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Underwater Remote Sensing Survey of Naval Station Pascagoula

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Prepared for
US Army Engineer District, Mobile

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Executive Summary

A review of the past cultural environment and an underwater remote sensing survey was conducted of the area covered by the proposed expansion of the existing ship channel at Naval Station Pascagoula. A multi-beam bathymetric survey, a sidescan sonar survey, and a magnetometer survey were performed between 16 and 18 May 2000. Targets of potential interest were selected by evaluating the characteristics of sidescan features and magnetic anomalies recorded during the surveys.

A high-resolution bathymetric contour map was produced. Thirty-two acoustic targets detected by the sidescan sonar and thirteen magnetic anomalies detected by the magnetometer were identified, positioned, and plotted on bathymetric and magnetic field strength contour plots. The targets and magnetic anomalies are discussed for significance. Six acoustic targets and 3 magnetic anomalies were identified as warranting further investigation and identification. Diver relocation and evaluation for these targets are recommended.

I. Introduction

An expansion of the existing ship channel at Naval Station Pascagoula has been proposed. Naval Station Pascagoula is located Sound on Singing River Island in Pascagoula Bay, a section of the Mississippi Sound. Singing River Island is about 600 ft southwest of the mouth of the Pascagoula River and just south of Ingalls Ship Yard (Figure 1, from NOS). Mississippi Sound is a microtidal regime with diurnal tides with a mean range of about 1 ft. The past cultural environment of the region and of pertinent prior work in the area is reviewed in Sections II and III.

An underwater remote sensing survey was conducted of the proposed channel boundaries to identify potential hazards, artifacts or other material that would impact the proposed dredging operation. The contract survey area is between Singing River Island and the Ingalls Ship Yard. It extends about 2500 ft west of the existing navigational channel to the turning basin, and 550 ft (expanded from 350 ft) south of the navigation channel on the west and central portion, and over 1500 ft southward on the eastern end. See Figure 2. A multi-beam bathymetric survey, a side scans sonar survey, and a magnetometer survey were conducted of the contract area in three separate surveys between 16 and 18 May 2000. The survey methodology and results are described in Section IV.

Targets of potential interest are tabulated and discussed in Section V. Following completion of the remote-sensing survey, a review of the data was conducted; the principal investigators selected those acoustic targets and magnetic anomalies with the greatest potential for representing submerged cultural resources. The evaluation of potential cultural significance of targets is dependent on a variety of factors. These selections were made by evaluating the characteristics of sidescan features and magnetic anomalies recorded during the survey. The sonar record gives a visible indication of the target; identification or evaluation of potential significance is based upon visible target shape, size, presence of structure and repeatability. The signal characteristics used for the selection of sidescan sonar targets included association with magnetic anomalies and other sidescan sonar targets, and indications, such as linearity and structural form, that a bottom feature represented an unnatural object. Targets such as isolated sections of pipe can normally be immediately discarded as non-significant, while large areas of above-sediment wreckage are generally easy to identify. The signal characteristics used for the selection of magnetic anomalies included anomaly amplitude or deflection intensity; area coverage, determined by duration of an anomaly along a trackline and extension of that anomaly on adjacent lines; and relative association of a given anomaly to other anomalies and to sidescan sonar targets.

Conclusions and recommendations for additional evaluations and further work are found in Section VI.

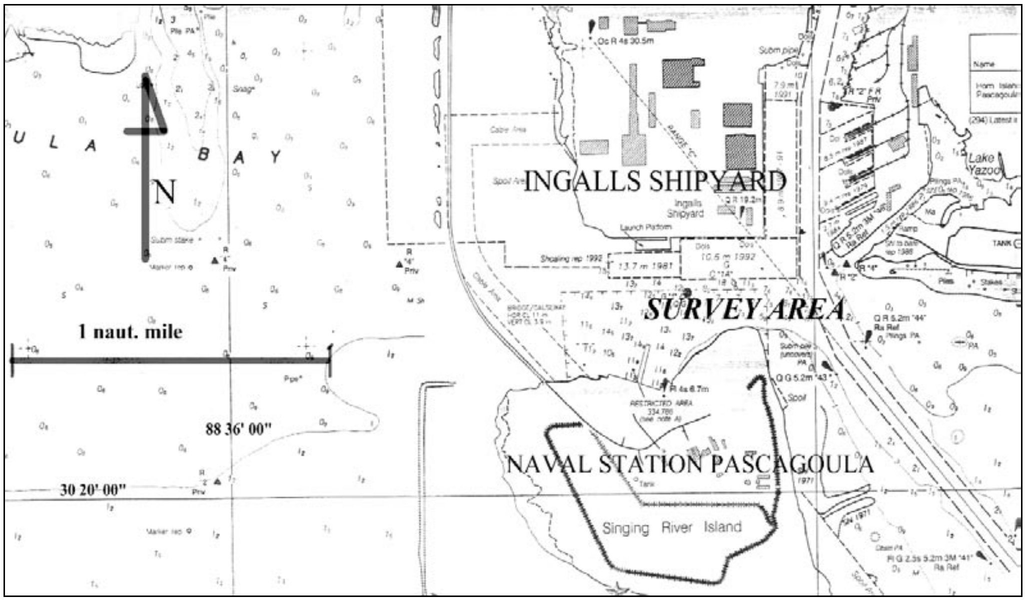

Figure 1. Pascagoula Vicinity

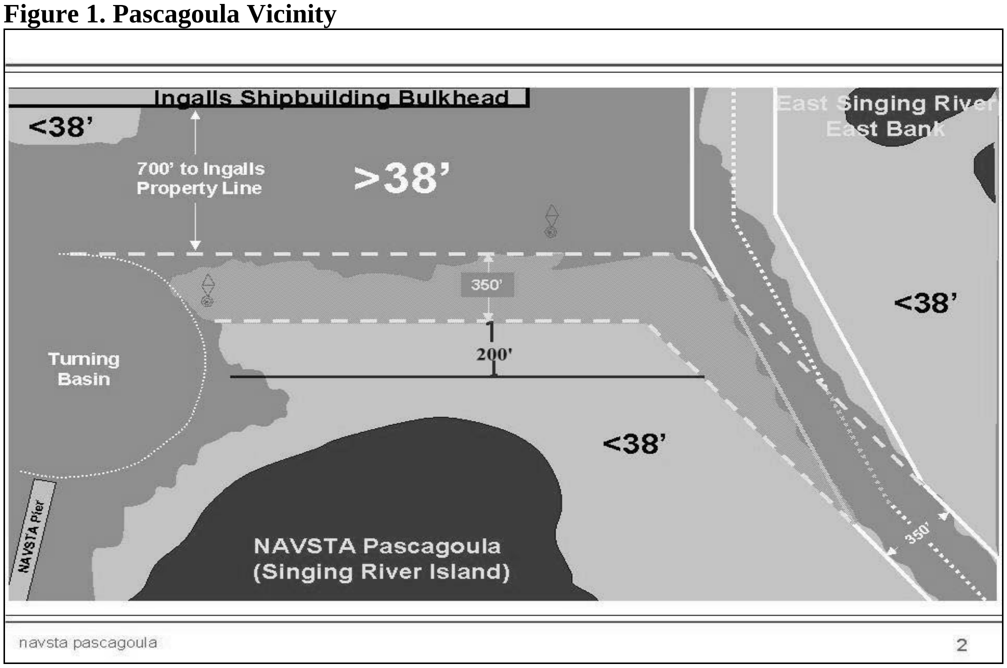

Figure 2. Contract Survey Area

II. HISTORICAL BACKGROUND

1. The Era of Exploration

The first officially recognized exploration of the gulf coast area is that of the expedition of Alonso Alvarez de Pineda, in 1519. However, it is possible that the northern coast of the Gulf of Mexico was explored by unknown parties before any of the later, historically recorded expeditions. The earliest period of exploration, during the late fifteenth and early sixteenth centuries, is characterized by a scarcity of documentation. The best evidence that the area may have been explored prior to any documented expeditions can be seen in some of the earliest maps of the Americas. The maps of La Cosa (1500), Cantino (1502), Caniero (1502), and Waldseemuller (1507) each contain detailed representations of the Florida peninsula and the gulf coast, which would indicate some familiarity with the area. While this suggests early, unrecorded voyages of exploration, it has been pointed out that during this time claims were still being made that the newly discovered lands were the fringes of the Orient, which Columbus claimed to have discovered, and that those early maps may only depict the southwest coast of Asia as it was known from the overland journeys of Marco Polo, which preceded the Columbian voyages (Fite and Freeman 1926:16, 26, 34).

Regardless of whether these maps depict knowledge gained during exploration of the gulf coast, or were merely misplaced representations of old knowledge, there is other evidence for early, unrecorded explorations of the gulf coast. As early as 1513, an expedition of Ponce de Leon, on a voyage to Florida, recorded encountering a Spanish speaking Indian. Additionally, in 1528, Narvaez recorded the presence of European objects in the possession of Indians in northern Florida, who related that the objects had originated in the Apalachee area in the Florida panhandle (Smith 1971: 56-58). Also, early sixteenth century European objects have been found archaeologically in several prehistoric sites on the northern gulf coast. However, these goods could just as easily have traveled overland via aboriginal trade routes as been brought directly to the area by early explorers.

Beginning with the Pineda expedition of 1519, and including subsequent expeditions of Narvaez, de Soto, and Tristan de Luna, the Spanish explorers were charged with the exploration and settlement of the gulf coast. Francisco de Garay, the governor of Jamaica who outfitted the Pineda expedition at his own expense, had high hopes for the newly discovered Gulf Coast (he even named it “la Provincia de Amichel”). Indeed, the Pineda expedition reported encountering inhabitants adorned with gold jewelry, and finding gold bearing streams (Galloway 1995:78). However, the archaeological record does not support this evidence, and subsequent explorations indicated that the region contained no treasure and no empires worth conquering. The Spanish subsequently devoted much of their attention to La Florida. The lack of documentary and cartographic information for the remainder of the sixteenth and for most of the seventeenth centuries indicate disinterest in the area by the Spanish.

2. The Era of Colonization

The European return to the area began with a renewed interest in the central gulf coast by the failed attempt of Rene-Robert Cavelier, Sieur de La Salle, to expand the area claimed by the French Crown for the territory of Louisiana. In 1685, La Salle attempted to establish a colony on Matagorda Bay in what is now eastern Texas, after failing to re-located the mouth of the Mississippi River, down which he had sailed on a previous expedition. Although La Salle lost his life in the colonization attempt, and the colony failed, the French interest in a territory that the Spanish regarded as their own simulated a renewed effort by Spain to explore and consolidate their hold on the central gulf coast.

The French attempt to secure control of the southern terminus of the Mississippi River system was soon renewed. In 1698, an expedition sailed under the command of Pierre Le Moyne, Sieur de Iberville, to locate the mouth of the Mississippi River. The Iberville expedition was to begin another colony to secure access through the Gulf of Mexico to the vast French territory of Louisiana. Finding that the Spanish had recently established a new foothold at Pensacola, Iberville sailed west. In April of 1699, he visited the Pascagoula River mouth, and attempted to establish a fort and settlement on the western bank of the delta. However, he soon discovered the river mouth and bay to be too shallow to make a good harbor, and abandoned the attempt (Higginbotham 1967:1-2). He eventually established a base at Biloxi.

Permanent European settlement of the area began as the result of the efforts of Iberville's younger bother, Jean Baptiste Le Moyne, Sieur de Bienville, to move the colony to Mobile Bay, a location which he considered better suited to maritime trade. A French seat of government was established in 1702 at Port Dauphin, on Dauphin Island near the entrance to Mobile Bay. It remained there until 1720, when it was moved to Biloxi, and then to New Orleans in 1722, where it remained until the close of the French period. However, the gulf coast remained important from a colonial and trade standpoint (Hamilton, 1910:102).

In spite of all the French activity, the population in the region remained small. In the early eighteenth century, three royal concessions were granted to colonists in the Pascagoula area. These included La Pointe, on the eastern side of the Pascagoula River delta, and Graveline on the west. A third concession on the upper Pascagoula River was established by Chaumont. Although Chaumont's concession was dissolved shortly after it was established, four families remained and formed most of the European population of the Pascagoula area. In addition to the La Point, Graveline and Rilleaux families, there were the Krebs, who were descended from an early German immigrant to the La Point concession and became the predominant family in the later years of the eighteenth century, and continued to be so after the region passed to British control after the Treaty of Paris in 1763.

Following the French and Indian War, the Treaty of Paris gave the French territories east of the Mississippi River to Great Britain. The Gulf Coast region came under the jurisdiction of the West Florida administrative district. The British granted further tracts of land to additional colonists, and expanded maritime commerce to the area. Commerce focused on the export of products obtained in trade with the local Indian tribes – primarily animal hides and pelts. Emphasis was also placed on the production of timber, naval stores, indigo, and cotton. During the French period, trade had been a government monopoly, while under British rule, trade was conducted by private enterprise, with a resultant increase in capital for local investment and expenditure. However, much of this effort was centered on the Mobile Bay area, and consequently, Pascagoula received little attention by the British.

After the Revolutionary War, the region passed back the Spanish. The few colonists in the Pascagoula area were allowed to keep their land holdings after giving and oath of allegiance to Spain and the Catholic Church. The population remained low during the Spanish period (Higginbotham 1967:4-11)

Since the European population of the Pascagoula area remained low throughout the colonial period, there is not much information to relate regarding the economy and maritime history of the area. Initially, the colonists cultivated grains and other vegetable products, including cotton and tobacco. Cotton was likely very important to the Krebs plantation, as Cain (1953:74-76) states that Krebs had invented an efficient cotton gin by 1772, more than twenty years prior to Eli Whitney's patent. Later in the colonial period and into the nineteenth century, however, emphasis changed from cultivation to the raising of livestock, as the surrounding region was apparently better suited for this type of economy (Mistovich et al 1983:15)

3. Early American Era

The Gulf Coast region was annexed by the United States in 1810 as part of the Louisiana Purchase. However, the non-Spanish majority were not absorbed willingly. Prior to the purchase of the territory from the French, these inhabitants rebelled, drew up a declaration of independence, and established the Republic of West Florida. It took a show of force by the United States to complete annexation of the newly formed, but not officially recognized, republic. Two years later, the Pascagoula region became part of the Mississippi Territory. Mississippi achieved statehood in 1817.

Early in the American Era, prior to 1840, the economy remained similar to that of the Colonial Era, with the predominant livelihood coming from cattle herding, and supplemented by small scale farming and hunting. However, at the same time in the interior of the state, the production of cotton was rapidly transforming the economy of the south. The larger port cities of New Orleans and Mobile prospered from the outflow of this new product. Since Pascagoula lacked a major navigable waterway extending into the interior, and hence, into the cotton belt (the head of navigation for shallow draft vessels was the confluence of the Leaf and Chackasaway Rivers in Greene County), its participation in this booming trade was limited, and commercial steamboat traffic never really prospered (Cain 1962:41)

In spite of these shortcomings, numerous attempts were made to extend the head of navigation, and trade was eventually established to the town of Enterprise. In 1818, the Mississippi Legislature appointed a commission to improve the navigability of the Pascagoula River system. Through a state lottery and land sales (Cain 1962:42), enough revenue was generated to operate a snag boat, and by 1842 the Chicasawhay and Pascagoula Rivers had been cleared of numerous obstructions. Although the completion of the Mobile and Ohio Railroad in 1855 quickly ended what little steamboat trade had been established, for a time a successful cotton trade between Pascagoula and Enterprise existed. With the establishment of the railroad, the rivers ceased to be a viable route for the transportation of goods, and were virtually forgotten until the timber trade of the later part of the nineteenth century.

4. Civil War and Reconstruction Era

Pascagoula was not a hotbed of military activity during the Civil War. As far as the historical record of shipwrecks is concerned, the Pascagoula area was virtually shut out of the war. Two exceptions exist to this statement. A common strategy employed by both sides during the war to obstruct navigation involved the scuttling of old or derelict vessels in navigation channels. Admiral Farragut's West Coast Blockading Squadron employed this as part of his effective strategy in the blockage of Mississippi Sound. Between 1862 and 1863, Union forces sunk six small captured fishing vessels in Petit Bois Pass to block the passage to Confederate blockage runners. Also, in a separate incident, the blockade-runner Fanny was chased through Horn Island Pass and into Pascagoula Bay, where it was run aground on the Pascagoula beachfront. The wreck supposedly is still there (Cain 1962:68; Higginbotham 1967:37-38)

Like the rest of the South after the Civil War, Pascagoula suffered Reconstruction era woes from 1865 – 1877. The one bright spot was the south Mississippi lumber industry, which began with the export of spar timber in the 1830s and 1840s. By the 1870s, Pascagoula was experiencing the great "Lumber Boom", as it was called (Mistovich et al 1983:18). Lasting until the 1930s, this boom transformed Pascagoula into a major international lumber and timber products exporting center by the 1880s. The replacement of axes with crosscut saws in the late 1880s tripled the output of logs, and by the time the boom ended, hundreds of thousands of logs had traveled down the Chicasaway, Leaf, and Pascagoula Rivers to sawmills in the Moss Point and Pascagoula vicinity. By the turn of the century, many commercial sawmills and log booms were in operation in the Pascagoula area, the most prominent of which were operated by the Robinson, White, Denny, Dantzler, Gautier, Tam, Danner, McIntosh, and Farnsworth companies (Mistovich et all 18983:18). During this time, the lumber industry thoroughly dominated the local economy, in much the same way the steel industry dominated the Pittsburgh economy during the early to mid twentieth century. The industry reached its peak during the first decade of the twentieth century, and declined from then on as the timber stands of the pine barrens were logged out. Also, as with the short-lived cotton trade of the nineteenth century, the completion of a railroad, this time extending from the interior to Mobile, served to signal the demise of the lumber industry, and it was largely defunct by 1930 (Cain 1962:43-45).

Although the timber industry was the dominating factor in the boom of the late nineteenth and early twentieth centuries, other industries also played a part. Wood product industries, including the production of turpentine and charcoal, added to the prosperity of Pascagoula and Moss Point. Large quantities of these products were shipped to largely domestic markets via small coastal sailing vessels, called "charcoal schooners", through Pascagoula. In addition to the wood products, paper production contributed to the local economy, eventually becoming the second most important local industry as the timber industry began to decline.

In accordance with this booming local economy, and fueled by the hope that Pascagoula would surpass Mobile and New Orleans as the most important trade center on the gulf coast, various projects were undertaken to improve navigation in the river system and improve access to the Horn Island Harbor and Pascagoula Harbor. In 1869, the State of Mississippi issued a private charter to complete what would become known as Noyes Channel, an 8 ft by 60-ft channel across the Pascagoula River bar. It was completed in 1870, and the private authority, which oversaw the operation, charged a toll for outgoing vessels. The U.S. Army Corps of Engineers , after preliminary surveys in 1873 and 1878, recommended that the State of Mississippi revoke the private charter and allow federal involvement. Accordingly, in 1880, the USCOE undertook the improvement of Horn Island Harbor, Pascagoula Harbor, and the lower Pascagoula River. Various fiscal appropriations were made in succeeding years, and by 1907, all but the largest seagoing vessels could ascend directly to Moss Point. This dredging and improvement directly stimulated seagoing trade to Pascagoula by eliminating the need for lighterage over the bars at Horn Island Pass and the mouth of the Pascagoula River.

5. Shipbuilding in Pascagoula

Another important industry in the Pascagoula area, and one, which is strongly related to submerged cultural resources, is the shipbuilding industry. Beginning from the earliest commercial shipyard, established by Ebeneezer Clark in 1843 just north of Moss Point, continuing through the years in yards established by European descended boat builders with names like de Angelo, Flechas, Piaggio, and Toche, and including the oldest continuously operated commercial boatyard in Pascagoula, run by the Krebs family since 1883 or 1885, there has been a strong shipbuilding tradition in Pascagoula. Indeed, the Ingalls Shipyard, at the mouth of the Pascagoula River, continued to prosper into the last half of the twentieth century.

The development of the shipbuilding industry in Pascagoula mirrors the development of the shipping industry. Initial shipyards, including the Clark shipyard, concentrated on the repair of small schooners and rivercraft, with the occasional construction of a new schooner or steamer. The number of boatyards in existence gradually and steadily increased through the second half of the nineteenth century and into the early twentieth. The opening up of Pascagoula Harbor to seagoing vessels in 1906 allowed larger shipyards to be built and to prosper. Even larger shipyards were opened during World War I to construct liberty ships under the United States Emergency Fleet Corporation. It was during this time that Moss Point became an important industrial center. The same occurred during World War II, when the Ingalls Iron Works, which had purchased the Gulf Ship Company (which had become the F.B. Walker and Sons boatyard in 1937), produced vessels for the allied cause at their shipyard by the Pascagoula River. Between the wars, a temporary lapse in shipbuilding occurred, which was ameliorated somewhat by the production of fishing craft.

6. Vessel Types

A multitude of European-built or European-style vessels were in use during the period of exploration and discovery. However, there is little specific information on vessels in use prior to 1870. Most records only give brief descriptions of the vessel type and little else. Therefore, it is often hard to distinguish among various types of vessels of the period by description alone. Many vessels were described by hull type, whereas others were described by their rig or sail configuration. Still others are described by both hull and rigging type. In any case, differences in vessel type are not always clear, and it is not always certain that any given vessel was described correctly at the time.

The first vessels to explore the Gulf Coast were small, ranging from 35 to 60 tons' burden. Most vessels remained small until after 1736, when they frequently ranged upwards of 500 tons. While many vessels before 1736 were 50 to 60 tons in range, many were between 100 and 200 tons burden. Even in 1759 small vessels of 50 tons were known to have made the passage from France to the Gulf region (Surrey 1916:78).

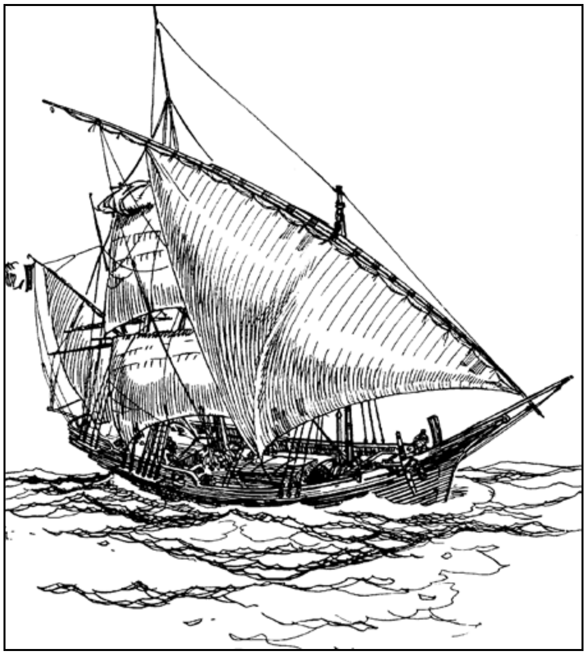

Figure 3. The Barque *Provencale* (as presented in Culver 1992:136)

The bark (or barque) has been described as a three-masted vessel with the fore and mainmast square rigged, while the mizzenmast was fore-and-aft rigged (Kemp 1993:61–62) (Figure 3). Those barks recorded by Chapman during the 18th century ranged in length from 64 feet (17 feet in beam) to 112 feet (27 feet in beam) (Chapman 1768:37–40).

Another type of vessel in use in the area during the age of exploration was a brigantine. A brigantine was two-masted, square-rigged on the foremast, and fore-and-aft rigged on the mainmast (Kemp 1993:109) (Figure 4). In 1718, an inventory of vessels in the Gulf was taken. Several of the vessels were listed as “brigantins.” One in Mobile was rated between 25–40 tons’ burden; another at Biloxi rated from 30–35 tons’ burden (as did a vessel named Le Pinere located between New and Old Biloxi). Two of the vessels were stranded and badly worm-eaten but could be repaired and put into service, “except the one at Biloxi” (Surrey 1916:71). Three other brigantines were at New Orleans, each ranging from 15–50 tons respectively (the 50-ton vessel being in a bad state of decay). Previous to 1731, the Company of the Indies began construction of a “brigantin” approximately 45 feet in length with a 19-foot beam. The vessel had a draught of 9 feet and a 76-ton capacity (Surrey 1916:71).

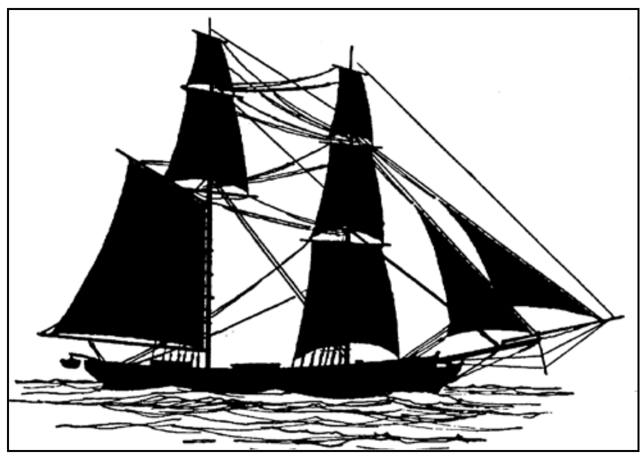

Figure 4. Typical rigged brigantine (as

During the 18th century the English used vessels called corvettes to explore the Gulf Coast as well as the Mississippi. Although originally a French design, no reference has been found noting that the French were using this type of vessel in the Gulf region during the 18th century. A corvette is defined as a flush-decked warship with a single tier of guns, and smaller than a frigate (but ship-rigged on three masts) (Kemp 1993:207) (Figure 5). In the 18th century a corvette was defined as a two-masted vessel with a bowsprit carrying a spritsail. After time the corvette design was modified, its size approaching that of a ship (Culver 1992:188).

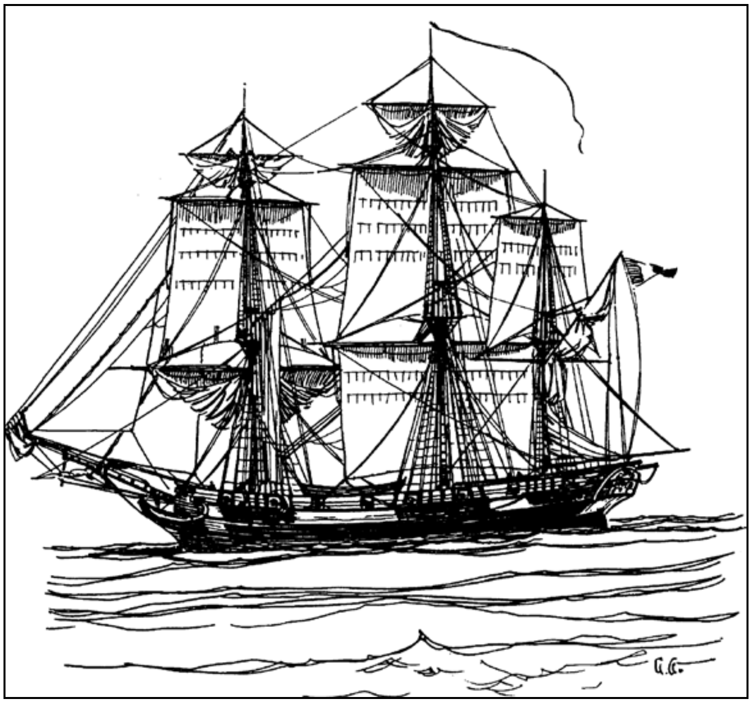

Figure 5. The corvette (as presented in Culver 1992:186).

Feluccas have also been mentioned as a vessel type in numerous French accounts from the 18th century. Feluccas have been described as small, fast sailing ships that could be powered by sail or oars. The use of feluccas in the Gulf region has been well documented. These vessels were used as coasting as well as transport vessels. Descriptions state that the vessel was a double-ender and could be sailed or rowed from either end (Surrey 1916:63). Records of a Spanish felucca built in Havana in 1786 state the vessel was 100 feet long and 27 feet wide (Mistovich and Knight 1983:31). However, draught lines of a French felucca recorded in the 18th century show a vessel with a length between perpendiculars of 43 5/6 feet and a moulded breadth of 8 5/6 feet. The vessel had a draught of 2 7/12 feet (Chapman 1768:70). The example from Chapman shows a vessel with a distinct bow and stern and would have therefore not been a double-ender.

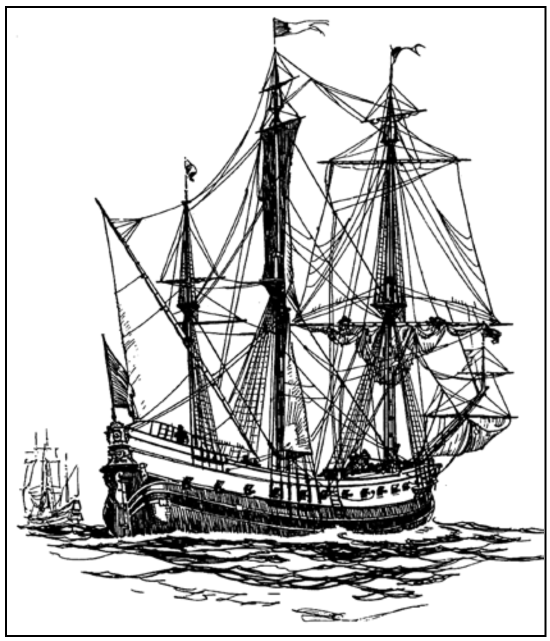

Figure 6. The flute (as presented in Culver 1992:103).

The French used the term "flute" to describe a vessel that had had some of its guns removed or moved below in order to make additional room for stores or troops (Figure 6). The word is the anglicized version of the Dutch term fluyt, a small supply vessel with a rounded stern (Kemp 1993:318). The French expression en flute referred to a vessel with guns on

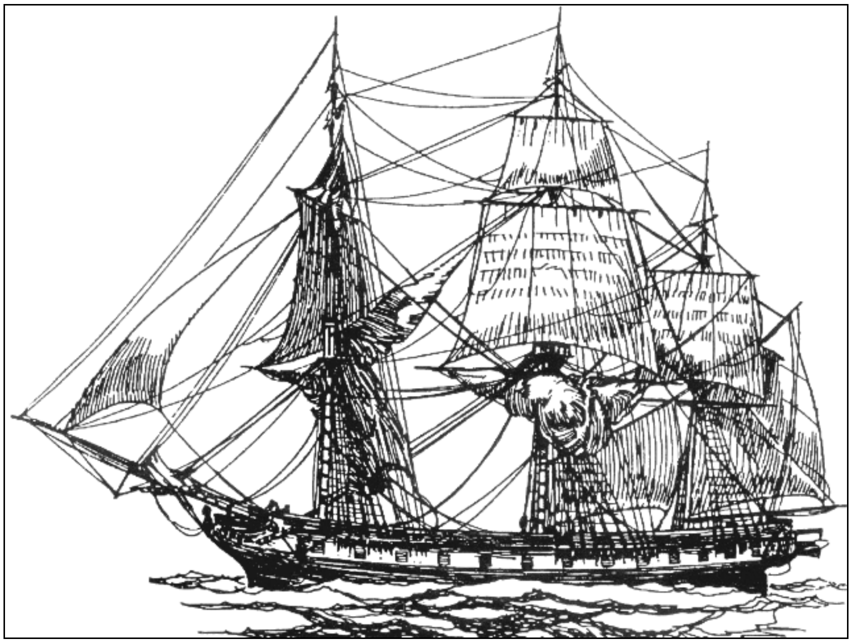

Figure 7. An 1820 frigate (as presented in Culver 1992:169).

the upper deck only, with the lower decks used for storage of goods or troops (Culver 1992:104). On his second voyage, Iberville returned to Biloxi Bay on January 8, 1700, onboard the Renommee and accompanied by the 700-ton flute Gironde, commanded by the Chevalier de Surgeres. Flutes were ship rigged and were therefore lengthy and wide in beam. This type of vessel would have had difficulty in passing into shallow harbors and would likely have been anchored offshore.

Frigates were another type of vessel used around the Gulf during the expansion of the southern territories. Iberville employed the use of two frigates (La Badine and Le Marinas) during his initial explorations of the Gulf Coast in 1699 (Giraud 1953:23). A frigate has been typically described as a three-masted, fully rigged ship with a main deck as well as a raised quarter deck and forecastle (Figure 7). They were armed with 24 to 38 guns that were carried on a single gun deck (Kemp 1993:329). Frigates were quick sailing vessels and were often used as lookouts and messengers. Plans of frigates from the 18th century show that frigates ranged in length from 56 to over 160 feet (Chapman 1768:11–17). The 56-foot frigate had a beam measurement of 18 1/2 feet and only one mast (Chapman 1768:17).

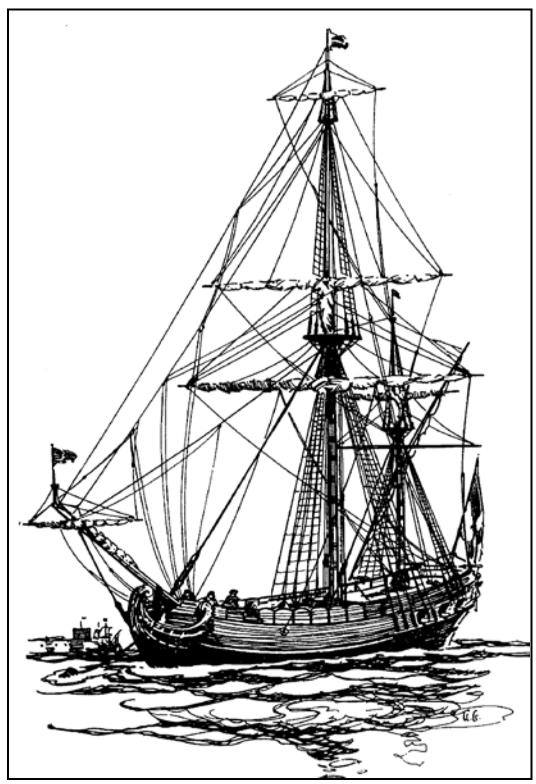

Figure 8. The ketch (as presented in Culver 1992:112)

Another vessel in use during the era of exploration, a ketch, has been described as a small sailing vessel with two masts; the mizzenmast is stepped before the rudder head. This description is not always appropriate, as some yawl-rigged vessels also had the same mast placement (Kemp 1993:447). With the main mast stepped back along with the mizzenmast, a ketch has been generically described as a vessel without a foremast (Culver 1992:113) (Figure 8). When Iberville left France to explore the Gulf, he supposedly sailed with his two frigates (La Badine and Le Marinas) and two ketches (Caruso 1966:228). Another source states that the two vessels that accompanied Iberville were two traversiers (Le Precieux and Le Biscayenne) (Higginbotham 1968:15). Whether or not the vessels were rigged as ketches and both statements are correct is unknown. Ketches were used extensively in the coastal trade and were adopted by many of the European maritime powers during the Napoleonic wars to aid in tending fleets (King et al. 1955:221). Two ketches recorded by Chapman during the 18th century were 76 to 85 feet in length with beams of 21 to 23 feet respectively (Chapman 1768:49). Although ketches were known as an effective vessel type during wartime, they were also used to carry freight and passengers. The main differentiating features of these vessels were the sail arrangement and the employment of cannons onboard (Surrey 1968:72).

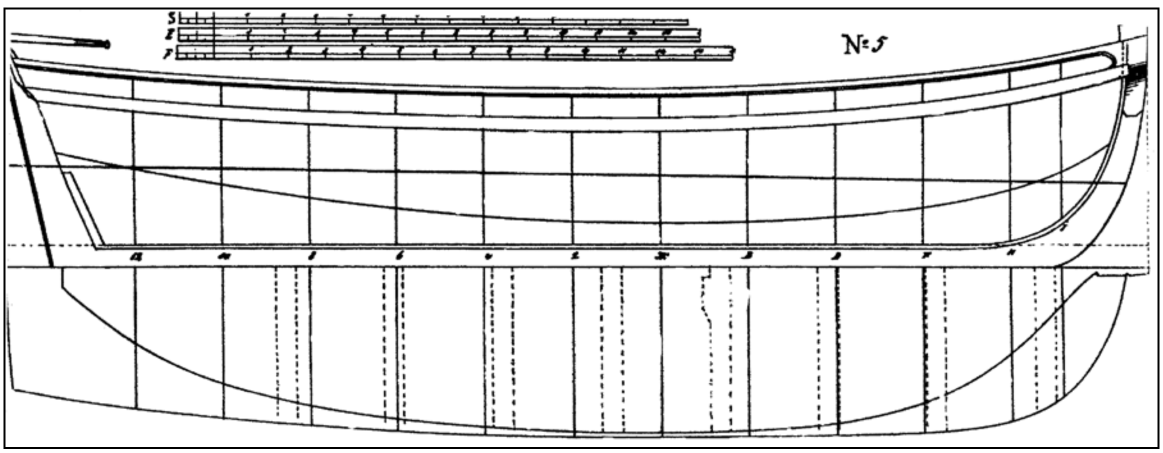

Figure 9. Hull lines of a 34-foot longboat (as presented in Chapman 1768:58).

A "Longboat" is a general term for a ship's boat, commonly a shallop. The vessel could be propelled by sail or oars and was typically round bottomed, 20 to 30 feet in length (Wilson 1983:32). Many had bluff bows with relatively narrow sterns, increasing their ability to perform as sea-going vessels (Lavery 1987:218). These boats were the largest vessels carried onboard a ship. Their principal purpose was transporting heavy stores to and from shore as well as taking water casks to shore to be filled. These boats were often stocked with provisions, as their secondary purpose was to serve as a lifeboat in case of emergency (Kemp 1993:496). Chapman surveyed a number of longboats in the 18th century. They ranged in length (between perpendiculars) from $18^{1}/2$ feet to 34 feet (Figure 9). The breadth moulded of these boats ranged from $7^{1}/3$ feet to 10 feet (Chapman 1768:58).

Another vessel in use during the Age of Exploration was called a pinnace. This was a small vessel that could be rowed or sailed and was initially designed to accompany larger ships. Although used primarily as ship tenders, pinnaces were known to accompany ships during voyages of exploration, being built to withstand substantial seas and adverse conditions. Pinnaces have been described as small ships, and the only difference between the two was in bulk and burden (Baker 1962:54). Many descriptions of pinnaces state that they had square sterns, and that the name "pinnace" came to denote a use or service rather than a specific vessel type (Baker 1962:56). Pinnaces were larger than longboats and differed from shallops in their square stern. Pinnaces were rigged in a variety of ways depending on the service they were to perform. An ocean crossing would require a different rig than that of a coastal mission (Baker 1962:59). Pinnaces ranged in size from approximately 30 feet in length (Chapman 1768:51) to upwards of 90 feet (Baker 1962:76) (Figure 10).

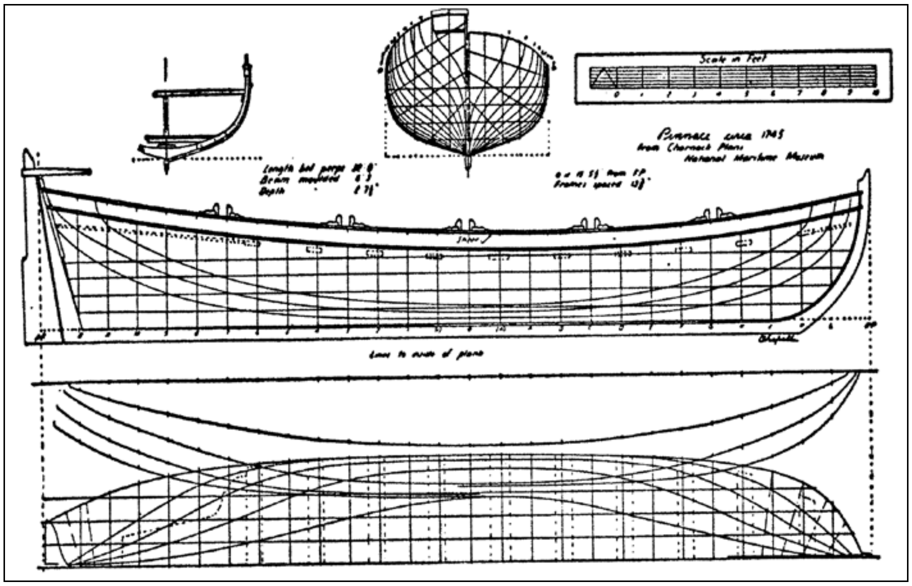

Figure 10. Hull lines of a 1700–1750 pinnace (as presented in Chapelle 1951:23).

The French used vessels called shallops (chaloupes) for a variety of reasons during the colonial period (Figure 11). Shallops were often employed by larger vessels for placing/lifting anchors and helping in times of distress (Surrey 1916:62). Shallops often varied in size from 4 to upwards of 60 tons. Shallops were usually open, heavily constructed, and useful for coastwise voyages. Rigging for shallops usually included a single mast fore and aft that was rigged with a sprit mainsail and a staysail. Some shallops had two masts with square rigging, a large mast amidships, and a small foresail stepped forward (Baker 1962:151). The term "shallop" was replaced later in the 18th century by the terms "longboat" and "launch" (Chappelle 1951:20). All these vessels were considered ship's boats and were used extensively throughout the 18th century.

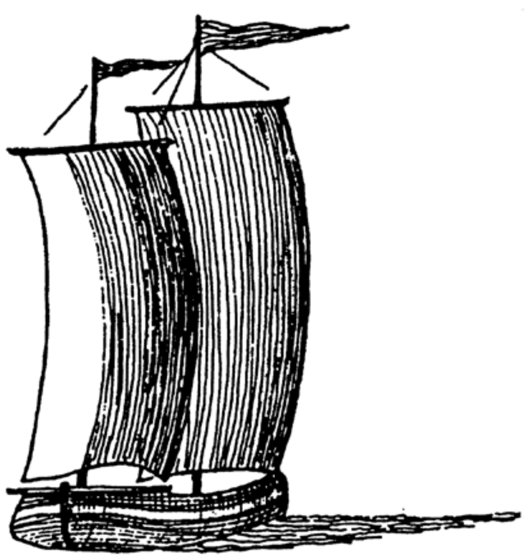

Figure 11. 1725 shallop (as presented in

Surrey states that as "early as 1704 two of these boats were at Biloxi, and in 1707 were brought into the transport service" (Surrey 1916:61). A shallop of 60 tons was also in use in the Gulf of Mexico near Deer Island (adjacent to Biloxi Bay), manned by a crew of five or six sailors (Surrey 1916:61).

Iberville made frequent mention of vessels called "smacks" during his early explorations off the Gulf Coast. However, a description of the vessel as a type is difficult to discern. A smack has been described as a small sailing vessel rigged as a cutter or ketch normally 15 to 30 tons in size and commonly used for inshore fishing (Kemp 1993:810). Smacks were often compared to "hoys" which were small coasting vessels that were constructed to upwards of 60 tons and were used extensively to transport passengers from port to port. These vessels usually had a single mast with a fore-and-aft sail (Kemp 1993:404). Chapman, in his work Architectura Navalis Mercatoria, provides the dimensions of a number of English and Dutch smacks and hoys. These vessels range in length from 39 1/4 feet (13 1/4 feet in beam) to 110 1/4 feet (27 feet in beam) (Chapman 1768:64–70).

Another vessel, called a traversier, has been mentioned in numerous accounts of voyages around the Gulf Coast. A traversier was often not a particular type of vessel but rather one that made frequent voyages between two points that were not far apart. In 1704 two traversiers were recorded making voyages between Louisiana and Mexico. Each of the vessels was rated at 50 tons. Traversiers could make passage to the West Indies and were also used as transport vessels (batiments de transport). However, Surrey states that traversiers could not get too close to shore for fear of grounding, so shallops were used to transfer supplies to shore. Traversiers were common throughout the French period in the Gulf but were employed less during the royal rule (Surrey 1916:63).

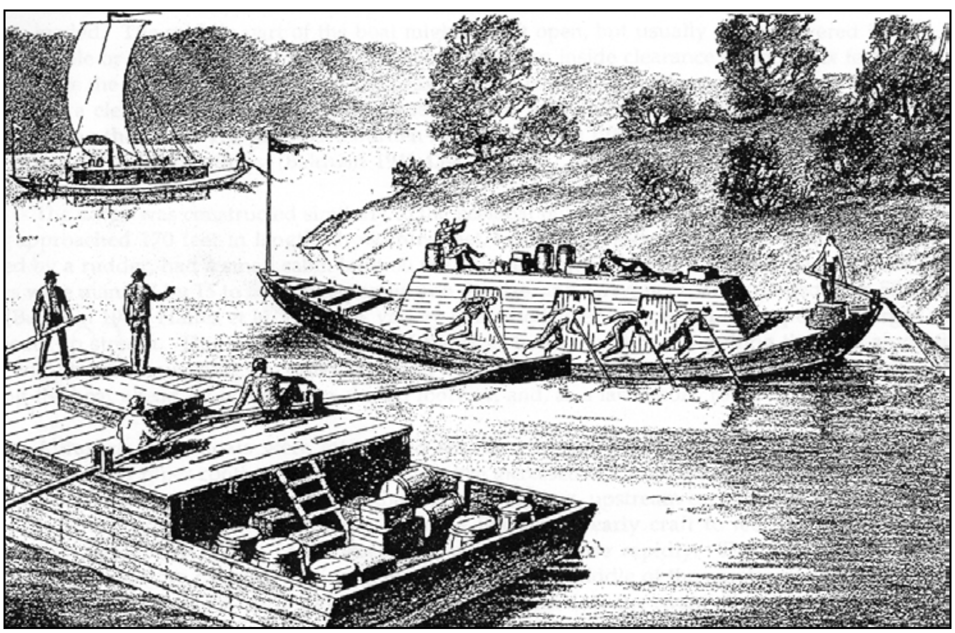

Figure 12. River scene showing a flatboat and two keelboats (as presented in Baldwin 1941:43)

With the advent of the Colonial Era, the maritime character of the area witnessed an increasing influx of watercraft types and numbers. Vessel types present during the Colonial Era were all powered by sail, and/or current, and included small coastal merchant vessels rigged as sloops and schooners, large merchantmen and warships, small local fishing craft, and early river craft which brought commodities by river to Pascagoula. During the nineteenth and early twentieth centuries, other vessel types emerged in use in the area, including river and coastal steamers, sailing craft such as lugers, sloops, schooners, ships, and barks, unpowered rivercraft of the flatboat family, Civil War vessels such as monitors and rams, small vernacular craft and fishing vessels such as bateaus, oyster boats, and bay shrimpers, as well as harbor craft like steam tugs, barges, and dry-docks.

Before the introduction of steam, the bulk of farm products from the interior were shipped downriver on rivercraft of the flatboat family. Often referred to as flats, family boats, New Orleans or Orleans boats, arks, Kentucky boats, and tobacco boats, flatboats were used to transport settlers, household goods, and livestock downriver to market (Figure 12). In addition, they were also used to transport various types of cargo, including cotton, flour, bacon, whiskey, cider, pottery, and the like. When the cargo was sold, the flatboats were either sold for lumber or abandoned, and their owners would return home (Baldwin 1941).

Prior to the ante-bellum period, the average size of flatboats increased substantially. From 1810 to 1819, the average flatboat capacity was 30 tons and cost $45 to construct. During the period between 1850 and 1860, flatboats averaged 146 tons capacity and cost an average of $219 to build with some able to carry 300 tons (Haites et al. 1975:15, 166). Unpowered, and only able to drift downriver with the current, the size and shape of flatboats varied, but generally consisted of a flat bottom, oblong shape, and a roof supported by planked sides. The average dimensions ranged from 12 to 20 feet in width and from 20 to 150 in length. Steered by a single thirty to forty-foot stern oar and two or more side sweeps, flatboats were also equipped with fireplaces or iron stoves for cooking and heating. They seldom had windows and almost never used anchors but used a line or cable to dock the boat. Pumps were also on board in case leaks occurred (Baldwin 1941: 48; Johnson 1963:116-120, 127-128).

Because the flatboat traveled only downstream, a different vessel type, the keelboat and its larger relative, the barge, evolved to handle upstream traffic. Coming into general use soon after the Revolution on the Ohio River, these vessels were built on a keel (actually built-in keels), ribbed, and covered with planks (Baldwin 1941:42-44; Haites et al. 1975).

The barge was constructed similarly to the keelboat but was larger, longer, and heavier. Barges often approached 170 feet in length, drew three feet, had a mast (often two, with square sails), were steered by a rudder, had a small cabin built on the rear deck, and a footway around the gunwales. The barges were manned by 15 to 50 men, depending on the size, and carrying capacity ranged from 50 to 150 tons (Baldwin 1941; Haites et al. 1975). A variety of methods were employed to propel the barges and keelboats up stream. These included poling (if the river bottom was hard), pulling the boat along the bank with towlines, warping or cordelling using a skiff to carry towlines out to a tree on the bank and pulling the boat ahead by walking the cleated footway, and, as a last resort, rowing (Baldwin 1941).

Although steamboats were introduced shortly after the advent of flatboats, keelboats, and barges, these latter types continued to be used and even increased in numbers and importance throughout the nineteenth century. However, due to the high cost of slow, upstream cargo carriage, the keelboat, although its use lingered on for decades,

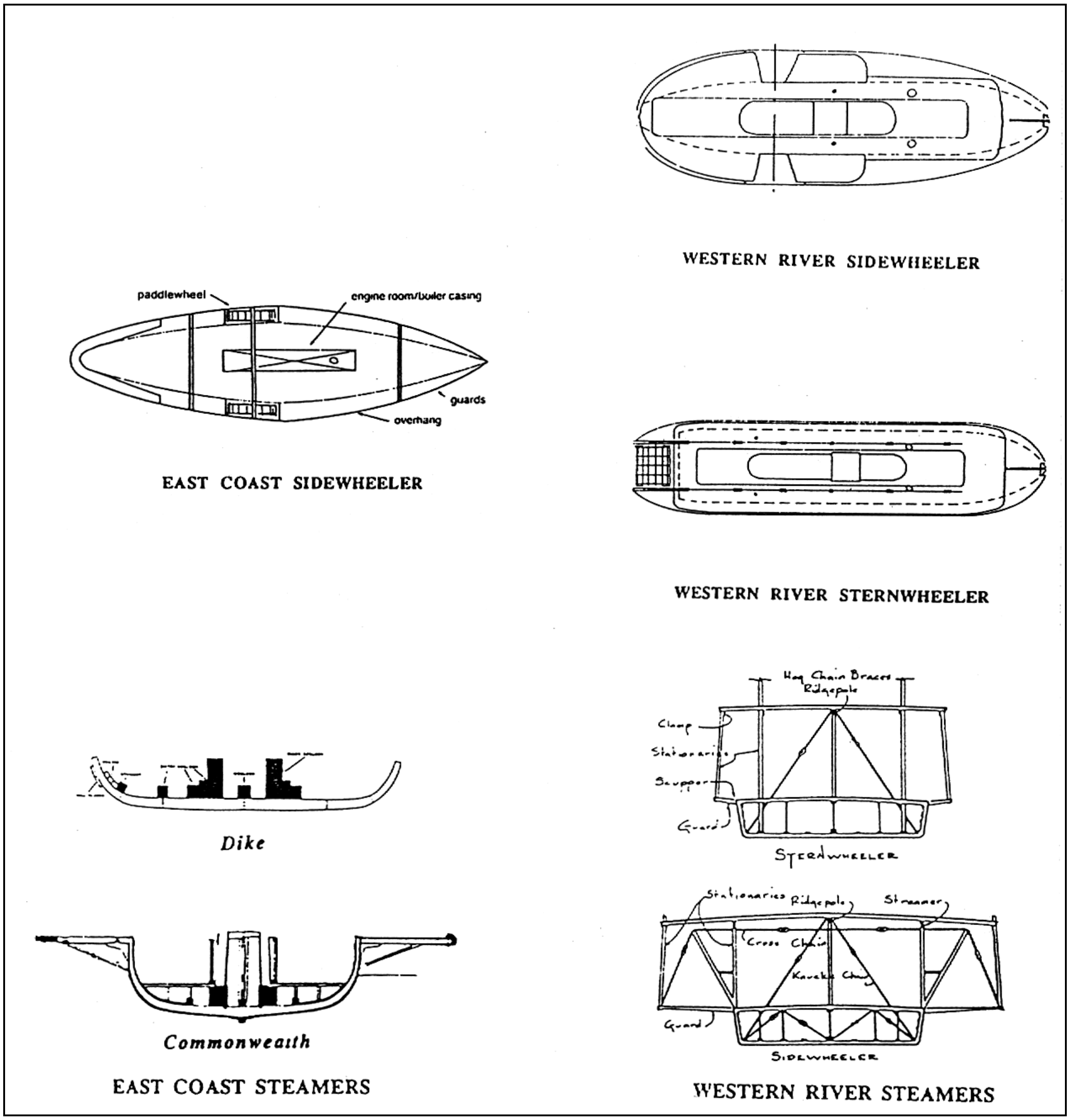

Figure 13. Comparison of hull shapes (top), and hull cross sections (bottom) of eastern seaboard and western river steamboats (as presented in Pearson et al. 1993)

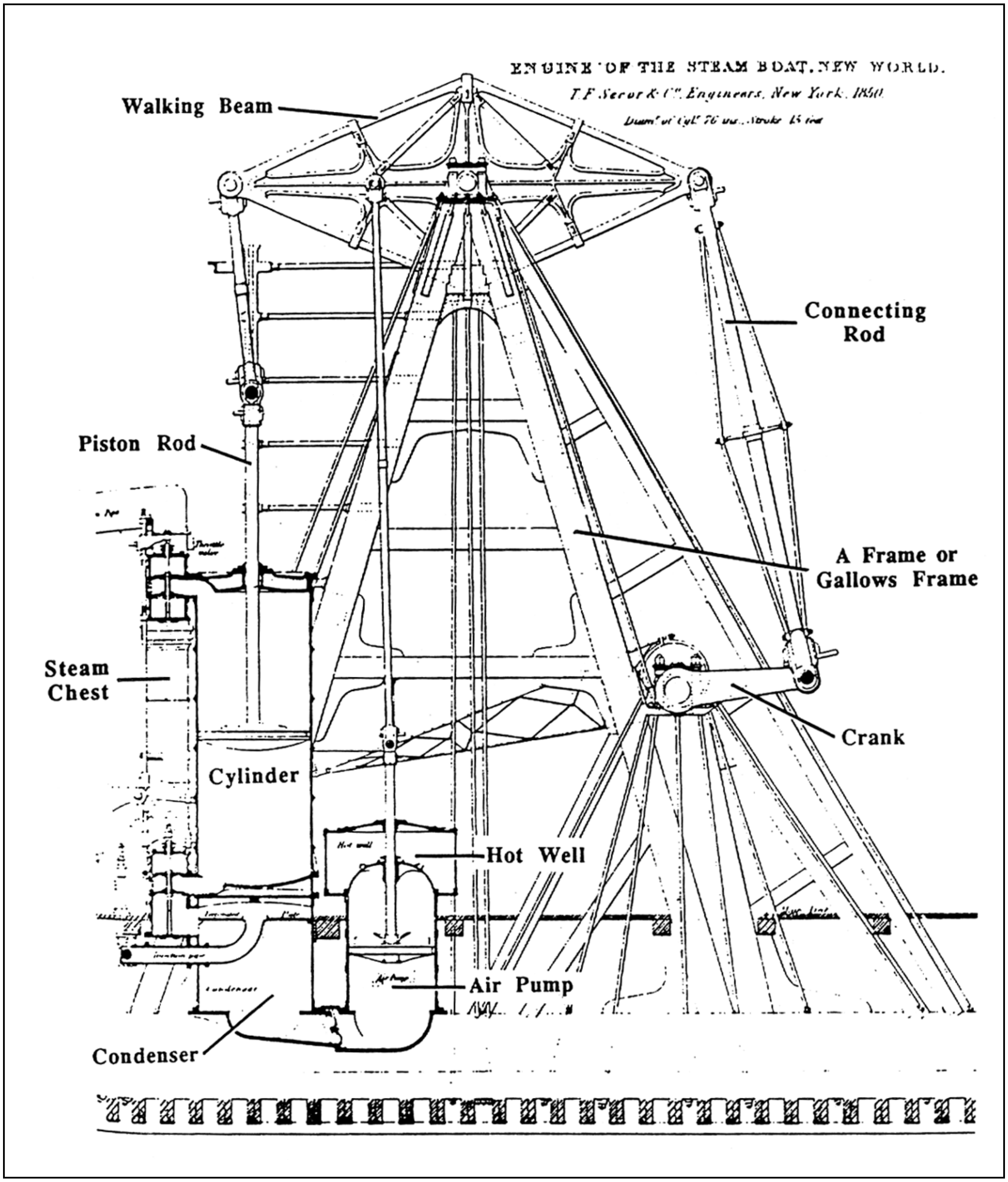

Figure 14. Major components of a mid-nineteenth century eastern seaboard low-pressure walking beam engine (as presented in Pearson et al. 1994).

was the first of the early craft to feel the competition from steam. The barge, the largest of the keelboats, went out of use rapidly. The flatboat, which was economical and easy to operate, continued in use through the middle of the nineteenth century (longer than keelboats on the major trunk routes) and persisted in use into the twentieth century on streams of the rugged hill country of Tennessee, West Virginia, and Kentucky (Haites et al. 1975:119-23; Hall 1984:181-186; Hunter 1949:52-58).

The historic steamboat was one of the most prominent vessel types employed throughout the region. There were essentially two types of steamboats employed in the area: the western rivers sidewheel and sternwheelers, and the eastern seaboard sidewheeler (Figure 13). These eastern seaboard designs had long, narrow, heavily framed, flat-bottomed hulls, and were not adapted to the western rivers' low water depth. Engines, furnaces and boilers were placed within the hull of these vessels along with the cargo. The most common engine type employed on eastern steamers was a centrally-located, low-pressure, walking beam engine (Figure 14).

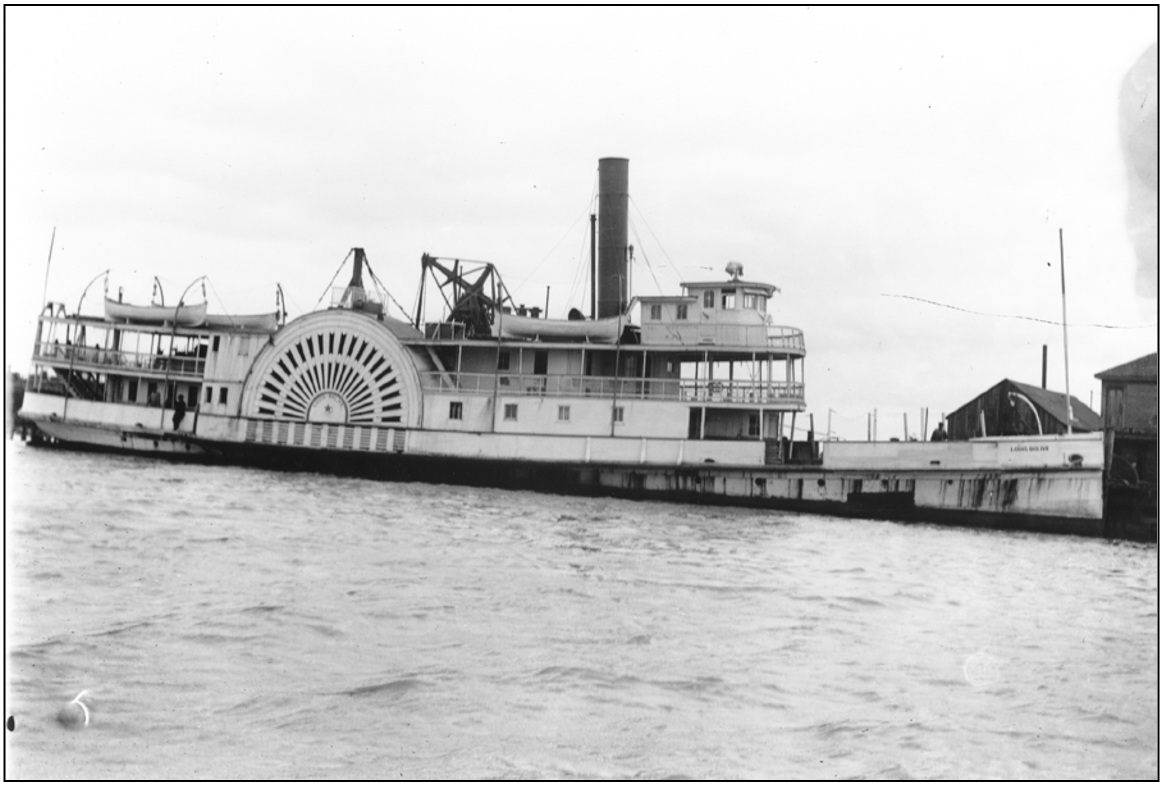

Figure 15. Steamboat Louis D'Olive, an eastern seaboard sidewheeler, built in Wilmington, Delaware in 1861 (courtesy of Overbey Collection, University of South Alabama Archives).

The eastern-built, coastal sidewheelers were well represented in the Gulf Coast area, serving as passenger and freight carriers, bay ferries and pleasure cruise boats. Steamers like the Louis D'Olive built in Wilmington, Delaware, plied the waters of Mobile Bay (Figure 15). Steamers like the Mary, a 234-foot iron hulled sidewheeler, also built at Wilmington, along with the Alabama, the Francis, and the Louise were part of the Charles Morgan fleet of coastal vessels which operated in the Mobile - New Orleans trade (Pearson et al. 1994).

While the first western rivers steamboats did not structurally differ much from their eastern seagoing counterparts, by 1840 a vast technical change had occurred, adapting the steamboats to the natural and economic conditions of travel along the western rivers. In adapting to the natural constraints of shallow, swift rivers, steamboats increased in length and breadth of hull, and decreased in depth. In the late 1820s, experimentation began with lighter methods of hull construction, and by the 1840s hull lines had become rectangular throughout, with a flat bottom and straight sides, and with curved surfaces of the hull largely confined within the short distances of the bow and stern (Hunter 1949:77, 80).

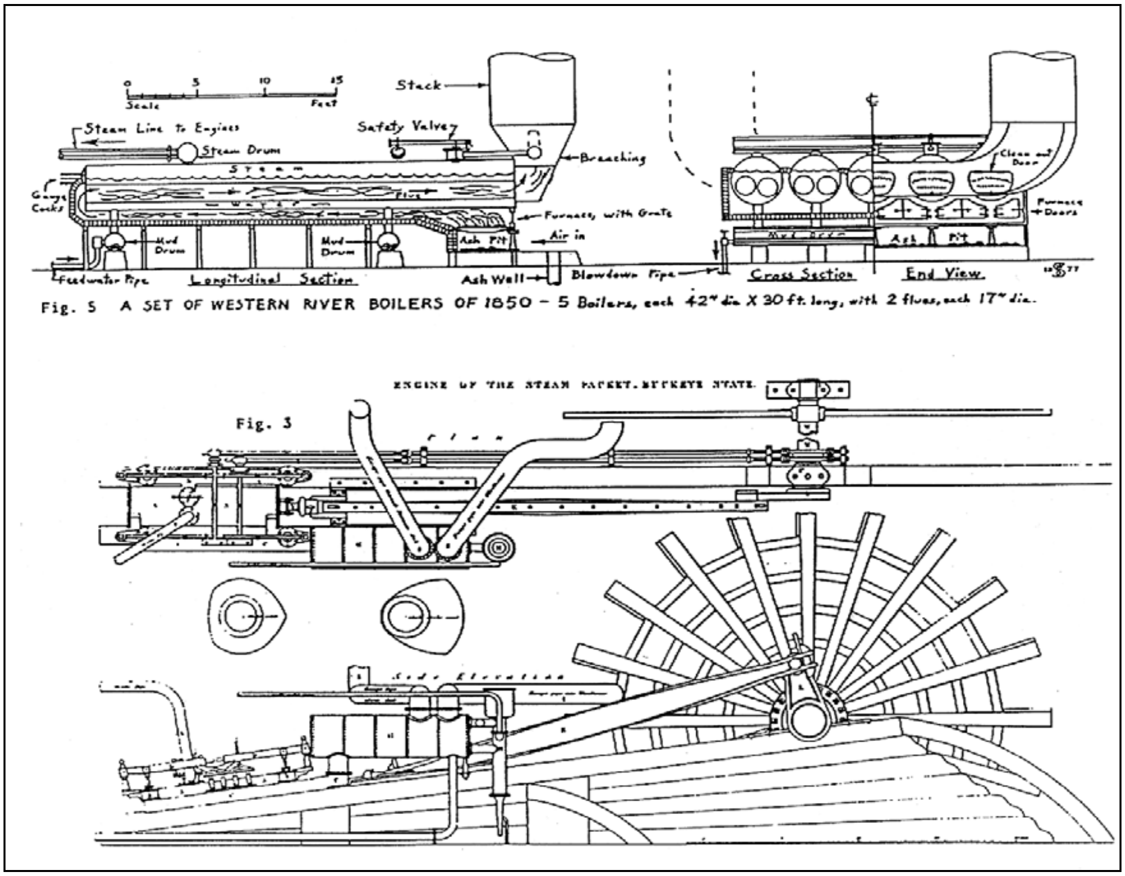

Figure 16. Illustration of an 1850s steamboat boiler and engine (as presented in Sawyer 1978:75).

Similar to the changes in vessel hulls, the propulsion systems were changing from low pressure condensing engines to high-pressure noncondensing ones. Low pressure engines, although safer and more fuel efficient, were replaced with high pressure engines that were faster and more maneuverable under the diverse navigational conditions present in western rivers. These engines were powered by long, horizontal, internal flue boilers (Figure 16). However, the major hazard associated with the high pressure engines was the common occurrence of a boiler explosion. These explosions were the greatest cause of death from steamboat accidents on the Mississippi (Duay 1992: 33-34; Donovan 1966; Hunter 1949:121-180).

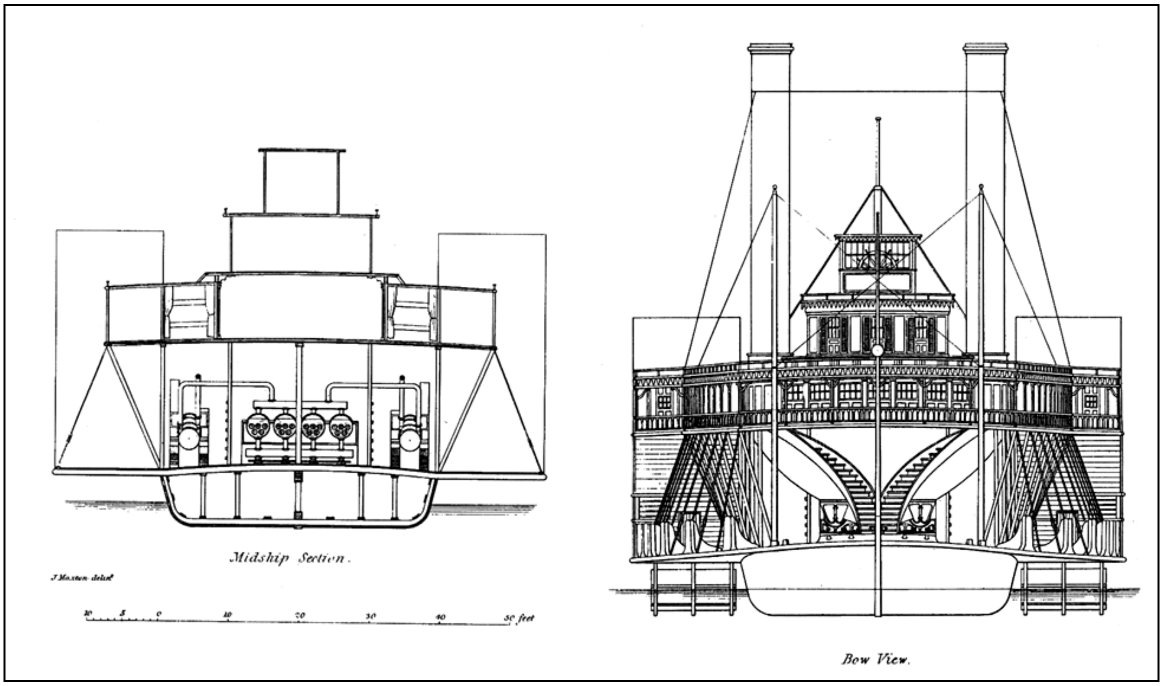

Figure 17. Midship section and bow view of a typical western rivers steamboat of the 1850s (as presented in Hunter 1949: 18).

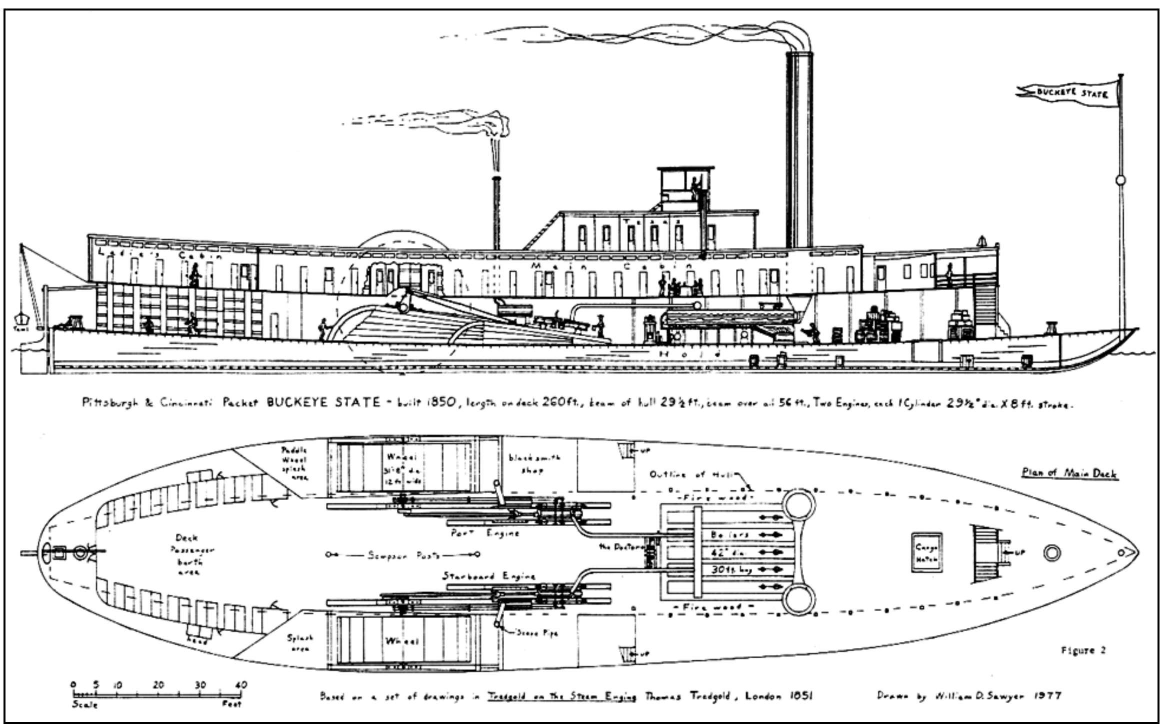

Figure 18. Plan and profile of a typical western rivers sidewheel steamboat of the 1850s (as presented in Sawyer 1979:74).

Illustrated in Figures 17 and 18, the typical western river steamboat of the 1850s was a flat-bottomed, shallow-drafted side-wheeler. Four-fifths out of water, the fully developed side-wheeler had three decks: the main deck, which covered and extended beyond the hull over the water as "guards"; the boiler deck, located above the boilers; and the hurricane deck. The pilot house stood atop the hurricane deck just aft of the stacks (Hunter 1949:90-91).

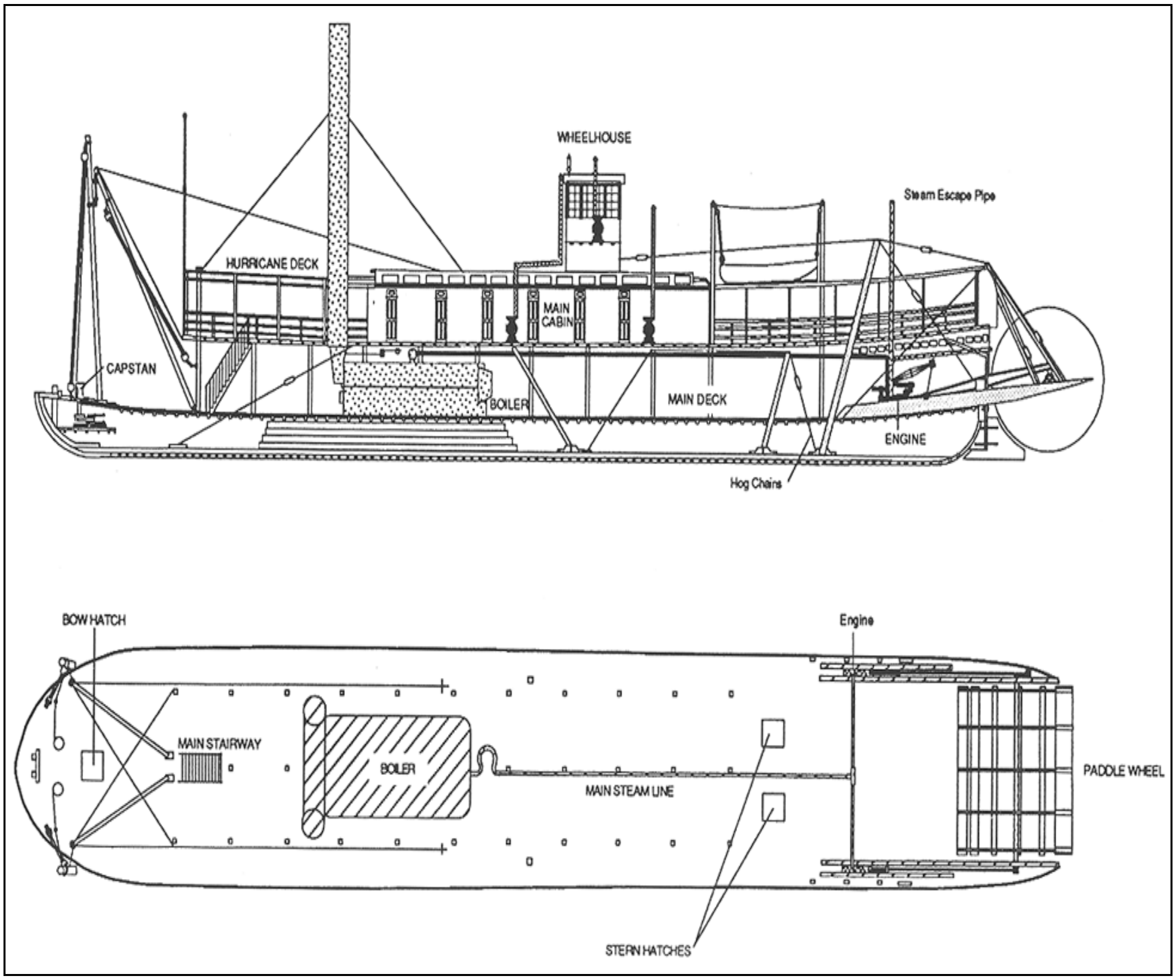

Figure 19. Plan and profile view of a typical western rivers sternwheeler (after Petsche 1974).

Used infrequently, except on small vessels, until after the Civil War, stern-wheeler propulsion replaced side-wheelers in the post-bellum decades due to "(1) the removal of the paddle-wheel from its recess in the stern; (2) the application of two engines to cranks fixed at right angle to each other at opposite ends of the paddle-wheel shaft; (3) the incorporation of the paddle-wheel assembly in the hog-chain system; and (4) the introduction of the multiple balance rudder" (Hunter 1949:172-173). By 1880, the stern-wheeler, cheaper to build, more effective in low water than side-wheelers, and more economical, had established itself as the dominant vessel type on the rivers of the interior (Figure 19).

Though less romanticized than the steamboats which plied the bay and rivers, one of the most prolific class of vessels found on the area waters were the schooners.

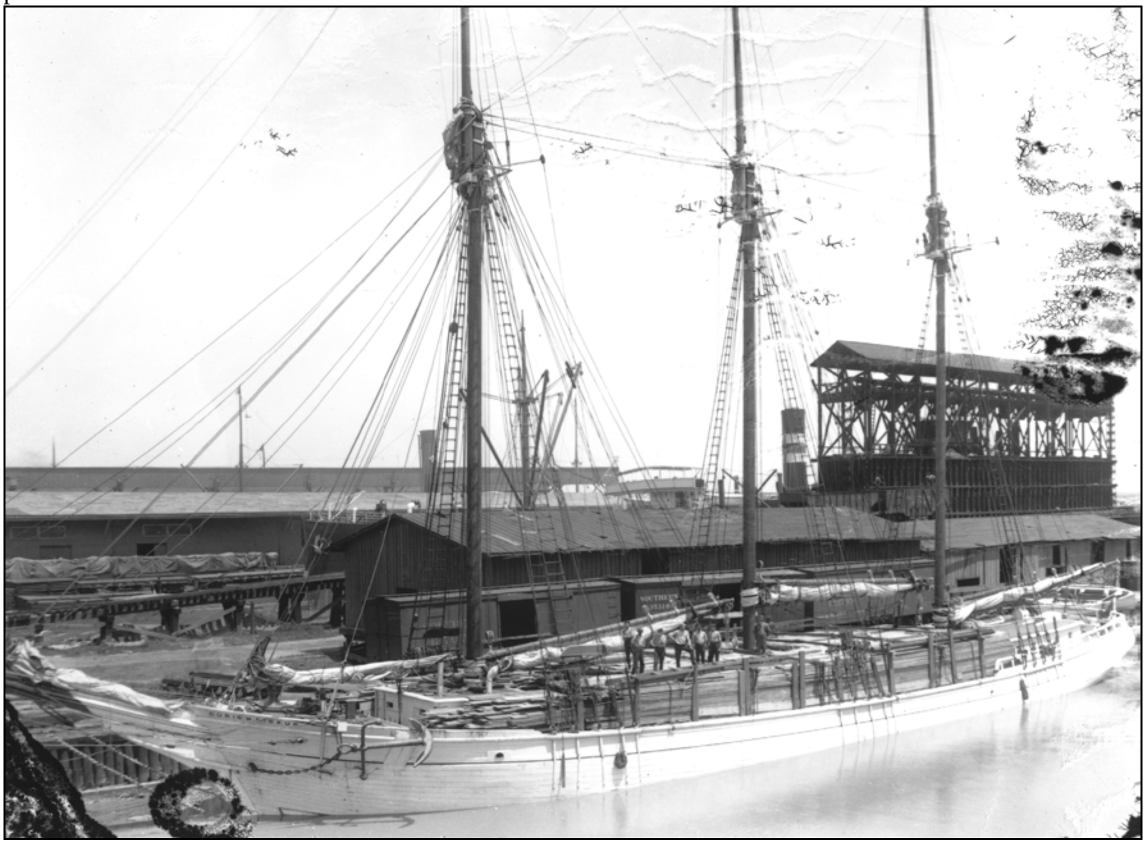

Figure 20. Photograph of a triple-masted lumber schooner fully loaded at Mobile Bay (courtesy of Overbey Collection, University of South Alabama Archives).

These included large blue-water schooners, coastal schooners, and locally built fishing schooners. Figure 20 shows a three-masted lumber schooner with a full cargo shortly after the turn of the century. These large schooners played a significant role in the local economy as lumber, and lumber products such as staves and shingles were one of the main exports from the area.

Another type of schooner used in the area was the light drafted coasting schooner. Flat-bottomed with a centerboard, it was designed to operate in the shoal water situations prevalent along the Gulf Coast waters and bays. Figure 21, a plan of the Bethune Blackwater Schooner, is representative of this now extinct type. Archaeologically documented in the Blackwater River near Pensacola Bay, Florida, the Bethune Schooner was involved in the lumber and brick industry, which flourished in Pensacola. She may even have frequented Mobile Bay as large amounts of the lumber and bricks from the Pensacola Bay area were transported to Mobile for transshipment (Baumer 1990).

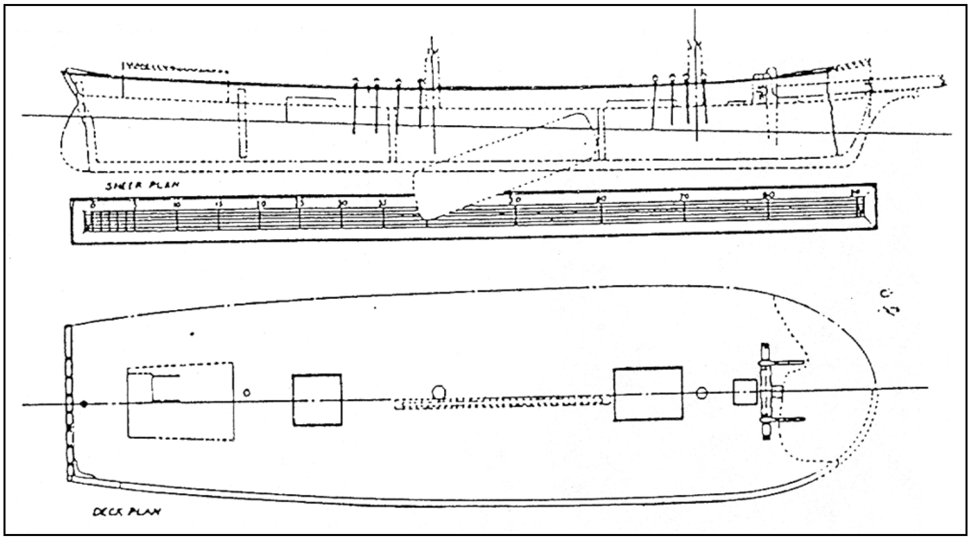

Figure 21. The double-masted Bethune Blackwater Schooner (as presented in Baumer 1990).

In 1937, offshore shrimp grounds were discovered, and vessels called shrimp trawlers began to be built, initially of wood, and after 1945, of steel. In the late 1930s, Florida Fishermen

> “introduced the "South Atlantic Trawler" when the potential for offshore shrimping in the Gulf was discovered. Begun as a variation of a powered vessel originally derived from the design of Greek sponge boats used on the west coast of Florida, the South Atlantic Shrimp trawler generally measured between 50 and 65 ft. long. The shrimp boat reached its present characteristic form and style in the very short period of time between the end of World War II and about 1950. Possibly as a result of the need for maximum rear deck working space, it was among the first powered fishing craft to have a forward-located pilot house. The hull, however, retained characteristics of the old Greek sponge boats with its full body, sweeping sheer line, and fine entrance” (Pearson et al 1993:114).

The small versions of this type, commonly called "shrimp trawlers," "bay shrimpers," or "shrimp boats," can still be found fishing the upper bay in and adjacent to the project area. Generally, these vessels, because of their relatively recent age, would not be considered historically significant if their remains were encountered in the project area. However, the earliest examples of this vessel type might be considered significant relative to National Register of Historic Places criteria, based on their evolving, yet distinctive, construction characteristics.

Besides the vessels employed to carry the products of the major industries in the Pascagoula area, there were a number of utility vessel which were used in day to day activities, including tugboats, pilot boats, river and sound freighters, sloops, catboats, launches, skiffs, and dugouts.

Typical of the tugboat was the iron-hulled Leo, built in 1882 in Philadelphia. It was a steam powered, single screw vessel 83 feet in length, 19 feet in beam, and seven feet deep from deck to keel (United States Bureau of Customs 1889:306). It followed the typical tugboat morphology, with a forward wheelhouse, and center engine room and stack. A locally constructed tug, the Eva, was similar in construction, with a 56 foot length, 16 foot beam, and 4 1/2 feet from deck to keel.

Sailboats, usually sloop or cat rigged, were used both for work and recreation, were built and used in many areas of the Gulf Coast, including Pascagoula. The catboat was popular around the turn of the century for use in organized sailing races. It has since has faded from popularity, and the sloop rig is now the popular choice of small recreational sailboats.

Figure 22. Early twentieth-century photograph of a small vernacular craft. Note passengers on naptha launch and towed bateau (courtesy of University of South Alabama Archives).

Two types of small vessels were used all over the Gulf Coast area for fishing, recreation, and short distance transportation of people and goods. Small, engine powered launches, like the one pictured in Figure 22, were common means of over-water transportation in the late nineteenth and early twentieth centuries, being used for general recreation and ferrying. Most were around 35 feet in length with a narrow hull and a canvas or wooden canopy. Small, oar-powered skiffs, which were sometimes rigged with a sail, were often used in the same manner.

III. PREVIOUS RESEARCH

There have been numerous terrestrial and underwater archaeological surveys conducted in the Gulf Coast area. Most involve locations other than in the direct vicinity of Pascagoula, i.e. Mobile or Biloxi. However, there is one maritime archaeological survey that directly involves the Pascagoula Bay area. In 1983, a more detailed cultural resources reconnaissance was conducted in Pascagoula Harbor by OSM Archaeological Consultants, Inc. (Mistovich et al 1983). This survey had both terrestrial and marine components, and included a reconnaissance survey of upland sites and a remote sensing survey of channel and disposal areas in the Pascagoula vicinity, and was conducted in preparation for a planned harbor improvement by the U.S. Army Corps of Engineers, Mobile District. In the terrestrial survey, nine prehistoric and/or historic sites were discovered or relocated, while the marine remote sensing survey recorded over five hundred anomalies.

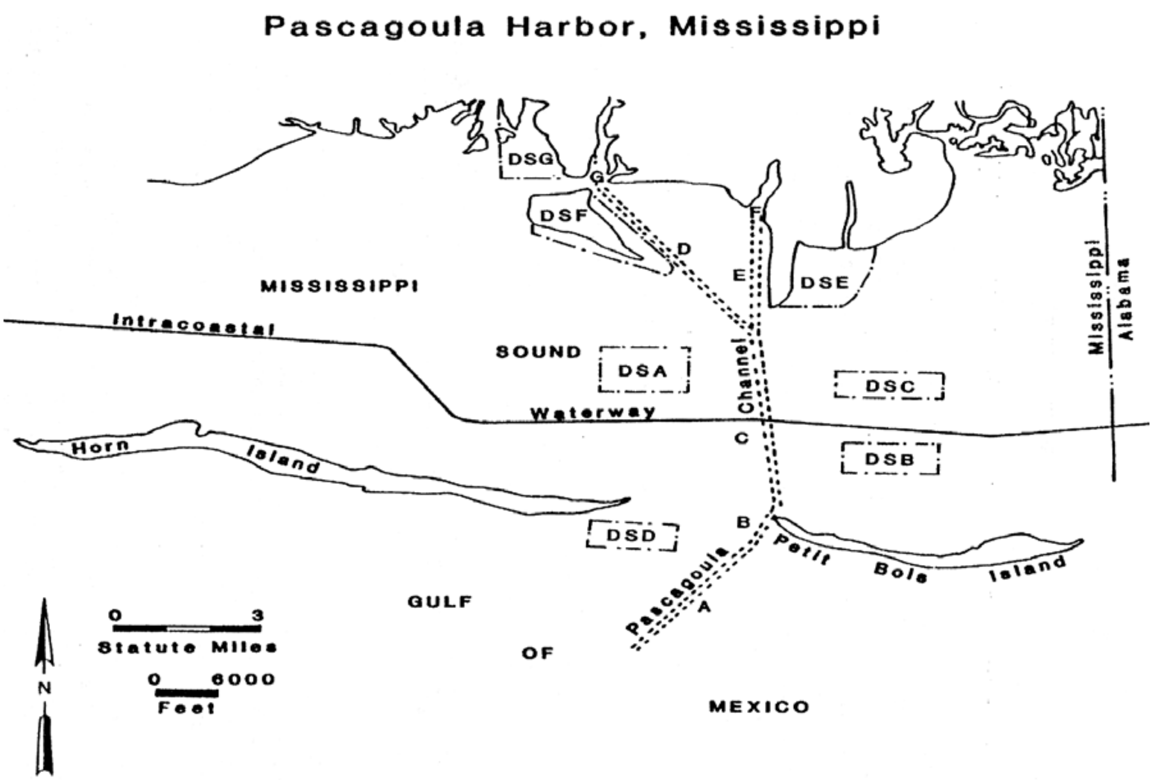

Figure 23. 1983 project area map showing areas surveyed. Note Segments D and G. (As presented in Mistovich et al. 1983:100).

There are several ways in which this study is relevant to the current project. Part of the current project area overlaps survey areas D and G in Mistovich et al. 1983 (Figure 23). In these areas, the 1983 survey located 110 anomalies in area D, and eighteen anomalies in area G. About half of these anomalies are identified as debris, pipelines, cables, piers, or harbor buoys. The rest of the anomalies (65) range in strength from 6 to 180 gamma, and are listed as unknown. However, there is no reliable positioning information included with the report, so no direct correlation can be made to modern anomalies or wreck sites located in the current project area.

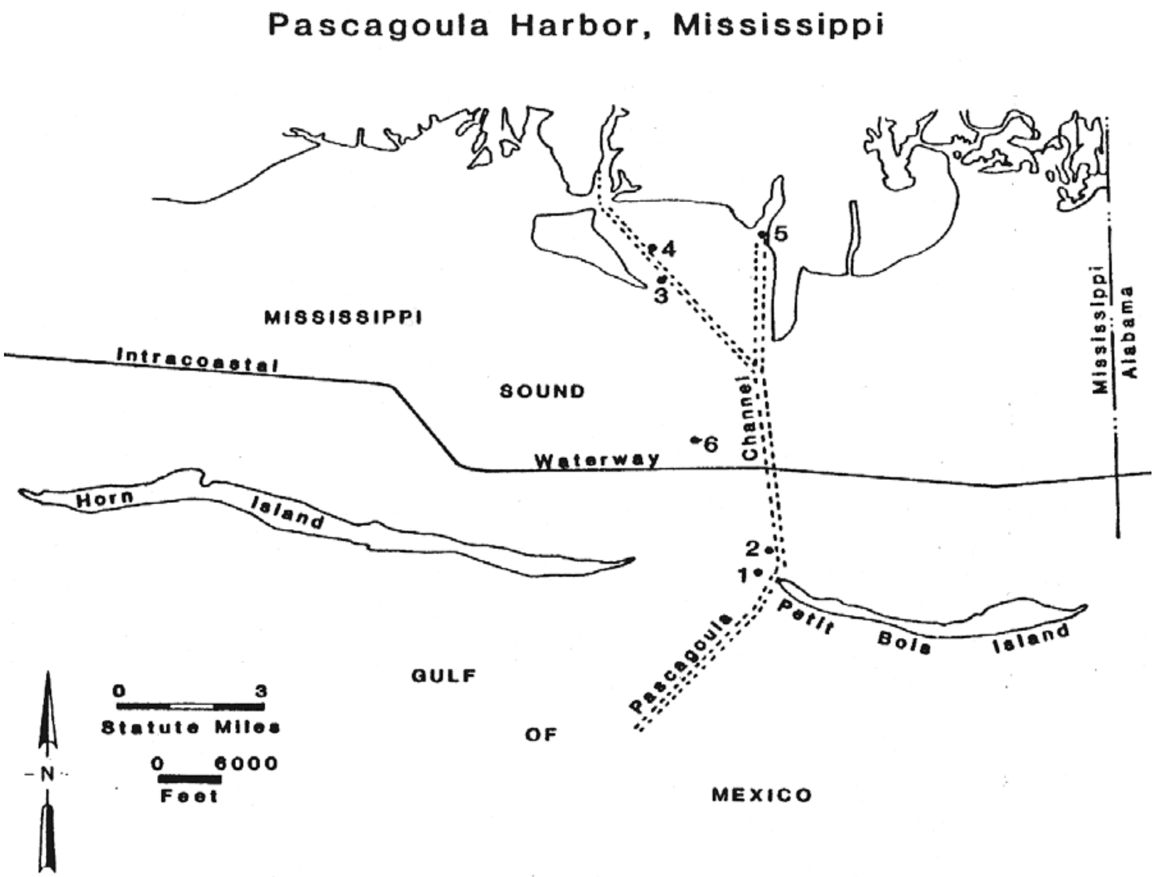

Figure 24. Map of anomalies correlated with known wreck sites. Note Correlations No. 3 and No. 4 (as presented in Mistovich et al. 1983:126).

Mistovich et al. did, however, locate two possible wreck sites that are close to the current project area (Figure 24 – listed as Correlation No. 3 and No. 4). Correlation No. 3 is listed as an unknown vessel, and gives two possibilities. The pleasure craft Mary Ann sank in 1981, and was salvaged shortly after, while in 1975, the 195 ft steel barge AGS 342 was reported stranded at this location. No report was made or removal or salvage of the barge, although Mistovich et al state that it was reasonable to assume that it was removed at some point (Mistovich et al. 1983:107-128. Correlation No. 4 is listed as an unidentified pleasure craft that foundered at this location in 1982. Subsequent attempts by the U.S. Coast Guard failed to relocate the wreck (Mistovich et al. 1983:128)

Other underwater archaeological research in the Gulf Coast areas is centered on Biloxi and Mobile Bays and include Bond 1984, 1985, 1986; Mistovich and Knight 1983; Krivor 1997, 1998; Duff and James 1994,1995; Pearson et al. 1989; Irion 1989; and Panamerican Consultants, Inc. 1995, 1998

IV. Survey Methodology

All surveys were conducted aboard the "C.B. LOW", a 30-ft, twin diesel aluminum survey vessel owned by EMC, Inc. Positioning for all surveys was obtained by a Trimble DSM-Pro Global Positioning System (GPS) operating in differential correction mode. Horizontal position uncertainty is less than one meter. Vertical position was obtained through periodically recording tidal elevation during the surveys at a tide board that was itself calibrated to a nearby 1st order benchmark.

The bathymetric survey used a Reson Sea Bat Model 8101 Multibeam Sonar. The sonar head was rigidly mounted below the vessel at a depth of -6 ft. An integrated TSS Model DMS 05 provided pitch, roll, and heave corrections to the raw sonar signals. The sonar was calibrated to the sound velocity profile at the start and end of the survey with an Odom Digibar sound velocity meter. Survey lines were spaced at 100-ft intervals.

The side scan sonar survey used an Imagenex Model 858 sonar operating at 350 kHz. The sonar head was rigidly mounted below the vessel at a depth of -6 ft. Sonar signals were recorded to hard disk and simultaneously printed on an EPC Model 8300 thermal graphic recorder. Survey lines were spaced at 100-ft intervals. Each line was surveyed twice in opposite directions. Maximum slant range was set at 150 ft, giving more than 100% overlap on adjacent lines.

The magnetometer survey used a Geometrics G-881 Marine Magnetometer, which uses cesium atomic resonance to control the frequency of the oscillator. The magnetometer was housed in a towfish that was deployed 75 ft behind the survey vessel at a nominal depth of -6 ft. Survey lines were spaced at 50-ft intervals.

The magnetometer's signals were processed, recorded, and displayed with MagSea software operating on laptop computer. Among other capabilities, this software automatically corrected recorded positions for the towfish layback distance behind the GPS antenna. Data were logged on the laptop's hard drive.

V. Survey Results and Discussion

Bathymetry The bathymetric survey data were analyzed and plotted using HyPac software. Measurements were thinned to provide a depth data point every 5 ft, and a contour plot was produced with 1-ft interval contours (Attachment A). Figure 25 is a reduced plot of the bathymetric contours.

Side Scan Sonar Side scan sonar data were detected using both thermal paper record and the on-screen color imagery. Targets were positioned directly from the thermal graphic images based on GPS position and towfish/bottom geometry. Moderate wave conditions (up to 1.5 ft significant wave height), a very high level of commercial and military vessel traffic, an interface between water masses with different densities, and a large population of individual and schooling fish created an acoustically noisy environment that complicated identification of "hard" targets on the bottom. Nevertheless, identifiable images were obtained of many significant features. Figure 26 clearly shows both the concrete anchor and the mooring chain of a navigational buoy. The left side of the image is the full-width view of the scan, with a box around the buoy mooring just right of center. The right side of the image is a twice-magnified view of the area inside the rectangle.

Potential targets were rated and assigned a confidence based on acoustic signature and repeatability. A target that was only visible in one pass was rated 3. A target that was identifiable in subsequent passes on the same line was rated 6. For example, Figures 27A and 27B show target 33A (inside red rectangle) when heading respectively east and west on the same survey line. A target that was clearly identified from an overlapping image on an adjacent line was rated 9; one that was identified on four or more scans received a score of 10. A target that, because of its location would be expected to visible from an adjacent survey line, but wasn't, had its confidence reduced to 5. Table 1 lists and locates 32 side scan sonar targets that rated 5 or higher. Positions are given in Mississippi East State Plane Coordinates (NAD 27) to the nearest 10 ft, the practical limit of location from side scan sonar imagery. These 32 targets are overlaid on the bathymetric contour plot (Attachment A, Figure 25).

Magnetometer Magnetic field strength was plotted as contours at 10-gamma intervals (Attachment B). In addition, all of the side scan sonar targets were overlaid on the same plot. Figure 28 is a reduced plot of the magnetic data.and targets. For clarity, a base field strength of 49,000 gammas was subtracted from the contour plot (i.e., a contour of 500 is actually a field strength of 49,500 gammas). A total of 13 magnetic anomalies or anomaly clusters were identified from the magnetometer survey that have characteristics which are representative of potentially significant targets (i.e., shipwrecks.) Table 2 gives coordinates. Because precise location of the source is not known or not localized, positions are provided only to the nearest 100-ft to facilitate identification of the appropriate anomaly on the plot. Discussion of each anomaly follows.

Figure 25. Bathymetric contours and side scan sonar targets

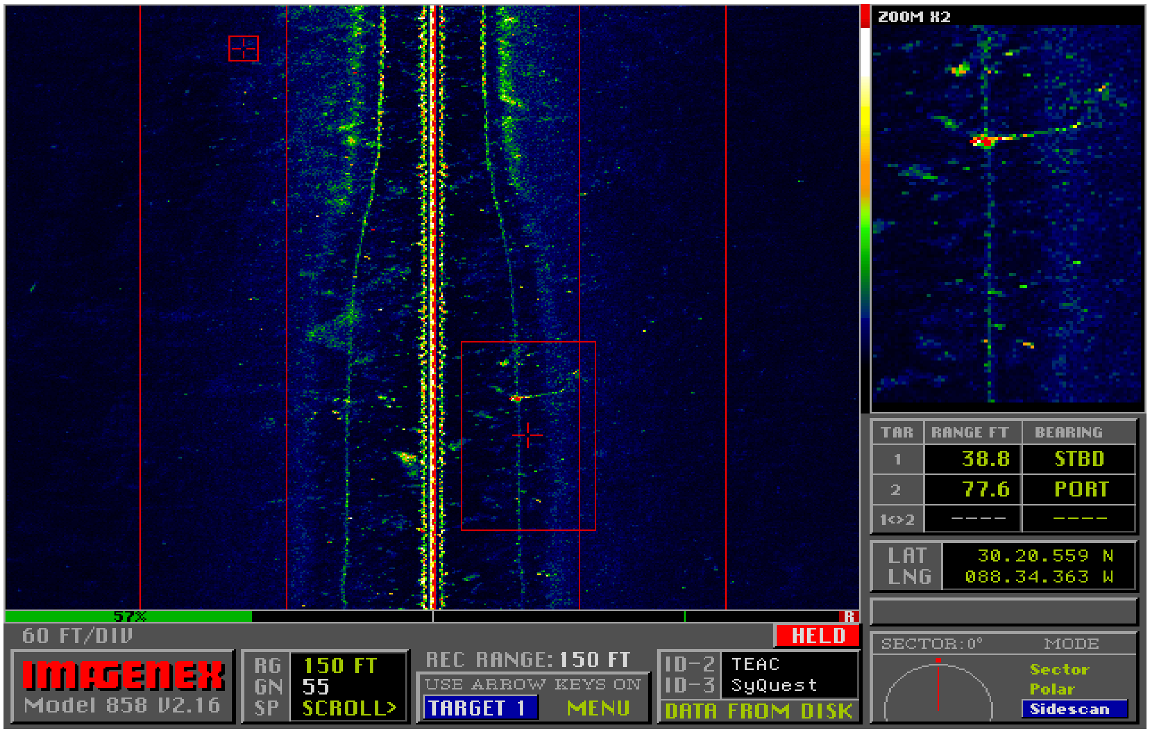

Figure 26 - Side Scan Sonar Image of Buoy Mooring

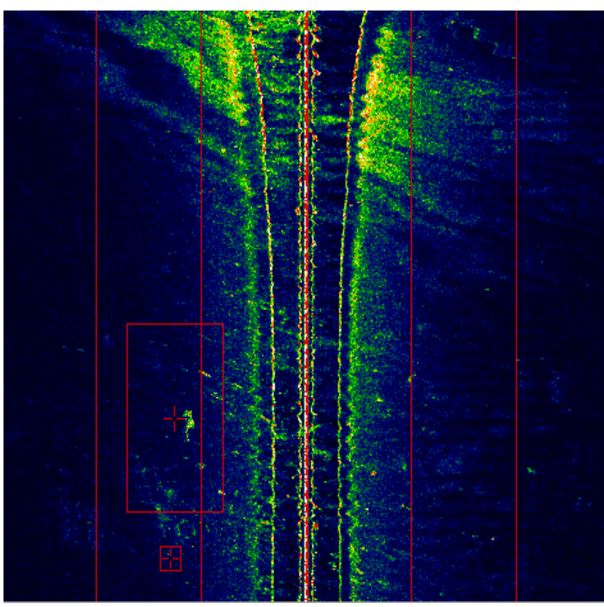

Figure 27A Target 33A, Heading West

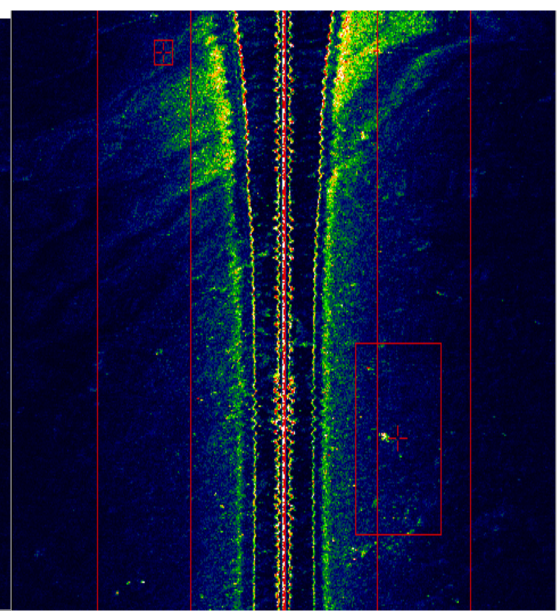

Figure 27B Target 33A, Heading East

Table 1. Side Scan Sonar Targets

Target #	Northing	Easting	Confidence	Comments
W1A	244940	244860	10	Medium point target
W1B	245020	584146	6	Smaller point target
W2A	244650	584600	6	Larger single target
W2B	244890	584380	6	Medium 2-point target
22A	245520	583290	5	Large cluster of small targets
22B	245580	583590	6	Larger, linear single target
22C	245510	583590	6	Larger point target
33A	245600	583610	10	Large single target
33B	245580	583420	10	Cluster of 3 targets
33C	245590	583230	9	Medium point target
33D	245600	583520	6	Cluster of 3 small targets
33E	245610	581920	6	Small point target
33F	245500	581810	6	Adjacent to Buoy 1 anchor
44C	245730	583350	10	Cluster of 3-6 larger targets
55A	245800	582890	5	Two point targets
55B	245800	583550	10	Larger single target
55C	245840	683600	5	Cluster of 3 smaller targets
55E	245850	583860	5	Indistinct
55F	245850	583550	5	Indistinct
55G	245810	583550	10	Larger cluster of targets
55H	245850	583360	5	Indistinct
55I	245840	582630	6	Cluster of smaller targets
55J	245820	582580	5	Cluster of larger targets
55K	245810	582260	5	Cluster of 3 targets
65A	245930	583960	6	Small point target
66A	245900	582100	6	Small point target
66B	245870	583360	6	Cluster of 4-6 targets
66C	245890	583570	6	Cluster of 3-4 larger targets
66E	245910	582800	6	Cluster of 2-3 small targets
66F	245860	581860	6	Small point target
76A	246020	583510	5	Large (over 10 ft) curvilinear
76B	245920	583050	6	Small point target

Figure 28. Magnetic Field strength contours and side scan sonar targets

Table 2. Magnetometer Anomalies

Number	Northing	Easting
1	246000	581300
2	245500	581500
3	246000	581900
4	245800	582500
5	245500	582700
6	245800	583100
7	245600	583200
8	245800	583300
9	245600	583800
10	245500	583900
11	245900	584200
12	245100	584100
13	244900	584100

Anomaly 1. Located at the western end of the northern survey area, Anomaly 1 is a linear anomaly that runs approximately north to south with a consistent gamma deviation of 10 gamma. With the possible exception of the northern tip, is outside of the project area. Lacking an acoustic image, the linear nature of the anomaly indicates it is a buried cable or pipeline. This target does not appear to represent a potentially significant anomaly.

Anomaly 2. Located at the southwestern corner of the northern survey area, Anomaly 2 is situated outside of the project area. This target does not appear to represent a potentially significant anomaly.

Anomaly 3. Located along the northern periphery at the western end of the northern survey area, Anomaly 3 is a large anomaly with a maximum measured gamma deviation of 120 gamma. Lacking an acoustic image and appearing as a single source object, the anomaly most likely represents a subsurface object at the north and outside of the project area. This target does not appear to represent a potentially significant anomaly.

Anomaly 4. Located near the center of the northern survey area, Anomaly 4 is actually a cluster of small anomalies. The eastern-most anomaly, with a maximum gamma deviation of 100 gamma, correlates with side scan target 55J, a cluster of 3 or 4 acoustic targets 1-to-3-feet in dimension. A complex cluster of small anomalies covering more than 1 transect line and with an attendant sidescan image, it is felt that this target has signal characteristics which could potentially represent a significant anomaly.

Anomaly 5. Located near the center of the survey area and to the southeast of Anomaly 4, Anomaly 5 is actually a cluster of large anomalies. The main anomaly, with a maximum gamma deviation of over 160 gamma, is probably associated with a large acoustic target to the south that is on the order of 100 ft by 20 ft (not numbered or plotted since it is outside the contract area). It is thought that the northern-most anomaly in the cluster is buried. A complex cluster of large anomalies covering more than 1 transect line and with an attendant sidescan image, it is felt that this target has signal characteristics which could potentially represent a significant anomaly.

Anomaly 6. Located to the northeast of Anomaly 5, Anomaly 6 is actually of three large anomalies, each with a maximum gamma deviation exceeding 120 gamma, one of which correlates with an acoustic target 76B. It is thought that the southern two anomalies within this cluster are buried. A complex cluster of large anomalies covering more than 1 transect line and with an attendant sidescan image, it is felt that this target has signal characteristics which could potentially represent a significant anomaly.

Anomaly 7. Located to the south and between anomalies 6 and, Anomaly 7 appears to be a dipole of at least 40 gamma with an attendant acoustic image, target 22A. Seeming to represent a single source object (i.e., pipe segment), it is not felt that this target has signal characteristics, which could potentially represent a significant anomaly.

Anomaly 8. Located near the western end of the northern survey area, Anomaly 8 appears to be a dipole of 50 gamma with an attendant acoustic image, target 44C. Seeming to represent a single source object (i.e., pipe segment), it is not felt that this target has signal characteristics, which could potentially represent a significant anomaly.

Anomaly 9. Located near the western end of the northern survey, Anomaly 9 appears to be a dipole of 110 gamma without an attendant acoustic image. Similar to Anomaly 8, Anomaly 9 appears to represent a single source object (i.e., pipe segment). It is not felt that this target has signal characteristics, which could potentially represent a significant anomaly.

Anomaly 10. Located at the confluence of western end of the northern survey area an the northern end of the southeastern leg, Anomaly 10 is somewhat problematic. A series of weak, almost "noise-like" signals, it is felt that Anomaly 10 most likely represents modern debris in the form of wire cable, a likely and common occurrence in this type of environment.

Anomaly 11. Located near the western end of the northern survey, Anomaly 11 is located outside of the current project area. Further work is not required on this target.

Anomaly 12. Although Anomaly 12 correlates with a sidescan target, the anomaly location is outside the current project area and further work is not required.

Anomaly 13. Anomaly 13 also correlates with a sidescan target, but the anomaly location is outside the current project area and further work is not required.

VI. Recommendations and Conclusions

The interpretation of remote-sensing data obtained from both the magnetometer and the sidescan sonar is an imperfect process at best, and, as stated by Pearson et al., "relies on a combination of sound scientific knowledge and practical experience" (1991:69). Acoustic signals pose particular problems in shallow water due to reverberation and wave and current induced noise (McGehee et al 1999; Hemsley et al 1990). The evaluation of remote-sensing targets with regard to a determination that the target does or does not represent shipwreck remains depends on a variety of factors and interpretation of data collected by the magnetometer is perhaps the most problematic. Magnetic anomalies are evaluated and prioritized on the basis of magnetic amplitude or deflection of gamma intensity in concert with duration or spatial extent; they are also correlated with sidescan targets. The problems of differentiating between modern debris and shipwrecks on the basis of remote-sensing data have been discussed by a number of authors. This difficulty is particularly true in the case of magnetic data, and therefore it has received the most attention in the current body of literature dealing with the subject. Pearson and Saltus state that "even though a considerable body of magnetic signature data for shipwrecks is now available, it is impossible to positively associate any specific signature with a shipwreck or any other feature" (1990:32). There is no doubt that the only positive way to verify a magnetic source object is through physical examination. With that said, however, the size and complexity of a magnetic signature does provide a usable key for distinguishing between modern debris and shipwreck remains (see Garrison et al. 1989; Irion et al. 1995; Pearson et al. 1993). Specifically, the magnetic signatures of most shipwrecks tend to be large in area and tend to display multiple magnetic peaks of differing amplitude.

Furthermore, Pearson and Hudson (1990) have argued that the past and recent use of a water body must be an important consideration in the interpretation of remote-sensing data, in many cases the most important criterion. Unless the remote-sensing data, the historical record, or the specific environment (e.g., harbor entrance channel) provide compelling and overriding evidence to the contrary, it is believed that the history of use should be a primary consideration in interpretation. What constitutes "compelling evidence" is to some extent left to the discretion of the researcher; however, in settings where modern commercial traffic and historic use have been intensive, the presence of a large quantity of modern debris must be anticipated. In harbor, bay, or riverine situations where traffic is heavy, this debris will be scattered along the channel right-of-way, although it may be concentrated at areas where traffic would slow or halt, and it will appear on remote-sensing surveys record as discrete, small objects.

With that said, a total of 13 anomalies or anomaly clusters were identified during the current survey. Of these 13, four targets (i.e., Anomalies 2, 10, 12, and 13) are outside of the project area and are not considered for further investigation. Six targets (i.e., Anomalies 1, 3, 7, 9, 10 and 11 do not retain signal characteristics indicative of potentially significant targets. Only three targets, Anomalies, 4, 5 and 6, reflect targets with signal characteristics which potentially represent historically significant resources (i.e., shipwrecks). It is recommended that these targets either be avoided by construction impact or be further archeologically investigated to determine their identity and assess their historical significance. This would require relocation, marking, and diver investigation, including visual identification where objects are accessible, and metal detector sweeps and probing where objects are buried. Acoustic targets 22B, 33A, 33C, 55B. 55J, and 76A because of their size and potential impacts on dredging activity warrant should be also relocated, marked, and evaluated by divers for significance and/or removal. Table 3 lists the targets recommended for further, detailed investigation.

The findings for this project area are not unlike those reported from similar settings where modern usage of a water body is heavy. Comparable to the present study are results from Mobile, Pascagoula, Galveston, and Matagorda Bays, and approaches to New York Harbor where modern commercial traffic is fairly high (Irion 1986; James 1991; Mistovich and Knight 1983; Mistovich et al. 1983; Pearson and Hudson 1990; Rogers et al. 1990; Tuttle and James 1996; Tuttle and Mitchell 1998). In remote-sensing studies conducted in these areas, non-significant modern debris constituted the bulk of magnetic signatures. Historic shipwrecks certainly exist in all these bays, but they can be extremely difficult to distinguish from modern debris, at least on the basis of magnetic data alone. In one survey of Mobile Bay, Irion (1986) reported that all the magnetic anomalies investigated were modern debris, much of it consisting of discarded steel cable. Pearson and Hudson (1990) reported similar findings in a remote-sensing survey of portions of the dredged navigation channel through Matagorda Bay, Texas, as did Rogers et al. (1990) for portions of the Gulf Intracoastal Waterway at the intersection of the Galveston-Freeport Cutoff and the Galveston Ship Channel. In the 1983 Pascagoula survey by Mistovich and Knight, a majority of the targets were thought to be composed of modern debris with the important exception of at least two shipwrecks which were located just to the south of the southeastern leg of our current project area. This indicates that while the majority of targets within a highly transited area like this will be modern debris, shipwrecks could also be present.

Table 3. Targets Recommended for Detailed Investigation

Number	Northing	Easting
22B	245580	583590
33A	245600	583610
33C	245590	583230
55B	245800	583550
55J	245820	582580
76A	246020	583510
4	245800	582500
5	245500	582700
6	245800	583100

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