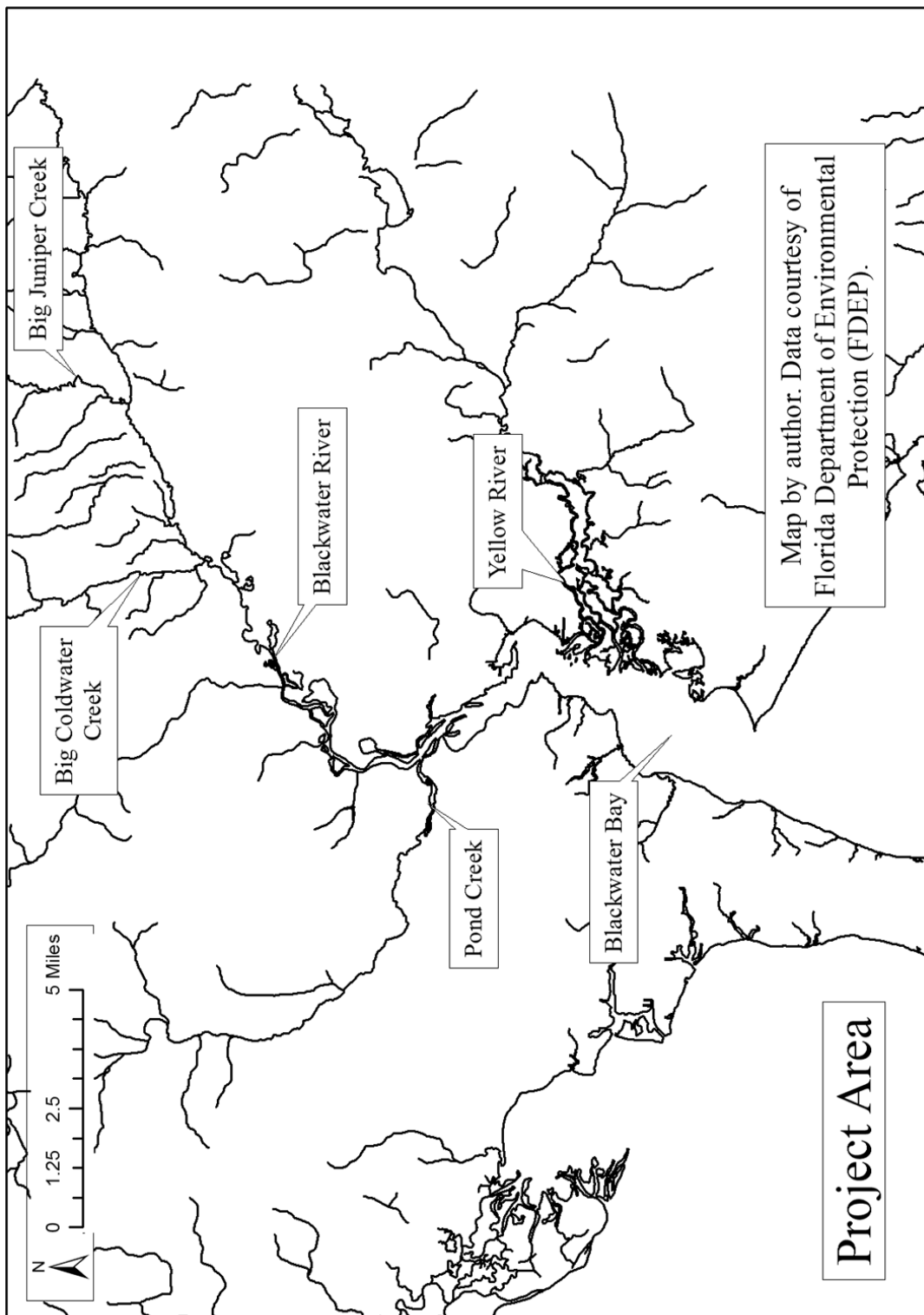


FIGURE 3. Project area. (Figure by author, 2013.)

Visibility is often low, ranging from 0 to 5 ft. (0 – 1.52 m), because of the high content of tannins. Occasionally there is an easing of the amount of tannins in the water, resulting in up to 10 ft. (3.1 m) of visibility for divers.

Geology

The Blackwater River drainage catchment area is part of the larger East Gulf Coastal Plain physiographic province, which stretches from Eastern Louisiana to the western portion of the Florida Panhandle, and reaches north into portions of western Tennessee and Kentucky (Fenneman 1938; Hunt 1974). The sediments which cover the project area are part of the Citronelle Formation, which were deposited about one million years ago as a result of alluvial activity during the Plio-Pleistocene (Puri and Vernon 1964). High-energy streams moved clays, sands, and gravel onto the coastal plain across wide alluvial fans, and simultaneously carved channels and ravines into the region's predominately flat topography.

During the Pleistocene, the Earth's most recent ice age, climatic shifts created glacial and interglacial periods, which lowered and raised the world's sea level over the course of several episodes (Phillips 1989:3–8). During periods of lowered sea levels the streams increased in speed, deepening the channels and increasing topographical relief. During interglacial periods the areas flooded with the advancing coastline, and stream activity slowed. This resulted in the deposition of upland sediments, heaping sands and clays into valley areas. During these interglacial periods the prominent features of the Pensacola Bay System, such as barrier islands and the mouths of bays, were formed.

Within the larger Coastal Plain, the Blackwater River catchment drains two subdivisions of the physiographic region: the Coastal Lowland and the Western Highland (Marsh 1966). A plateau that tends southward composes the Western Highland, while nearly level, dissected

plains make up the Coastal Lowland Subdivision (which is less than 100 ft., or 30.5 m, above sea level). The Western Highlands, however, are more than 290 ft. (88.4 m) above sea level at the headwaters. The primary portion of the Blackwater Drainage is a stream that runs eastward as opposed to north-south. Four southward-running, dendritic, parallel drainages feed into the main stream. This main stream may be the remains of a relict sound into which the other four unconnected streams flow (Phillips 1989:3–8).

The soils that make up this drainage area can be categorized into four main types, which are composed of several soil associations (Weeks et al. 1980). The first are sandy, droughty soils located chiefly in the Western Highlands. These soils, known as the Lakeland-Troupe association, are well to excessively drained, and provided areas for timber production. The second type are well-drained soils with loamy subsoil, which are also found in the Western Highlands. They are found on nearly level to undulating hills as opposed to the rolling sand hills with narrow bottom lands of the Lakeland-Troupe association. These soil associations are named the Red Bay-Lucy, Dothan-Orangeburg, and Troupe-Dothan-Bonifay associations. Unlike the Lakeland-Troup association, these soils are well-suited to agriculture. The next soil type is poorly to very poorly drained sandy and loamy soils, which are located in both the Coastal Lowlands and Western Highlands. These soils, the Pactolus-Rutledge-Mulat association, formed on gently sloping areas. While soils in this association are not suitable for agriculture, they are appropriate for pastureland and timber production. The final soil type is located in the floodplains and low plains in the Blackwater Drainage, and are characterized (as one might imagine) as prone to flooding. These soils are in both the Coastal Lowlands and Western Highlands physiographic subregions, and belong to the Bibbs-Kinston-Johns association. Unlike the other soil types in the catchment area, these are not suitable for any agricultural activities.

Hydrography

The Blackwater River itself has a drainage area of 860 mi.² (1,384 km²), 580 mi.² (933 km²) of which come from Santa Rosa County. It discharges 1,490 ft.³ (454 m³) per second (cfs or cms) into the Blackwater Bay; 1,100 cfs (335 cms) of the flow is exclusively from Santa Rosa County (Musgrove et al. 1965:51). The river runs south, southwest, and finally curves south again just before it reaches Milton. At this point the river becomes broader, slower, and gradually deeper (Boning 2007:52). As the river opens up into Blackwater Bay, the banks become marshier and the river is most affected by tidal regimes, which affect the river almost 14 mi. (22.5 km) north of Blackwater Bay. These tides are minimal, diurnal tides that average 1.1 ft. (0.34 m) amplitude (Lewis 2010:7). The primary species of trees located along the banks and surrounding forests are longleaf pine, cypress, dogwood, and water oak (Boning 2007:53). The tidal portions of the river are affected by anthropogenic processes, with considerable development along the river historically, including the prominent brick and lumber industries and the establishment of the communities of Bagdad and Milton.

The largest tributary that flows into the Blackwater River is Big Coldwater Creek with a total drainage area of 241 mi.² (388 km²). The average flow as recorded by the Florida Geological Survey is 542 cfs (165 cms), of which 517 cfs (157 cms) comes from Santa Rosa County (Musgrove et al. 1965:49–50). The amount of discharge for Big Coldwater Creek is closely tied to the amount of rainfall, thus in March and April, during periods of intense spring rain, the discharge also increases. This is also true for July and August, while October is the month with the least amount of discharge (Musgrove et al. 1965:51). Several species of oak (including swamp chestnut, laurel, and live), juniper, magnolia, water tupelo, and pine trees line the banks. It is a shallow creek with a fine sandy bottom, and has infrequent sandbars and

logjams which break up the current. Agricultural fields produce runoff of sediments, nutrients, and pesticides, which are fed into the Western Fork tributary of the creek, while the East Fork is much less affected by anthropogenic forces (Boning 2007:48–49).

Big Juniper Creek is another large tributary feeding into the Blackwater River, entering about five miles northeast of Big Coldwater Creek. Its drainage area is 146 square miles (234 km). Its average flow is 260 cfs (79 cms), from which 240 cfs (73 cms) originates in Florida. A little more than half of the flow comes from base flow—the water that seeps in from mostly groundwater sources—and the rest comes from drainage (Musgrove et al. 1965:51). This tributary is—because of its groundwater sources and surroundings composed mostly of park land (Blackwater River State Forest)—largely unaffected by anthropogenic processes from farming or development. Like Big Coldwater Creek, Big Juniper has plenty of water tupelo, water oak, and magnolia trees, but it is surrounded by sizable longleaf pine forests (Boning 2007:50–51).

The Yellow River, which empties into the project area at the Blackwater Bay, is actually the largest river system in the project area. The river begins in Covington County, Alabama, and is joined by its major tributaries including Lightwood Knot Creek, Clear Creek, and Five Runs Creek (Boning 2007:62). Its watershed is roughly 1,200 mi.² (1,931 km²), with Florida housing 700 mi.² (1,127 km²) of it. This dwarfs the Blackwater River and its tributaries. While no sites in this study are located within the Yellow River itself, it plays a vital role in the ecology of the lower Blackwater River. Additionally, it impacts the site environment of the *City of Tampa* directly, emptying into the bay just east and southeast of the site.

The bottom morphology of the Blackwater River is rather variable in terms of depth. During fieldwork, the observed depths in the channel ranged from 6 ft. (1.8 m) to 60 ft. (18.3 m) in the lower 8 mi. (13 km) of the Blackwater River. Some deeper portions are the result of

naturally recessed areas in the river, but the deepest part of the channel is located at the Milton Railroad Swingbridge. The deep depression directly beneath the swinging bridge is likely scoured during flooding events when stream currents run faster than normal.

Sedimentation

Sedimentation is an important part of site formation, as increased sedimentation at a site can create a preserving environment, while erosion can expose sites, inducing physical, chemical, and biological changes that dramatically increase the degradation of a site. Of all the natural site formation processes, Ward et al. (1999) place primacy on sedimentation and erosion. The simplest way to visualize the process of sedimentation as it relates to hydrography is via the Hjulstrom diagram (Figure 4). This straightforward diagram demonstrates the relationship between velocity of flow, erosion, transportation, and sedimentation. It explains why fast-running rivers have sandy bottoms, and why clay and silt bottoms shift as flow velocity slows near alluvial fans.

One way of measuring sedimentation is through lead-210 analysis (Pb-210). Through this method, the scientist can determine the amount of sedimentation over a century (Flett 2009). As uranium-238 in the soil decays, it eventually becomes a gas and ends up in the atmosphere. The product is Pb-210, which maintains a stable population in the atmosphere through time. It returns to the sediment via precipitation and adheres to soil particles. The decay of Pb-210 to polonium-210 gives researchers a way to date when the Pb-210 left the atmosphere, and thus a way to date sediments. For marine archaeological sites, researchers use this data to estimate average sedimentation rate per year, as well as long-term trends through time.

Jane Caffrey and William M. Landing (2013, elec. comm.) measured a 0.35 cm/year (0.14 in./year) linear accumulation rate for the top 15 cm (5.9 in.) of sediment in Marquis Basin

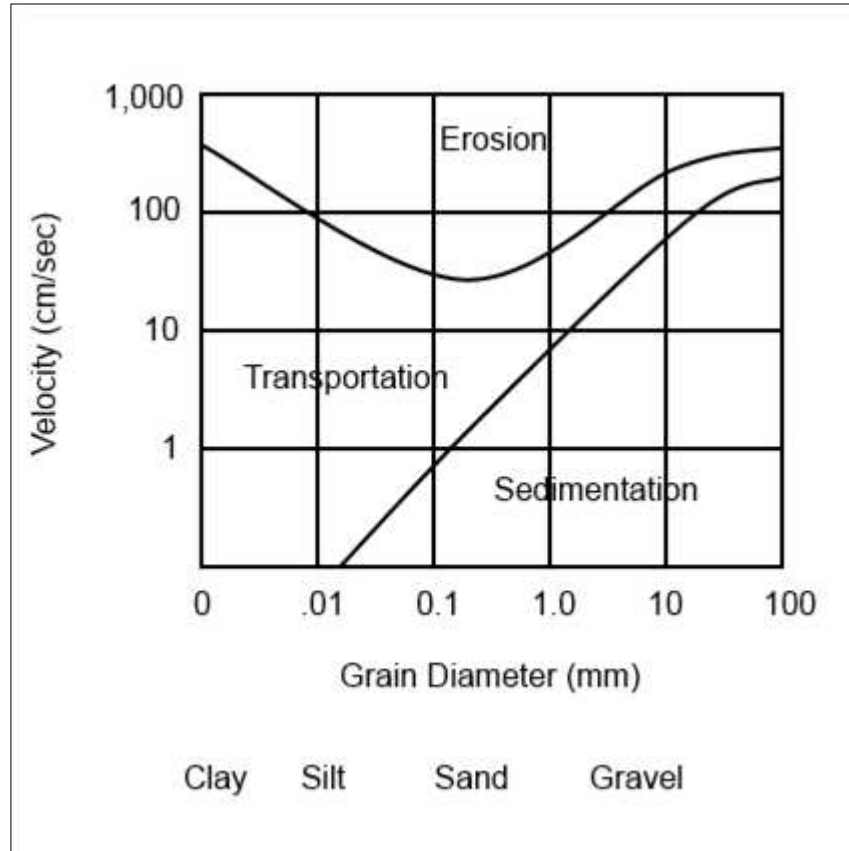


FIGURE 4. Hjulstrom diagram. (Adapted from Herz and Garrison 1998:24.)

in 2010. Below that, the Pb-210 signal was undetectable. Marquis Basin is an ideal place for this analysis, as it is a protected location within the project area that retains a steady accumulation of sediment through time, without heavy erosion from channel activity. This data points to a relatively slow accumulation of sediment in the area over time, although unfortunately sedimentation could not be quantified for more than about 40 years ago. Roughly 20 miles west of the project area, in the Escambia River Delta, Landing and Caffrey (2013, elec. comm.) found a sedimentation rate of 0.48 cm/year (0.19 in./year).

Sedimentation in both areas has been influenced by historic logging. Logging along rivers, and subsequent deforestation, is a major component of landscape alteration and sediment accumulation in fluvial systems (Petts and Foster 1985:1). Logging activities have played a

strong role in the changing morphology of the river. With the excessive amount of deforestation during the lumber booms in the 19th and early 20th centuries, washout from the river's catchment area has likely caused incredible sedimentation in some areas.

Biology

The shipworm is an enemy of all wooden ship sites in warm, marine waters, and even though their absence has been assumed by others (Sjoldal 2007:86; Pickett 2008:4), the shipworm does have some presence in the project area. They likely only survive in Blackwater Bay, where salinity is higher, and probably only during periods of little rainfall, which allows salinity levels to rise. In a 1978 report on fauna in the Pensacola Bay System, focused primarily on estuarine species, Cooley (1978:71) notes the presence of two wood-boring mollusks found during the survey. Scientists conducted the survey from 1961-1963 at several locations across the system, and while they had no stations in Blackwater Bay, Cooley (1978:2-3) asserts that fauna are essentially the same as those in Escambia Bay.

Surprisingly, the teredo worm (*Teredo navalis*) was not present in the survey, which is interesting due to the ubiquity of the animal throughout marine waters, and the evidence noted on many ship sites throughout the Pensacola Bay System. It is the species most blamed for the absence of timbers on shipwrecks, yet the biologist recorded not a single one. This is likely related to the bias in sampling, since they could only be found when looking at wood. Targeted studies would likely produce greater numbers of this species.

Another relatively common wood-boring mollusk, the wedge piddock (*Martesia cuneiformis*), was not well-represented in the survey of fauna. Cooley ranked it as an uncommonly recorded species, as it was not regularly caught, and found only in small numbers. Additionally, the wedge piddock was found only in high-salinity (>20‰) areas. However, the

author regarded this as unexpected. The numbers could well be higher than the data represented in the study (Cooley 1978:71).

Finally, the little-known “Gould's shipworm” (*Bankia gouldi*) seems to be the most common shipworm in the Pensacola Bay System. Scientists found them in benthic water, feeding on submerged wood. They were common in higher salinity zones, but only rarely found in intermediate salinity (10-20‰). Benthic waters in Blackwater Bay fall within this intermediate salinity zone during portions of the year, and recorded salinity levels from this thesis research are reported in Chapter 5.

Of the three species, Gould's shipworm is the most likely to be present in the project area, if the data from this report are representative. This could certainly explain the current state of timbers on the Shield's Point schooner barges, which are covered in worm holes both outside and within the ship. It also explains the extant timber on *City of Tampa*, which is only present for areas which were likely covered by sediment until more recently (the frames and planking only project to less than a foot proud of the riverbed, while machinery, the boiler, and other metal components project three feet or more). These organisms likely migrate in during times of higher salinity, but their numbers are lowered during periods of rainfall.

Although many species are present on the sites across the project area, few have considerable impacts on the sites themselves. Algae is present on many of the sites, particularly Swingbridge, which is most likely the result of nutrient expulsion from the Milton Wastewater Treatment Plant directly across the river. Fish are attracted to the sites, but even sheepshead, which may chip timbers as they eat barnacles, have few effects on them (although, fish do bring fisherman, which can occasionally and inadvertently harm sites, as discussed in a later chapter). Bacteria do have an effect on artifact taphonomy, but species and amounts are currently

unavailable. Some of the information on bacteria is inferred from data gathered in this project presented in Chapter 5.

Hurricane Return Cycles

Efforts should be made not only to know how storm events affect sites, but also to determine the level of endangerment they cause. One way of establishing this is by examining return cycles. The analysis of return cycles aims to predict how often certain natural events occur on average. This, in turn, gives the researcher an idea regarding how many times that natural event (e.g. a flood) will occur over a period of time. Sites in this project are particularly vulnerable to hurricane events, so including return rates on hurricanes informs long-term management strategies.

Hurricanes are significant contributors to sedimentation and erosion in the Blackwater River. They completely scour some areas to hardpan sediments (such as the shell hash at *City of Tampa*), while simultaneously depositing material in other areas. Sites can be completely destroyed or scattered, and previously accessible sites can be blanketed with sand and silt. Besides wind and surge damage, hurricanes bring substantial amounts of rain, temporarily causing dramatic increases in stream discharge. The highest peak of discharge over the past 50 years was 23,900 cfs (7,285 cms), a direct result of Hurricane Georges in 1998 (Lewis 2010:11). Compare this with the previously recorded average of 1,490 cfs (454 cms).

The National Oceanic and Atmospheric Administration (NOAA) accounts for hurricane return cycles by calculating return rates for specific locations along the coast. To make the calculation, they find the average number of hurricanes (of various intensities) that come within 50 nautical miles over the course of 100 years (National Oceanic and Atmospheric Administration 2013). For instance, if a coastal city has a major hurricane (Category 3 or above)

return rate of 25 years, it means that 4 hurricanes of that magnitude passed within 50 nautical miles of the location over 100 years. From this, one can predict that 4 major hurricanes will pass within those boundaries in the next century on average.

The Pensacola Bay area has a hurricane return rate of 10, and a major hurricane (greater than 96 knot winds) return period of 28 years (NOAA 2013). For Fort Walton Beach, the return period for major hurricanes is only 22 years. This means that hurricanes will pass within the vicinity of sites in the project area once a decade. Since the project area is between Pensacola Bay and Fort Walton Beach (although closer to the former), major hurricanes will pass through the area every 22-28 years. Luckily, the area is somewhat protected by land and Santa Rosa Island (a barrier island). As a photo (Figure 5) from Milton after the hurricane of 1916 illustrates,



FIGURE 5. Photograph from Milton after the 1916 hurricane. (Courtesy of the University of West Florida Special Collections Department, University of West Florida, Pensacola, FL.)

however, the location is still assailable (McGovern 1976). Hurricanes continue to affect the sites. A remote-sensing survey conducted after Hurricane Ivan (2004) showed that two sites in the Shield's Point locus were covered with more sediment than before (Sjoldal 2007:98).

Conclusion

This chapter revealed the primary geographical constituents of the Blackwater River catchment which may affect sites in the project area. The geology, hydrology, chemistry, and biology interact and subsequently impact archaeological sites. Investigating the broader geography of the project area informs the archaeologist about recurring and potential site formation processes. When studying fluvial systems, the researcher must remember that rivers are open systems, and if one is to determine what factors are at play, one must learn what enters and exits that system, how fast, and how often. Managing archaeological sites responsibly requires holistic approaches in order to predict future impacts.

CHAPTER III

PREVIOUS ARCHAEOLOGICAL INVESTIGATIONS

Prior to this investigation, a great deal of research went into each of the five selected sites. Work ranged from the late 1980s and continued to the execution of this project. All vessels were documented during the Florida Bureau of Archaeological Research's (BAR) Pensacola Shipwreck Survey (PSS) (Franklin et al. 1992). Subsequent, site-specific research has been the result of student projects, usually thesis research. These investigations formed the foundation for planning this project, as well as provided data for broader site analysis and interpretation.

The BAR survey located 15 ship sites in the Blackwater River (Franklin et al. 1992:150). Local residents knew many of the sites, and played an important role during the reconnaissance phase. The survey was part of an ambitious, statewide plan to find and document submerged cultural resources in Florida. This project was critical following the passage of the Abandoned Shipwreck Act of 1987 (Franklin et al. 1992:iii). Part of the scope of work was to provide baseline data for future management plans, which was successful as demonstrated through current research in the Blackwater River.

In addition to local informants, BAR conducted remote-sensing surveys of the project area to locate sites. A long-range navigation (LORAN) system provided positioning data with accuracy within 0.1 to 0.25 nautical miles offshore, but was considerably less accurate inshore due to irregular signal transmission over land and water. The University of West Florida (UWF) Division of Anthropology and Archaeology has since recorded accurate positions on many of the sites using modern GPS technology. A proton procession magnetometer allowed archaeologists to locate ferromagnetic anomalies associated with potential historic sites and/or ship components

(e.g. ship fasteners, anchors, and ballast). Side-scan sonar provided acoustic imaging of the marine floor, showing both sonar anomalies and bottom conditions. Due to the ability of side-scan sonar to provide photograph-like representations, archaeologists can easily interpret objects with potential cultural significance.

Following the BAR survey, UWF conducted additional remote-sensing surveys in the Blackwater River. A magnetometer investigation of the Shield's Point area was one of the major campaigns (Sjoldal 2007:38). The data yielded the location of three previously undiscovered sites, which were later documented using non-intrusive archaeological survey methods. UWF continues to survey the Blackwater River as part of the summer archaeological field methods course and ongoing research projects. Additional research goals included refinement of previously known sites using sonar imagery to enrich existing information. These sonar data provided comparative observation in this research.

The following sections describe the archaeological research histories for each of the sites investigated beginning with Bethune Schooner and ending with the *City of Tampa*. Previous research summarized through theses and reports laid the groundwork for this project. These descriptions reflect the material available at the time of writing this thesis. Graduate student research underway on *City of Tampa* will soon produce a site-specific thesis, and should be referenced when available for up-to-date research on the site.

Bethune Schooner (8SR985)

Located on the margin of a slough known as Morton's Basin (connected to the Blackwater River), the Bethune Schooner has not likely been forgotten since it was originally abandoned in situ. In February of 1988, Warren Weeks originally notified the Florida Division of Historical Resources (DHR) about the site. Within the month, DHR personnel Roger Smith,

James Dunbar, and Phil Gerrell visited and assessed the site. They determined the vessel to be a 19th-century schooner of historical significance (Baumer 1990:11). The site was named after John Bethune, the owner of the adjacent property.

Smith and Dunbar returned to the site with Steve Richardson, Warren Weeks, and Bill Mills in April of 1988 (Baumer 1990:11). As heavy vegetation covered the wreck, the crew cleared the site and brushed sediment off the starboard rail cap, transom, topside, and windlass. Smith documented the site on video, and the crew measured the overall length (LOA) and breadth of the ship. The charred timbers from the bow were removed from the site and later stored at Weeks' home.

David Baumer (1990) documented the site with a team of volunteers during July of 1989. He executed the documentation of the vessel using a sophisticated system of survey measurements based primarily on a longitudinal baseline. The baseline stretched from the pawl post at the bow to the center of the transom. In addition to traditional baseline-offset strategies (where a point is referenced using a measurement perpendicular to the baseline), he triangulated points by measuring from two points on the baseline. Further recording relied on measuring from established points and measurements from the waterline.

Baumer (1990:15) wrote that the most of the hull was intact. It ranged in depth from -2 ft. (0.61 m) to -13 ft. (3.96 m) below the waterline, and much of the portside of the vessel was covered in sediment and vegetation. Along with being located away from the channel, he attributed burial to the vessel's excellent preservation. The measured length was 96 ft. (29.26 m), a beam of 25 ft. 11 in. (7.9 m), and an estimated draft of 6 ft. 9 in. (2.06 m). Baumer (1990:26) used the United States tonnage law (used from 1789 to 1868) to calculate a tonnage of 93.2 tons.

The vessel maintained many intact features. Baumer (1990:15) recorded three hatches with preserved coamings, pawl post, and an opening formerly fitted with a cabin house. Other fittings included chain plates, dead eyes, and eye bolts, and remaining machinery comprised the windlass, bilge pump, and parts of the fore fife rail winch. Construction of an adjacent boat dock resulted in the burning and removal of timbers and ship components to create extra space; the report specified no construction date for the pier. Although badly charred, these objects were mostly undamaged. The archaeologists returned portions of the knight heads, port hawse pipe, bull's eye, gammon iron, and a wrought iron strap that the land owners had previously burned and removed after destroying portions of the bow to make way for the dock (Baumer 1990:18).

Overall, Baumer extensively documented the vessel during his month on the site in 1989. This allowed comparison with several candidates for vessel identities, but none fit the description perfectly. The most plausible candidate was the *Hornet*, which was listed in a deed from 1866 from Jackson Morton to his son (Baumer 1990:26-27). However, as the deed states that the vessel sank in the Blackwater River, Baumer believed that the *Hornet* could not be the Bethune Schooner. Even with the extensive research accomplished, Baumer (1990:30-31) recommended further architectural documentation and test excavations inside the hull. Such excavations would produce both line drawings and construction plans. He presented five primary aspects to record: outboard starboard profile; inboard profile; deck plan; reconstructed rigging plan; and structural joints, fittings, fasteners, and machinery. He felt the surrounding area should also be surveyed for cultural materials that may be associated with the vessel.

Milton Railroad Swingbridge Hull (8SR1488)

The Milton Railroad Swingbridge Hull (Swingbridge Wreck) was first documented by archaeologists during the PSS (Franklin et al. 1992). The report does not state how the vessel

was located during the survey. Local informants likely identified and reported it, as portions of the stem assembly are visible above the water during extreme low water levels. During the survey archaeologists performed a brief assessment of the site but no in-depth investigation (Franklin et al. 1992:180).

Among their observations were basic measurements (using a longitudinal baseline with the zero point at the bow) and identification of materials. The vessel measured 61 ft. (18.6 m) long, but lacked a beam measurement due to vessel distortion. The ship listed radically to port (at a 65 to 70 degree angle), with many timbers crushed or warped. Iron fasteners held hatches in place on the deck, and caulking filled gaps between deck planks made of pine. The archaeologists noted a 1.5 ft. (0.5 m) diameter hole in the deck at 31 ft. (9.5 m) on the baseline, an unidentified iron concretion at 32 ft. (9.8 m) on the baseline, and a steering station at 52 ft. (15.9 m) on the baseline. This station, which had turned 90 degrees from center due to disarticulation, had an iron wheel with a bronze nut.

The currents in the river channel, which affect the sternmost section of the vessel, were noted by Franklin et al. (1992:180-183). Nearby dredging compounds these effects on the site, as does navigational traffic in the river. Although the site was considered threatened, they only recommended that the site should be measured with “cursory construction features noted and identified” (Franklin et al. 1992:183). With the information recorded, they could only state that the vessel was probably 19th or 20th century, and may have been dragged to its current location from elsewhere.

Documentation later continued under UWF’s Maritime Field School. Fieldwork proceeded during the summers of 2010-2012. In 2010, the vessel was recorded using a longitudinal baseline. During a few site visits in 2011, students recorded additional

measurements using the previously established baseline. In 2012, under the field direction of graduate student Marisa Foster (2013), students re-recorded the site using a newly established longitudinal baseline tied to two supplementary baselines (Figure 6). Four datum points (constructed of PVC pipe) were placed on the site and referenced to the baseline. From those, Foster used the direct survey

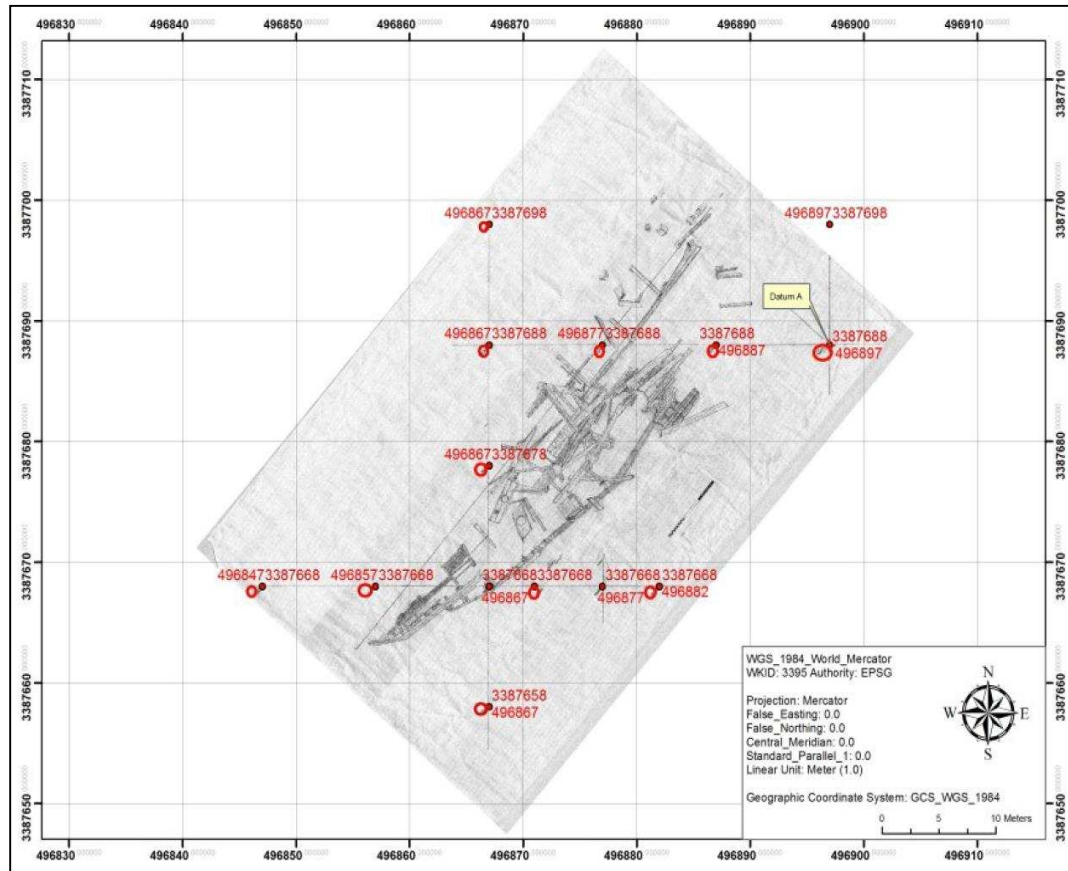


FIGURE 6. Georeferenced site plan of Swingbridge Hull (Foster 2013:70).

method (DSM) and Site Recorder software to triangulate three-dimensional measurements for several locations on the hull. DSM relies on measuring from at least three datum points to each recorded point in order to establish its position in space. These points produced a representation of the site—with x, y, and z coordinates—more accurate than basic baseline-offset methods.

Foster also removed artifacts such as iron fasteners and bottles for documentation and

conservation. Many of the mobile artifacts (such as bottles) were assumed to be intrusive and post-date vessel loss (Foster 2013:88).

Unfortunately, even with a thorough documentation of the site, no vessel candidate was found. Foster attributed the loss of the vessel to an accidental fire while the ship was docked. She extrapolated this from the presence of charred timbers towards the aft of the ship. The condition of the vessel did not facilitate accurate measurements of length, width, or draft—all necessary components for determining the ship's identity. No attributes of the vessel's construction led to a time period association for the vessel better than the one produced during the PSS. Due to the preponderance of intrusive artifacts, Foster could determine no reliable *terminus ante quem*.

Foster (2013:86) suggested future field work to address unanswered questions. Her magnetic contour map (based on a diver-held magnetometer survey from 2012) indicated several areas of interest. In addition to these areas, she believed test excavations would expose informative ship architectural features and artifacts. Using an induction dredge would uncover intact structure from the port side of the vessel, which is buried in the sediment. Foster (2013:89) stated that the vessel was in a state of relative equilibrium with the environment, particularly the buried components.

Snapper Wreck (8SR1481)

Like the Bethune Schooner, the Snapper Wreck has probably been known to locals since its original abandonment, which is how the site was found during the PSS (Franklin et al. 1992:158). Locals referred to the site as a “snapper ketch,” although the authors of the report thought it was more likely schooner or cutter-rigged. The vessel measured 68 ft. (20.7 m) LOA with a 22 ft. (6.7 m) beam. The schooner's hull was found to be in good condition with the exception of the stern. The survey report recommended that additional work be done, since the

vessel was of historical significance due to its presumed association with red snapper fishing in the Gulf of Mexico. They also believed that the site was in danger of perishing. The site is near the channel, and the authors concluded it would degrade quickly over time.

UWF continued work on Snapper Wreck in May 2001 under Florida BAR 1A-32 archaeological research permit number 9900.27 (Raupp 2004:2). The purpose of the continued work was to determine whether or not Snapper Wreck matched the construction style of a fishing vessel of the time. The site was still in great condition with many structural components intact, and most of the site was still exposed above the sediment. This allowed for extensive documentation of the site without the need for excavation (Figure 7). Students under the direction of graduate student Jason Raupp quickly mapped features and the extents of the hull using baseline offset measurements (Raupp 2004:77-80). This survey utilized a longitudinal baseline down the centerline of the vessel as well as a sheer baseline. Divers tied the sheer baseline to the portside hull planking of the vessel. The survey team gently hand-fanned to expose and record buried features. Although the site was recorded using metric tape reels, Raupp later converted dimensions to feet and inches for comparative purposes. Due to the low visibility conditions at the site, Raupp recorded only one usable video. From this video, which was recorded on the preliminary dive, Raupp pulled several still images for his thesis.

In addition to baseline offsets, divers probed the sediment to determine the buried extents of the site (Raupp 2004:80). The first intent was to determine if other timbers in the vicinity of the vessel were physically connected to it. Probing also located several anomalies in the site vicinity. Because the anomalies were one to three feet below the sediment, and dredging equipment or other excavation methods at the site were not being utilized, the anomalies were not uncovered.

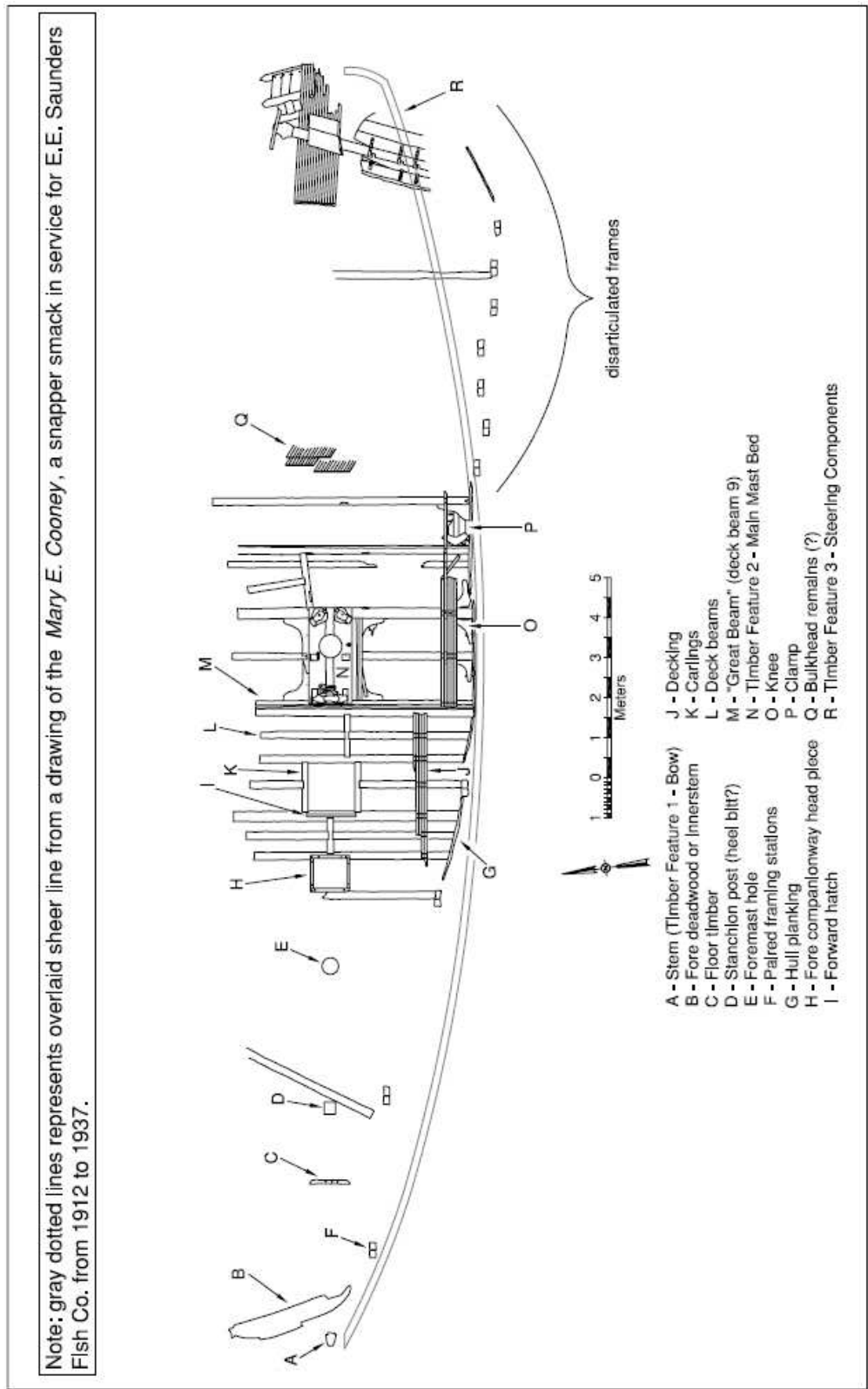


FIGURE 7. Site plan of Snapper Wreck (Raupp 2004:82).

Overall, the site was recorded with a 33 m (108.27 ft.) LOA, and a 7 m (22.97 ft.) maximum beam. Although that beam measurement closely matched the record from the PSS report (22.97 ft. vs 22 ft., respectively), the LOAs were significantly different (108.27 ft. vs 68 ft.). Like the Swingbridge Wreck, Snapper Wreck's remains listed considerably, approximately 60 degrees to starboard. The buried portions of the starboard side were intact and preserved beneath the sediment. Students detailed many structural elements of the vessel including the keel, stem, sternpost, frames, deck beams, carlings, and knees.

The site contained several artifacts which were removed during the investigation (Raupp 2004:126-132). These provided clues to the age, construction, and use of the vessel. Artifacts included a bronze gudgeon fastener, a deck light, two iron drift pin fragments, two copper tack fragments, a snap case bottle base, and one piece of copper sheathing. Archaeologists documented the artifacts (storing them in fresh water to preserve them), and later returned most of them to the site. Roy A. Whitmore analyzed and identified several wood samples from the vessel, all of which were known to be used in the construction of vessels in Massachusetts (Raupp 2004:124). The artifacts and vessel construction provided a *terminus post quem* circa 1850 and a *terminus ante quem* circa 1935. From the information gathered, Raupp concluded that the vessel must have been constructed in New England before transferring to the Gulf of Mexico. *Guanacaste* (8SR1492)

Guanacaste is one of the Shield's Point vessels located just north of Bay Point. This vessel was once highly visible, but is now disarticulated and submerged below the river's surface. Because of exposure over the waterline at low tide, these sites (now excluding *Guanacaste*) have never left the collective memory of boaters and residents on the Blackwater River. Although no longer one of the vessels visible from the surface (those are *Palafox*, *George T. Locke*, and *Dinty*

Moore), *Guanacaste* was still visible above the waterline with articulated deck planking during the PSS (Franklin et al. 1992:165). Gordon Wells originally identified the ship as *Guanacastle*, which is the same spelling used in the PSS report (Franklin et al. 1992:179). However, the vessel's name was written as *Guanacaste* in two other interviews as well as a thesis (Sjoldal 2007:22), and this thesis utilizes the latter spelling as it has been adopted by local archaeologists.

The vessel was so well preserved during the PSS that even the weather deck was present. Due to the hazard that fasteners and the degraded deck presented to divers, they only recorded basic measurements of the vessel. Combining field measurements with an aerial photograph, they were able to produce a basic site plan which included the hatches. The ship measured 160 ft. (48.77 m) LOA and 32.5 ft. (9.91 m) at the beam. BAR archaeologists collected two wood fragments, and Lee Newsom at the Florida Museum of Natural History later identified them both as *Pinus* sp (Franklin et al. 1992:179). The hard group pine family includes longleaf and the local variety of yellow pine. The two samples had such similar growth rings that Newsom asserted they could be from the same tree or group of trees.

Franklin et al. (1992:179-180) determined the four Shield's Point vessels were all in the lumber trade. Although similar in construction, all exhibited unique histories. They recommended further research on the vessels as a group, particularly because of their local significance. This recommendation led to future research by UWF graduate students in the following decade.

Paul Sjoldal (2007), a UWF graduate student, took a nomothetic approach and studied the four Shield's Point wrecks as a group as opposed to focusing his research on an individual site. This was the answer to the recommendation made in the PSS report, and it relied on field work done by the UWF maritime archaeology field school in 2003. During that field season

students recorded the four Shield's Point vessels using a mixture of DSM and baseline-offset measurements (Sjoldal 2007:38-40). The original goal of the field season was to excavate the vessels and record all preserved structure. Due to difficulties with acquiring dredging permits, the strategy changed to non-intrusive survey of exposed ship structure. Although the ships were salvaged after abandonment and burned to the waterline, their lower hulls remained intact. This allowed for plenty of useful information about the vessels' architecture.

By the 2003 field season, the deck of *Guanacaste* had collapsed (Sjoldal 2007:65). This was a terrible loss to the well-preserved structure, but it allowed students to examine previously unrecorded parts of the hull interior. Students recorded the keelson, cant frames, frames, ceiling planking, hull planking, deck beams, and deck planking (Sjoldal 2007:67). All planking utilized traditional butt scarphs. No artifacts were found during the investigation.

Sjoldal (2007:76) argued that 8SR1492 was more likely *Jackson* than *Guanacaste*. *Jackson* was one of the ships J. T. McNair, Sr. identified in a newspaper article from 1964 (Watley 1964). The List of Merchant Vessels of the United States (LMVUS) labeled *Jackson* as a non-sailing vessel, unlike *Guanacaste*. During the 2003 field season, students were unable to locate any mast step assemblies at the 8SR1492 site. Additionally, the dimensions listed for *Jackson* were similar to those of the site: 48 m (160 ft.) LOA recorded during the PSS versus 51.82 m (170 ft.) in the LMVUS, and 9.9 m (32.5 ft.) versus 9.75 m (32 ft.) at the beam. However, Sjoldal insisted that thorough archival and archaeological work be done to demonstrate the 8SR1492 site is *Jackson* before changing the designation.

City of Tampa (8SR1490)

By the time BAR conducted the PSS, the only known, exposed part of *City of Tampa* remaining was the boiler (Franklin et al. 1992:183). For many years, *City of Tampa* retained a

visible presence above the waterline in Blackwater Bay. Even after taphonomic processes reduced the hull dramatically, the boiler stack projected proud of the water. It has been a known hazard on NOAA navigational charts, and many locals knew the name that belonged to the ruined vessel. Due to the paucity of material found during the PSS, and the relatively recent time in which *City of Tampa* operated, the information on the site constituted merely one page in the PSS report.

The only two suggestions for further research were to delineate the extents (if any) of remaining structure below the mudline, and to find supporting evidence that the site remains belong to *City of Tampa* (Franklin et al. 1992:183). Archaeologists performed no probing to determine subsided site remains, but they recorded the exposed portion of the boiler. It measured 14 ft. (4.27 m) long, 6 ft. (1.83 m) wide, and 6 ft. (1.83 m) high. The stack measured 2 ft. (0.61 m) long by 2 ft. (0.61 m) wide, and an oblong hole was noted but not measured. BAR archaeologists acknowledged the historical significance of *City of Tampa* as an example of coastal vessel construction and machinery, but recommended no immediate work on the vessel.

Early in 2012, I decided to include *City of Tampa* in this study due to its historical significance. It also offered the chance to incorporate a site with a large metal component. This would provide insight into the effects natural site formation processes are having on metal in the Blackwater River and Blackwater Bay. Unfortunately, while the basic location of *City of Tampa* was available, no one had accurate GPS coordinates for the site. As no site remains were visible above the water, and the PSS LORAN-derived location did not line up with any ship remains, I planned to conduct side-scan sonar and magnetometer surveys to relocate the site. By 2013, UWF graduate student Andy Derlikowski decided to write a thesis dedicated to *City of Tampa*, including a thorough examination of its history and archaeology. He had some concern over the

scarcity of preserved remains since only the boiler was found during the PSS, but was hopeful that preserved materials below the mudline could be exposed through dredging and excavation.

The subsequent survey showed that those fears were unfounded. During April of 2013, we began surveying in Blackwater Bay to relocate the boiler. We first covered the area around a marked location on nautical charts with the side-scan sonar. Sonar images revealed not only the boiler which was described in the PSS report, but also the exposed hull remains, machinery, and the propeller shaft to the south of the boiler. Although barely proud of the river bottom, much of the framing was visible on the sonar record.

Students began surveying the site using baseline-offsets and triangulation during the 2013 UWF maritime field school. The propeller shaft and propeller, portions of the machinery, some frames, and the boiler were measured and recorded. Work at the site is ongoing at this writing, and future plans may include excavating portions of the site in addition to completion of the plan-view map. While most of the information about the vessel's past will come from archival research, excavation could help fill in the gaps regarding the day-to-day lives of passengers and the cargo carried by *City of Tampa*. In addition, once mapping is complete, aspects of the vessel's use-life history (e.g. hull additions or reductions) may come to light.

Conclusion

The previous research on these five sites serves as the source material for the comparisons made in this thesis. I used this primary research data to make general statements about behavior in Chapter 4. Broadening the focus from site-particular to nomothetic offers new direction and information for research on ship sites in the Blackwater River. Additionally, these earlier investigations created a snapshot of each site at the time of exploration. These baselines allowed me to extrapolate natural and human-initiated changes that occurred at each site.

Knowledge of local site-altering forces, the primary focus of this thesis, would have been weakened without baseline information from these site reports and theses.

CHAPTER IV

SOCIAL HISTORY AND BEHAVIORAL ARCHAEOLOGY

Ship sites in the Blackwater River formed through a wide variety of human actions. Examining the historical and archaeological record for these sites provided the information to understand the cultural factors of site formation. Of these contributing behaviors, abandonment processes were the most prevalent across sites in the river. Abandonment was the likely termination for all vessels in this project except *City of Tampa* (which was a tragic loss). Factors varied that led to the eventual abandonment or loss of each vessel, as did strategies for dealing with them post-depositionally. Exploring the social and post-depositional histories of these vessels will add to the body of knowledge on submerged ship sites within the Blackwater River, Santa Rosa County, Florida.

Behavioral archaeology is not only useful in the world of academic archaeology, but also in presenting archaeology to the layperson. A primary component of proper management of cultural resources is presentation, and this must include strategies for revealing archaeology to the public. In order to do this successfully, archaeologists give meaning to archaeological sites by making the past interesting or relevant to the public. Understanding common behavioral threads across sites provides additional opportunities to connect with a public audience.

In both systemic and archaeological context, people have given meaning to these vessels. This began with construction, original use, secondary use, abandonment or loss, post-depositional interaction, and finally the modern meanings imbued upon the sites by historians and archaeologists. Many share a stake in the significance attributed to sites, including descendent populations, local residents, and all those in the archaeological audience. These individuals deserve careful consideration—not just the academic and professional community.

This chapter outlines the behavioral processes that led to the current conditions of these sites. The first section briefly reviews each site. Next, the formation processes section extrapolates how the behavioral processes as described by Schiffer (1976, 1996) and Richards (2008) relate to the sites in this study. Behaviors include actions particular to an individual site and tied to broader historical context. Finally, the discussion section speculates on the changing meaning associated with these sites through time.

Background

This section describes each ship's social and post-depositional history with information that builds on Chapter 3. The material has been derived from several reports, theses, and recent fieldwork conducted by the University of West Florida. Although the sample is skewed toward ships that have been interred and preserved in the archaeological record as opposed to a representative sample of all ships at the time, these vessels give light to important aspects of history. Each ship's social history and interment illustrates a glimpse of day-to-day life, the rise and decline of industries, and the choices that were made to keep ships as viable resources.

The first of these vessels, the Bethune Schooner (8SR985), emerged during the mid to late 19th century. David Baumer (1990) published the first research on this ship in a site report, which was based on fieldwork conducted in the late 1980s by volunteers and archaeologists from the Florida Bureau of Archaeological Research. Baumer explained that the Blackwater River was an important part of the 19th-century Pensacola lumber and brick industry. Bagdad and Milton, the two prominent industrial towns on the river, capitalized on the availability of local natural resources. Timber and brick production boosted the area economy. Many of the residents in the area depended on the money from these industries, whether directly employed in the trade or through local businesses that relied on the increased flow of commerce.

The Bethune Schooner, located 2.6 miles northeast of Milton in Morton's Basin, was found in context with bricks and cut lumber. In addition to the vessel's architectural features, the setting linked it with the booming lumber and brick industries from the 1830s to 1870s (Baumer 1990:32). It is unclear whether or not the owner originally used this centerboard schooner for trade in the Milton/Bagdad area, or if the vessel was acquired there later in life. The vessel showed characteristics typical of coastal traders along the Gulf Coast, so it was possibly in its primary usage when abandoned.

While little is known about the next site, the Milton RR Swingbridge Hull (8SR1488), this vessel was also most likely associated with the lumber industry on the Blackwater River. It sank just south of the Milton Railroad Swingbridge, for which the site was named, and was a sailing vessel (likely a schooner). Foster (2013) speculated that the vessel was either involved in the 19th-century lumber industry or possibly associated with the snapper industry in Pensacola, Florida. The most plausible hypothesis is that the Swingbridge Wreck hauled lumber, since the vessel was abandoned too far north to be associated with major fish houses on Pensacola Bay. If the owner wanted to repair a fishing vessel, the reasonable option would be to dry-dock at a shipyard in Pensacola Bay. Abandonment (or loss) close to Milton suggests that the Swingbridge Hull was a lumber vessel, and not used for fishing snapper.

The events that led to the loss or abandonment of the Swingbridge Wreck have eluded archaeologists. Foster's (2013) prevailing hypothesis was that the vessel was lost through an accidental fire. She posited that the vessel docked near Milton, and during that time the stern of the vessel caught fire. The fire severed all lines connected to the dock except for the bow line. The fire hypothesis explains the burnt timbers from the midship section and aft, as well as the disarticulation of structure towards the bow. Stress from the remaining line could have distorted

the bow, compounded by the fact it was exposed above the waterline after the stern sank. Historic documents or maps featuring the orientation of the dock could support this hypothesis. Additionally, historical records could emerge which show that the burned timbers resulted from an attempt to salvage metal components, and not the cause of loss.

The third site in this discussion is an example of a snapper-fishing ship, located on the western side of the river near Bagdad. This vessel, called simply the Snapper Wreck (8SR1001), was most likely a snapper smack (a fishing schooner), and employed in early-20th-century Pensacola (Raupp 2004:133). Unlike the Bethune Schooner, which was probably in its primary usage before abandonment, many snapper smacks in this area were not. In fact, they were typically recycled from vessels used in New England to fish for cod and halibut. Recycling was a cheap alternative to building vessels from scratch. The process of recycling vessels from New England was known as “selling south” (Raupp 2004:140). Raupp (2004:140–143) stated that the vessel was likely in service to the snapper industry sometime between 1890-1935. He postulated that the vessel was abandoned either in the process of “mothballing,” or abandoned after refusing costly maintenance with little return on investment. Mothballing is the practice of leaving a vessel in a safe area to sit during lulls in industry or worker strikes, and to protect it from hurricanes and storms. These vessels are occasionally left too long and undergo irreversible damage, or must be abandoned entirely when an industry goes into decline. After abandonment the vessel would have been stripped for sellable resources and left to disintegrate. Mothballing and selling south played a critical role in the history of the next site as well.

Guanacaste (8SR1492) is one of the Shield’s Point schooner barges, which are located south of Bagdad on the western side of the river. Since we know the historic name of the vessel, we can gain a better understanding of its social history. *Guanacaste* had also been “sold south”

after operating in New England. *Guanacaste* traveled far across the United States before arriving in Pensacola (Sjordan 2007:36–37). It was originally constructed in Portland, Oregon, in June 1917. The owners used it for fishing in New York from 1917 to 1918. It then moved to Delaware, and fished there until 1924 before finally ending up in Pensacola. After fishing in Pensacola for only two years, the ship was converted into a schooner barge. Schooner barges were commonly used during the early 20th century for transporting lumber in Santa Rosa County. Due to a decline in the local lumber economy, the owner “laid up” (mothballed) *Guanacaste* during the 1930s (Sjordan 2007:37). After years of mothballing, the owner eventually stripped and abandoned *Guanacaste*.

The final vessel, *City of Tampa* (8SR1490), had a particularly rich social history, which provides strong material for interpreting local archaeology to the public. *City of Tampa*, a screw steamer, made daily trips between Milton and Pensacola transporting passengers and goods. Its captain even made special trips for local events (such as dances) as documented by Bingham (1991). Tragically, the vessel caught fire in 1921 while docked at the Bay Point Mill docks. To avoid spreading fire to other ships and structures, it was pushed out into the channel and drifted east across the river (Franklin et al. 1992:183). While this tragic event resulted in no loss of life, the event differentiated *City of Tampa* from the use-life histories associated with many other vessels in the Blackwater River. Examining the social history of these vessels is essential for enriching site significance and presentation for the purposes of public archaeology. Research into site formation ascribes additional meaning and significance to these sites.

Formation Processes

In order to better understand change among sites in the study area, this investigation utilized a behavioral-archaeology approach to categorizing shifts in form, function, and

ownership. Cultural formation processes of vessels begins with original construction and traces all changes to the present day. In the past decade archaeologists made great strides in the broader analysis of the cultural formation processes of ship sites (Gibbs 2005, 2006; Richards 2008; Smith 2010), which this thesis builds upon. The following are the main cultural processes that operated on the sites in this study: primary mercantile phase, reuse, discard, and reclamation.

Primary Mercantile Phase

The primary mercantile phase (Richards 2008:119–120) is the time in which a ship is used for the purpose the owner had it constructed originally; in this case, specifically for commerce and mercantile functions. However, a primary support phase relates to ships originally constructed as towed vessels (such as barges). The Bethune Schooner was likely in its primary mercantile phase, serving as a transport vessel for brick and lumber on the Blackwater River. It is possible that the Swingbridge Wreck was in its primary phase before loss, but this was unclear without historical data. Both cases would require knowing the ship's identity to obtain relevant documents. Snapper Wreck also lacked identity to confirm or deny its role primary phase, although narrative evidence from local informants indicated that the ship became a leisure vessel after retiring from the fishing industry (Greg Cook 2013, pers. comm.). This would be an example of secondary use, which is a type of reuse process.

Reuse

Reuse is a process that allows an object to stay in the systemic context, i.e., the object stays in the cultural system. This is as opposed to objects that have been taken out of systemic context and transferred to an archaeological one. This type of behavior was integral for ship owners who wanted to extend the life of a ship. For instance, Richards (2008:127) found that, in Australia, vessel modifications resulted in an incredible increase in use-life: about nine years on

average. Reuse can be subdivided into several distinct sub-processes, including lateral cycling, secondary use, and recycling.

Lateral cycling (Schiffer 1996:29; Richards 2008:55) describes a change in the user or transfer of ownership when the object retains the same usage. For instance a schooner is sold from one company to another but stays as a vehicle of maritime commerce. “Selling south” was a major way lateral cycling played into the maritime commerce of the greater Pensacola area. As previously discussed, this described the process of selling ships from New England to people (mostly in the fishing business) on the Gulf Coast. Fishing practices for cod and halibut fisheries were analogous to red snapper fishing in the South, but with calmer conditions. Selling south benefitted both ship owners in New England and the Gulf Coast.

In contrast, secondary use (Schiffer 1996:30–32; Richards 2008:55) occurs when the object changes function, but its form stays mostly the same. This was common as ships underwent significant degradation. Secondary use describes the process of conversion to schooner barges from seaworthy schooners, a common behavioral process during the early-20th-century lumber boom on the Blackwater River (Morris 1984; Holland 2006:24). This was specifically the secondary support phase (Richards 2008:120), since the vessel was altered from self-propulsion to a towed structure. The conversion process involved shortening the length of the ship, increasing the amount of weight it could carry, and reducing the number of crew members necessary to run it. This process of recycling was a common part of resource acquisition in this area, and part of the same “selling south” phenomenon involved with lateral cycling. It enabled New England companies to get rid of vessels that needed increasing amounts of attention and maintenance, and allowed small companies in the south to acquire vessels that could be altered for their purposes without building a new ship. As stated earlier, Snapper Wreck

may have actually been in secondary use when it was lost. Local informants recently reported to an archaeologist that a couple bought the ship to use as a pleasure cruiser after it had been retired from fishing (Greg Cook 2013, pers. comm.). One night while docked in Bagdad, the owner neglected to engage the bilge pump. He realized his mistake too late, and the listing vessel sank soon after. No available written evidence supports this, but the site setting at a busy dock adds credibility to an accidental loss scenario. Abandonment makes the most sense away from traffic.

Another type of reuse is recycling (Schiffer 1996:29), which occurs when material is reused in some other manner. Recycling moves things from the archaeological context back to systemic context. This is especially prevalent in maritime archaeology as salvage. An example was the use of ship timbers and ballast to build survival camp structures (Gibbs 2003).

Salvaging was evident in several cases within the Blackwater River, but not in all expected situations. Salvage did not occur with Bethune Schooner, which should have been easily accessible for salvage operations from the shore. However, on *City of Tampa*, the boiler was recorded several meters northeast of the ship's hull. This was likely evidence of salvage, as someone tried to extract machinery or the engine from the lost ship by lifting and moving the boiler. Interestingly they did not salvage the boiler itself. Boiler technology was being supplanted with combustion engines, and the boiler may not have been worth keeping or selling.

Another instance of recycling occurred with the removal of iron fasteners from the Shield's Point schooner barges. Removal reclaimed the metal for other uses. The four ships, including *Guanacaste*, were first placed in a protected cove in Blackwater Bay. The owner of the ships engaged a local man strip them of metal components, which filled three train cars (Watley 1964). The barges were later burned to the waterline by locals for unknown reasons. This was possibly done to extract additional metal from the ships for selling. Because it would have been

done by opportunists and not the owner, the act would have constituted a reclamation process, not recycling.

The Long Island Maritime Museum (2014) celebrates the once-popular practice of burning ships to reclaim their metal materials. Each year someone in the community donates a wooden vessel to be destroyed. The museum holds an annual, all-ages event in which participants can socialize and observe the vessel reduce to ashes and scraps of metal. This provides a fundraising opportunity for the museum, as well as a way to educate community individuals about maritime history.

Discard Processes

When a person transfers an object from systemic to archaeological context, it is a discard process (Schiffer 1996:89; Richards 2008:55). Discard is useful in spatial analysis at multiple scales. “In the field, artifact locations are recorded with reference to grid systems, but locations can also be described in terms of behaviorally significant divisions of space, such as activity areas and the domains of various cultural units” (Schiffer 1996:17). In this way, we can understand the deposition of the vessels at Shield's Point. The protected cove serves as a behaviorally significant division of space. The owner placed the ships there originally for mothballing, and finally abandoned them there completely. This space was useful for being out-of-the-way but still easily accessible for salvage operations.

One hypothesis asserts that the Snapper Wreck was abandoned in its current location because the cost of repair outweighed return from profits. The ship would have been left to rot at the docks near a shipyard (Raupp 2004), which possibly happened to Swingbridge Wreck as well. Unfortunately, original damage versus subsequent degradation is unclear. A hurricane destroyed the city of Milton in 1916 and likely caused significant distortion of many sites.

De facto refuse (Schiffer 1996:89) refers to a situation in which materials still have utility, but their location is abandoned as a whole. This can occur at multiple scales. It can also be the abandonment of an individual site after people have finished salvaging materials. De facto refuse can also be the abandonment of an entire ships' graveyard. The Blackwater River as a ships' graveyard fits this classification, not because the population as a whole left, but because industries utilizing maritime infrastructure did.

Reclamation

Reclamation (Schiffer 1996:90) works against de facto refuse. Reclamation occurs when materials in the archaeological context are removed and brought back into the systemic context through post-abandonment salvage and scavenging (Schiffer 1996:99). In the maritime context this primarily takes the form of scavenging (Richards 2008:58). Scavengers remove materials from abandoned or wrecked vessels and reintegrate them into the systemic context.

Richards (2008:58) describes scavenging as “a generic term related to the exploitation of objects following their discard.” This practice includes the act of looting, which has socioeconomic factors at play in the decision to remove materials from archaeological contexts. Risk therefore becomes an element for consideration, as the possibility for profit from the illicit sale of artifacts, or the inherent value of the item to the collector, must outweigh the perceived danger to the individual by engaging in the action. Active looting on these sites was evidenced both by the removal of the boiler stack at *City of Tampa* and the removal of deadeyes from *Bethune Schooner*. However, in the case of the Blackwater River, this may have been less motivated by profit, and more influenced by the capture of cultural capital. Collectors have likely displayed artifacts at their properties as tangible pieces of local history.

Discussion

Meaning shifted several times for a vessel from the time it was in use to its abandonment, wrecking, or scuttling. Thus the object transitions from being a tool to being something else, having mostly departed the sphere of human activities. Schiffer refers to this as the transfer from systemic to archaeological context:

The archaeological record differs from other cultural phenomena because the materials that comprise it—artifacts, features, residues—are no longer participating in a behavioral system. The non-behavioral state of cultural materials is known as the *archaeological context*...materials within an ongoing behavioral system—they are handled or observed—are in *systemic context*. [emphasis in original] [1976:27-28]

Perhaps this distinction is too stark—especially in the case of ships in the Blackwater River. Although the ships are no longer in use, they are still visible. Even when they are not immediately visible, they may constitute navigational hazards or attract fish (and subsequently local fishermen). Submerged ship remains can persist in behavioral context, but does that exclude them from the archaeological context? This question is important if we are to consider the differences between visible archaeological objects like monuments (Stonehenge, for example), and compare them with the invisible archaeological objects and sites that we walk over daily without knowing. Individuals on the Blackwater River have observed the decaying remains of some of these vessels since they were initially lost or abandoned.

When it comes to understanding the processes leading to the eventual abandonment and loss of the vessels in the Blackwater River area, historical context is crucial. Several economic

factors were at play that affected the growth and decline of local industries, as well as the choices of individuals to build, buy, alter, and abandon ships. The Great Depression had an obvious impact, but was merely a *coup de grâce* for an already doomed area as the timber industry was in a steady decline following World War I (Drobney 1994).

The port in Pensacola declined during this period primarily because of its dependence on the timber industry, which had not been managed in a sustainable manner (Pearce 1990:134). There was an apparent lack of foresight on the part of the local timber industry, which eventually depleted the resource. The area was not prepared for this economic blow, and in the coming decades it became the cause of broad abandonment of maritime infrastructure along the river.

Another important piece of context for this period is shifting technology from sail-powered vessels to steam. During the late 1800s, steam vessel technology improved, making steam ships increasingly competitive with traditional sailing ships. However, sailing vessels persisted long after the introduction of the steam engine to ships. Sailing vessels carried a greater amount of tonnage until the 1880s, and steamships did not outnumber sailing ships until the first decade of the 20th century (Gould 2000:240). Several examples in the Blackwater River, such as the schooner barges at Shield's Point and the Snapper Wreck, reveal this persistence. Although sailing vessels carried on, one should consider that the data presented here were biased in favor of vessels that were abandoned and preserved in the archaeological record. This bias skewed the sample toward the obsolete forms of vessels and propulsion, and did not provide a representative sample of all the ships that were present on the river at a given time.

In addition to broad historical context, there are a few main activities archaeologists focus on when investigating vessels. Babits and Corbin-Kjorness (1995:34) encourage researchers to ask the following question: “Was the vessel present at the site because it was a derelict, wrecked

or abandoned, accidentally or deliberately grounded, stripped or burnt before ultimately being examined as an archaeological site?” This is important in the interpretation of an archaeological site by archaeologists a century or more after these activities have taken place, but it may have had immediate effects on the meanings associated with ships at the time. The accidental loss of a ship compares differently with leaving one behind for fiscal reasons (i.e., wrecking vs. abandonment). Wrecked vessels could be viewed as tragedy and associated with loss of life and property. Abandonment could become tangled up with ideas of “oldness” and decay, like how one views a neighbor’s junked car.

Conclusion

The various actions of individuals on the Blackwater River through the years contributed to the current configuration of the sites in this study. The Blackwater River is a ships’ graveyard as defined by Richards (2008). It is located in a river, a prime environment for large-scale ship abandonment. This river is semi-tidal with little discharge of water, making it an ideal location for mothballing and abandoning vessels. Additionally, it was once an area of dense economic activity, strongly fueled by the timber industry. Ship owners engaged in many processes to avoid abandoning vessels as they became obsolete or ill-suited for their original function. As ships grew past their use they were dismantled and salvaged. Salvage made their materials reusable. As the industry declined, many vessels were mothballed and later abandoned after being stripped of valuable metal and machinery. This chapter examined the range of these types of behaviors in changing Blackwater River ship sites throughout recent history. Research like this can help archaeologists and historians better understand historic trends in the change of form, function, and ownership.

CHAPTER V

METHODS AND RESULTS

This research design aimed to represent the diversity of sites in the project area. Environmental variety played a role in site selection, in addition to selecting each site for its archaeological and historical significance (as discussed in Chapter 3). Location highlighted the variance in site environments from one locus to another. Selected sites side by side (such as the Shield's Point vessels) would have obscured the diverse settings that constitute this relatively small area of river. Although distribution was important, having some baseline data from previous investigations allowed for comparisons later in analysis. In sum, these three factors determined the selected sites: environmental variance from site to site, archaeological/historical significance, and data provided from previous investigations.

In order to have a baseline for understanding the ongoing site formation processes at sites along the Blackwater River, I gathered data using a variety of methods and multidisciplinary approaches. Some data required multiple measurements over a period of time. By combining time-lapse data over six months from each site, the research accounted for spatial and temporal variation. Compiled data showed the overall environmental dynamics across sites, and these data shed light on how the sites formed and changed. Although all the sites are in the Blackwater River, the amount of ecological diversity in the river shows the need for understanding environments at the on-site and regional scales. Studying the processes of formation directly will help in developing future management strategies.

Beyond site selection, this investigation was designed to directly investigate the prime movers in site formation. Ward et al. (1999) identified the prime movers as part of defining the process-oriented approach for gathering data on natural formation processes. These include the

physical, chemical, biological, and anthropogenic processes at work on any site. To approach these aspects of formation, this project gathered the following types of data: water quality, sedimentation and erosion, geochemistry, diver visual appraisals, and side-scan sonar imaging. The next section describes the methods and results of data acquisition separated by type.

Water Quality

In the context of site formation processes, water quality testing provides information about the water column chemistry around a site. Chemical conditions affect the preservation and degradation of archaeological materials, and those chemical conditions are not stagnant. Shifts in water chemistry are not captured in cases where a set of tests are performed at a site only once. For instance, pH (which affects the corrosion of ferrous materials) fluctuates throughout the year, particularly in a river. Water quality testing over the course of six months chronicled a range of chemical shifts that result from outside influences (especially rain).

This study focused on water temperature, dissolved oxygen, conductivity, salinity, and pH for its water quality component. Water samples were taken once a lunar cycle over the course of six months at each site. The lunar cycle provides better temporal control than the standard calendrical month due to the lunar cycle's standard length of 29.5 days. However, this schedule could not be followed strictly. Scheduling conflicts with other departments for the use of the water quality testing instruments and some days falling on the weekend (when university boats could not be utilized) meant that some samples had to be recorded a day or two from the scheduled day. Sampling days are tabulated in Table 1.

Water sampling was not tied to the tides, which would have provided for greater control of variables. For safety purposes, the time of day for sampling was limited to daytime operating hours. Times ranged from morning to late afternoon, with all sampling across the five sites

completed within a six-hour window. Limiting the lapse of time ensured that samples reflected a reliable snapshot of conditions.

TABLE 1
WATER SAMPLING DATES, TIMES, AND NOTES

Date	Time	Samples
April 5	12:00 – 15:00	Only surface samples, and no pH
May 3	14:00 – 16:00	All samples
June 3	8:30 – 11:00	All samples
July 2	8:30 – 14:00	All samples
July 30	10:00 – 14:00	All samples
August 30	9:00 – 11:00	All samples

During the first day of sampling, I did not sample benthic water or pH. A standalone pH sampler was utilized on subsequent trips. Benthic sampling began when the UWF Environmental Studies Department was kind enough to provide a Van Dorn sampler (Figure 8). A Van Dorn sampler is a tube sampler that allows water to pass through it as it descends through the water column. Once it reaches the target depth (just above the river bed for this investigation), the operator triggers the plungers on either end of the tube to shut. This traps a sample of water at the target depth, which can be tested when raised to the surface.

Surface water samples were taken by filling a dense plastic cup with water from the side of the boat. Benthic water was acquired with the Van Dorn sampler. The depths of each benthic sample were: *City of Tampa* at 7 ft. (2.1 m), *Guanacaste* at 8 ft. (2.4 m), Snapper Wreck at 15 ft. (4.6 m), Swingbridge Hull at 17 ft. (5.2 m), and Bethune Schooner at 8 ft. (2.4 m). When deploying the device, the caps were pulled away from the ends and locked above the tube, allowing water to pass through the sampler. Nylon line connected the tube to the operator, who held a sliding lead weight. When the tube was at the intended depth, the operator launched the weight down along the line. As it hit the top of the tube, a mechanism released the two caps, locking benthic

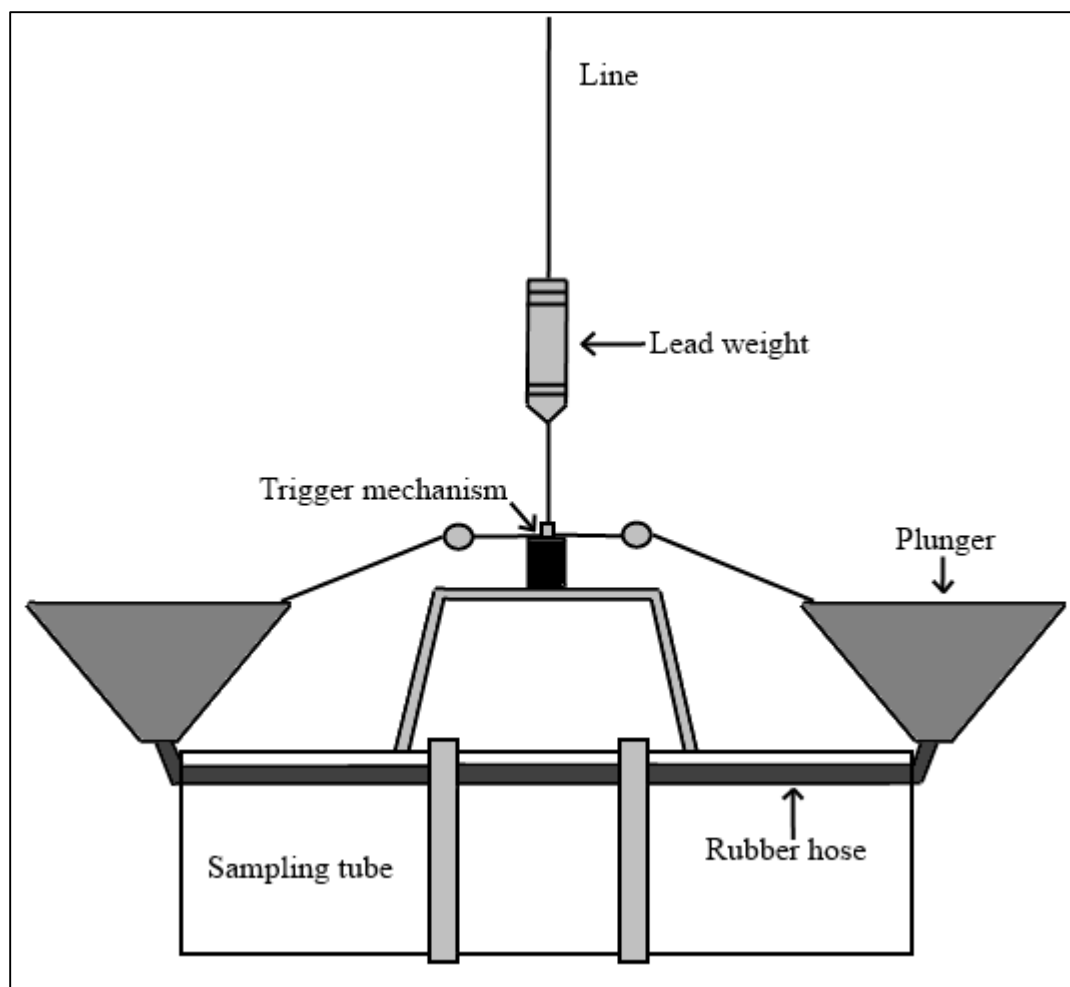


FIGURE 8. Van Dorn water sampler. (Figure by author, 2014.)

water in the sampler. Finally, the tube operator retrieved the sampler via its connecting line, and the operator poured the sample into another dense plastic cup for ease of measurement.

The YSI 85 (Handheld Dissolved Oxygen, Salinity, and Conductivity Instrument) measured conductivity, dissolved oxygen, salinity, and temperature. The YSI 85 handheld console is shown in Figure 9. Each morning, the anode was cleaned and held in the device with a small amount of deionized water (DI water). The machine was then turned on and allowed to self-calibrate for 15 minutes before use. Once the samples were acquired, the anode was placed into the sample, and measurements were read to an assistant recording the data. While the dissolved oxygen reading was taken, the anode was slowly swirled around the container (at

roughly one foot per second), which compensates for the oxygen consumption occurring at the sensor (YSI, Incorporated 1998:18). After all measurements were taken from a sample, the anode was rinsed thoroughly with DI water.



FIGURE 9. YSI 85. (Photo by author, 2013.)

An Oakton Waterproof pHTestr 30 Pocket pH Tester was used for measuring pH. Its sturdy materials and waterproof nature allowed it to be suspended in the water sample while the meter refined its measurement. The pH measurements from the device were accurate to ± 0.01 .

The pH meter also had to be calibrated before use. To do this, two solutions of predetermined pH were used: one with a pH of four, and another with a pH of seven. The user immerses the sensor in one of the solutions, allows the device to find the pH, and then presses a button to confirm the calibration. The same is done with the other solution after rinsing the sensor with DI water.

The pH meter was used the same way as the YSI, although it required much more time for each reading. Because of this, the user allowed the pH to read one sample while the YSI read another. For instance, the pH meter was used to read the benthic water sample at the same time

as the YSI read the surface water sample. By the time recording was done with the YSI, the pH usually had settled on an accurate reading.

Some data is publicly available regarding the hydrological regimes and water quality for the Blackwater River (including tides, water speed, temperature, and water level), but these are limited to two stations, of which the Milton Riverwalk station was most relevant. This data was provided by the Florida Department of Environmental Protection, and included tabulated water quality information from January 2011 to August 2013. This information was used to compare trends over greater periods of time in the river. Please note that this station is directly across the river from the Swingbridge site.

The following sub-sections present the water quality data. Conductivity is not reported since it assists no more to the analysis beyond salinity. The YSI actually uses the conductivity reading to calculate salinity, but conductivity is not very useful as a comparison to other sites. The discussion in this thesis relies on understanding salinity, thus conductivity is excluded here.

Salinity

Figure 10 and Figure 11 show the salinity levels at each site over the course of the project. The values are displayed in parts per thousand (‰). Salinity levels generally fell within the freshwater to brackish range. The highest recorded value was 16.1 ‰ at the bottom of the water column at Snapper Wreck, and the lowest level was 0 ‰, which was observed at three sites on the surface and two sites on the bottom. The drop in salinity levels reflects the input of freshwater via rainfall during the summer, which will be elaborated on in Chapter 6.

pH

Most of the pH values recorded are relatively neutral, falling within the six to eight range (Figure 12 and Figure 13). However, at the two northernmost sites, pH fell below six. The river's

pH fell during the same points that salinity did. This is also related to rainfall. Rainwater is acidic, thus it lowered the river's pH. However, pH elevated where river water began mixing with water from the bay. Water from the sea has a higher pH than freshwater.

Dissolved Oxygen

Dissolved oxygen (DO) measurements (given in mg/l) are displayed in Figure 14 and Figure 15. Dissolved oxygen on the surface fluctuated up and down from one month to the next. This is also reflected in the data gathered by FDEP from Milton throughout the year (presented in Chapter 6). All sites appeared to have similar readings during each sampling period. While no long-term trend could be extrapolated for surface dissolved oxygen from this project, the FDEP data for Milton show that DO is higher from December to May than it is from June to November. Benthic DO was more variable. Of the five sites, Swingbridge Hull had the greatest amount of change, ranging from 1.27 mg/l to 8.92 mg/l. Benthic water was generally about 2 mg/l lower than the surface, except at the end of July, when surface and benthic values were nearly the same.

Temperature

Surface and benthic temperature are given in the graph below in degrees Centigrade (Figures 16 and 17). Surface temperatures rose with air temperatures during the summer. Benthic temperatures tended to follow the same trend. One noticeable difference was Bethune Schooner, whose benthic temperature was usually the coldest temperature recorded. At any site other than Bethune Schooner, benthic and surface temperature had little variance. There was seldom much diversity in temperatures between sites as well. The northern sites had colder benthic temperatures than southern sites. Surface temperatures were less predictable, but generally had the same tendency.

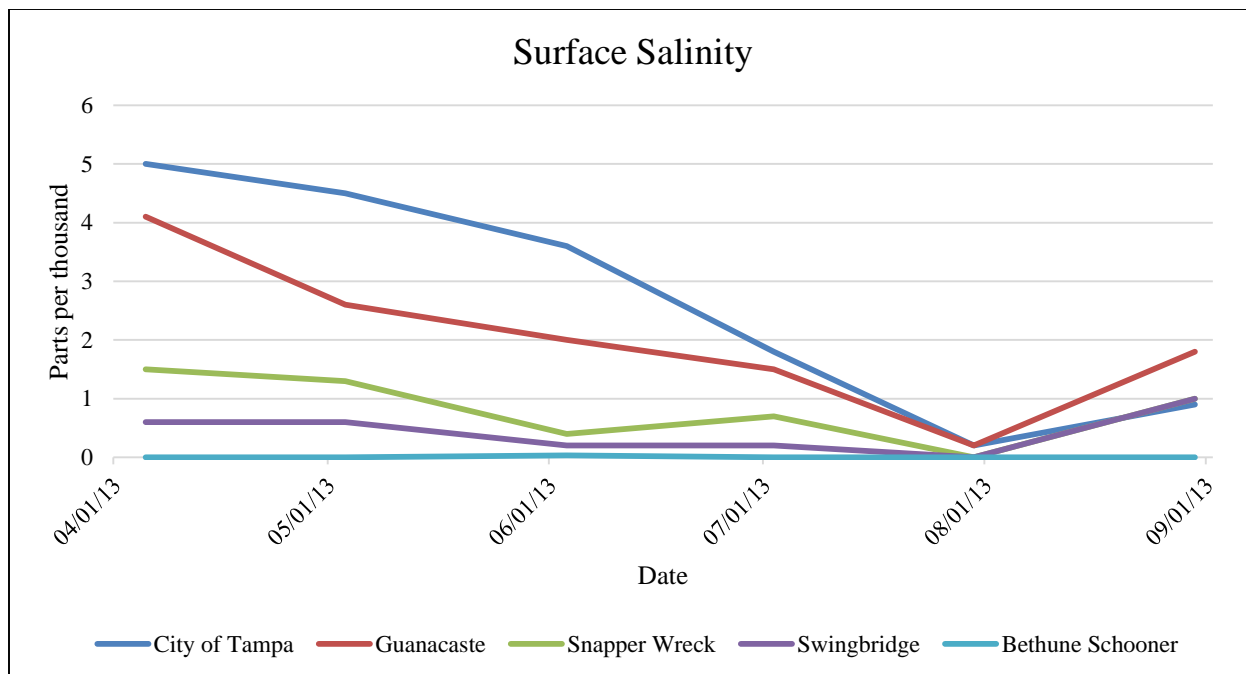


FIGURE 10. Surface salinity. (Figure by author, 2014.)

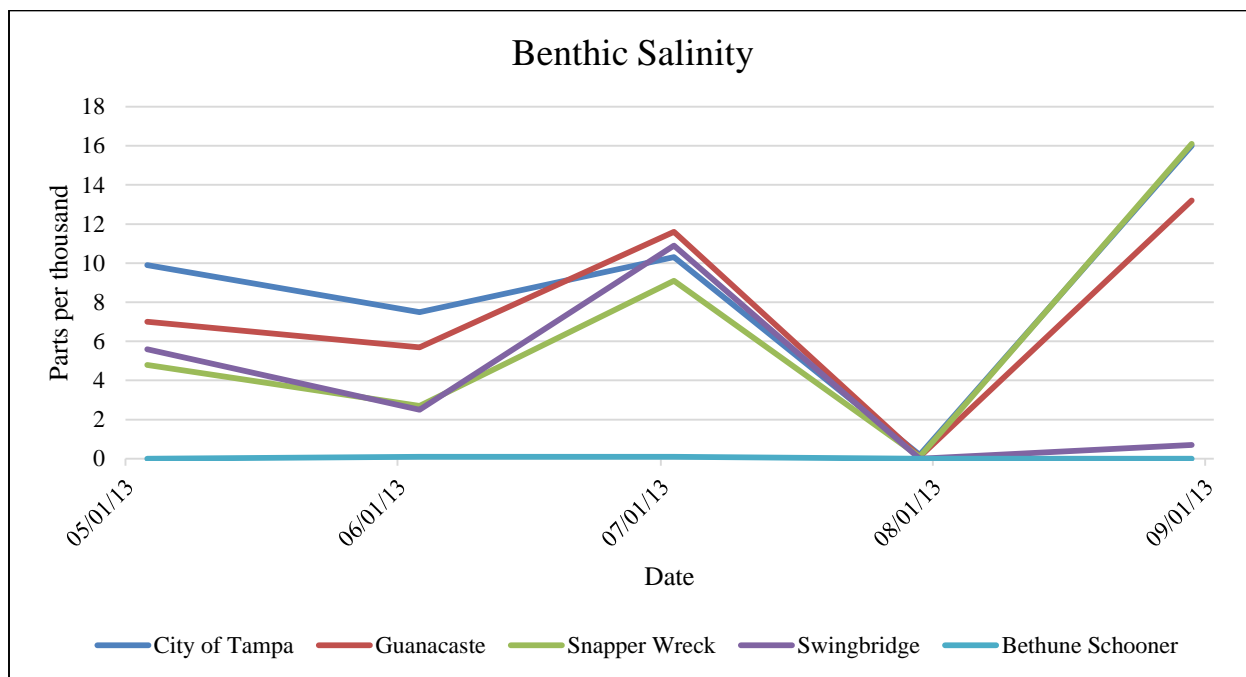


FIGURE 11. Benthic salinity. (Figure by author, 2014.)

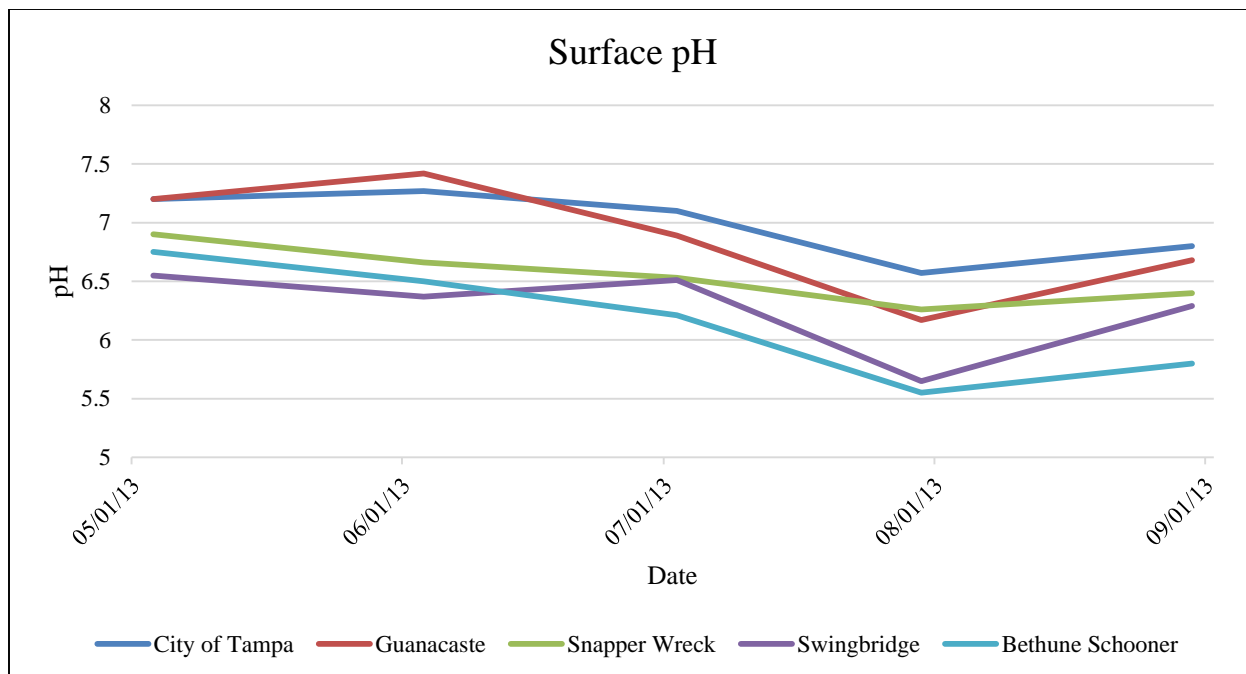


FIGURE 12. Surface pH. (Figure by author, 2014.)

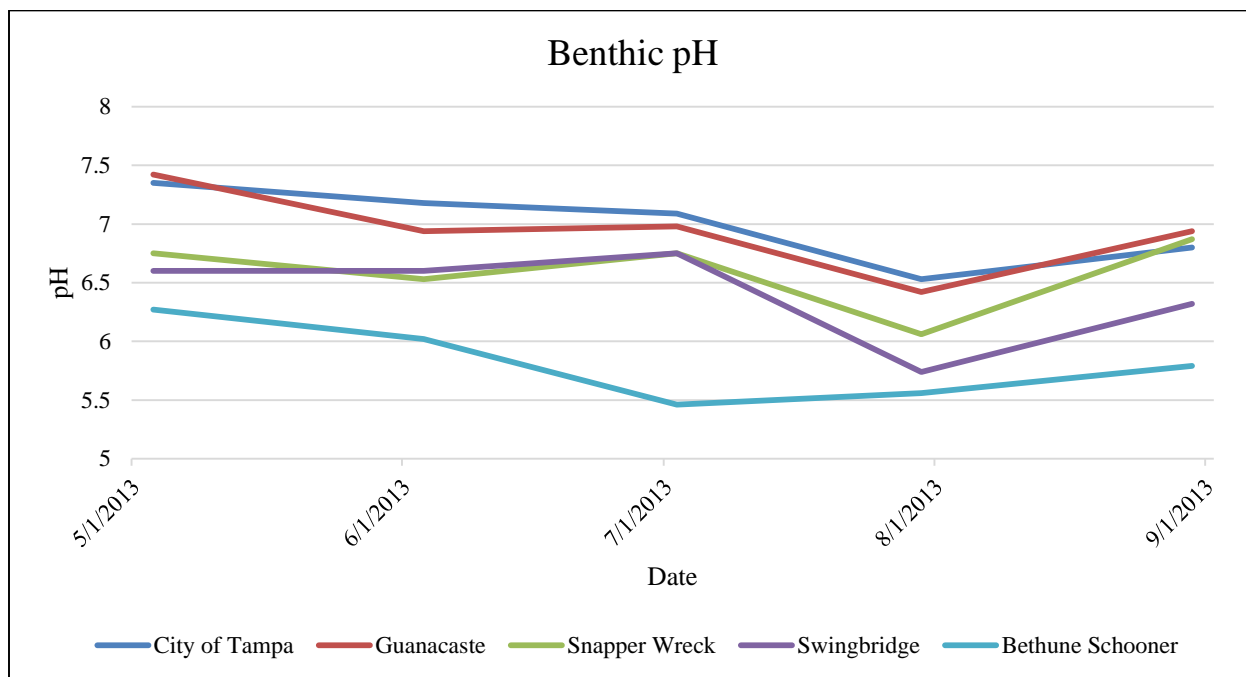


FIGURE 13. Benthic pH. (Figure by author, 2014.)

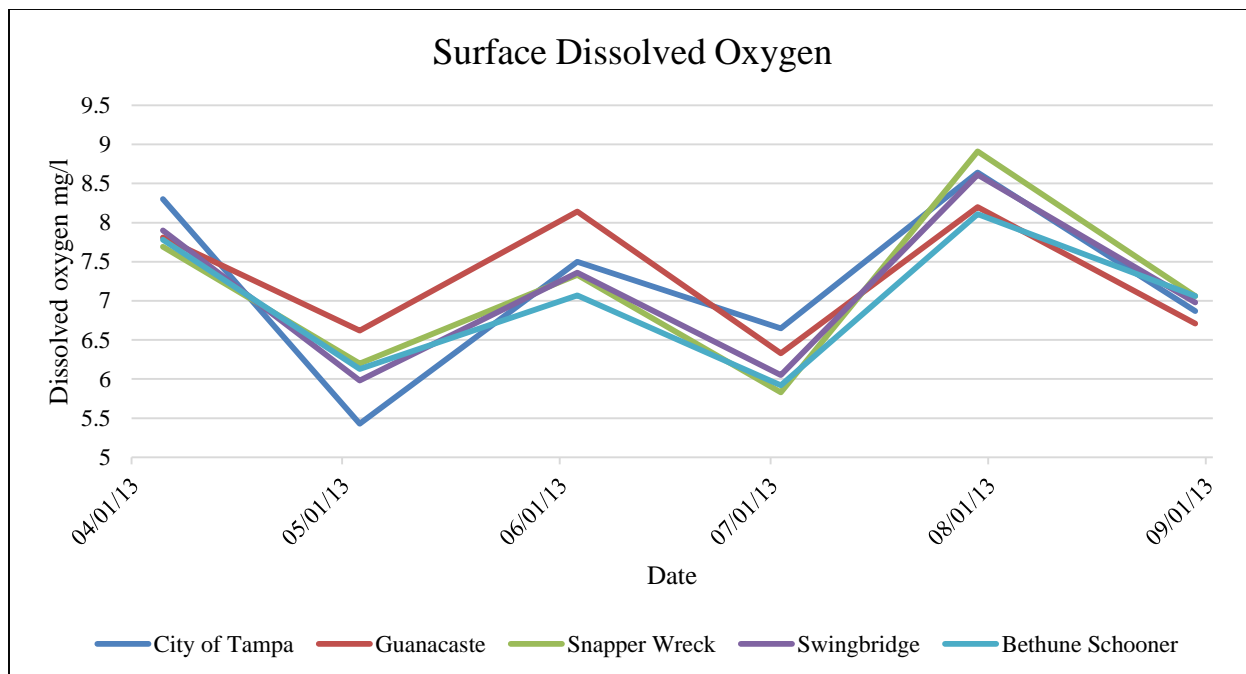


FIGURE 14. Surface Dissolved Oxygen. (Figure by author, 2014.)

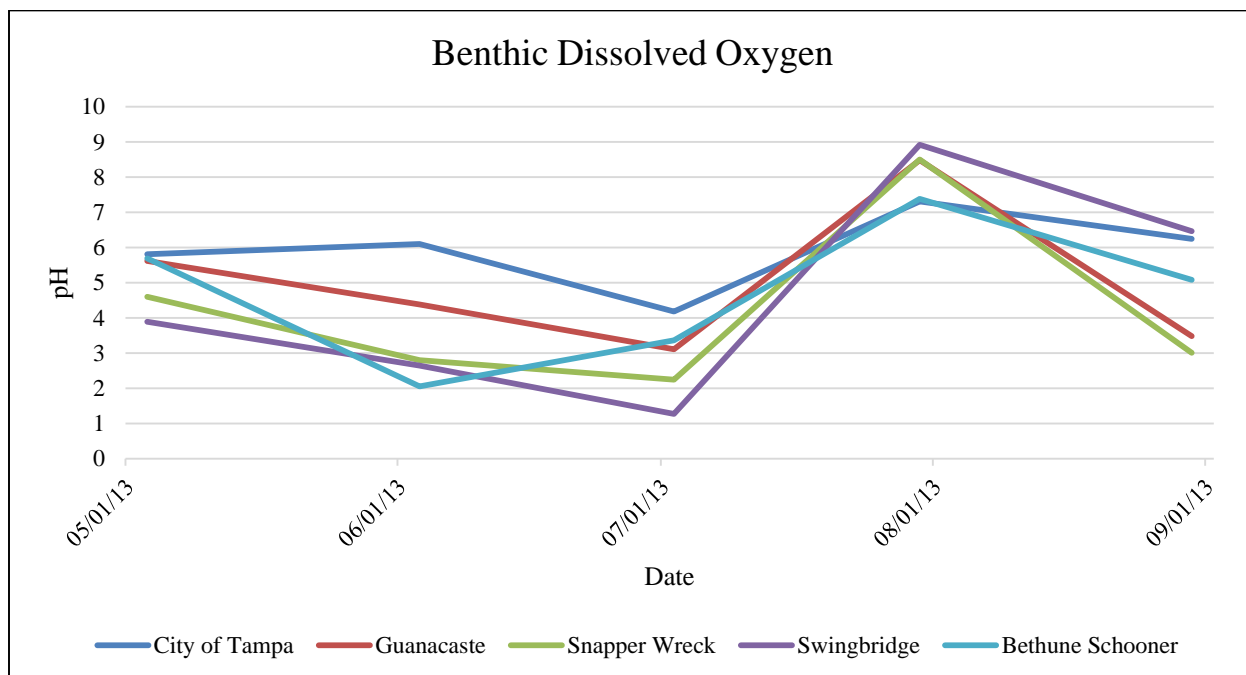


FIGURE 15. Benthic Dissolved Oxygen. (Figure by author, 2014.)

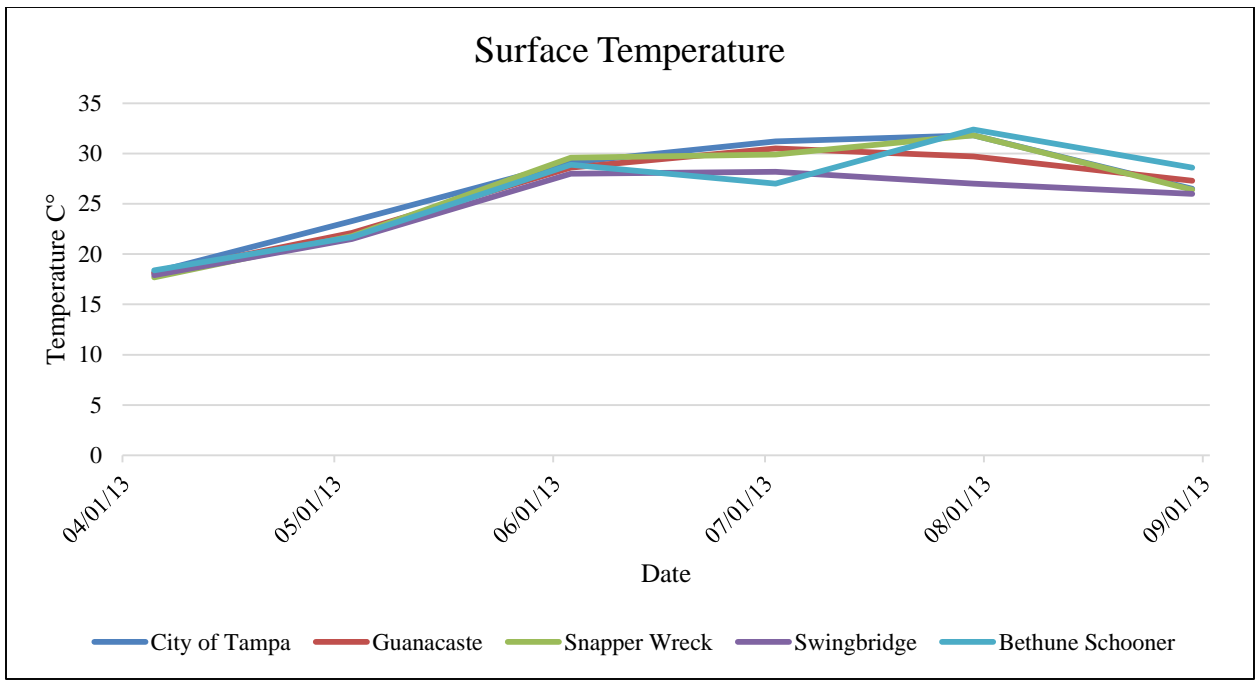


FIGURE 16. Surface Temperature. (Figure by author, 2014.)

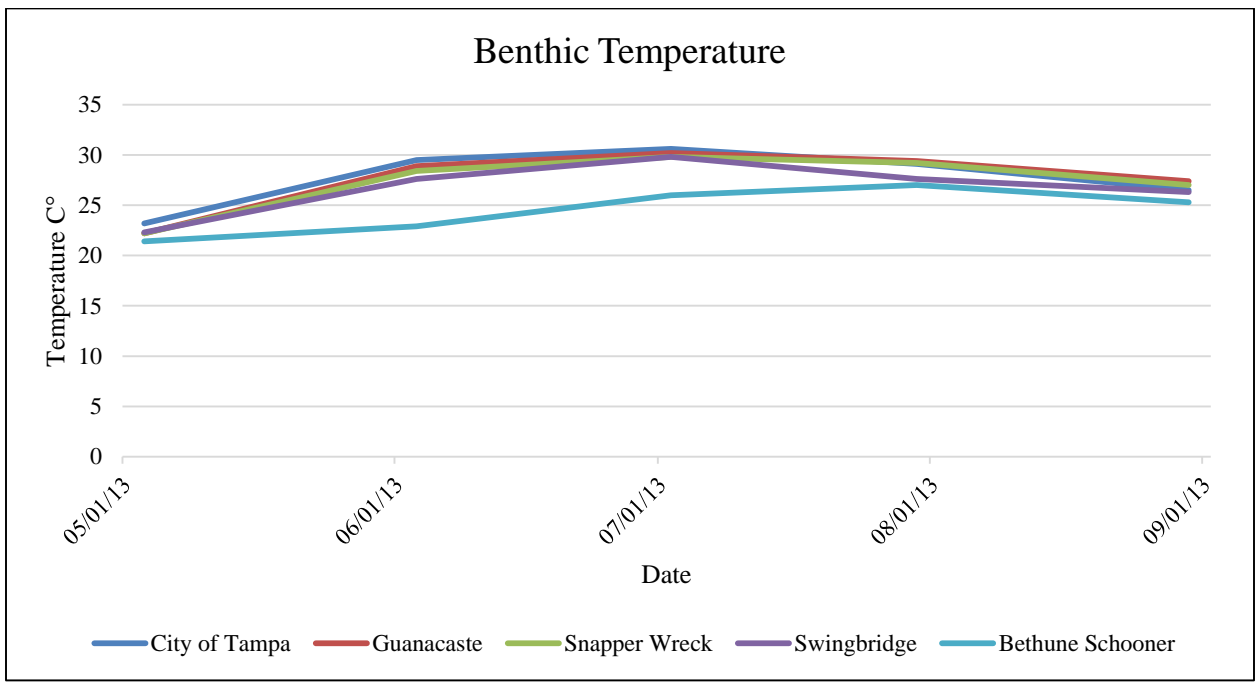


FIGURE 17. Benthic Temperature. (Figure by author, 2014.)

Sediment Pins

At least one sediment pin was planted at each site in an area that was anticipated to display productive erosion or sedimentation. Productive areas were determined on a site-by-site basis, which will be explained in the following paragraphs. Typically, researchers placed pins where sediment is accumulating or scouring based water current trends, i.e., up-current and down-current of the site. The pins were roughly 1.52 m (5 ft.) long pieces of steel rebar, which were wrapped on one end with pink flagging tape for easy relocation. Figure 18 shows two field school students preparing to place the pin on the site of the *Guanacaste*. To secure the pins, divers used a mallet to hammer each one deep enough into the sediment to be stable. At Snapper Wreck, this pin had to be almost completely driven into the sediment to remain stationary. Pins were placed and measured at each site on 4 June 2013. The pins were recorded again on 30 July 2013 to determine the amount of sedimentation and erosion at each location.

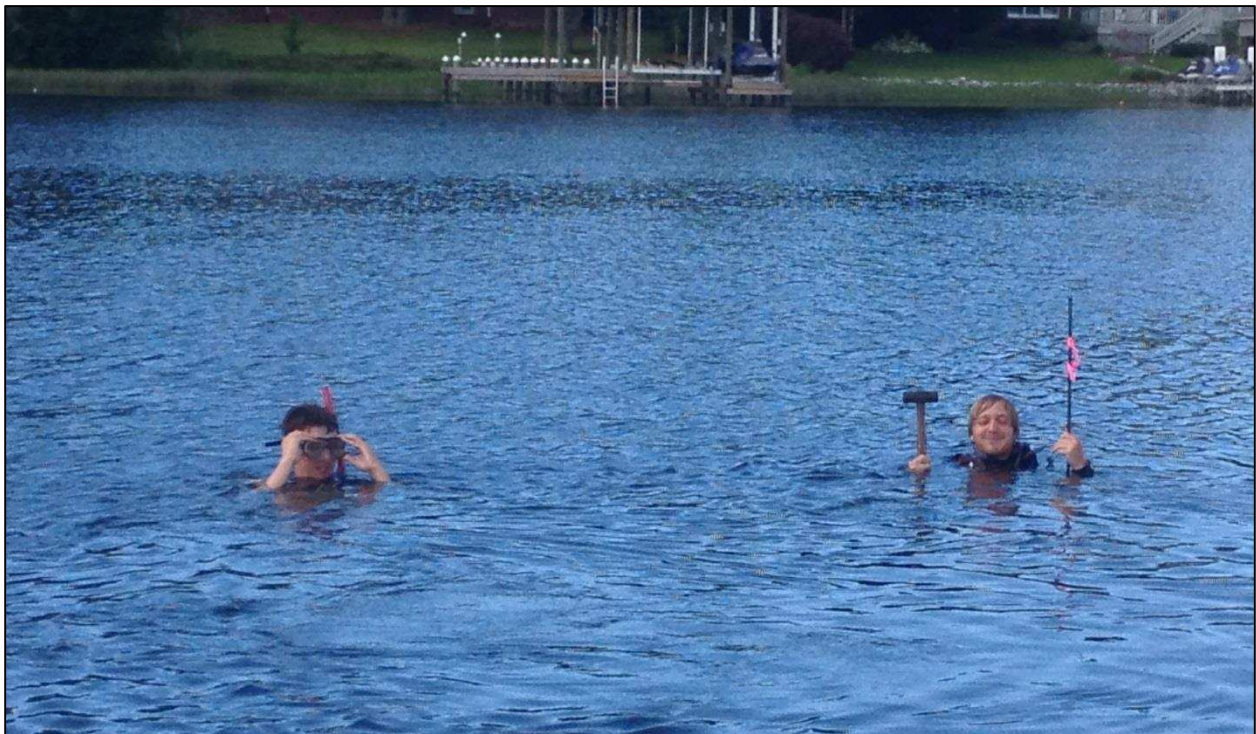


FIGURE 18. Students placing sediment pin at *Guanacaste*. (Photo by author, 2013.)

One pin was placed on Bethune Schooner. Due to the amount of silt on the vessel itself, a diver was able to plant it in sediment on the deck. The pin was placed southwest of the windlass, near the starboard gunwale. Since much of the burial occurring at this site comes over the port gunwale from the adjacent river bank and covers the deck, the deck was the prime location to record changes in deposition.

For Swingbridge Hull, two pins were planted on the site: one on the up-current side and one down-current. The up-current pin was placed near midships on the port side, just north of some extant timber by which the baseline once ran. The down-current pin was placed outside the starboard side of the hull, directly south of the first pin.

The Snapper Wreck received only one pin, set near the bow on the starboard side of the vessel. Because the site is located near an active boat dock and relatively deeper part of the channel, this area should show the greatest amount of activity and therefore change at the site.

At *Guanacaste*, only one pin was used as well. The protected cove likely receives little erosion outside of storm events. The hull has become quite disarticulated over the past two decades, so the pin was placed just forward of the stem to make relocating the pin easy in the future. Otherwise, the pin might be impossible to find on the difficult-to-navigate site.

Lastly, divers planted two pins on *City of Tampa*. The idea was similar to Swingbridge Hull: catch sedimentation and erosion on the up-current as well as down-current sides of the site. The up-current pin was placed north of the boiler. The down-current pin was placed about two meters south of the machinery located at midships.

These pins were left on each site after the project was completed. This was done to ensure that, as a part of site monitoring via periodic site visits, data can be easily measured. Subsequently, archaeologists can map long-term erosion and sedimentary trends. The

measurements for each pin are given in Table 2. The amount of sedimentation or erosion between the first and second measurement follows the measurements. Positive values indicate sedimentation, while a negative values mean erosion. The number identifies order of pin placement at sites with more than one pin.

Of the seven pin sites, the greatest amount of change occurred at Snapper Wreck, which had five centimeters of accumulation. Bethune Schooner was next with four centimeters of erosion. The rest of the sites had much less change, and it is difficult to assert that a difference of only one centimeter is not just due to sampling error. Divers probably disturbed sediments as they worked at each site, which would contribute to observed sedimentation and erosion. Long-term monitoring of the pins will provide better indications of sediment transport.

TABLE 2
SEDIMENT PIN MEASUREMENTS AND AMOUNT OF SEDIMENTATION/EROSION
(measurements in centimeters)

Pin ID	September 4	July 30	Sedimentation/Erosion
<i>City of Tampa 1</i>	44	44	0
<i>City of Tampa 2</i>	47	46	-1
<i>Guanacaste</i>	46	47	1
Snapper Wreck	26	21	-5
Swingbridge 1	48	46	-2
Swingbridge 2	51	51	0
Bethune Schooner	61	65	4

Sediment Cores

Small sediment cores (20 cm deep) were extracted to test for sulfide (S²⁻) content in the pore water. Each core was extracted from within one meter of a sediment pin. This was done in order to quickly and easily relocate their locations on site plans, and did not reflect any site-specific sampling strategies. Recording sediment qualities (such as color and grain size) were not

part of the sampling strategy, so I performed no sophisticated sediment grain analyses. However, I did observe that sediment texture in the cores ranged from sandy silt to clayey silt. Table 3 shows the sulfide (S-) concentrations in millimoles. The only missing measurements are the *Guanacaste* samples for 15 cm and 20 cm, which were lost during extraction. *City of Tampa* and *Swingbridge Hull* have the lowest concentrations of S²⁻. *Bethune Schooner* and *Guanacaste* (although missing the two deeper samples) showed the highest concentrations of S²⁻.

TABLE 3
PORE WATER S²⁻ CONCENTRATIONS

Depth	<i>City of Tampa</i>	<i>Guanacaste</i>	Snapper Wreck	Swingbridge	Bethune Schooner
5 cm	0.151	0.138	0.446	0.598	0.391
10 cm	0.293	1.835	0.339	0.230	1.449
15 cm	0.208	N/A	1.258	0.260	0.286
20 cm	0.204	N/A	0.433	0.668	2.012

Diver Survey

The most straightforward form of monitoring and management was visual appraisal. Divers performed a basic survey of each site and recorded any visible damage or changes to major features. Data from these surveys provided a comparison to earlier investigations. While simple, this method provides specific examples of degradation through time. For some sites the diver survey was the first visit from an archaeologist in many years.

The last time an archaeologist investigated *Bethune Schooner* was David Baumer's (1990) research. I relocated the site in December 2012 using information from Baumer's report. Students surveyed the vessel during the 2013 summer field school by identifying and briefly describing the conditions of the windlass, pawl post, deadeyes, and transom. Only four of the eight previously noted deadeyes remained. Divers noted that a deadeye at midship was barely

attached, similar to a deadeye noted by Baumer (1990:22). The other features retained great coherence. Unfortunately, silt and vegetation covered the vessel since the last investigation. Without a permit to excavate, other features were inaccessible. Furthermore, time constraints and uncertainty about environmental changes affecting the site ruled out any clearing activities. Unlike Bethune Schooner, Swingbridge Hull was already being surveyed during this project.

Marisa Foster (2013) studied the Swingbridge Hull for her thesis, with fieldwork stretching over the course of the 2010, 2011, and 2012 UWF maritime field schools. The results of her research were used as a comparison with the work done by the Florida Bureau of Archaeological Research (BAR) in the early 1990s (Franklin et al. 1992). Swingbridge Hull remained mostly unchanged since the BAR survey. Through her intensive examination of the vessel she created a complete picture of the site. Besides the discrepancy in overall length (noted in Chapter 3), the noticeable difference from the BAR survey is that the steering station at 15.9 m (52.2 ft.) on the baseline is now missing. Although Swingbridge Hull underwent recent investigations, Snapper Wreck and *Guanacaste* had not been examined for about 10 years.

The survey of Snapper Wreck benefited from the time lapse since previous research. Snapper Wreck had two comparative points from which to draw: the original BAR survey and Raupp's (2004) thesis research conducted during the 2001 UWF field school. Divers assessed the main mast bed, the fore deadwood, the portside knees, and the steering components. Although the site is near a busy dock, the features retained good integrity from the BAR project through the 2013 survey. Snapper Wreck was fortunate to stay preserved this well, which was not the case for *Guanacaste*.

At the site of the *Guanacaste*, little could be done in the way of feature location. In addition to low visibility, the scattered timbers that made up the remains of the disarticulated hull

appeared chaotic. Locating specific hull features was almost impossible. For this reason, there are no data on specific features, and the time-lapse comparison in this thesis relies heavily on previous aerial and side-scan imagery for *Guanacaste*. Considering the excellent state of preservation during the PSS (Franklin et al. 1992:179–180), *Guanacaste* has clearly suffered the greatest degradation.

The only information for *City of Tampa* available before this project was from the PSS (Franklin et al. 1992:183). After relocating the site using side-scan sonar and magnetometer, Andrew Derlikowski began studying *City of Tampa* in 2013 as a thesis topic. The boiler was the only known feature prior to discovering the hull and propeller shaft on sonar records. At the time of writing, the vessel was still in the early stages of documentation. However, some information has come from preliminary dives. Divers noted the presence of a crab trap in the boiler, which points to the prevalence of crabbing in Pensacola Bay System. They also note shell hash and coarse sands around midship, which may be evidence of localized scour.

Side-Scan Sonar Imaging

Side-scan sonar remote sensing data was gathered at three sites. UWF graduate students conducted the survey using a Marine Sonics Centurion Splash Proof system with a 1200 kHz frequency. The sonar operated and recorded using Marine Sonic's Sea Scan software. Operating the sonar at high frequency produced greater clarity in the images (at the expense of range) for later comparison. During this project I obtained side-scan data for *City of Tampa*, *Guanacaste*, Snapper Wreck, and Swingbridge Hull. Bethune Schooner was in a constrained location that precluded survey with side-scan sonar.

As of 2013, the side-scan images for *City of Tampa* were the only overall visualization available for that site (Figure 19). The sonar data was acquired during the spring 2013 search for

the site. Luckily, one pass by the vessel provided a complete view of the site; no mosaicing was necessary. The image showed the location and orientation of the exposed hull timbers (a), machinery (b), propeller shaft (c), and boiler (d). The remnants of the boiler stack sit atop the boiler, and couplings show distinctly along the propeller shaft.

Students previously scanned *Guanacaste* in 2006 using a 600 kHz Marine Sonics tow fish (Figure 20). The image shows *Guanacaste* (a), *George T. Locke* (b), and Shield's Point #5 (c). The 2013 rescan of the site provided a higher-resolution picture (Figure 21). Sonar imagery was the only practical way to understand the site given its chaotic condition. The disarray of *Guanacaste* (a) contrasted with the remarkable preservation of *George T. Lock* (b). Although individual timbers were visible, describing notable hull features was impossible.

Sonar imaging from the Swingbridge Hull site produced impaired records due to the extreme slope near the shore (Figure 22). The site depth ranged from just below the surface to 25 feet deep. What the data showed aligned closely with the documentation provided by Foster (2013). In addition the sonar image reveals scour near the stern of the vessel (a), manifested as acoustic shadow (dark area on the sonar record). This bathymetric feature was not noticeable for divers on the site. The data also showed a sonar contact north of the hull (b).

Finally, Snapper Wreck was previously scanned in 2006 (Figure 23). While the overall layout of the hull was visible, individual features are obscured due to the lower (600 kHz) frequency of the sonar. I scanned again in 2013, but the sonar interface malfunctioned during the survey. Fortunately, the sonar captured a portion of the vessel before the glitch, recording the eastern portion of the site. This sonar image (Figure 24) displayed two features from Raupp's (2004:82) site plan: the steering components (a) and main mast bed (b). Additionally, a large and potentially significant sonar contact sits north of the site in the river channel (c).

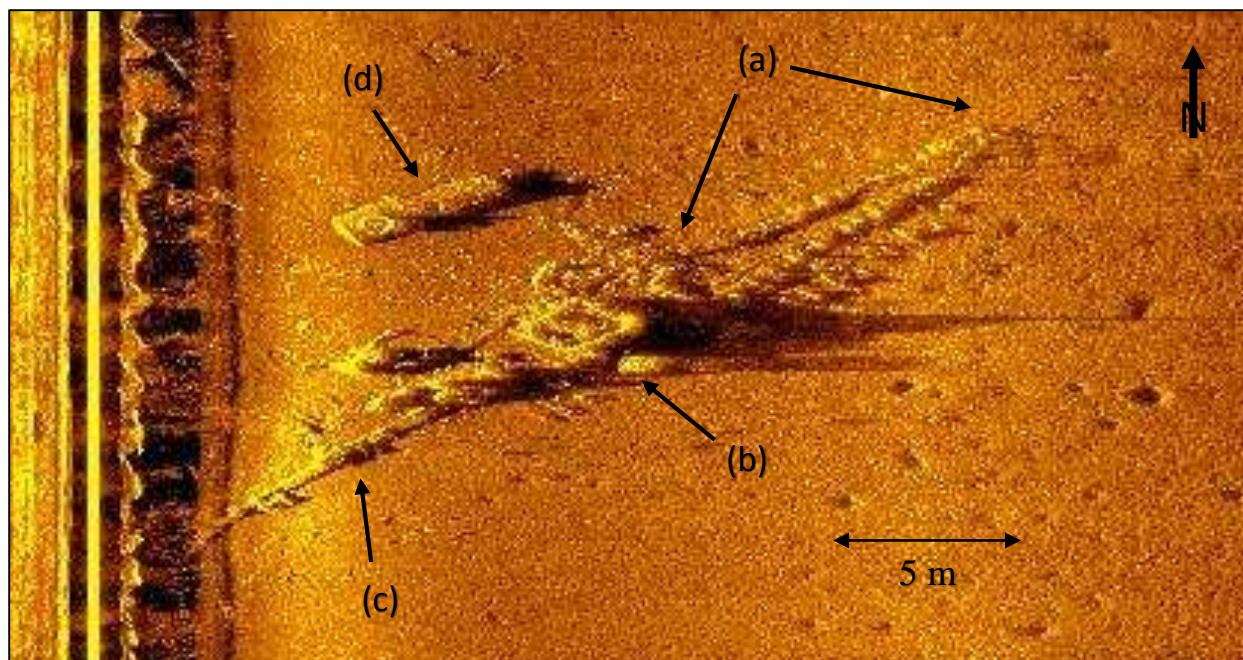


FIGURE 19. 2013 *City of Tampa* side-scan sonar imagery: (a) exposed hull timbers; (b) machinery; (c) propeller shaft; and (d) boiler. (Figure by author, 2014.)

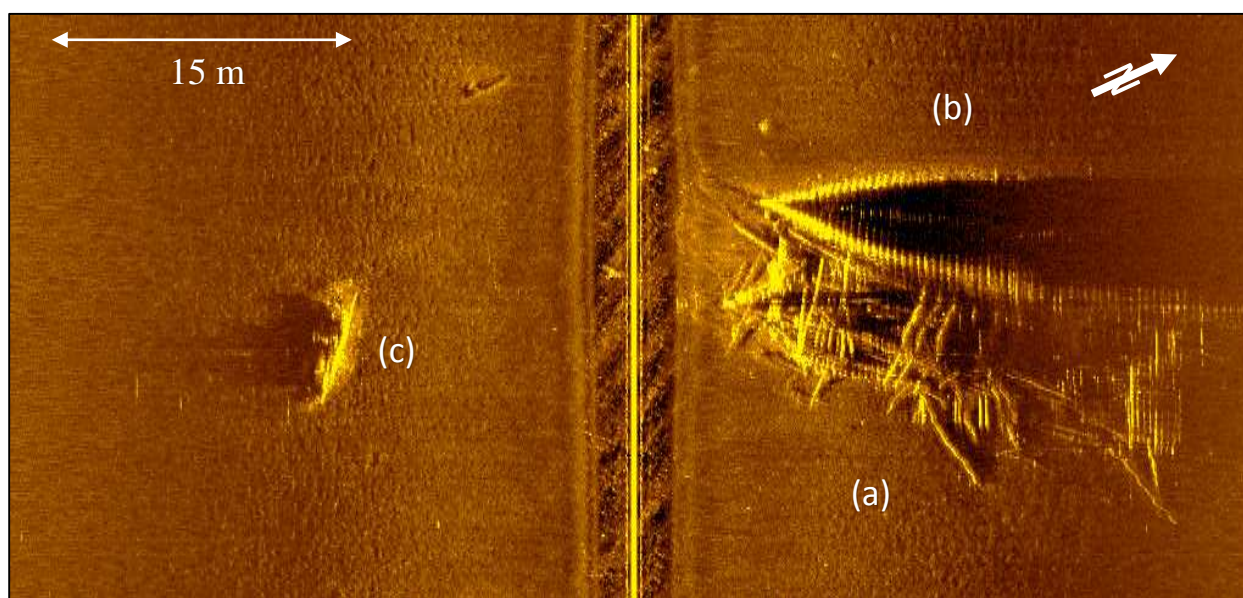


FIGURE 20. 2006 (a) *Guanacaste*, (b) *George T. Locke*, and (c) *Shield's Point #5* side-scan sonar imagery. (Figure by author, 2014.)

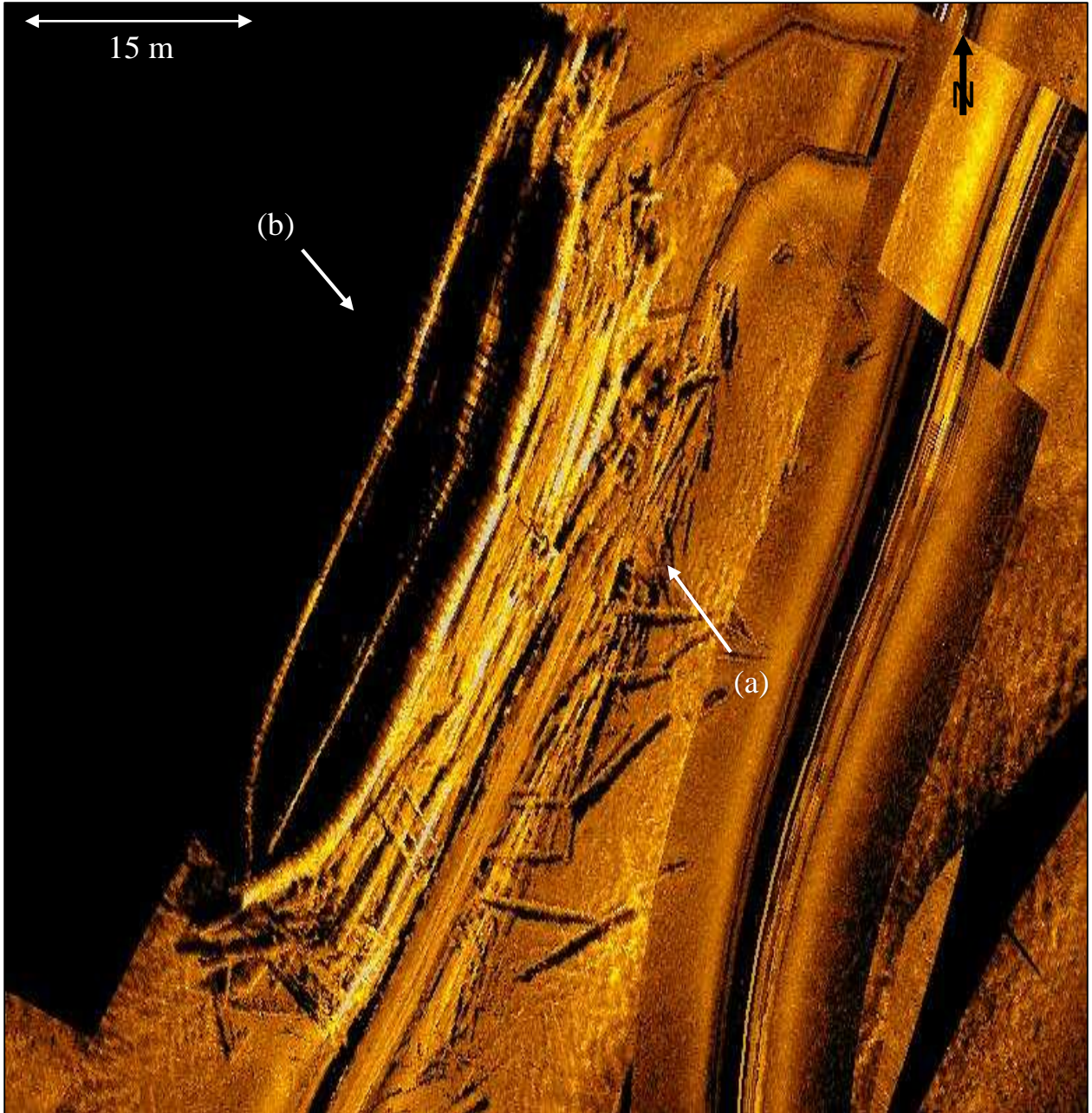


FIGURE 21. 2013 mosaicked side-scan sonar imagery from (b) *George T. Locke* and (a) *Guanacaste*. (Figure by author, 2014.)

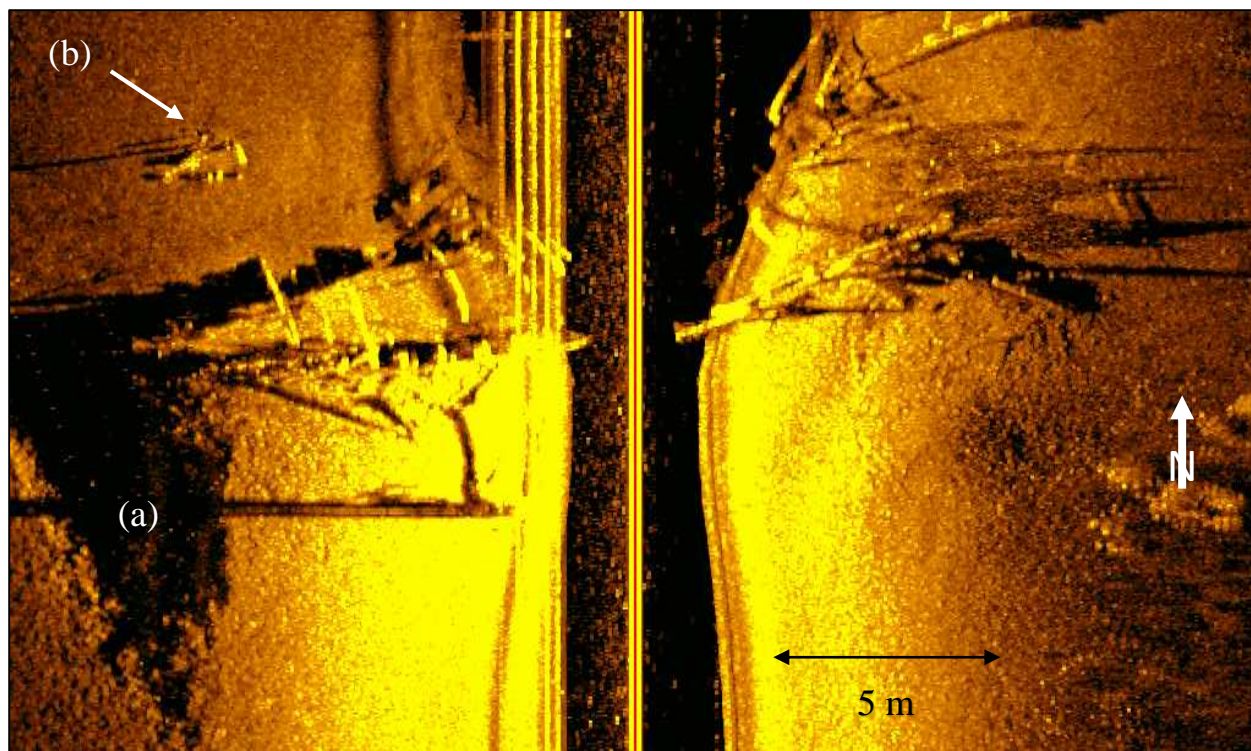


FIGURE 22. 2013 Swingbridge Hull side-scan sonar imagery: (a) scour; (b) sonar contact.

(Figure by author, 2014.)

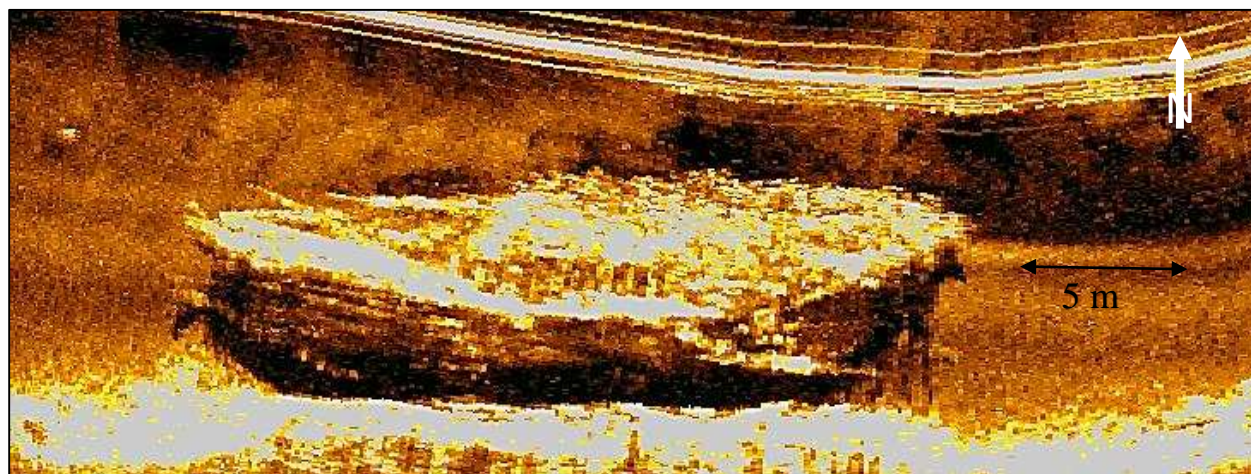


FIGURE 23. 2006 Snapper Wreck side-scan sonar imagery. (Figure by author, 2014.)

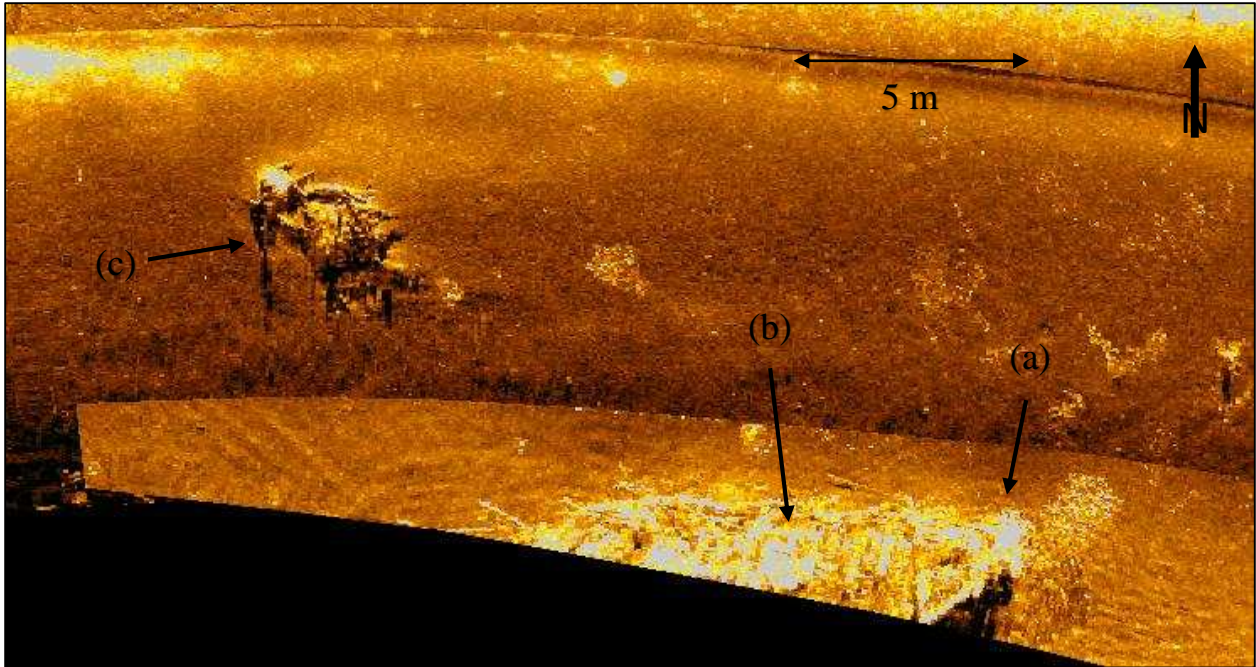


FIGURE 24. 2014 Snapper Wreck side-scan sonar imagery: (a) steering components; (b) main mast bed; and (c) sonar contact. (Figure by author, 2014.)

Conclusion

These data allowed me to capture broad changes in the sites through time. This project used water quality, sedimentation and erosion, geochemistry, diver visual appraisals, and side-scan sonar imaging to assess the formation processes at work. The physical, chemical, biological, and anthropogenic processes were quantified and qualified through a multidisciplinary approach. Additionally, this chapter was meant to serve as a guide for how to replicate (and hopefully improve) site formation methodologies. Additional data using these methods will enrich the available material, providing essential comparative data for future projects. The following chapter (Chapter 6) will combine and discuss the results of this research project to explain the observed fluctuations.

CHAPTER VI

DISCUSSION

My primary goal for this thesis was creating a strategy to understand and manage sites in a ships' graveyard. To do so included understanding the cultural factors at play in producing these sites as well as determining the natural mechanisms of site formation. The previous chapter described the methods used in this project and presented the data relevant to those processes. This chapter explains the significance of the information gathered and how it is useful for site management. Water quality data from this project compared with data from the Northwest Florida Water Management District (NFWFMD) show similarities and differences between loci. I also present some anthropogenic processes in addition to the natural ones. While Chapter 4 covered most of the behavioral processes that formed the sites—which are anthropogenic processes—this chapter deals with other human impacts on the sites since deposition. I present several in situ conservation methods which could slow degradation at these sites. I also discuss the popular strategies of site burial and cathodic protection as they relate to these sites. This is followed by a brief discussion of public archaeology possibilities built on the information gleaned in this project. In the final portion of this chapter I relate the conclusions of this research.

Post-Depositional Processes

The sites in this study are located in low-energy environments. In high-energy environments, the focus of change falls on physical processes. The greatest concern tends to be with currents, channel meandering, surges, and other agents of sedimentation and erosion. However, in the absence of such high-energy influences, chemical and biological processes become the main concern (Ward et al. 1999:565). Degradation is typically slower in low-energy environments than in high-energy environments. Thus, this project's research design explores

formative forces more broadly than other studies on site formation (Adams 1985; MacLeod 1995; Quinn et al. 1998; Ward et al. 1999), extending beyond a physical-process focus. The following sections explain the relationships of post-depositional forces at work on these sites.

In the context of site formation processes, water quality testing provides information about the water column chemistry around a site. Chemical conditions affect the preservation and degradation of archaeological materials, and as underwater sites are part of open systems, those chemical conditions change. Shifts in water chemistry are not captured in cases where a set of tests are performed at a site only once. For instance, pH (which affects the corrosion of ferrous materials) fluctuates throughout the year, particularly in a river. Water quality testing over the course of six months chronicled a range of chemical shifts that result from outside influences (especially rain). The changes in water chemistry reflect the weather trends throughout the year. The NFWMD records water quality data at Riverwalk Park in Milton once each week. The samples were taken at .5 ft. (.15 m) below the water surface. For comparative purposes, figures in this chapter reflect data from August 2012 to August 2013.

Salinity

According to the data collected during this project and through NFWMD (Figure 25), salinity in the Blackwater River is primarily affected by rainwater, groundwater, and seawater coming in from the bay. There are periods with little rain, particularly October, which is the driest month of the year. During that time the salinity levels rise as less fresh water pushes from the northern parts of the river. This allows salt water from the bays to migrate farther upriver. On the other hand, during heavy-rain periods the salinity levels drop throughout the project area. Fresh water deposited by rain in the Blackwater River drainage area collects in the river and

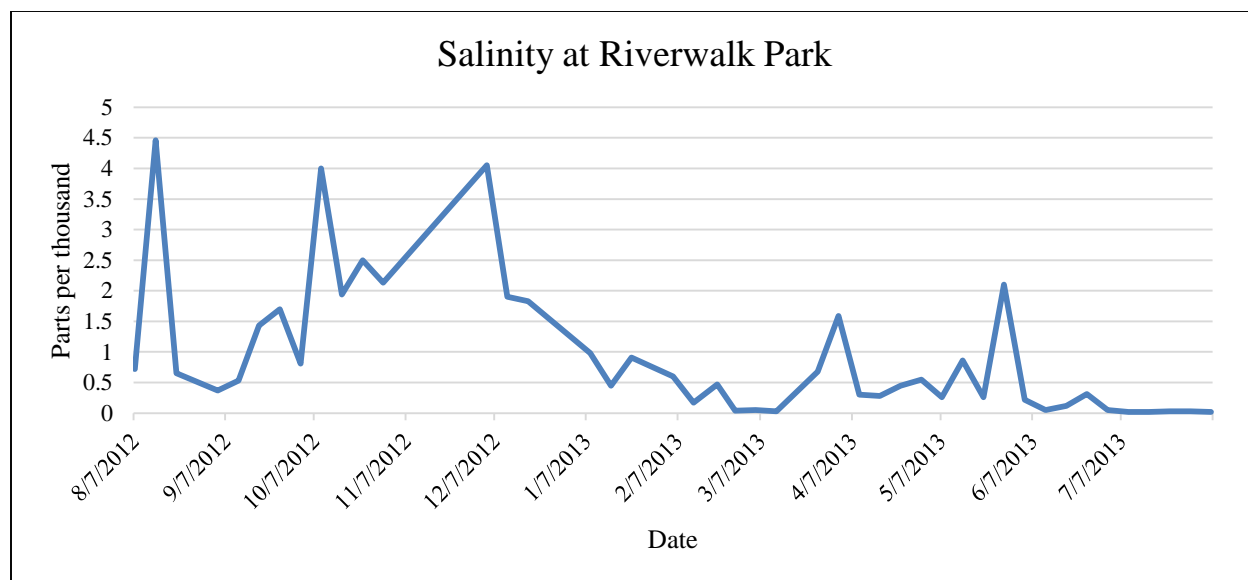


FIGURE 25. Salinity at Riverwalk Park in Milton. (Figure by author, 2014.)

pushes salt levels down. This seasonal flux assures that while salts are building up in the materials, they are also being flushed and naturally desalinated at other times during the year.

Blackwater Bay can be highly stratified as illustrated by the difference in surface and benthic salinity (Chapter 5). Benthic salinity levels were usually higher than surface salinity levels. At *City of Tampa*, the benthic salinity levels always showed salt present during the project. Artifacts from *City of Tampa* would therefore require more time for desalination than the other sites in this study. In any event, all waterlogged artifacts, if recovered, should be properly desalinated before continuing with conservation (Hamilton 1996).

Salt buildup can be a major problem for artifacts from underwater environments. As salts accumulate in the materials they crystallize. This crystallization causes expansion within the object, cracking, distorting, and otherwise damaging the artifact. This process is particularly destructive when the object dries. To avoid this, artifacts should be kept wet after removal and until residual salts have been removed. In addition to the direct effects on artifacts, salt affects the ecology of sites.

One important way that salinity affects ecology is through the fauna that tolerate or thrive in saltwater. As discussed in Chapter 2, the Gould's shipworm is common in the Pensacola Bay System. It can survive in Blackwater Bay during times of low rainfall, which means *City of Tampa* and *Guanacaste* are at risk of destruction from shipworms. Actually, damage from shipworms is obvious on the hull remains of the Shield's Point vessels. Gould's shipworms probably reduced the hull of *City of Tampa* to its current state, which is mostly just the bottom of the vessel which is buried in the mud and therefore protected from shipworms.

pH

Although the Blackwater River is considered to be acidic because of the tannin-rich water, most of the ship sites in the area are within the tidal portion of the river. The acidic waters of the northeastern portion of the river are turned neutral by the interaction with seawater which is higher in pH. This has led to a mischaracterization of site conditions, with other researchers believing the sites to be preserved in an acidic environment (Raupp 2004; Sjordal 2007; Pickett 2008). In truth, with the exception of the northernmost sites during periods of heavy rainfall, the water has a neutral pH. The northern sites tended to have a lower pH than the southern sites, but even at Riverwalk Park in Milton, 5.5 was the lowest recorded pH value (Figure 26). Surface and benthic values were similar at most sites, but the Bethune Schooner site was usually more acidic on the bottom than on the surface.

For iron artifacts at underwater sites, pH plays a large role in corrosion rates. In tropical marine waters, iron undergoes a brief, but rapid, increase in corrosion potential. The formation of concretions and marine fouling offsets this by limiting the exposure of iron to dissolved oxygen, thus reducing corrosion (MacLeod 1995:53). Higher pH precipitates dissolved calcium carbonate in the water column, forming concretions on ferrous materials. In lower pH conditions,

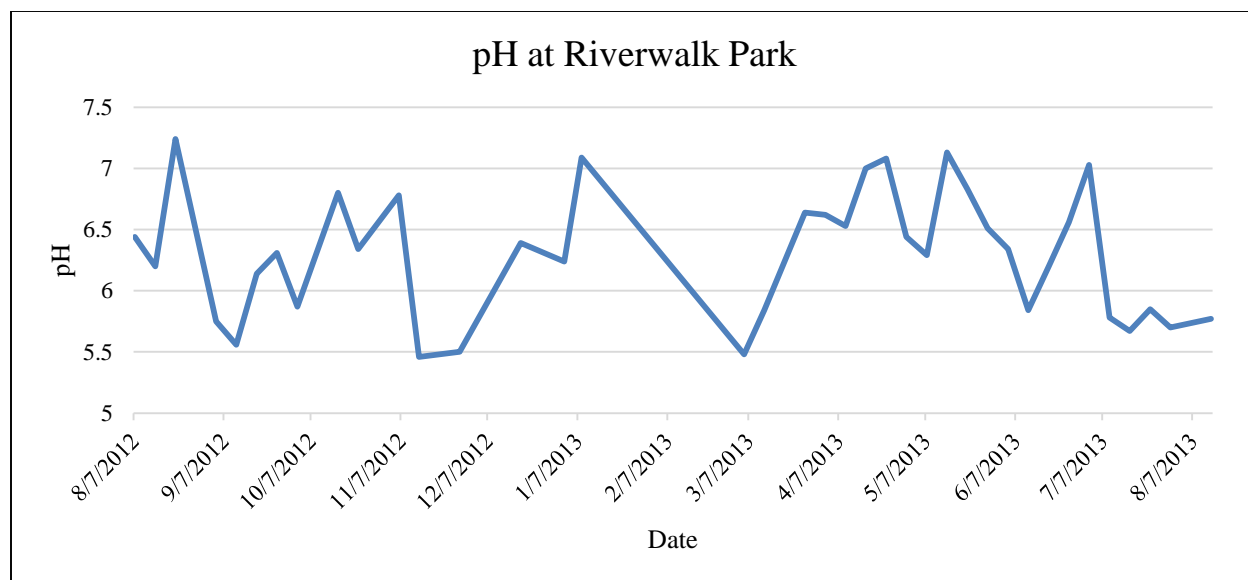


FIGURE 26. pH at Riverwalk Park in Milton. (Figure by author, 2014.)

and conditions without dissolved calcium carbonate, concretions will not form. However, corrosion accelerates in low pH water (Ammar and Riad 1958).

Dissolved oxygen

Dissolved oxygen affects the biology of the river and bay. The most obvious oxygen relationship tied to in situ preservation is aerobic and anaerobic environments. Aerobic bacteria consume organics, and therefore an oxygen-rich environment will be detrimental to many archaeological materials. Anaerobic environments can only support anaerobic bacteria. While these conditions generally preserve organics, sulfate-reducing bacteria (which are anaerobic) create sulfides. These sulfides are mainly a problem for archaeologists because when fresh water is reintroduced to them (or the sulfides are otherwise oxygenated) they produce sulfuric acids which break down materials. The *Vasa's* conservators have this problem, because the polyethylene glycol used to conserve timbers sealed these sulfur compounds in the wood, and they are gradually degrading the materials. Although anoxic conditions were never observed within the water column, work done within other parts of the Pensacola Bay System has demonstrated

anoxic benthic water (Jane Caffrey 2013, pers. comm.). The closest any of the sites came to anoxic levels in the water was at the beginning of July, when Swingbridge Hull was at 1.27 mg/l. At Riverwalk Park, the lowest recording was about three mg/l during August 2012 (Figure 27).

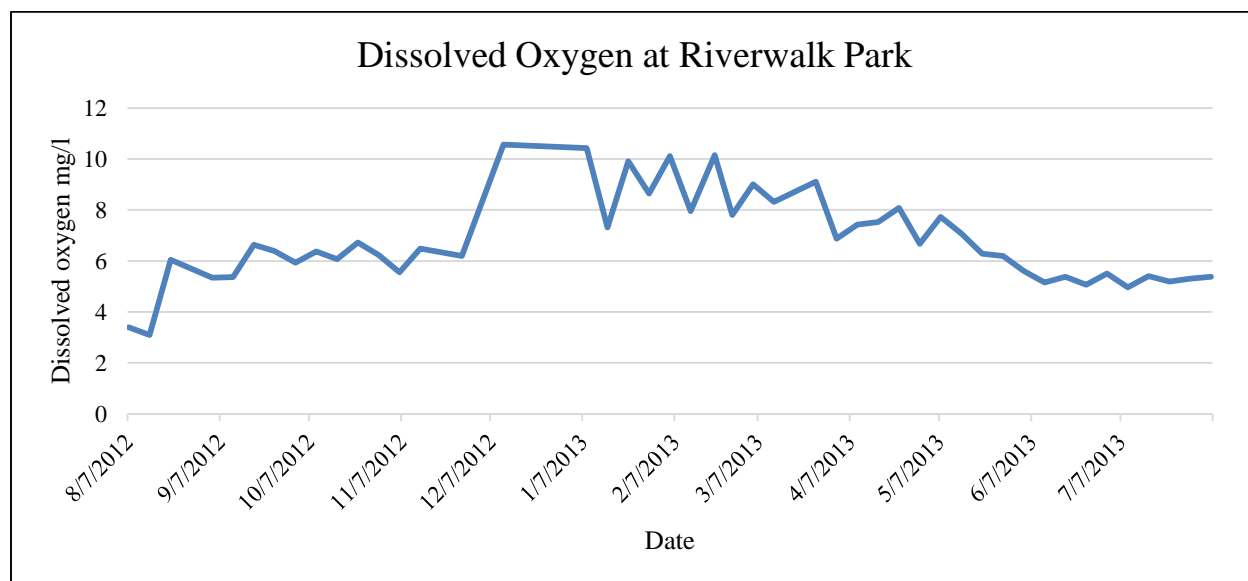


FIGURE 27. Dissolved oxygen at Riverwalk Park in Milton. (Figure by author, 2014.)

Temperature

The fluctuation in temperature simply follows the changes in air temperature; the water is coldest in winter and warmest in the summer (Figure 28). However, at individual sites the temperature may vary based on other factors. Benthic temperatures even vary from surface temperatures. The temperature of these sites ranged from 17.7 °C to 31.8 °C on the surface and 21.4 °C to 30.6 °C on the bottom. The river stays relatively warm year round. Along with being located along the Gulf Coast, warm temperatures may be due to ground-water sources that feed the river (Musgrove et al. 1965:51).

As discussed in Chapter 2, temperature controls biology. Within the Blackwater River and Blackwater Bay, the temperature stays relatively warm all year long. This means many

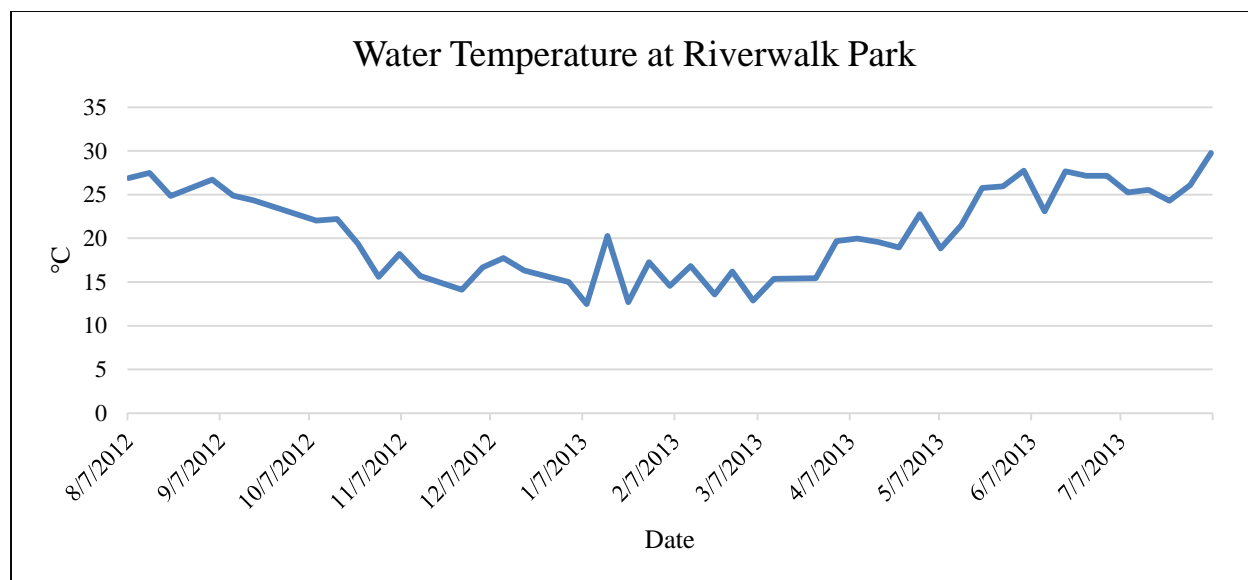


FIGURE 28. Water temperature at Riverwalk Park in Milton. (Figure by author, 2014.)

species can thrive throughout the year. Changes in temperature throughout the year probably affect the distribution of species in the project area. If the presence of certain species during seasonal periods became important to the management of these sites, additional research should be conducted. For instance, restricted access is given to archaeological work on sites in the Escambia River during sturgeon spawning periods (U.S. Fish and Wildlife Service and National Oceanographic and Atmospheric Administration 2003).

Temperature is related to other forces acting on artifacts. Conventional wisdom holds that ship sites in cold waters will have faster corrosion of iron components but slower concretion compared to their tropical sites. This is related to pH, but also has ties to the relationship between temperature, salinity, and dissolved oxygen (Steyne and MacLeod 2011:342). In-depth studies of the corrosion rates of ferrous objects on sites would benefit from additional time-lapse studies.

Sedimentation and Erosion

Very little sedimentation and erosion occurs on the sites chosen in this study. The most dramatic changes occur during storm events such as floods or hurricanes. However, two sites

exhibited significant amounts of change, and this can be explained. The erosion at Bethune Schooner is almost definitely the result of diver activity while investigating the wreck. Four centimeters of erosion in such a protected environment is unlikely, particularly because sediment is being trapped on the deck of the ship by the starboard gunwale. At Snapper Wreck, however, the five centimeters of accumulation is probably related to runoff from construction at the Bagdad boat launch, which is just upstream from the Snapper Wreck. This construction involved excavating a hole in which to lay sewer pipe, and generated large amounts of loose sediment which washed into the river.

Sedimentation and erosion affects submerged metals in various ways. Copper and copper alloys (such as brass and bronze) were for centuries a popular material for sheathing hulls to protect them from shipworms and marine fouling (Macleod 1982:267). This works because the interface between the metal and seawater generates a toxic oxide film. This film inhibits colonization and attacks from wood-boring mollusks. Many sites demonstrate this process through the presence of concretion-free cupreous artifacts. However, chemical alterations at this interface can lead to colonization. A rise in pH causes the precipitation of calcium carbonate in sea water, forming concretions upon which organisms can adhere (Macleod 1982:268). This can result from contact with more reactive metals, such as iron. In anoxic conditions, anaerobic bacteria generate sulfides which adhere to the surface of the metals. When again exposed to aerobic conditions through erosion, areas covered with copper sulfides are susceptible to colonization and fouling (Macleod 1982:268). Luckily, the freshwater of the river lowers the pH of the project area and lowers the amount of calcium carbonate in the water. This means that impacts to cupreous metals in the project area are minimized.

To account for the presence of sulfides, the project included a test for sulfides (S²⁻) in sediments at each site. While not a thorough sampling at each site, it did provide an indication of which sites had higher S²⁻ concentrations in the sediments than others. Please note that some sulfides take the form of iron sulfides (Jane Caffrey 2013, pers. comm.), which were not recorded. As previously indicated, the highest values were found at Bethune Schooner and *Guanacaste*. Both Bethune Schooner and *Guanacaste* are in low-energy, protected areas where mixing rates are likely lower, thus allowing less of the oxygenated water to penetrate into the sediment. Additionally, algae and bacteria use up much of the oxygen in the water column, creating anaerobic environments in which the sulfate-reducing bacteria thrive.

Hydrologic Damage

Pressure from water currents have noticeable effects on the exposed portions of sites. Floods and hurricanes, which additionally create flooding episodes, distort and scramble sites. Among the sites in this study, *City of Tampa* could be the most vulnerable. It is exposed to water currents from the channel, and it is closer to the ocean than the other sites. This makes it assailable by hurricanes and floods. Snapper Wreck sits near the channel in Blackwater River, and suffers from similar risks of damage from water currents during flood episodes. However, it is better protected from hurricane surges coming from the ocean. The Swingbridge Wreck is partially in the channel, and its present layout demonstrates significant distortion from water currents, especially surges. The deep area adjacent beneath the Milton railroad swingbridge creates a localized, high-current force exhibiting greater pressure on the site than currents in other portions of the channel in the Blackwater River. The greatest load is forced against stern of vessel. This force will likely continue to impact the site. Scour seen on sonar records (Chapter 5) is further proof of the high current. Conversely, *Guanacaste* and Bethune Schooner are in

protected areas. These locations benefit from less exposure from water currents, leaving the vessels relatively unaffected.

Anthropogenic

People engage in many activities on the Blackwater River and Blackwater Bay, both commercial and recreational. People fish, swim, boat, and dive there, and more economic development in and around the river will occur in the future. Archaeologists have examined this topic increasingly in recent years. In their article, Evans et al. (2009) discuss the importance of working with developers in order to protect cultural resources, as well as engaging with the public regarding all manner of activities destructive to sites (such as farming and fishing). Although the authors are more directly speaking about working with industry leaders and encouraging action through legislation, this sort of thinking can be applied at the local scale as well through educational outreach to people involved in activities on the river. Raising awareness about the significance of submerged sites through public archaeology is paramount. The Florida Public Archaeology Network has been crucial in this endeavor. Other organizations such as the Blackwater Pyrates and the Blackwater River Foundation are established entities that are already involved in the protection and monitoring of these sites. Cooperation with these groups will result in positive outcomes for submerged sites in the Blackwater River.

Currently, fishing is popular in the Blackwater River and Blackwater Bay. There was evidence for this on most of the sites, in addition to direct observation during field work. At *City of Tampa*, a crab trap was lodged within the boiler, and fishing line has been found on the site. Fishing line has often been found on Snapper Wreck, and to such an extent that I included it as a hazard during dive safety briefs. While *Guanacaste* was probably used as a fishing spot—along with the other Shield's Point vessels—no direct evidence of damage from fishing activities has

been confirmed. The continuing disarticulation of the site was almost definitely the result of recreational boating of some kind, which is addressed later. Fisherman have been observed at and around Swingbridge Hull, but no direct damage or related refuse (such as fishing line) has been reported. Finally, Bethune Schooner was in a protected area near a private home, which likely limited traffic to the site. Note that in addition to damage to sites from fishing activities, which were minimal for the sites in this project area, trash accumulated on these sites as a result. Modern, intrusive artifacts have been found on most of the sites in the area. Luckily, groups such as the Blackwater Pyrates have taken an active role in slowing litter through public outreach like their annual river cleanup.

General boating traffic, as stated before, also has an effect on these sites. Turbulence from propellers disturbs sediments and shallow-water sites are vulnerable to direct impact from boats. Anchors can snag on materials, disarticulating and/or scattering site components. This seems to be the most reasonable explanation for the excessive scrambling of hull timbers from *Guanacaste*. The timbers appear to be more jumbled and extend farther than expected if simple hull collapse were the only factor, especially considering that the site is in an area protected from strong currents. Areas susceptible to currents, like Swingbridge Hull and Snapper Wreck, may have compounded effects from boat traffic. These effects are probably negligible, however, in comparison to the force from naturally occurring currents.

Finally, looting is a problem for managing any archaeological site, including the sites in this study. As outlined in Chapter 4, scavenging activities have occurred on several of these sites, such as the removal of *City of Tampa*'s boiler stack and deadeyes from Bethune Schooner. While all sites are at risk from looting, some items are more at risk than others. This is especially true for easily identifiable items from sites. The other deadeyes from Bethune Schooner are easily

removable and could be monetarily valuable in addition to their significance as historic artifacts. The propeller from *City of Tampa*, while difficult to remove, is certainly at risk in light of the boiler stack removal. There is no easy solution to looting, but educating the public about the benefits of archaeology and preservation is an important part of site protection. In addition, working with local groups and creating site preserves can be part of the management strategy, as discussed later in this chapter.

In Situ Conservation

As nautical archaeologists move forward with greater emphasis on in situ preservation of sites and archaeological materials, as illustrated by the 2001 UNESCO Convention on the Protection of Underwater Cultural Heritage that focused on in situ preservation, it is imperative that we examine ways of managing sites and find ways to impede their degradation. There are many reasons for this, from the staggering costs of excavation and conservation of artifacts from marine environments, to leaving a record for future archaeologists to be able to answer their own questions through subsequent excavations or surveys. Indeed, due to the fragile nature of many submerged site environments, and the impact of disturbance on the site and ecosystem, any excavation should only be carried out with a set of well-guided research questions and a deep knowledge of the site's environment.

It is often assumed that after a short period of drastic corrosion and/or degradation that submerged archaeological materials enter a state of equilibrium. While the materials eventually may reach a state of reduced, or even negligible, deterioration, they still are a part of dynamic, open systems in underwater environments. They may be buried and uncovered, their chemical surroundings altered, various biota may interact with them, and a variety of other forces may impact them. Conservation methods can play a role in mitigating these forces.

Conserving Metals In Situ

New and effective means of conserving iron artifacts on the seabed emerged in recent decades and continue to be developed and refined. Nine cast-iron cannons were found off the coast of Italy, and one was selected to undergo conservation using cathodic protection starting in 2007 (Bartuli et al. 2011). Archaeologists found open circuit potentials were, on average, -500 mV, so the cannons were actively corroding (Bartuli et al. 2011:5). This potential was altered using two zinc anodes connected to the test cannon. Although there has been no publication since the early stages of the treatment, they had planned on recording the actual potentials during the course of conservation (Bartuli et al. 2011:6). Other archaeologists (MacLeod 1987; Steyne and MacLeod 2011) have also documented the success of such treatments in inhibiting corrosion.

The use of zinc anodes in slowing the corrosion of iron, as well as decreasing the level of chlorides in the material, seems pretty straight forward. The main iron component that would be a candidate for such conservation would be the *City of Tampa's* boiler and machinery, which are prominent parts of the extant ship structure. Raising this item would probably be out of the question due to size and the cost of conserving and storing it. However, it is still historically significant enough to justify some expenditure on in situ conservation. Using sacrificial anodes to control the corrosion potential would be warranted.

Site Burial

One of the simplest interventions is simply burying the site. This impedes biotic forces like shipworms, and can limit the dissolved oxygen upon which aerobic bacteria thrive. There are several considerations, however, including where to get the sediment. Depending on the hydrological regimes, larger grain sediment like coarse sand may be necessary to use, as finer grain sediments are more easily removed under high currents. This should be easily established

by studying the surrounding sediment, which will reflect the sort of sediment that is deposited and left on-site. The second matter for contemplation is the surrounding ecosystem, which might be adversely affected by large-scale deposition of sand or silt. This is one of the many reasons that in situ conservation measures should be interdisciplinary and done in conjunction with environmental scientists.

Archaeology Underwater: The NAS Guide to Principles and Practice (Dean et al. 1992) has a section dedicated to these conservatory measures. It is included, quite appropriately, within the site monitoring section, following the section that outlines how to monitor change in site environment and ways of measuring corrosion potential. Their main suggestions are sediment deposition and sand-bagging, but they also describe the possibility of wrapping timbers in filter fabrics to impede fouling (Dean et al. 1992:222). This practice is complicated by the actual act of wrapping fabric around all the exposed timbers as well as the fact that certain fabrics could potentially change the microenvironment by closing it off.

In the same section, the idea of using plastic sea grasses to help stabilize sediment and impede erosion is presented. This method has resulted in mixed success. Although weighted artificial grass mats do protect the site and encourage the buildup of sediment (and they can be strategically placed, so as not to obscure the entire structure), this method sometimes is not possible because of disturbance to the local ecosystem (Skowronek and Fischer 2009:96). However, the technique has been used effectively (Harvey 1996; Staniforth 2006). All reburial activities must consider the surrounding ecosystem through consultation with biologists and ecologists. In this area, disturbances associated with reburial could affect the fragile habitats of some species such as oyster beds (Holland 2006:32).

One aspect of burial or reburial of sites not previously addressed is the matter of visibility. If one is managing a site and decides that covering it is the best option, one must also sacrifice the ability for visitors (divers, snorkelers, etc.) to see it. Depending on the type of site, this may be doubly beneficial, for instance in the case of sites that have been severely looted and are at continued risk for future damage from sport divers, such as the Soldier Key Wreck in Biscayne National Park, Florida (Allen Wilson 2012, pers. comm.). In the case of a heritage preserve, this will certainly lessen the interest for would-be visitors, and could even encourage divers to hand-fan sediment away, upsetting the chemical and biological balance of the site. If using artificial sea grasses, as mentioned earlier, one could place them strategically so as to assist in the areas that needed the greatest structural support, not necessarily burying the whole ship. This method should be used more often, but it is cost prohibitive at this writing.

Public Archaeology

The National Historic Preservation Act (NHPA) of 1966 caused a major shift in the manner archaeological and historic sites were viewed. The Section 106 process vastly improved awareness of cultural and historic resources, and assisted in their protection from destruction by development. This process employs many archaeologists outside of academia today. A side effect of this act is that we have operationalized what makes something “historic,” and here I mean eligible for inclusion on the National Register of Historic Places. This alters the view of materials, buildings, ships, etc. that are at an age between really old and modern. Prior to this Act, removing a building that was 70 years old in order to build a newer, safer, or otherwise preferred structure was standard practice; now, these aging but not ancient buildings must, in many cases, be considered for their historic potential before demolition. The NHPA is not the only measure of assessing significance, but it did structure the way archaeologists and historians

managed properties and resources. Resource managers should remember that the statutory divide between modern and historic seldom aligns with the one perceived by the public at large.

Underwater heritage preserves benefit from community individuals interested in their history and divers willing to protect cultural resources. This could be a challenge for archaeologists because it reduces their role in managing sites, but the benefits of an engaged, informed community are numerous. Community members interested in preserving archaeological resources on the Blackwater River already are in place, including two local organizations: the Blackwater Pyrates and the Blackwater River Foundation. Although the Blackwater River offers little visibility in many cases for diving or snorkeling, there are alternatives. Several sites are visible from the surface at low tide, such as the schooner barges at Shield's Point. However, local organizations and residents may not wish to encourage greater exposure of the sites, and ultimately they should have the right to grant or restrict access.

Another quandary arises from trying to underline the importance of sites without drawing too much unwanted attention which could result in looting and other destructive activities. There are disparate views and methods in historic preservation and archaeology, in that some seek to bring an in-person experience of history to the public by allowing buildings to be entered and touched, landscapes to be walked, and other human creations experienced firsthand. Robert Stipe (1983:59) outlines the importance of this form of historic representation well by saying, "First, we seek to preserve because our historic resources are all that physically link us to our past... Archives and photographs and books are not sufficient to impart the warmth and life of a physical heritage. The shadow simply does not capture the essence of the object." Navigating the divide between protecting archaeological resources from obliteration and pilfering, while also allowing the public to have access to their shared history, is something that can only be solved on

a case-by-case basis, and determined through consultation between archaeologists, historians, government entities, local community members, and others that have a stake in the matter.

Conclusion

Geographically, the Blackwater River and Blackwater Bay are well equipped for preserving ship sites. Currents are generally low, and the tannin-rich water assists in the preservation of wooden hulls. The Blackwater River discharges a mere 1,490 cfs, and the tide fluctuation of Blackwater Bay is only a 1.1 ft. (0.34 m) amplitude (Lewis 2010:7). The local ecology lent itself to a booming lumber industry, and deforestation is known to cause excessive sedimentation in fluvial systems (Petts and Foster 1985:1). Jane Caffrey and William Landing (2013, elec. comm.) estimated a sedimentation rate of 0.35 cm/year (0.14 in./year) over the past 40 years in Marquis Basin, which is connected to the Blackwater River, using lead-210 analysis. While teredo worms are absent in the project area, Gould's shipworms have probably damaged the southernmost sites according to their recorded distribution (Cooley 1978). Hurricanes cause some of the most rapid and dramatic effects on sites in the project area. NOAA (2013) gives a 10-year return rate for hurricanes, and a 28-year return rate for major hurricanes. As rivers and bays are part of open systems, site managers must continue to study the sites and their environments holistically to better understand and protect them.

The archaeological interpretations in this thesis were built from many earlier research projects, including cultural resource management programs and previous student theses. The Pensacola Shipwreck Survey (PSS) conducted by the Florida Bureau of Archaeological Research (BAR) provided a wealth of information on sites in the entire Pensacola Bay System (Franklin et al. 1992). David Baumer (1990) authored the first archaeological report on Bethune Schooner through research assisted by local volunteers and BAR. Marisa Foster (2013) wrote her thesis on

Swingbridge Hull using field research done with UWF's 2010-2012 maritime archaeology field schools with the intent of determining a vessel identity or type. Jason Raupp (2004) studied Snapper Wreck to confirm or deny the hypothesis that it was actually an early-20th-century fishing vessel. Paul Sjordal (2007) also conducted his thesis research during UWF maritime archaeology field schools, and his objective was a nomothetic approach to understanding the site formation processes of the four Shield's Point vessels (including *Guanacaste*). Finally, Andrew Derlikowski has begun writing a thesis on *City of Tampa* as of this writing. These research projects served as baselines for understanding changes the sites have undergone in recent years. They also allowed me to write about broad behavioral processes at work on the sites in the project area.

The sites in Blackwater River and Blackwater Bay formed as a result of many human choices. I approached understanding these choices through a site-formation-processes framework, informed especially through Schiffer's (1976; 1996) behavioral archaeology and Richards' (1998; 2003; 2008) application of behavioral archaeology to maritime archaeology. The most prevalent behaviors at these sites were related to abandonment processes. The boom and bust of local brick and lumber industries resulted in large-scale expansion and later contraction of maritime infrastructure during the 19th and 20th centuries (Pearce 1990; Drobney 1994). Changes in technology from sail to steam also contributed to abandonment behaviors as steam-powered vessels became more reliable, although sailing ships did persist in popularity through the early 20th century (Gould 2000:240). "Selling south" was a popular strategy for ship owners in New England to get rid of ships losing seaworthiness, as well as for southern businesses to acquire cheap vessels which could still be used in the Gulf of Mexico (Raupp 2004:140). After abandonment or loss, anthropogenic site formation processes continued through

salvage and scavenging. Examples include the salvaging of metal components from *Guanacaste* (Watley 1964), and the removal of machinery from *City of Tampa* (Andrew Derlikowski 2014, elec. comm.). As the local lumber and brick industries collapsed, abandoned vessels slowly accumulated in the Blackwater River and Blackwater Bay. As a protected area often used for mothballing vessels and optimal for large-scale vessel abandonment, it fits Richards' (2008) classification of a ships' graveyard.

Overall, these sites are in environments ideal for preservation. However, one must understand the risks faced in any preservation situation. In this case, the sites are almost entirely exposed above the bottom of the river, and some are exposed to open air when the water level is low. Additionally, aerobic conditions will continue to allow bacteria to feed on hull timbers. The greatest overall risk results from storm events, particularly hurricanes, which bring brief but dramatic periods of destruction and alteration. Researchers must account for all deleterious factors. This research emphasizes the importance of gathering site formation data over a period of time in order to directly observe forces and their effects. These data will subsequently serve as a baseline for future studies, which will improve site management strategies.

In order for resource managers to properly manage their sites, they must seek out tools and resources that may be available to them. One aim of this project was to show that even without owning expensive equipment, one can gather data relevant to site preservation conditions. Developing relationships with departments and organizations in the natural sciences can lead to mutually beneficial results. Other entities and agencies loaned instruments and provided data for this project, as they were interested in the data to be produced. Hopefully this project will inspire others to continue expanding their research across disciplines, as holistic strategies will no doubt lead to greater outcomes.

REFERENCES

Adams, Jonathan

1985 Sea Venture: A Second Interim Report-Part 1. *The International Journal of Nautical Archaeology and Underwater Exploration* 14(4):275–299.

Ammar, I. A., and S. Riad

1958 Effect of pH on Corrosion Potentials. *The Journal of Physical Chemistry* 62(2):150–154.

Babits, L. E., and A. Corbin-Kjorness

1995 Final Report on an Archaeological Survey of the Western Shore of the Pungo River from Wades Point to Woodstock Point. East Carolina University, Greenville, NC.

Bartuli, Cecilia, Roberto Petriaggi, Barbara Davidde, Emanuela Palmisano, and Gaetano Lino
2011 In Situ Conservation by Cathodic Protection of Cast Iron Findings in Marine Environment. Paper presented at the 9th International Conference on NDT of Art, Jerusalem, Israel.

Bates, C. Richards, Mark Lawrence, Dean Martin, and Philip Robertson

2011 Geophysical Methods for Wreck-Site Monitoring: the Rapid Archaeological Site Surveying and Evaluation (RASSE) Programme. *The International Journal of Nautical Archaeology* 40(2):404-416.

Baumer, David

1990 *Bethune, Blackwater Schooner Report*. Florida Archaeological Reports 21. Bureau of Archaeological Research, Division of Historical Resources, Florida Department of State, Tallahassee.

Bingham, F. F.

1991 *Log of the Peep O' Day*. Patagonia Press, Bagdad, FL.

Boning, Charles R

2007 *Florida's Rivers*. Pineapple Press, Sarasota, FL.

Cooley, Nelson R.

1978 *An Inventory of the Estuarine Fauna in the Vicinity of Pensacola, Florida*. Florida Marine Research Publications. Florida Department of Natural Resources, St. Petersburg, FL.

Dean, Martin, Ben Ferrari, Ian Oxley, Mark Redknap, and Kit Watson (editors)

1992 *Archaeology Underwater: The NAS Guide to Principles and Practice*. Archetype Publications, London, UK.

Doehring, Donald O.

1978 Landforms and Soils. In *Sourcebook on the Environment*, Kenneth A. Hammond, George Macinko, and Wilma B. Fairchild, editors, pp. 399–418. The University of Chicago Press, Chicago, IL.

Drobney, Jeffrey A.

1994 The Transformation of Work in the North Florida Timber Industry, 1890-1910. *Gulf Coast Historical Review* 10(1):93–110.

Evans, Amanda, Antony Firth, and Mark Staniforth

2009 Old and New Threats to Submerged Cultural Landscapes: Fishing, Farming, and Energy Development. *Conservation and Management of Archaeological Sites* 11(10):43–53.

Fenneman, N. W.

1938 *Physiography of the Eastern United States*. McGraw-Hill, New York, NY.

Flett, Robert

2009 Understanding the Pb-210 Method. Flett Research.

<<http://www.flettresearch.ca/Webdoc4.htm>>. Accessed 25 October 2013.

Foster, Marisa

2013 Paradox on the Blackwater River: The History of an Unknown Shipwreck. Master's thesis, Department of Anthropology, University of West Florida, Pensacola, FL.

Franklin, Marianne, John William Morris, III, and Roger C. Smith

1992 *Submerged Historical Resources of Pensacola Bay, Florida*. Bureau of Archaeological Research, Division of Historical Resources, Florida Department of State, Tallahassee.

Gibbs, Martin

2003 The Archaeology of Crisis: Shipwreck Survivor Camps in Australasia. *Historical Archaeology* 37(1)128–145.

2005 Watery Graves: When Ships Become Places. In *Object Lessons: Archaeology and Heritage in Australia*, J. Lydon and T. Ireland, editors, pp. 50–70. Australian Scholarly Publishing, Melbourne, Australia.

2006 Cultural Site Formation Processes in Maritime Archaeology: Disaster Response, Salvage and Muckelroy 30 Years On. *The International Journal of Nautical Archaeology* 35(1):4–19.

Gould, Richard

2000 *Archaeology and the Social History of Ships*. Cambridge University Press, Cambridge, UK.

Hamilton, Donny L.

1996 *Methods of Conserving Underwater Archaeological Material Culture*. U.S. Department of Defense, Legacy Resource Management Program, Washington, DC.

Harvey, P.

1996 A Review of Stabilization Works on the Wreck of the *William Salthouse* in Port Phillip Bay. *Bulletin of the Australian Institute for Maritime Archaeology* 12(1):13–16.

Herz, Norman, and Ervan G. Garrison

1998 *Geological Methods for Archaeology*. Oxford University Press, New York, NY.

Holland, Laura Kathleen

2006 *Maritime Technology in Transition: Historical and Archaeological Investigations of the Schooner Barge Geo. T. Locke (8SR1491)*. Master's thesis, Department of Anthropology, University of West Florida, Pensacola, FL.

Hunt, Charles B.

1974 *Natural Regions of the United States and Canada*. W. H. Freeman and Co., San Francisco, CA.

Jordan, Brian

2001 *Site Characteristics Impacting the Survival of Waterlogged Wood: A Review*. *International Biodeterioration & Biodegradation* 47(1):47-54.

Lewis, F. Graham

2010 *East Bay/Blackwater Bay/Lower Yellow River Preliminary Baseline Resource Characterization*. Special Report. Northwest Florida Water Management District, Pensacola, FL.

Long Island Maritime Museum

2014 *Annual Events at the Long Island Maritime Museum*. The Long Island Maritime Museum, West Sayville, NY <http://limaritime.org/annual_events.html> Accessed 23 November 2014.

Marsh, Owen T.

1966 *Geology of Escambia and Santa Rosa Counties, Western Florida Panhandle*. Florida Geological Survey Bulletin No. 46. Tallahassee, FL.

MacLeod, Ian D.

1982 *Formation of Marine Concretions on Copper and Its Alloys*. *The International Journal of Nautical Archaeology and Underwater Exploration* 11(4):267-275.

1987 *Conservation of Corroded Iron Artefacts: New Methods for On-Site Preservation and Cryogenic Deconcreting*. *The International Journal of Nautical Archaeology* (16):49-56.

1995 *In Situ Corrosion Studies on the Duart Point Wreck, 1994*. *The International Journal of Nautical Archaeology* 24(1):53-59.

McGovern, James

1976 *The Emergence of a City in the Modern South: Pensacola 1900-1945*. The University of West Florida Foundation, De Leon Springs, FL.

Morris, Paul C.

1984 *Schooners and Schooner Barges*. Lower Cape Publishing, Orleans, MA.

Muckelroy, Keith

1976 The Integration of Historical and Archaeological Data Concerning an Historic Wreck Site: The *Kennemerland*. *World Archaeology* 7(3):280–290.

1977 Historic Wreck Sites in Britain and Their Environments. *The International Journal of Nautical Archaeology and Underwater Exploration* 6(1):47–57.

1978 *Maritime Archaeology*. Cambridge University Press, Cambridge, UK.

Musgrove, Rufus H., Jack T. Barraclough, and Rodney G. Grantham

1965 *Water Resources of Escambia and Santa Rosa Counties, Florida*. Report of Investigations. Florida Geological Survey, Tallahassee, FL.

National Oceanic and Atmospheric Administration

2013 Tropical Cyclone Climatology. NOAA National Hurricane Center.

<<http://www.nhc.noaa.gov/climo/#cp100>>. Accessed 25 October 2013.

Pearce, George F.

1990 Pensacola, the Deep-Water Harbor of the Gulf: It's Development, 1835-1930. *Gulf Coast Historical Review* 5(2):128–141.

Petts, Geoffrey E, and Ian Foster

1985 *Rivers and Landscape*. Edward Arnold, Baltimore, MD.

Phillips, John C.

1989 *Archaeology on the Blackwater: Phase Two*. Report to Blackwater Prestressed Concrete, Bagdad, FL, from The Underwater Archaeological Consortium, Memphis, TN.

Pickett, Shane Gilliam

2008 Harbor Kings: Analysis of Shield's Point Wreck #5 Using a World Systems Perspective. Master's thesis, Department of Anthropology, University of West Florida, Pensacola, FL.

Puri, H. S., and R. O. Vernon

1964 *Summary of the Geology of Florida and Guidebook to the Classic Exposures*. Florida Geological Survey Special Publications 5. Tallahassee, FL.

Quinn, Rory

2006 The Role of Scour in Shipwreck Site Formation Processes and the Preservation of Wreck-Associated Scour Signatures in the Sedimentary Record: Evidence from Seabed and Sub-surface Data. *Journal of Archaeological Science* 33:1419–1432.

Quinn, Rory, J. R. Adams, J. K. Dix, and J. M. Bull

1998 The *Invincible* (1758) Site—an Integrated Geophysical Assessment. *International Journal of Nautical Archaeology* 27(3):126–138.

Quinn, Rory, Martin Dean, Mark Lawrence, Steve Liscoe, and Donald Boland

2010 The Role of Time-lapse Bathymetric Surveys in Assessing Morphological Change at Shipwreck Sites. *Journal of Archaeological Science* 37:2938–2946.

- Quinn, Rory, Wes Forsythe, Donald Boland, Paul Lane, and Athman Lali Omar
 2007 Process-based Models for Port Evolution and Wreck Site Formation at Mombasa, Kenya. *Journal of Archaeological Science* 34:1449–1460.
- Raupp, Jason Thomas
 2004 Hook, Line, and Sinker: Historical and Archaeological Investigations of the Snapper Wreck. Master's thesis, Department of Anthropology, University of West Florida, Pensacola, FL.
- Richards, Nathan
 1998 The History and Archaeology of the Garden Island Ships' Graveyard, North Arm of the Port River, Port Adelaide, South Australia. *Australian Archaeology* 47:75-80.
- 2003 *Deep Structures: An Examination of Deliberate Watercraft Abandonment in Australia*. Doctoral dissertation, Department of Archaeology, Flinders University, Adelaide, Australia.
- 2008 *Ships' Graveyards: Abandoned Watercraft and the Archaeological Site Formation Process*. University Press of Florida, Gainesville.
- Schiffer, Michael
 1976 *Behavioral Archaeology*. Academic Press, New York, NY.
- 1996 *Formation Processes of the Archaeological Record*. University of Utah Press, Salt Lake City.
- Sjordal, Paul Goodwin
 2007 The History and Archaeology of Ship Abandonment at Shield's Point. Master's thesis, Department of Anthropology, University of West Florida, Pensacola, FL.
- Skowronek, R. K., and G. R. Fischer
 2009 *HMS Fowey Lost and Found: Being the Discovery, Excavation, and Identification of a British Man-of-War Lost off the Cape of Florida in 1748*. University Press of Florida, Gainesville.
- Smith, Lindsay S.
 2010 Maritime Systems in Transition and the Elizabeth City Ships' Graveyard, North Carolina. Master's thesis, Department of Anthropology, East Carolina University, Greenville, NC.
- Staniforth, Mark
 2006 In Situ Stabilization: The *William Salthouse* Case Study. In *Underwater Cultural Heritage at Risk: Managing Natural and Human Impacts*, R. Grenier, D. Nutley, and I. Cochran, editors, pp. 52–54. UNESCO, Paris, France.
- Stewart, David J.
 1999 Formation Processes Affecting Submerged Archaeological Sites: An Overview. *Geoarchaeology* 14(6):565-597.

Steyne, Hannah, and Ian MacLeod

2011 In-Situ Conservation Management of Historic Iron Shipwrecks in Port Phillip Bay: A Study of J7 (1924), *HMVS Cerberus* (1926) and the *City of Launceston* (1865). *Bulletin of the Australasian Institute for Maritime Archaeology* 35:67–80.

Stipe, Robert

1983 Legal Techniques in Historic Preservation. In *Readings in Historic Preservation: Why? What? How?*, Norman Williams Jr., Edmund H. Kellogg, and Frank B. Gilbert, editors, pp. 52–61. Rutgers University, Center for Urban Policy, New Brunswick, NJ.

U.S. Fish and Wildlife Service and National Oceanographic and Atmospheric Administration
2003 Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Gulf Sturgeon; Final Rule. *Federal Register* 68:13370-13495.

Ward, Ingrid, Piers Larcombe, and Peter Veth

1999 A New Process-based Model for Wreck Site Formation. *Journal of Archaeological Science* 26:561–570.

2003 A Process-Oriented Approach to Archaeological Site Formation: Application to Semi-arid Northern Australia. *Journal of Archaeological Science* 30:1223-1236.

Warren, Daniel J., Robert Church, Roy Cullimore, and Lori Johnston

2004 *ROV Investigations of the DKM U-166 Shipwreck Site to Document the Archaeological and Biological Aspects of the Wreck Site, Final Performance Report*. C&C Technologies, Inc., Lafayette, LA.

Waters, Michael R

1996 *Principles of Geoarchaeology: a North American Perspective*. University of Arizona Press, Tucson.

Watley, Jim

1964 Dead Ships Haunt Bay. *Pensacola News Journal*, 9 August. Pensacola, FL.

Weeks, Herbert H., Adam G. Hyde, Alfred Roberts, Douglas Lewis, and Craig R. Peters

1980 *Soil Surveys of Santa Rosa County, Florida*. United States Department of Agriculture Soil Conservation Service, Washington DC.

YSI, Incorporated

1998 *YSI Model 85 Handheld Oxygen, Conductivity, Salinity, and Temperature System Operations Manual*. YSI, Incorporated, Yellow Springs, OH.