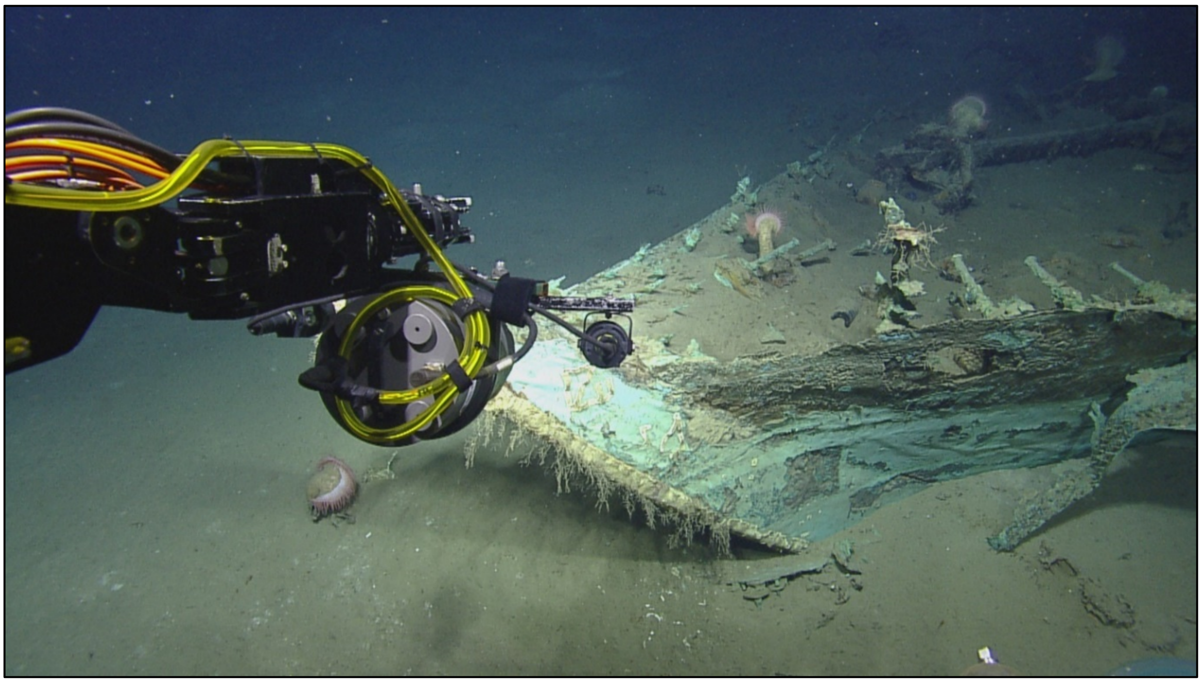
Technical Report
BOEM 2021-057

Wakes Across the Gulf: Historic Sea Lanes and Shipwrecks in the Gulf of Mexico



U.S. Department of the Interior
Bureau of Ocean Energy Management
Gulf of Mexico Regional Office

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Bureau of Ocean Energy Management
Office of Environment
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ABOUT THE COVER

The early 19th-century shipwreck dubbed “Monterrey A” was documented in 2013 with a remotely operated vehicle in over 4,000 feet of water by the Bureau of Ocean Energy Management and the National Oceanic and Atmospheric Administration in the Keathley Canyon Area of the Gulf of Mexico.

CITATION

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List of Abbreviations and Acronyms

Short Form	Long Form
APD	Application to Drill
BLM	Bureau of Land Management
BOP	blowout preventer
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management, Regulation, and Enforcement
BSEE	Bureau of Safety and Environmental Enforcement
CE	common era
CFR	Code of Federal Regulations
DOI	US Department of the Interior
DR	dead reckoning
EA	environmental assessment
EO	Executive Order
FONSI	Finding of No Significant Impact
Gulf	Gulf of Mexico
GOMR	Gulf of Mexico region
MMS	Minerals Management Service
NHPA	National Historic Preservation Act of 1966, as amended
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NTL	Notice to Lessees
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
USCG	US Coast Guard
USGS	US Geological Survey

1 Introduction

1.1 About This Technical Report

The National Historic Preservation Act (NHPA) (Public Law 89-665; 54 U.S.C. 300101 et seq.) was enacted in 1966 and has been amended several times since. The NHPA was enacted to preserve historic and archaeological sites in the United States (US) as a response to the nationwide destruction of cultural heritage from federally initiated programs, such as the Federal Aid Highway Act of 1956, which initiated the Interstate Highway system, and the Urban Renewal Program launched under President John F. Kennedy. A report coordinated by then First Lady Claudia "Lady Bird" Johnson (United States Conference of Mayors 1966) first brought public awareness to the issue that resulted in the NHPA, which, among other things, requires federal agencies to evaluate the impact of all federally funded or permitted projects on historic properties (buildings, archaeological sites, etc.) through a process known as a Section 106 Review.

Although the original focus of the NHPA and regulations was on terrestrial sites, Section 106 requires Federal agencies to consider the effects of their proposed Federal and federally-funded undertakings under their jurisdiction on historic properties in any state, including the state's submerged lands and waters. Section 106 also applies to Federal agencies with the statutory authority to license, approve, or permit an undertaking, both domestically and internationally, including the Outer Continental Shelf (OCS) and the Exclusive Economic Zone (Varmer 2014:54).

However, the implementing regulations at 36 CFR §800.4 and guidance provided by the Advisory Council for Historic Preservation (ACHP) frequently fail to account for the unique challenges of the marine environment. For example, the Secretary of the Interior's Guidelines and Standards for Archaeology and Historic Preservation encourages archival research first before undertaking survey to determine if significant resources could be affected by an undertaking. On land, that might involve consulting historic maps of the local geography showing locations of buildings, settlements, cemeteries, roads, or other once visible features of the landscape. At sea, out of sight of land, that comes to mean something very different. This technical report partly addresses that need to conduct archival research to assess the potential presence of historic resources at sea, namely historic shipwrecks, in the Gulf of Mexico.

The analysis follows the "landscape" model by establishing where ships were documented to have traveled, and, therefore, may have wrecked, in the Gulf of Mexico (Gulf). BOEM archaeologists chose to study contemporary charts and navigation guides rather than attempt to chart historic losses using incomplete and inaccurate contemporary and secondary sources. Landscape models have been used in this way to predict shipwreck locations in the Mediterranean (Conlin 1999, Leidwanger 2013), off Australia (Duncan 2004), the Great Lakes (Caporaso 2011), and Norway (Törnqvist 2013).

To begin to develop a landscape model for the occurrence of shipwrecks in the Gulf, one must first understand how and to what extent human societies have made use of and been influenced by its unique environment to develop transportation networks to facilitate exploration, colonization, trade, warfare, and communication.

Chapter 1 introduces the issue of addressing the challenge of assessing the potential presence of historic resources at sea as required by Section 106. Chapter 2 situates the Gulf in this historical context as an explanation of how, when, where, and why these transportation networks developed. Any model requires a thorough understanding of the limitations of the data used to produce it. In the case of analyzing the potential for the occurrence of ship losses in the open sea, the data come from sources that are sometimes hundreds of years old from observations made by men using tools that are primitive by today's standards.

Chapter 3 discusses the historic map sources used to develop the landscape model. The limiting factors of the technology used to make the observations that went into the making of these maps are described in some detail. It also serves as a caution of the limitation of using any historical source to make a definitive statement regarding a geographic location within an otherwise featureless seascape. Section 3.7 includes a table with links to pertinent maps from the 17th century to the 20th century.

Chapter 4 describes notable historic shipwrecks that have been discovered, mostly by the oil and gas industry, in the Gulf. BOEM believes this provides verification for the use of the landscape model approach. None of the over 30 confirmed historic shipwrecks discovered in the Gulf were located in the "high probability historic shipwreck" blocks discussed below. BOEM believes this is the strongest argument that can be made against the use of previous modeling efforts and necessitates a different approach apart from cataloguing historic accounts of wreck events to evaluating where, historically, ships would have sailed.

Chapter 5 describes the current approach of addressing the potential for the presence of historic resources within the Gulf and presents the report's conclusions. It summarizes the shortcomings of previous attempts at constructing a predictive model for the occurrence of shipwrecks in the Gulf and discusses evidence to support the approach proposed in this document.

Based on a correlation of the predictive results of the modeling effort and the physical discoveries of historic shipwrecks in the Gulf over the past 57 years, BOEM is confident that the burden of review necessary to determine future steps in a "reasonable and good faith effort" to identify historic properties within the area of potential effects of the bureau's actions has been met.

2 Cultural Geography: Ports of the Gulf of Mexico

Shipping routes have long been correlated with shipping losses, i.e., shipwrecks throughout the maritime world. Analyzing and studying those routes should, then, provide a window on predicting where certain types of shipwrecks are likely to occur. Trade routes in the Gulf of Mexico (Gulf) have evolved due to a variety of environmental and behavioral factors, which include:

- the location of anchorages and ports
- navigational hazards
- prevailing winds and currents
- frequency and severity of storms
- technological capabilities
- economic considerations
- the willingness to accept or mitigate risk (Duncan 2004).

2.1 Indigenous Maritime Trade

Pre-Columbian civilizations, such as the Maya, maintained a thriving maritime trade along the coasts of Mesoamerica and the Caribbean Islands, including Cuba. This commerce was practiced using large seagoing canoes (Figure 1), such as that reported by Columbus' son Ferdinand on his fourth voyage (Leshikar 1996). The Maya traded in a vast array of goods from across Mexico and Central America, including cotton, salt, jade, obsidian, cocoa, tropical bird feathers, and slaves (Cohen 2018). Archaeologists have long speculated a connection between Mesoamerican and Native American mound-building civilizations along the Northern Gulf Coast. Linguistic evidence has suggested a connection between the Mobile Bay area and Totonacan speakers of east-central Mexico as evidence of trans-Gulf trade ca. 1000 CE, although archaeological evidence for maritime trade between Mesoamerica and the Northern Gulf Coast remains lacking (Kaufman 2014).

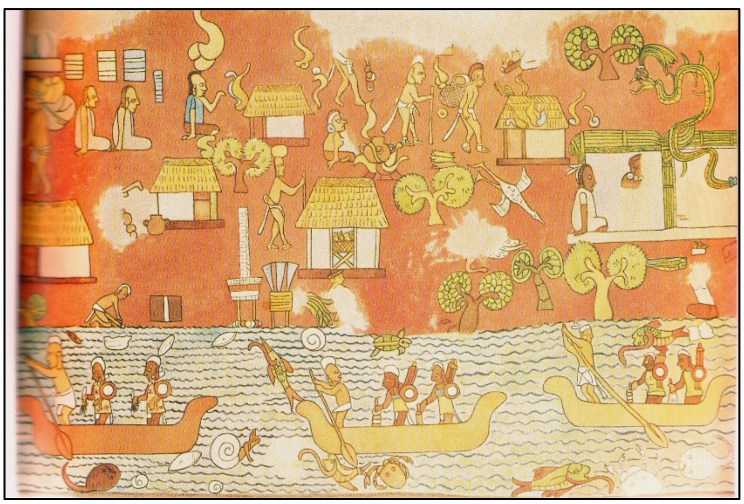

Figure 1. Mural depicting Toltec sea-going canoes from the Temple of the Warriors, Chichén Itzá, Mexico

From: http://indigenousboats.blogspot.com/2014/04/maya-canoes.html

2.2 Spanish Expeditions and Conquests

The first European entered the waters of the Gulf in 1508. Sebastian de Ocampo circumnavigated Cuba, proving it to be an island rather than a peninsula. He was followed by Alonso Álvarez de Piñeda, who led several expeditions in 1519 to map the coastline of the Northern Gulf from the Pánuco River in Mexico to present-day Florida. The remnants of an expedition lead by Spanish explorer Pánfilo de Narváez earned the dubious distinction of being the first Europeans to shipwreck on the coast of the Northern Gulf near Galveston Island in 1528. One of the few survivors of this doomed expedition was Álvar Núñez Cabeza de Vaca, who spent the next eight years wandering through the American Southwest and Northern Mexico.

Following the subjugation of the Aztec Empire in 1521 by Spanish adventurers commanded by Hernán Cortés, Spain set out almost immediately to exploit its rich natural resources, especially the precious metals of gold and silver. Motivated by "gold, God, and glory," Spanish conquistadors were driven not so much to settle their possessions in the New World as to exploit them for maximum profit in order to one day return to Spain as wealthy men. To further this end, in 1503 the Spanish Crown formed the Casa de Contratación, a maritime council located in Seville that licensed and administered all colonial trade, shipping, navigation, and ran a postal service. As soon as significant quantities of gold and silver began flowing to Spain, European pirates began to lie in wait off the coast in search of wealthy prizes.

Enemies of Spain soon began to cruise the Caribbean with the same intent, leading eventually to the development of the treasure fleet system, or *flota*, during the reign of Charles V (1516–1556). Merchantmen, in accordance with a requirement of the Casa de Contratación, were already required to sail together as a group. The addition of armed vessels traveling with the merchantmen during times of war would soon become a permanent feature of the treasure fleets. Two separate fleets were to leave for the New World each year on a prescribed schedule. The fleet would leave Spain (initially from Seville and later Cadiz) from February through September with a peak in July, along with ships bound for Honduras, Cuba, and Hispaniola, sailing down the coast of Africa until they reached the Cape Verde Islands. There the fleet turned west, using the prevailing trade winds until they entered the Caribbean. Here the ships divided into two separate fleets: the *Nueva España* fleet and the *Tierra Firme* fleet (after 1648 this fleet was termed *Los Galeones*). The first fleet sailed to New Spain's (Mexico) port of Veracruz, keeping south of the Greater Antilles, crossing the Yucatan Channel, and sailing along the southern Gulf. Arrival at Veracruz occurred in the summer; but arrivals occurred from May through November with a peak in September. The *Nueva España* fleets were ordered to winter in New Spain. The second fleet sailed to the South American mainland ports of Cartagena, Nombre de Dios, and Porto Bello. (Lugo-Fernández et al. 2007). Once the cargo was loaded, the fleets prepared for the return journey. The Nueva España *flota* left Veracruz from February through August, with a peak in June, and sailed along a northeasterly route into the Northern Gulf to the west coast of Florida. Here the *flota* made its way down towards Cuba. The two *flotas* would rendezvous at Havana for the voyage home to Spain after the ships were refitted and made ready (Figure 2).

Figure 2. *Het uitzeilen van de Spaanse vloot van Havanna* (the Spanish fleet in Havana), attributed to Bonaventura Peeters, 1662

Image from the Rijksmuseum. See https://www.rijksmuseum.nl/nl/collectie/RP-T-1881-A-114

The *flota* system reached its peak between 1590 and 1600, with an average of 100 ships per year making their way across the Gulf, and persisted in some form, more or less annually for nearly 300 years. The route they took from Veracruz to Havana was well established and was dictated by prevailing seasonal winds, especially easterly Trade Winds, and the presence of the Loop Current, which circulates through the Yucatan Channel into the Northern Gulf of Mexico and out the Florida Straights (Hamilton et al. 2014). An analysis of the Spanish sailing routes revealed that the return leg consisted of two branches, depending on the wind direction at departure. The long or northern branch consisted of an arch that went north to latitude 27.5° N, then east, turned southeast near Florida until reaching Dry Tortugas, and headed south to Havana through the Florida Straits. The second or southern branch went only to latitude 25° N, proceeded east until the Dry Tortugas, and reached Havana, similarly to the long route. The basic route pattern was established by Anton de Alaminos in 1519 during his return trip to Spain to inform the King about the progress of the Mexican conquest (Lugo-Fernandez et al. 2007). It is important to note that though latitude could be calculated fairly accurately by early mariners, longitude could not be determined with any precision until 1773, when John Harrison perfected the chronometer. As a result, the Spanish relied on depth soundings and dead reckoning (DR) to determine when to steer south for Havana. The voyage typically lasted from eight to 24 days but could take as long as three months.

It is impossible to know how many or precisely where ships may have been lost during these many known voyages between Veracruz and Havana. A study conducted for BOEM in 2011 illustrates the challenges of attempting to locate evidence of historic shipwrecks in deep water from hundreds of years ago where there were no survivors, but succeeded in determining that losses did, in fact, occur with regular frequency (Krivor et al. 2011). In one example, three vessels from the 1554 fleet that was blown off course by a violent storm–*Santa Maria de Yciar, Espiritu Santo,* and *San Estebán*–wrecked off South

Padre Island, Texas (Arnold and Weddle 1978) (Figure 3). The location of these historic ships had been lost to time until one of them was discovered during the dredging of the Port Mansfield channel in the late 1950s. The dredge passed right over *Santa Maria de Yciar*, destroying it. Another, believed to be *San Esteban*, was documented by the Texas Historical Commission. Similarly, three wooden-hulled and copper-sheathed shipwrecks carrying cannon, crates of muskets, and a cargo that included hides, lay in over 4000 feet of seawater at the bottom of the Gulf, almost 200 miles from land. Known as Monterrey A, B, and C, these shipwrecks have yet to be identified by name or affiliation but are believed to have been lost in a storm.

Figure 3. Artist's rendition of one of three Spanish ships wrecked on South Padre Island, Texas in 1554

From the Texas Historical Commission at https://www.thc.texas.gov/public/upload/archeology-marine-tx.pdf

Spanish attempts to settle other parts of the Gulf coast were initially met with disaster. In 1559, Tristán de Luna y Arellano landed in Pensacola Bay, Florida with some 1,500 people on 11 ships from Veracruz, Mexico. Later that same year, the colony was decimated by a hurricane that killed an unknown number of people, sunk six ships, grounded a seventh, and ruined their supplies. Convinced that Northwest Florida was too dangerous to colonize, the Spanish abandoned it for the next 137 years. Three of the wrecks from de Luna's fleet, dubbed Emanuel Point I, II, and III, were discovered and investigated by the Florida Bureau of Archaeological Resources and the University of West Florida (Smith 2018, St. Meyer 2016).

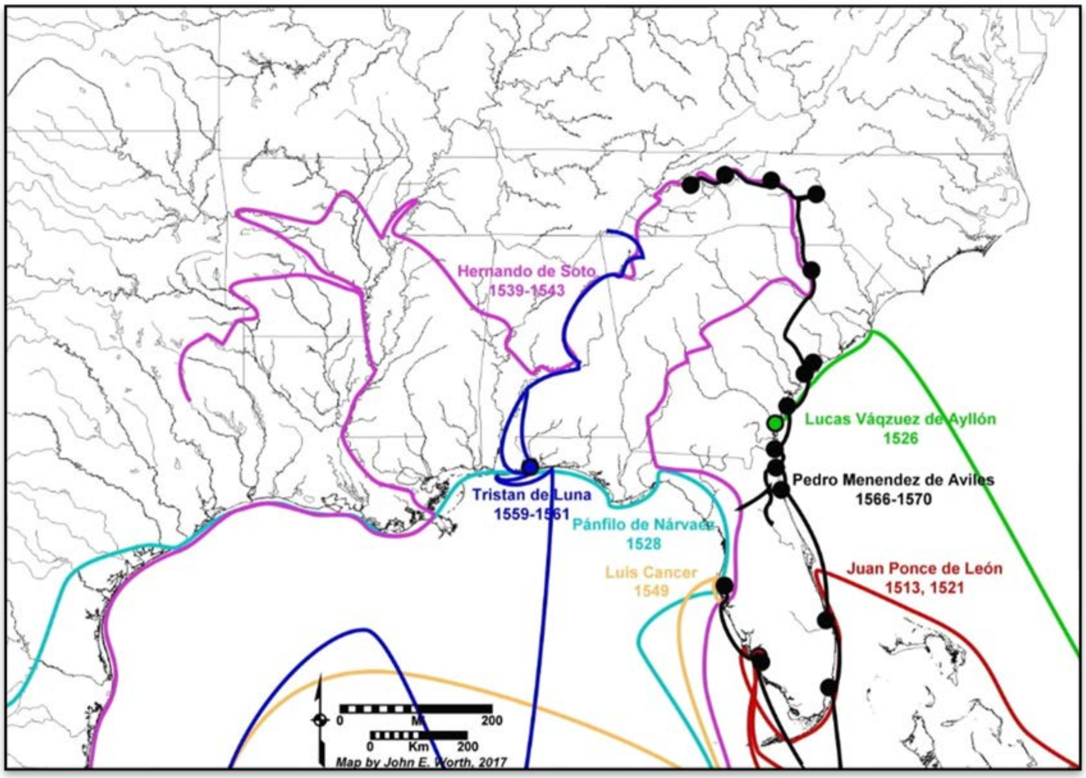

Figure 4. Major Spanish expeditions before 1565

From the faculty homepage of Dr. John E. Worth: https://pages.uwf.edu/jworth/jw_spanfla_maps.html

In 1698, the Spanish re-settled Pensacola, driven by the need for timber, primarily for ships' masts and spars. The lumber trade between Pensacola and Veracruz lasted for the next 20 years, although only four shipments were successfully delivered (Krivor et al. 2011:29). The site of the only natural, deep harbor on the Northern Gulf Coast, Pensacola eventually rose to prominence, spurred by the founding of the British trading company Panton, Leslie, & Company in 1786 and by Spain granting them a monopoly over the Indian trade in East and West Florida. From there, the natural resources of the interior, such as furs and skins, were packed in the Company's fleet of schooners and brigantines and were shipped to warehouses in the Bahamas and eventually to England. The ships returned with cargoes of weapons, gunpowder, tools, cloths, dyes, liquor, and various trinkets.

2.3 France, Spain, and Louisiana

The Gulf was a "Spanish sea" dominated by Spanish shipping for nearly 200 years until the French entered, first with the tragically failed colony of René-Robert Cavelier, Sieur de La Salle (1685) and later with the successful enterprise in 1699 of Pierre Le Moyne d'Iberville. This second effort culminated in the 1701 construction of a fort at present day Mobile, Alabama. Seventeen years later, in 1718, Iberville's brother, Jean-Baptiste Le Moyne de Bienville, founded New Orleans on a crescent bend in the Mississippi River at the site of the present-day French Quarter. By 1723 New Orleans was established as the capitol of French Louisiana. France established new trading routes from their Gulf trading ports of Biloxi, Dauphin Island, Mobile, and New Orleans, fulfilling La Salle's dream of planting a French colony to exploit the strategic importance and rich natural resources of the Mississippi River (Weddle 1991). France, in 1731, stood at a considerable disadvantage in the commercial world compared with the Dutch and English, who had a hundred merchant vessels sailing for every one belonging to France (Surrey 1916:169). French routes ran first to the colonies on the Windward Islands and then to the Gulf Coast. In this way, goods were shipped to and from markets in the islands, New France, and the continent with little variation between 1699 and 1762.

In 1762, France ceded control of Louisiana to Spain. As Spain's interests in the Northern Gulf increased, Spanish naval and merchant vessels became more numerous along the coast. In 1766, two ships from this period, *El Nuevo Constante* and *Corazón de Jesús y Santa Bárbara* were driven onto the Louisiana coast by a storm. Pearson and Hoffman (1995) documented the remains of *El Nuevo Constante* (Figure 5), but *Santa Bárbara* has never been found. Another vessel of the period, *El Cazador,* was a Spanish brig that sank in 1784 while carrying coinage to the Spanish colony of Louisiana to support its faltering economy. The wreck was discovered accidentally by trawling fishermen in 1993 and subsequently exploited for its valuable cargo by treasure salvors.

Figure 5. Cannon recovered from the wreck of *El Nuevo Constante* off Louisiana

From the Louisiana Division of Archaeology, https://www.crt.state.la.us/dataprojects/archaeology/elnuevoconstante/

Spain was confident enough of the loyalty of its North American colonies to side with the French against Great Britain during the American Revolution. Bernardo de Gálvez, the Spanish governor of Louisiana, sympathized with the American cause and facilitated resupply of blockaded American ports through New Orleans, took measures against British smuggling, and established free trade between Cuba, Yucatan, and New Orleans. After war was declared by Spain and France against Great Britain in 1779, Gálvez seized the British province of West Florida. He also defeated British colonial forces at Fort Bute, Baton Rouge, and Natchez and captured Mobile and Pensacola, denying the British any base of operation along the Gulf Coast. The latter was accomplished despite the fact that 64 ships and over 4,000 men of his invasion force had been scattered across the Gulf by a powerful hurricane. Gálvez's actions during the American Revolution led the British to divert resources to another front from their 13 North American colonies fighting for independence.

In 1800 Louisiana was secretly returned to France by the Third Treaty of Ildefonso according to which Spain agreed to exchange its North American colony of Louisiana for territories in Tuscany. However, a slave revolt in Saint-Domingue (present-day Haiti and Dominican Republic), followed by a yellow fever epidemic that killed over 40,000 French troops, ended Napoleon Bonaparte's ambitions in the Americas.

In 1803, he agreed to sell the vast territory to the fledgling United States for $15 million. Some 15,000 refugees from Saint-Domingue fled to New Orleans by sea; the largest group was expelled from Cuba in 1809–1810. Some 10,000 Dominguens arrived in New Orleans over a six-month period, doubling the population of the city (Dessens 2017).

The push for US westward expansion soon was underway. Any hope the Spanish had of protecting New Spain from US infiltration vanished in 1808 with Napoleon’s usurpation of the Spanish throne. The French emperor invaded Spain, forced both the Spanish King Carlos IV and his son to abdicate, declared the Bourbon dynasty of Spain deposed, and installed his brother, Joseph Bonaparte, as King Joseph I of Spain (Knight 1998:49). The protracted Peninsular War that followed encouraged ambitious criollos to revolt against their colonial governments in Latin America while Spain lacked the capacity to react. Revolution soon spread throughout North, Central, and South America, with only Cuba and Puerto Rico remaining steadfastly loyal to Spain out of fear of a slave revolt similar to that in Haiti. This triggered a series of events that led to the collapse of the Spanish Empire in the Americas and independence movements that would spill over to the Gulf. In November 1811, the city of Cartagena declared independence from the Viceroyalty of New Granada and organized itself as an independent province, issuing commissions to privateers who would sail against Spain and her assets in the Americas (Head 2009:27).

The dissolution of the Spanish Empire was complete with the independence of the Kingdom of New Spain in 1821, which was to become a constitutional monarchy. Augustín de Inturbide, the commander of a royalist army in southern New Spain, was proclaimed Emperor of an independent Mexico in May 1822. The short-lived empire lasted just eight months and ended with Inturbide’s resignation in the face of opposition lead by Antonio López de Santa Ana. The Viceroyalty of New Spain had become the Republic of Mexico.

2.4 Pirates, Privateers, Slave Smugglers

In the two decades following the outbreak of revolution in Spanish America, insurgent and Spanish privateers and Cuban-based pirates initiated more than 1,600 prize actions throughout the Atlantic Ocean (McCarthy 2013:157). Many of these took place in the Gulf and targeted Spanish shipping from Veracruz to Spain.

Jean Laffite, in 1805, established a base of operations along the Louisiana coast at Barataria, specializing in black market commerce and slave trading, in addition to piratical activities. Laffite benefited from the increased activity in the Gulf and his operation expanded after establishing warehouses in New Orleans, Donaldsonville, and Barataria. Three main groups of privateers operated in the Gulf during the early decades of the 19th century: French privateers under commission from Guadalupe, South American privateers authorized by commissions from Buenos Aires and Cartagena, and US privateers aiding the government in the war against Great Britain. Many of those who participated in this activity were Americans—the greatest number hailing from Baltimore—still fresh from sailing against British shipping during the War of 1812, and from New Orleans where French and American sailors privateered for Cartagena and Mexico (Head 2008:269).

In August 1816, Louis-Michel Aury, the former captain of the French privateer *Guillaume*, one-time smuggler of slaves, commodore in the Cartagenan navy and associate of Simón Bolívar, established a base at Galveston, an island no-man’s-land off the coast of Texas in disputed territory claimed by the US, Spain, and Mexico (Chipman 1992). Galveston was perfectly situated for US merchants to funnel supplies and munitions to Mexican rebels and to serve as a prize court for privateers to unload their captured cargoes. José Manuel de Herrera, envoy of the rebellious Republic of Mexico, arrived on the island to declare Aury governor on September 13, 1816. Aury's brief tenure was far from peaceful: it was marked by disputes with other filibusterers and freebooters including Henry Perry, who commanded troops sent by the New Orleans Association for an invasion of Texas, and Francisco Xavier Mina in charge of another filibustering operation[1]. Aury eventually agreed to cooperate with Perry and Mina after the latter fell out with the New Orleans Association when they pressed him to invade Pensacola rather than Mexico. On April 7, 1817, the expedition left Galveston with Aury's eight ships and Mina's 235 men for Soto la Marina in Tamaulipas (Brown 1906:237). When Aury returned, he found that his base at Galveston had been occupied in his absence by Jean Laffite after he abandoned Barataria. Aury sailed away to join the Scottish adventurer Gregor MacGregor in attacking Spanish Florida from his base on Amelia Island. Though he had survived being shot by his own men, numerous shipwrecks, sea battles, and other misadventures, Aury reportedly was killed when he was thrown from a horse in 1821 (Dabney 1938:116).

Privateering and piracy had grown to such significant proportions in the Gulf that in 1817 the Spanish ambassador to the US, Luis de Onís y González-Vara, formally complained to US President James Monroe, claiming that the US government was tacitly supporting revolutionary governments in South America by standing by while US captains bearing letters of marque preyed on Spanish shipping. The Port of Baltimore was singled out by the Spanish ambassador as a site where "whole squadrons of pirates" were outfitted (Morgan 1969:41). At issue was the illegal smuggling of enslaved Africans through Amelia Island, Florida; Barataria in Louisiana; and Galveston, Texas from captured Spanish ships sailing to Cuba and New Spain where the international trade was still legal. Both the US and Britain had passed laws to abolish the international slave trade in 1807. Privateers captured thousands of slaves and sold them in or near US ports, as customs agents turned a blind eye. The Spanish-American governments that commissioned these privateers benefitted through sharing the profits and by crippling enemy trade. Often, however, legal prizes bled into illegal pirating if the legitimacy of the government supporting the privateers was questioned or if the privateers began seizing neutral merchant ships. The Gulf and the Caribbean were notorious breeding grounds for these patriot-pirates (Batterson 2013).

Eventually the US Navy succeeded in driving out most of the piratical activity in the Gulf. In the spring of 1820, the notorious Jean Laffite razed his base at Galveston and vanished from history. As the wars for independence wound down in Latin America, letters of marque were no longer issued to provide legal cover. Though some illegal smuggling of enslaved Africans continued to occur, it was in a much-reduced capacity. The schooner *Clotilda*, whose 1860 wreck was discovered in the Mobile River in 2019, is believed to have been the last US vessel to illegally transport captives directly from Africa to the South (Keyes 2019).

As tension between Texas colonists and the Mexican government escalated into the 1830s, Texans acquired arms and created a privateer "navy." Factions in New Orleans continued their aid to revolutionary groups in the Gulf, albeit this time to Texas, as a source of funding, arms, and sometimes vessels (Borgens 2004: 24–25). The British Royal Navy, a regular presence in the Gulf and West Indies, closely monitored unfolding events in the region and supported the Mexican cause against the Texan colonists. The Mexican Navy also stemmed the smuggling of contraband goods and gunrunning, focusing

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[1] A filibuster or freebooter, in the context of foreign policy, is someone who engages in an (at least nominally) unauthorized military expedition into a foreign country or territory to foment or support a revolution. In pre-Revolution Texas, that seemed to be something of a national pastime. Many an ill-fated scheme to invade Texas was hatched in bars in the French Quarter. The New Orleans Association was a secretive group of businessmen, bankers, politicians, slavers, and pirates.

on both Texan and US shipping along the coast. The Texas Revolution itself was brief, initiated by events at Gonzales in October1835 and ending with the battle at San Jacinto in April 1836.

When war broke out between Texas and Mexico, the provisional government of Texas recognized the need to form a navy to protect the supply lines among New Orleans and Galveston, Matagorda Bay, and the mouth of the Brazos River. The first seven vessels of the Texas Navy lasted until 1837, by which point all of them had been lost (Daniel 2010). The Second Texas Navy, consisting of the 170-ton schooners *San Jacinto*, *San Antonio* and *San Bernard*, the 400-ton brigs *Wharton* and *Archer*, the steam packet *Zavala*, and the 600-ton sloop-of-war *Austin* engaged in coastal surveys, interdicting smuggling, and in supporting an insurrection of Yucatecan rebels against the central Mexican government. In 1842, *San Antonio* was lost in a storm on its way from Matagorda to Sisal, Yucatan.

2.5 The Golden Era of the US Merchant Marine, 1830–1850

The period between 1830 and 1850 has been termed the “golden era” of the US merchant marine. Due principally to the demand of the east coast and Europe for Gulf coast cotton, new lines developed to form a shipping triangle connecting the Gulf ports to New York and Europe. The steamboat, which first appeared in New Orleans in 1812, significantly spurred the development of commerce up and down the Mississippi River. In addition, steamboats were used to tow blue water sailing ships up the 93 miles from the mouth of the river to New Orleans, significantly reducing the final leg of their voyage from weeks or months to mere days or hours and making New Orleans far more attractive to commerce as a deep water port. The simple innovation of sailing on a schedule also gave the American economy a boost in the first half of the 19th century. Traditionally, ships sailed when they had loaded enough cargo to justify a voyage. Passengers could be delayed days or even weeks waiting for the holds to fill. After the War of 1812, ship owners in New York began experimenting with regular timetables, and the 1820s and 1830s saw a boom of scheduled shipping lines across the ocean and along the coasts. Known as “packet ships,” these sturdy vessels carried cargo (mainly cotton), mail, and passengers on a regular schedule between New Orleans and Boston or New York. During this period, New York came to dominate the shipping of the Gulf Coast; this control continued until the Civil War began in 1861 (Laing 1974).

Along the Gulf Coast and that of the Texas Republic (1836–1845) more ports arose to draw lumber, grain, and cotton commerce. New Orleans became an important market for Texas cattle shipped across the Gulf from Galveston and the now-abandoned port of Indianola on Matagorda Bay. Beginning in 1848 and continuing up to the Civil War, from 2,900 to 6,000 head of cattle per year were shipped from the port of Galveston (Surdam 1997: 479).

One of the most prominent figures in 19th-century maritime history in the Gulf was Charles Morgan, for whom Morgan City, Louisiana, was named. Morgan established the first regular steamship service in Texas in the 1830s and ran a mail service between New Orleans and Veracruz, Mexico. By 1855, Morgan’s Southern Steamship Company established routes between New Orleans, Galveston, and Port Lavaca, and by 1860 Morgan was operating six regular routes in the Gulf. Morgan's greatest goal after the Civil War was to develop a unified system of steamship and rail lines that would connect the Gulf southwest with the Mississippi Valley, northern Latin America, and the Atlantic and Pacific coasts (Baughman 1968:208). Between 1877 and 1885, Morgan realized much of his dream. Of the 117 steamships owned by Morgan or his corporate enterprises between 1833 and 1885, the wrecks of three have been discovered in the Gulf or contiguous waters (Irion and Ball 2001: 50).

2.6 The Civil War

During the Civil War, the Gulf was a theater of conflict for Union blockaders, Confederate blockade runners, and Southern "commerce raiders" or privateers. Early in the war, US President Abraham Lincoln proclaimed a blockade of southern ports as part of the "Anaconda Plan" to strangle the South from re-supply. Confederate President Jefferson Davis responded in kind by issuing letters of marque to Confederate privateers to target US shipping. Just as Bermuda was an important point of embarkation for fast, purpose-built ships attempting to run the blockade of Southern ports on the Atlantic, so Havana, Cuba, served the same purpose for ships attempting to run the blockade of Gulf ports, principally the port in Mobile, which did not fall under Union control until 1864, as well as Brownsville and Galveston. New Orleans, which surrendered within days of Admiral David Farragut's fleet's passage of the two forts on the lower Mississippi on 28 April 1862, was removed early as a point of re-supply for the Confederacy. Confederate privateers, meanwhile, exacted a terrible cost on US shipping. By 1862, the CSS *Sumter,* a converted mail steamer, had destroyed 18 US merchant ships on her cruise from New Orleans to Gibraltar. The CSS *Alabama* sank the steamer USS *Hatteras*, the only US warship sunk at sea by the Confederacy, off the coast of Galveston in the summer of 1862. *Alabama* sank a record 76 vessels before being sent to the bottom off Cherbourg, France, by the USS *Kearsarge* 19 June 1864.

The Civil War left in tatters the infrastructure that the South required to resume normal trade. Railway lines were destroyed and the harbor at Mobile was blocked by the extensive network of defenses installed by Confederate engineers (Irion 1990). *Thomas Sparks*, an early iron-hull, screw-driven steamship, wrecked on the harbor obstructions in 1866 prompting serous attention to re-opening the ship channel into the city. New Orleans, which had fallen early in the conflict, was largely unscathed by war but suffered from the fact that most of its commerce before the war had been controlled through Northern cities and Southern merchants had failed to build their own merchant fleets or to the make major harbor improvements that ports in the North had. Nevertheless, after the Reconstruction period, maritime commerce revived with traffic moving on coastal and direct routes to South American, European, Caribbean, and eastern US markets. The southern ports established direct contacts to destinations outside the Gulf, breaking with past reliance on New York's control of Southern commerce (Laing 1974). However, the US merchant marine never fully recovered its pre-Civil War prominence.

The effects of Confederate raiders, lost markets, and increased costs combined to allow a greater share of Gulf vessels to become foreign. Norwegian, British, Danish, Dutch, German, Italian, and Columbian vessels called at Southern ports and defined new sailing routes to new places like Tampa (1885) and Port Arthur (1897) (Garrison et al. 1989b: II-23). Minerals such as phosphate (Tampa) and oil (Port Arthur) joined lumber, grain, and cotton as exports from Gulf ports through the Yucatan and Bahama Channels. Tampa became a major Gulf port after the arrival of the south Florida railroad in 1885 with the concomitant entry of the Plant Steamship Line (Smyth 1898). New economic vessel designs, such as schooners and propeller driven steamers, plied the Gulf at the turn of the 20th century. Commercial traffic on these routes continued throughout the first half of the 20th century with little change until the outbreak of World War II. Cotton remained an important commodity, but booming coastal economies significantly diversified exports, especially in lumber. In 1887, Mobile alone shipped out 30 million board feet of lumber and 75 million shingles (Sledge 2017: 780). Bananas were among the most popular imports, brought by United Fruit Company steamers from Central American plantations. Transporting US tourists to the Caribbean became a profitable side-line. Other products shipped out of Gulf ports included coal, grain, lead, copper, steel, aluminum, sulfur, phosphate, tobacco, bauxite, and machine parts.

2.7 World War II

During 1942 and 1943, a fleet of over 20 German U-boats cruised the Gulf, seeking to disrupt the vital flow of oil carried by tankers from ports in Texas and Louisiana. U-boats sent 56 vessels to the bottom; 39 of these are now believed to be in state or Federal waters off Texas, Louisiana, and Florida (Church et al. 2007). After their initial, devastating success, U-boat attacks in the Gulf became rare by the end of 1943 after merchant vessels began cruising in armed convoys. The opening of the "Big Inch" pipeline from Texas to New Jersey also contributed to freeing the war effort from relying on ships to transport crude oil. One German U-boat, U-*166*, was sunk in the Northern Gulf by the US Navy (Church et al. 2007).

With the end of the World War II, shipping patterns returned to normal and even more traffic entered secondary ports as well as those used in the 19th century. The goods that were carried changed over the century, with oil-derived cargoes supplementing agrarian exports in the western Gulf and grains or manufactured goods performing the same role at central and eastern Gulf ports. The principal axis of traffic shifted westward from the east-central Gulf to the west-central Gulf, reversing the 19th to early 20th century pattern. A major factor was the opening of the Panama Canal in 1914, giving easier routes to west coast and Asian markets.

2.8 Founding Dates of Historic Ports of the Northern Gulf of Mexico

2.8.1 Texas Ports

- Galveston (1816, 1821)
- Port Aransas (1820, 1839)
- Freeport/Velasco (1830s)
- Houston (1836)
- Sabine (1840)
- Port Isabel/Brownsville (1840s)
- Indianola (1844–1886)
- Corpus Christi (1845)
- Port of Texas City (1893)
- Port Arthur (1897)
- Port Lavaca (1900s)
- Port of Beaumont (1908)
- Matagorda Ship Channel (1962)

2.8.2 Louisiana Ports

- Balise, New Orleans (1718)
- Lake Charles (1803)
- Grand Terre (1810–1821)
- Morgan City (1850)
- Grand Chenier (1870–1920s)
- Plaquemines Port (1954)
- Port of Greater Baton Rouge (1956)

2.8.3 Mississippi Ports

- Biloxi (1699)
- Pascagoula (1870s)

- Gulfport (1887)

2.8.4 Alabama Ports

- Dauphin Island (1699)
- Mobile (1710)

2.8.5 Florida

- San Marcos-Apalachee (1679)
- Pensacola (1699)
- Charlotte Harbor (Late 18th century)
- Apalachicola (1821–1865)
- Key West (1822)
- Cedar Key (1830–1890s)
- Tampa (1831)
- Port of St. Joe (1830s)
- Port of St. Andrews (Panama City developed during World War II as a major shipbuilding and industrial center) (1908)

3 The Precariousness of Navigation: Mapping Ships' Routes, as Illustrated by Contemporary Maps

> "If you want to learn to pray, go to sea."
>
> –Portuguese proverb

To understand where ships historically sunk, foundered, or were otherwise lost in the Gulf of Mexico (Gulf), one must know from whence and to where they sailed and what routes they took. The primary data for that analysis comes from the masters of the ships themselves as reported to the cartographers of their day. Maps and sailing directions made from their observations were of enormous commercial and military value and were often closely guarded state secrets. Such documents have been critical to navigators for the safe operation of their vessels for millennia; examples survive from ancient Greece as early as the 6th century B.C.E. However, these observations were only as good as the technology, science, skill, and intuition of the observer. This chapter discusses some of those limitations to accurate reporting and examines the development of sailing routes in the Gulf over four centuries. Section 3.7 includes links to pertinent maps, analyzed for this technical paper, from the 17th century to the 20th century.

3.1 Navigation in the Age of Sail

The period between, roughly, 1571 and 1862 is known as the Age of Sail; trade and warfare were conducted primarily by sailing ships, rather than oar-propelled vessels. During most of the Age of Sail, there were two complementary methods of sea navigation: coastal navigation or pilotage, and deep-sea or oceanic navigation. The difference between the two methods was one of context. A ship engaged in the coastal trade might use coastal navigation most of the time. But a ship engaged in deep-sea voyages between different countries might use coastal navigation within 20 to 30 miles of its port of departure, then deep-sea navigation, and finally coastal navigation again when it came within 20 to 30 miles of its port of destination. Neither method was particularly accurate.

Pilotage relied on keen observation of terrestrial objects, tide prediction, written sailing directions (called "rutters"), and cardes (a type of coastal map), laying a course well offshore to avoid shoals or reefs but still keeping in sight of headlands, lighthouses, seaports, or large noticeable features like church towers or steeples on the coast. Oceanic navigation relied on using a variety of instruments to observe astronomical bodies, taking measurements of the relationships between these bodies and the earth, then using mathematical computation and tables to translate these readings into a usable vessel location and course. Both types would have been practiced over what is now the US Outer Continental Shelf (OCS), which stretches from three to 200 miles offshore.

Two publications were found of particular use for understanding the practice of navigation and its reliability and replicability during this period. The first is a thesis submitted under the Nautical Archaeology Program at Texas A&M University (see Swanick 2005). The second is the illustrated contents of the course "Navigation and Logbooks in the Age of Sail" offered at the US Naval Academy (Reaveley 2010). Unless otherwise noted, the information presented below is drawn from these two sources.

3.1.1 Latitude

When the English explorer Martin Frohbisher set off in search of the Northwest Passage in 1576, he carried with him a brass standing level, a cross-staff (*balestotta*)[2], a universal Mercator projection, six navigation charts, twenty compasses, eighteen hourglasses, and an astrolabe[3] (Swanick 2005). Spanish explorers in the 16th century would have been similarly equipped with instruments used to calculate their latitude from observations of the sun and the North Star, the speed of their vessel, and their heading.

Mariners used the astrolabe to determine the latitude of a ship at sea by measuring the sun's noon altitude (declination) or the meridian altitude of a star of known declination in the Mediterranean world since at least the 2nd century A.D. The mariner's astrolabe was a graduated circle with an alidade used to measure vertical angles. They were designed for use on boats in rough water and/or in heavy winds, conditions in which true astrolabes were too unwieldy to handle. Sea astrolabes had been made specifically for Vasco da Gama's voyage in 1497 and have been recovered from the 1554 wreck of *San Esteban*[4] off Padre Island, Texas (Arnold and Weddle 1978). On a smaller astrolabe, say 6 to 7 inches in diameter, a reading to even 20 minutes of degrees (roughly 23 miles) accuracy was difficult.

The 16th century navigator could also calculate latitude using a cross-staff, five to six feet in length, square in cross-section, and graduated on one side in degrees and minutes. A perpendicular crosspiece slid along the length of the staff to take measurements. Holding one end to the eye, the navigator moved the sliding crosspiece until the top end was on the center of the sighted star, such as Alpha Ursae Minoris (Polaris) or the sun, and the bottom was even with the horizon. The cross-staff's accuracy suffered from two design limitations. First, it was too long to hold steady on the deck of a ship, and second, the cross-staff had to be held in place for several minutes to catch the highest point of the sun's meridian passage, which required the navigator to stare directly into the sun for some time. Many navigators lost their sight as a result (Swanick 2005).

As early as the mid-1400s, the sea quadrant[5] came into use. The sea quadrant was a wooden quarter-circle with a 90° arc connecting the two opposing corners, graduated with degrees and minutes along the arc. A string was attached to the central corner and held up to be aligned with the sun or star being sighted. The place where the string crossed the arc provided an angular measurement. The navigator used two sighting vanes along the edge to make the observation, and a simple plumb-bob suspended from the apex of the instrument indicated the latitude.

Around the end of the 16th century, the cross-staff and the quadrant evolved into the backstaff[6] or Davis quadrant. The benefit of the backstaff was that it relied on the use of the sun's shadow and didn't require looking directly into the sun. To use the backstaff, the navigator, with his back to the sun, holds the instrument in front of him and places it on his shoulder. To find the altitude, the navigator would move the vanes along the arcs and view the horizon through a small slit. He would move the shadow vane on the smaller arc until the edge of the vane casts a shadow on the slit of the horizon vane. While doing this, the navigator would also look through a peephole in the vane on the larger arc and through a slit in the

[2] See the Mariners' Museum and Park, https://exploration.marinersmuseum.org/object/cross-staff/
[3] See the Mariners' Museum and Park, https://exploration.marinersmuseum.org/object/astrolabe/
[4] See Texas Beyond History, Spanish Shipwrecks in 1554, https://www.texasbeyondhistory.net/coast/images/he4.html
[5] See the Mariners' Museum and Park, https://exploration.marinersmuseum.org/object/quadrant/
[6] See the Mariners' Museum and Park, https://exploration.marinersmuseum.org/object/back-staff/

horizon vane to view the horizon. This allowed him to find the altitude of the sun by viewing the horizon and the sun's shadow at the same time through the horizon vane.

The backstaff later evolved into two other instruments: the octant[7] and the sextant[8]. In 1731 John Hadley developed a far more accurate octant that came into general use after 1750 (Swanick 2005). The sextant was developed after 1767 and modified for use at sea after 1770. Octants have been observed on several wrecks in the Gulf, believed to date from around 1820, so clearly, they remained in favor with mariners for some years, perhaps because they were less expensive than sextants. When properly used under stable conditions, the octant's readings were accurate to within a few nautical miles. The sextant, which is still in use today by mariners who want a back-up to electronic GPS, is accurate to about one-fifth of a minute or 0.2 nautical miles.

3.1.2 Longitude

The captain of a sailing ship also needed to keep careful track of his dead reckoning (DR) longitude. For much of the Age of Sail (mid-16th to mid-19th centuries), determining longitude was beyond the ability of most navigators who could not perform the complex astronomical navigation calculations required in celestial navigation using moon-star hour-angles, nor readily identify many of the several thousand stars then visible in the sky. The astronomical calculation of "observed longitude" was simply not practical.

An alternative would have been to use the "Equation-of-Time," based on the fact that there are 360° of longitude around the earth, and the Earth rotates on its axis once every 24 hours. Therefore, every hour the Earth rotates 15° of longitude, and every 4 minutes of time equals one degree of longitude. This method, however, required a monumental technological advancement with the development of a timepiece capable of keeping time accurate within seconds for months on end in all conditions of weather and movement of the ship.

In 1707 the Royal Navy lost four warships and up to 2,000 sailors on the rocks off the Isles of Scilly because of a navigational error in longitude. In response, in 1714 the British Parliament passed the Longitude Act, which awarded a prize of £20,000 for a solution which could find longitude to within half a degree (equivalent to 30 nautical miles). John Harrison, a self-educated English carpenter and clockmaker, is credited with finding a practical solution to the calculation of longitude with the development of a series of marine chronometers ending with the H4[9] in 1761, which exceeded the threshold for accuracy set by the Longitude Act (Sobel 1995). However, because accurate chronometers were extremely expensive and difficult to keep safe in a sailing ship environment, they remained rare and this method of determining longitude was not readily available.

The Royal Navy did not routinely issue naval ships with chronometers until 1825 and they were not common in merchant vessels for decades. It was not, in fact, until World War II that the Hamilton Watch Company succeeded in mass-producing a chronometer accurate enough to be reliably used in navigation. The captain's longitude derived from his DR calculations therefore probably remained unchanged into the mid-twentieth century and after a couple of weeks at sea, most deep-sea ships had no idea of their real longitude to within 50 to 100 miles. DR longitude calculations relied on accurately recording the ship's

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[7] See the Smithsonian National Museum of American History, https://amhistory.si.edu/navigation/type.cfm?typeid=4

[8] See the Smithsonian National Museum of American History, https://amhistory.si.edu/navigation/type.cfm?typeid=6

[9] See Royal Museums Greenwich, https://collections.rmg.co.uk/collections/objects/79142.html

compass course each hour, the ship's speed as measured by the logline, and any significant changes in the wind which might affect the ship's leeway due to windage. Windage leeway was a significant problem because ships had very little keel area and would be driven off course downwind by the wind pressure on the sails and hull. The ship's course steered by the helmsman was rarely the ship's actual Course-Made-Good (the direction in which a ship or vessel has traveled with the effects of current, wind, and helmsmanship).

Sailing ships generally cruised at 5 to 7 knots (1 knot = 1 nautical mile per hour) and had to take into account winds varying in both strength and direction. Ships constantly needed to tack, zigzagging along their course, because they could only sail no more than 60 degrees into the wind without losing too much headway and gaining too much leeway, and so they generally averaged only approximately 100 miles per 24-hour day in actual "distance-made." The wind strength and its trends were very important for sailing ships because wind velocity increases the strength of the wind increases almost as the square of the wind velocity. The winds at the height of the topsails and top-gallant sails 100 feet to 150 feet above the sea would be up to 10 knots stronger than the wind at sea level. This is the reason a square-rigged ship's sails are made smaller in square yardage higher on the masts (Reaveley 2010).

3.1.3 Coastal Charts

During the 18th and 19th centuries, coastal charts became available that showed the type of seabed, for example, mud, sand, shells, or shingle (small stones) so the captain could estimate where he was based on depth and bottom type. When the sounding-lead[10] was cast and its base hit the seabed, some material would stick to the soft tallow inset into the end. The hand-lead-line could be used while the ship maintained slow headway in 20 fathoms or less. The line was marked at different depths by colored pieces of cloth or leather to provide the leadsman with quick indications of the water depth, which he immediately shouted to the quarterdeck officer. The deep-sea lead-line required the ship to be at a stop, or hove-to, and could measure up to 100 fathoms, being marked with two knots at 20 fathoms, three knots at 30 fathoms, etc. The deep-sea lead-line also had a tallow inset to take a sample of the seabed.

The coastal chart could be supplemented by even more details in the annually-published, "Coasting Pilot" for that area, which provided highly detailed information on buoys, marks in channels, and the best approaches to harbors to remain clear of shoals. Examples of Coasting Pilots for the Gulf include Derrotero De Las Islas Antillas, De Las Costas De Tierra Firme, Y De Las Del Seno Megicano (De Paula Santander 1826) and The Columbian Navigator (Purdy 1823). The Columbian Navigator, for example, advised captains sailing off the coast of Louisiana between present-day Cameron and the Isle Dernieres to approach no closer than 10 fathoms (60 feet) of water as the bottom "is most commonly foul and full of oyster banks (and) most dangerous to navigation" (Purdy 1823:136). During hurricane season between August and September, captains were advised to approach no closer than the 20-fathom bathymetric contour. The Columbian Navigator also helpfully added, regarding New Orleans, that "there are few places where human life can be enjoyed with more pleasure or enjoyed to more pecuniary profit" (Purdy 1823: 137).

Using his charts and these simple navigational methods and equipment, the captain or master of a sailing ship could safely navigate round-trip voyages of several hundred miles or more. Although thousands of ships were lost at sea in storms or ran ashore due to navigation errors, tens of thousands of ships sailed the

[10] See Royal Museums Greenwich, Sounding lead and line: https://collections.rmg.co.uk/collections/objects/42893.html

world for more than 500 years using latitude, log, lead, and lookouts. Rarely, however, would they have been capable of proceeding on a straight, repeatable course between one port and another over long distances in the open sea. In the Gulf, for example, captains were advised to approach the Balize Pass of the Mississippi River, Mobile, or Pensacola well to the eastward of their destination to take advantage of prevailing winds blowing from east to west. During the 16th to 19th centuries, ships traversing between two of the Gulf's most important ports, Veracruz in Mexico and Havana, Cuba, sailed North or North Northeast close to the wind from Veracruz to between the 27.5°N and the 25°N parallels and then west to the Florida coast (Lugo et al. 2007). This indirect route allowed mariners to take advantage of the Loop Current that flows northward from the Yucatan Channel to the east, exiting through the Florida Straits, while at the same time avoiding the contrary easterly Trade Winds. The trip lasted between eight and 28 days but could require as many as 87 days (Lugo-Fernandez et al. 2007).

3.2 The Age of Exploration and Colonization

Early in 1520, the first crude hand-drawn map[11] of the Gulf was prepared by the pilots who accompanied Alonso Álvarez de Pineda the year before. It was the first European map portraying the Gulf that was based on actual exploration (Weddle 2019). The first printed map[12] of the Gulf appeared with a 1524 edition of Hernán Cortés's second letter to the crown, along with a map of the Aztec capital of Tenochtitlan. For most of the 16th century, the Spanish had little interest in mapping the Northern Gulf Coast, but that changed abruptly in 1685 when they learned that René Robert Cavelier, Sieur de La Salle, had landed in what they had considered their territory. In what is surely one of the worse examples of errors in judging longitude, La Salle, seeking the mouth of the Mississippi River, landed instead at Matagorda Bay, Texas. Between 1686 and 1687, the Spanish searched unsuccessfully for La Salle's colony, circumnavigating the Gulf for the first time and mapping it in detail. Unfortunately, these maps have been lost. Also, Spanish desire for secrecy meant that few maps at all from this period were published.

Several 18th century British, French, and Spanish maps depict the typical routes taken by Spanish treasure fleets sailing from Veracruz in New Spain to Havana, Cuba. The basic route pattern was established by Anton de Alaminos in 1519 during his return trip to Spain to inform the King about the progress of the Mexican conquest. The long or northern branch consisted of an arch that went to latitude 27.5° N, then east, turned southeast near Florida until reaching Dry Tortugas, and headed south to Havana through the Florida Straits. The second or southern branch went only to latitude 25° N, proceeded east until the Dry Tortugas, and reached Havana, similarly to the long route (Lugo-Fernández et al 2007). For example, Pierre Mortier's 1703 map *Théâtre de la guerre en Amerique telle qu'elle est à present possedée par les Espagnols* (Figure 6) depicts the more northerly "route de la flota de Vera-Cruz aux Havana."

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[11] See The Cortes Rift, http://www.texascounties.net/articles/texas-in-the-16th-century/discovery2.htm

[12] See Vistas Gallery, Map of Tenochtitlan and the Gulf of Mexico from Cortés' Second Letter, https://vistasgallery.ace.fordham.edu/items/show/1781

Figure 6. Pierre Mortier's 1703 Théâtre de la guerre en Amerique telle qu'elle est à present possedée par les Espagnols

From The Portal to Texas History, from Map Collections at the University of Texas at Arlington. See: https://texashistory.unt.edu/ark:/67531/metapth251715/

A more southerly route is shown as a hand annotation on a rare copy of Felipe Bauza's 1836 map *Carta Esferica de la costas del seno Mexicano con parte de la isla de Cuba y canales adjacentes* in a private collection[13]. The manuscript annotations illustrate the tracks of two ships; one is the course of *Churacca*, a 132-ton brigantine or *pailebot* based in Havana, that ran the packet route between Veracruz and Havana. The second line traces the route of the frigate *Isabel II*. The French rutter *Manuel de la Navigation dans la Mer des Antilles et dans le Golfe du Mexique* (de Kerhallet 1853) depicts a route following the 25°N parallel labeled as the route between Veracruz and Havana "during the season of the Northers."

3.3 The First Half of the Nineteenth Century

The first half of the 19th century, particularly after the conclusion of the War of 1812, witnessed an explosion of economic growth. Americans flooded into unsettled areas, steam navigation facilitated the flow of goods up and down the Mississippi River, and demand was high for southern resources, such as cotton and timber. By the 1840s New Orleans had grown to be the fourth largest city in the country; the increased trade is reflected in period charts such as de Kerhallet's sailing guide *Manuel de la Navigation dans la Mer des Antilles et dans le Golfe du Mexique* (de Kerhallet 1853). The guide provides detailed descriptions of routes and hazards to ports throughout the Gulf and provides illustrations of prominent features and landmarks visible from sea to aid navigators at a time when the calculation of longitude with the use of an accurate chronometer was still beyond the reach of most navigators. The Columbian Navigator (1823:133) notes, for example, that differences in longitude reported for Galveston vary between sources commonly used by navigators by as much as 15 minutes and warns that the Sabine River could easily be mistaken for Galveston Bay. De Kerhallet's chart (Figure 7) also depicts primary routes during different seasons between ports in Texas, Louisiana, Mississippi, Alabama, and Florida, and those in Mexico and Cuba.

[13] See Geographicus, https://www.geographicus.com/P/AntiqueMap/GulfofMexicoFlorida-bauza-1836

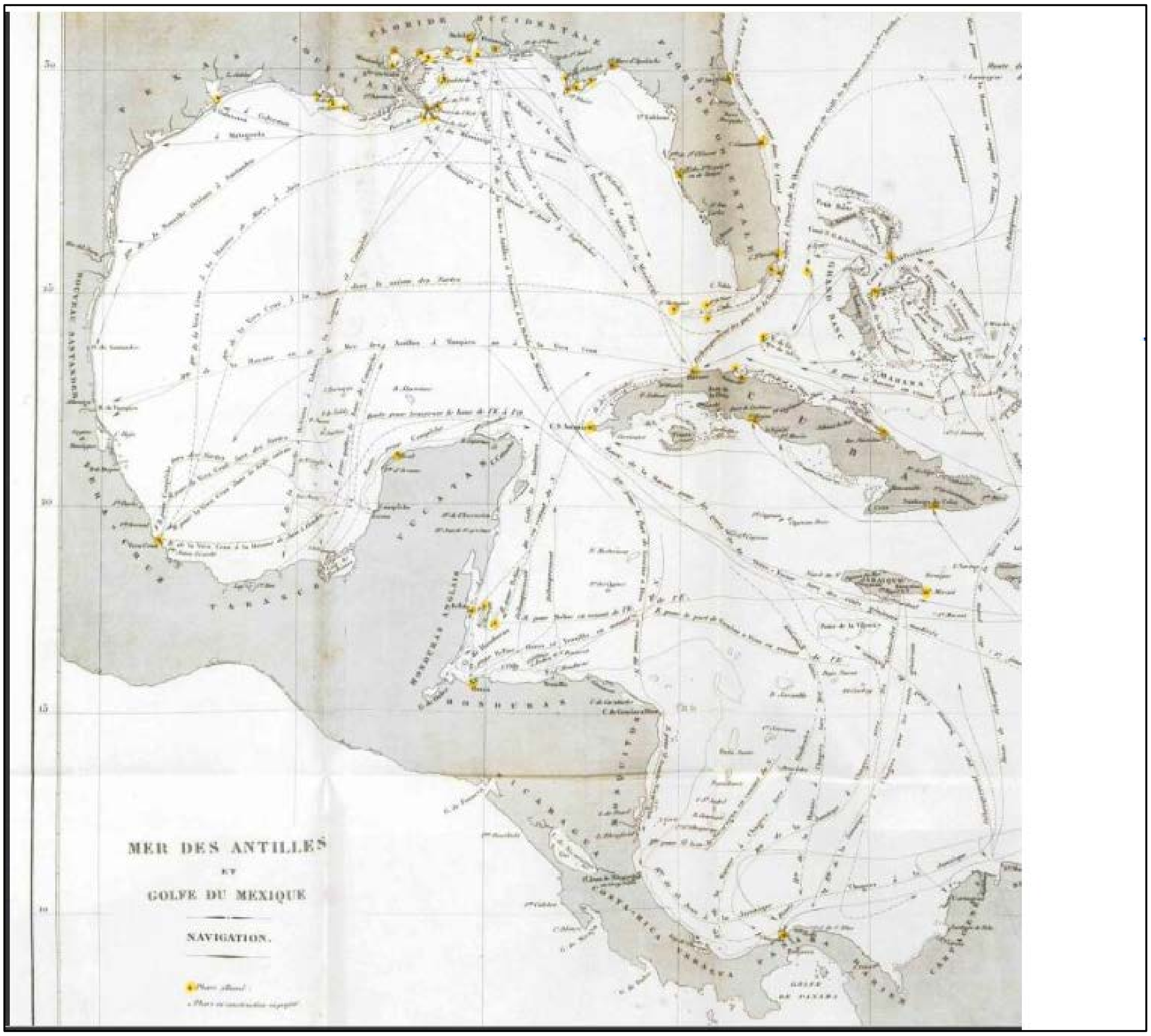

Figure 7. Manuel de la Navigation das la Mer des Antilles et dans le Golfe du Mexique

For this discussion, the most important work is Matthew F. Maury's 1852 Wind and Current Chart of the North Atlantic (Figure 8). This was one of a series of hydrographic charts for the Atlantic, Pacific, and Indian Oceans produced by Matthew Fontaine Maury under the auspices of the US Hydrographic Office. The charts incorporated data that Maury initially compiled from ships' logs stored at the Navy's Depot of Charts and Instruments (which later became the Naval Observatory). Maury then obtained massive amounts of navigational, hydrographic, and meteorological data from the recent voyages of Navy and commercial ships whose officers submitted the information on specially designed abstract logs created by Maury in return for free copies of the Wind and current charts. Six types of charts were produced: Series A, Track charts; Series B, Trade wind charts; Series C, Pilot charts; Series D, Thermal charts; Series E, Storm and rain charts; and Series F, Whale charts. In the Gulf, the chart depicts over 130 individual ships' routes from the 1820s through the 1840s derived from their logbooks. Though only a fraction of the ships that traversed these waters during these years are represented, their routes crisscross the Gulf and illustrate the fact that there was virtually no part of the Gulf that was not frequented by sailing ships during the historic period.

Figure 8. Wind and current chart of the North Atlantic, by M.F. Maury, A.M. Lieut. US Navy

From: American Geographical Society Library Digital Map Collection, University of Wisconsin-Milwaukee, https://collections.lib.uwm.edu/digital/collection/agdm/id/1483/

The Gulf was among the regions visited by US commercial whalers beginning in the late 1700s, and possibly as early as the 1760s. For more than a century, they hunted sperm whales (*Physeter macrocephalus*) and blackfish (probably short-finned pilot whales, *Globicephala macrorhynchus*) in the Gulf (Reeves et al 2011). Reeves et al. (2011) documented 204 voyages from 53 logbooks from whalers between 1788 and 1877 (Figure 9). The area between latitude 28° and 29° north and longitude 89° to 90° west was considered one of the profitable sperm whaling grounds in the North Atlantic in the late 18th through 19th centuries. Commercial whaling ships sailed primarily from the Massachusetts ports of New Bedford and Nantucket initially and Provincetown in later years.

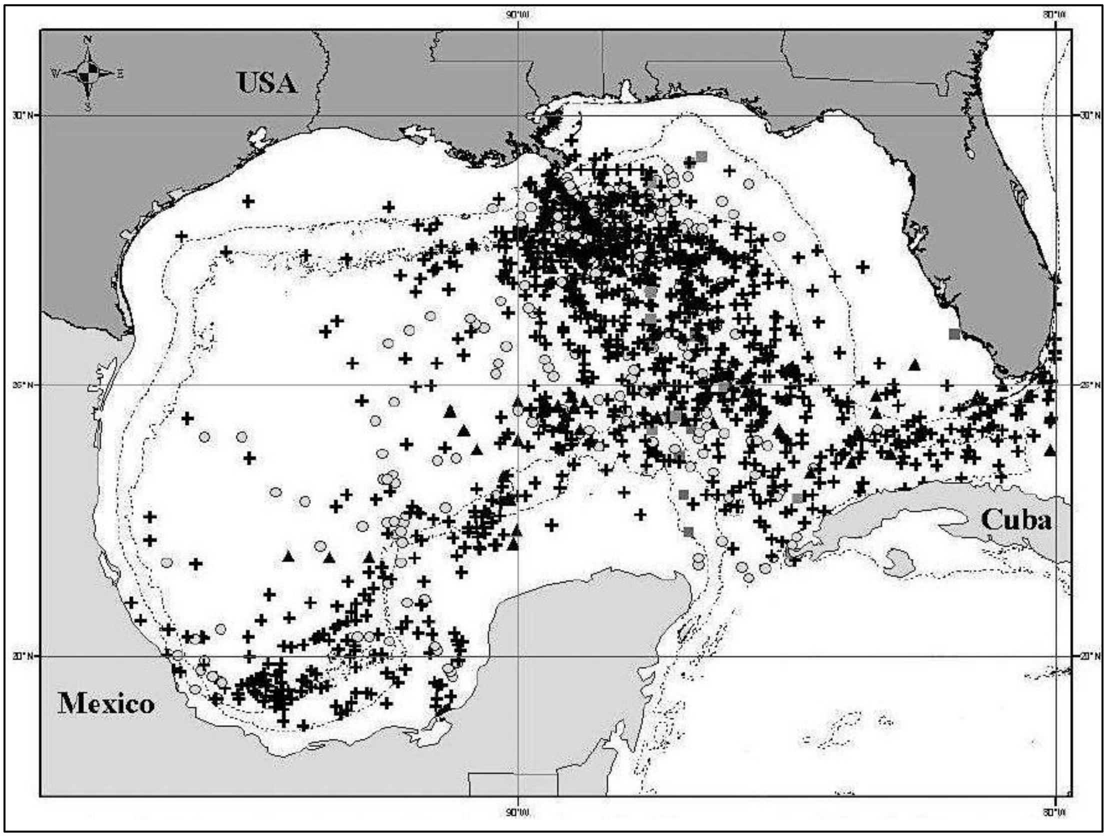

Figure 9. Daily positions of US whaling vessels in the Gulf of Mexico

Circles are January–March positions, crosses are April–June, triangles are July–September, and squares are October–December (after Reeves 2011: Fig.4).

3.4 The Late Nineteenth and Early Twentieth Century

Route maps of the late 19th and early 20th centuries principally illustrate two major advancements in transportation after the Civil War: the large-scale adoption of the steamship for maritime commerce and the growing interconnectedness of transportation networks including roads, rail, and sea. The steamship freed mariners from the reliance on the wind to plan their routes, resulting in more direct courses between ports. Sextants, improved charts, and more affordable chronometers contributed to making routes shorter and more direct. The expansion of trade with Latin America also resulted in direct routes to Central and South America and the Caribbean. Ships with the United Fruit Company contributed to the development of the cruise ship industry by carrying tourists to exotic locations in Latin America on the outbound trip and cargoes of bananas on the return voyage (Martin 2016).

3.5 World War II

The immediate effect of the 1941 attack on Pearl Harbor was to increase the capacity of Allied shipping by some 8 1/2 million gross tons of ocean-going ships liable to enemy attack. A large proportion of this tonnage in the Western North Atlantic could not be given suitable convoy and air protection due to the US' failure to build ships in preparation for war. As a result, many "soft spots" were exposed to the Axis U-boats that had by 1942 considerably increased in number and ability to operate at long distances from their bases, sometimes in "wolf packs." The U-boats quickly took advantage of the opportunity and, ignoring the cross-Atlantic, concentrated their attacks on the largely unescorted shipping along the Atlantic seaboard, in the Caribbean, and the Gulf, with disastrous results for Allied shipping. Tankers carrying vital supplies of oil from ports in Texas and Louisiana were especially vulnerable. Losses in these areas during June 1942 caused world-wide sinkings to reach a new high of 702,000 gross tons. By July 1, 1942, a network of convoys in the Sea Frontier areas had been organized and within several months the enemy had found it profitable to withdraw from coastal zones and resume attacks on ocean convoys (Naval History and Heritage Command 2019). Numerous casualties of U-boats (Figure 10), such as *Gulfoil* and *Gulfpenn*, to name just two, have been located on the seafloor in the Gulf (Church et al 2007).

Figure 10. Conning tower of the German submarine U-*166*, sunk 30 July 1942 by the US Navy in the Gulf near the mouth of the Mississippi River

Image courtesy Ocean Exploration Trust.

3.6 Modern Trade to the Present

Since the end of World War II, maritime traffic in the Gulf has grown exponentially, with a steady increase in commercial fishing, recreational boating, offshore oil industry support vessels, hydrographic survey vessels, cruise ships, container ships, oil tankers, car carriers, and others (Figure 11). Ironically, navigation throughout this period relied largely on more sophisticated versions of traditional methods - navigation by the sun and stars, depth sounding, and time calculation for longitude. Electronic hyperbolic radio navigation systems, such as Loran-C, did not become commonplace until the late 1970s. The introduction of civilian satellite navigation in the 1990s led to a rapid drop-off in the use of Loran-C. Today, anyone with a smartphone connected to a satellite GPS can determine his or her precise position anywhere on Earth within feet, something that would have been unimaginable to the navigators that first ventured into the unexplored waters of the Gulf.

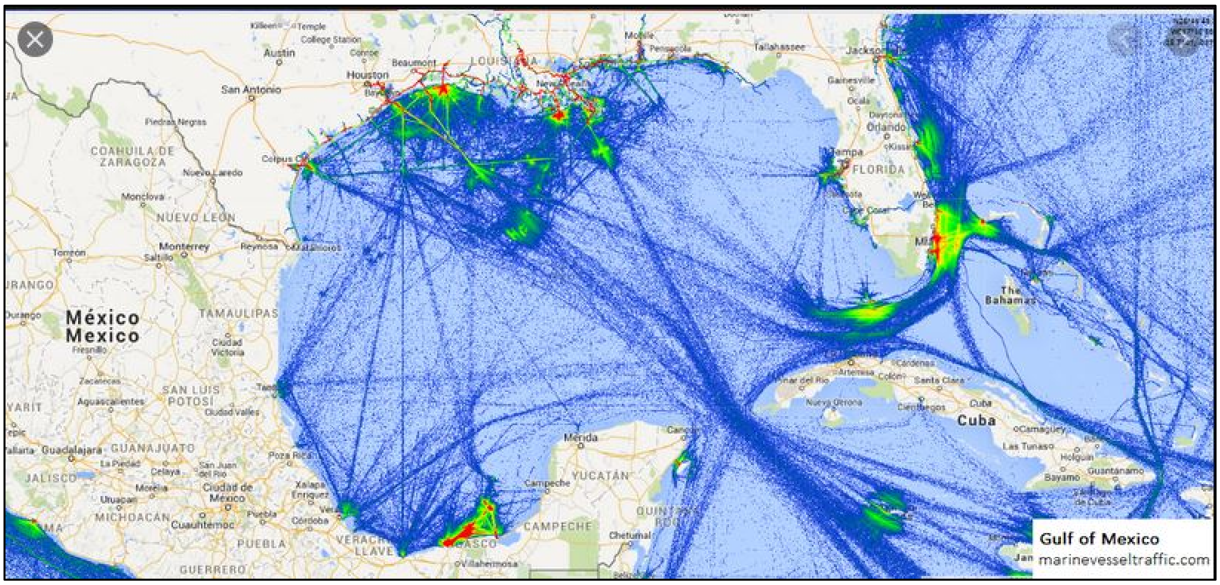

Figure 11. Modern maritime traffic patterns in the Gulf of Mexico, based on accumulated data broadcast from ships' Automated Identification Systems (AIS) integrated into their GPS navigation equipment

3.7 Seventeenth- to Twentieth-Century Map Sources

Table 1. Maps, chronologically listed, from the 17th to the 20th century

Map Title, Host or Location, URL	Author(s)	Date
Stoel des Oorlogs in America waar in vertoont werden alle desself voornaamste eylande Insulae Americanae Nempe: Cuba, Hispaniola, Iamaica, Pto Rico, Lucania, Antiliae, vulgo Caribae Barlo-et sotto-Vento etc. Atlas of Mutual Heritage, The Netherlands https://www.atlasofmutualheritage.nl/nl/Kaart-Caribisch-gebied.7772	Cornelius Dankerts	1696
Mapa de la Isla de Cuba y del Golfo de Mexico Alamy Stock Image https://www.alamy.com/mapa-de-la-isla-de-cuba-y-del-golfo-de-mexico-siglo-xviii-location-museo-naval-ministerio-de-marina-madrid-spain-image209036081.html?pv=1&stamp=2&imageid=774A3270-224B-4231-996F-379EC8B87647&p=697458&n=0&orientation=0&pn=1&searchtype=0&IsFromSearch=1	Ministerio de Marina, Madrid	17__
Le vieux Mexique, ou, Nouvelle Espagne avec les costes de la Floride : faisant-partic de l'Amerique septentrionale The Portal to Texas History, University Libraries, Denton, TX https://texashistory.unt.edu/ark:/67531/metapth2463/	Nicolas Fer	1702
Teatre de la Guerre en Amerique telle qu'elle est a prefent Possedée par les Espagnols The Portal to Texas History, University Libraries, Denton, TX https://texashistory.unt.edu/ark:/67531/metapth251715/	Pierre Mortier	1703
A Map of the West-Indies or the Islands of America in the North Sea; with ye adjacent Countries; explaining what belongs to Spain, England, France, Holland &c Barry Lawrence Ruderman Antique Maps, Inc., La Jolla, CA https://www.raremaps.com/gallery/detail/33849ct/A_Map_of_the_WestIndies_or_the_Islands_of_America_in_the_North_Sea_with/Moll.html	Hermann Moll	1715
A Chart of ye West Indies or the Islands of America in the North Sea Being the Present Seat of War University of Florida Digital Collections, Jacksonville, FL https://ufdc.ufl.edu/UF00072144/00001/1x	Hermann Moll	1719

Map Title, Host or Location, URL	Author(s)	Date
Stoel des Oorlogs in America waar in vertoont werden alle desself voornaamste ellande Sanderus Antique Maps & Books, Ghent, BE https://sanderusmaps.com/our-catalogue/antique-maps/america/west-indies/antique-map-of-antilles-by-danckerts-c-6774	Cornelius Danckerts	1720
Carte du Mexique et de la Florida : des terres angloises et des Isles Antilles, du cours et des environs de la Riviere de Mississippi Boston Public Library, Norman B Leventhal Map Center Collection, Worcester, MA https://www.digitalcommonwealth.org/search/commonwealth:x633f873g	Guillaume de L'Isle	1722
Tabula Geographica Mexicae et Floridae &c. Carte du Mexique et de la Floride, des Terres Anglaises et des Isles Antilles, du Cours et des Environs de la Riviere de Mississipi George Glazer Gallery, Antiquarian Globes, Maps & Prints, New York City, NY https://www.georgeglazer.com/wpmain/product/map-united-states-southeast-tabula-geographica-covens-mortier-amsterdam-1722/	Jean Covens & Corneille Mortier	1722
A Map of the West-Indies &c Mexico or New Spain. Also ye Trade Winds and ye Several Tracts made by ye Galeons and Flota From Place to Place…. Barry Lawrence Ruderman Antique Maps, Inc., La Jolla, CA https://www.raremaps.com/gallery/detail/25122/a-map-of-the-west-indies-c-mexico-or-new-spain-also-ye-tr-moll	Hermann Moll	1729
A Map of the West-Indies or the Islands of America in the North Sea; with ye adjacent Countries; explaining what belongs to Spain, England, France, Holland &c . . . Barry Lawrence Ruderman Antique Maps, Inc., La Jolla, CA https://www.raremaps.com/gallery/detail/47641/a-map-of-the-west-indies-or-the-islands-of-america-in-the-no-moll	Hermann Moll	1733
Mappa Geographica, Regionem Mexicanam Et Floridam Terrasque adjacentes, ut et Anteriores Americae Insulas, Cursus itidem et Reitus Navigantium versus flumem Missisipi Library of Congress, Geography and Map Division, Washington, DC https://www.loc.gov/item/2010587361/	Matthaus Seuter	1740
A New Mapp of the West Indies, or the Islands of America in the North Sea British Library Online Gallery, London, GB http://www.bl.uk/onlinegallery/onlineex/carviews/a/largeimage69775.html	Robert Morden	1740

Map Title, Host or Location, URL	Author(s)	Date
America Septentrionalis: A Map of the British Empire in America and the French and Spanish Settlements adjacent thereto Museum of the City of New York, New York, NY https://collections.mcny.org/Collection/America-Septentrionalis-2F3XC58QPVER.html	Henry Popple	1743
An Accurate Map of the West Indies exhibiting not only all of the islands possessed by the English, French, Spaniands & Dutch, but also all the Towns and Settlements on the Continent of America adjacent thereto Library of Congress Geography and Map Division, Washington, DC https://www.loc.gov/resource/g4390.ar168100/	Emanuel Bowen	1767
The West Indies, including part of Virginia, North Carolina, East Florida, South Carolina, West Florida, Georgia, Louisiana, and the Gulf of Mexico Library of Congress Geography and Map Division, Washington, DC https://www.loc.gov/resource/g4390.ar168100/	John Cary	1783
De Golf van Mexico de eilanden en het omleggende land : zaamengesteld en op nieuw gecorrigeerd volgens de beste waarnemingen The Portal to Texas History, University Libraries, Denton, TX https://texashistory.unt.edu/ark:/67531/metapth252047/	Jan Barend Elwe	1792
A New Map of North America with the West India Islands, divided according to the Preliminary Articles of Peace, Signed at Versailles, 20, Jan 1783 Classical Images Antiquarian Maps, Prints & Books, Melbourne, AU https://www.classicalimages.com/products/1794-thomas-pownall-kitchin-large-post-revolutionary-war-map-of-north-america	Thomas Kitchin	1794
Carta Esferica de la costas del seno Mexicano Con parte de la isla de Cuba y canales adjacentes Biblioteca de Catalunya, Madrid, SP http://mdc.csuc.cat/cdm/ref/collection/mapesBC/id/360	Felipe Bauza	1836

Map Title, Host or Location, URL	Author(s)	Date
Composite: Chart of the World on Mercator's projection, III-IV David Rumsey Historical Map Collection, Stanford Libraries, Stanford, CA https://www.davidrumsey.com/luna/servlet/detail/RUMSEY~8~1~299353~90070344:Composite--Chart-of-the-World-on-Me?sort=Pub_List_No_InitialSort%2CPub_Date%2CPub_List_No%2CSeries_No&qvq=q:A%20chart%20of%20the%20world%20on%20mercator%27s%20projection;sort:Pub_List_No_InitialSort%2CPub_Date%2CPub_List_No%2CSeries_No;lc:RUMSEY~8~1&mi=3&trs=45	W.H. Lizars	1841
Skeleton map showing the rail roads completed and in progress in the United States Library of Congress Geography and Map Division, Washington, DC https://www.loc.gov/item/gm70005376/	United States. Congress. House	1848
Wind and Current Chart of the North Atlantic American Geographical Society Library Digital Map Collection, University of Wisconsin–Milwaukee Libraries, Milwaukee, WI https://collections.lib.uwm.edu/digital/collection/agdm/id/1483/	Matthew F. Maury	1850
Map showing the N.E. & S.W. Alabama R.R. with its connections also the principal routes between New York and New Orleans Library of Congress Geography and Map Division, Washington, DC https://www.loc.gov/item/98688742/	Hoyer & Ludwig	185_
Wind and Current Chart of the North Atlantic Barry Lawrence Ruderman Antique Maps, Inc., La Jolla, CA https://www.raremaps.com/gallery/detail/35099mb/wind-and-current-chart-of-the-north-atlantic-by-mf-maury-maury	Matthew F. Maury	1852
Manuel de la Navigation dans la Mer des Antilles et dans le Golfe du Mexique Issu, Bibliothèque numérique Manioc / SCD Université Antilles https://issuu.com/scduag/docs/nan13016-1-2	Philippes de Kerhallet	1853
Map exhibiting the fixed location of the main trunk of the New-Orleans, Opelousas & Great Western Railroad of Louisiana Library of Congress Geography and Map Division, Washington, DC https://www.loc.gov/item/98688729/	G.W.R. Bayley	1859

Map Title, Host or Location, URL	Author(s)	Date
Texas New Orleans Railroad and its Connections in the U.S. Boston Rare Maps, via Texas State Historical Association, Austin, TX https://tshaonline.org/handbook/online/articles/eqt06	A.M. Gentry	1860
Pl. 1. Planisphere : Elementaire et Illustre David Rumsey Historical Map Collection, Stanford Libraries, Stanford, CA https://www.davidrumsey.com/luna/servlet/detail/RUMSEY~8~1~320494~90089617:Pl--1--Planisphere---Elementaire-et?sort=Pub_List_No_InitialSort%2CPub_Date%2CPub_List_No%2CSeries_No&qvq=q:Vuillemin%20atlas;sort:Pub_List_No_InitialSort%2CPub_Date%2CPub_List_No%2CSeries_No;lc:RUMSEY~8~1&mi=1&trs=350	Alexandre Vuillemin	1861
Washington Map of the United States David Rumsey Historical Map Collection, Stanford Libraries, Stanford, CA https://www.davidrumsey.com/luna/servlet/detail/RUMSEY~8~1~200371~3000301:Washington-Map-of-the-United-States?sort=Pub_List_No_InitialSort%2CPub_Date%2CPub_List_No%2CSeries_No&qvq=w4s:/when%2F1861;q:map%20of%20the%20united%20states;sort:Pub_List_No_InitialSort%2CPub_Date%2CPub_List_No%2CSeries_No;lc:RUMSEY~8~1&mi=11&trs=63	Robert Smith and S. Taintor	1861
Carta Hydrographica David Rumsey Historical Map Collection, Stanford Libraries, Stanford, CA https://www.davidrumsey.com/luna/servlet/detail/RUMSEY~8~1~1300~90111:Carta-Hydrografica-	Antonio Garcia Cubas	1885
Diagram of the Transcontinental lines of road Showing the Original Central Pacific and Union Pacific And their Competitors Barry Lawrence Ruderman Antique Maps, Inc., La Jolla, CA https://www.raremaps.com/gallery/detail/49221/diagram-of-the-transcontinental-lines-of-road-showing-the-or-united-states-pacific-railway-commission	Washington, D.C.	1887
Routes to India, Plate 1 David Rumsey Historical Map Collection, Stanford Libraries, Stanford, CA https://www.davidrumsey.com/luna/servlet/detail/RUMSEY~8~1~312757~90082008:Routes-to-India--Plate-1?sort=Pub_List_No_InitialSort%2CPub_Date%2CPub_List_No%2CSeries_No&qvq=q:Routes%20to%20India;sort:Pub_List_No_InitialSort%2CPub_Date%2CPub_List_No%2CSeries_No;lc:RUMSEY~8~1&mi=6&trs=154	J.G. Bartholomew	1893

Map Title, Host or Location, URL	Author(s)	Date
Correct Map of the Railway & Steamship Lines Operated by the Southern Pacific Company Barry Lawrence Ruderman Antique Maps, Inc., La Jolla, CA https://www.raremaps.com/gallery/detail/65660/correct-map-of-the-railway-steamship-lines-operated-by-the-poole-brothers	Southern Pacific Company	1893
"Via Eastern": *The Eastern & Associated Telegraph Companies Cable System* Bill Burns, The Atlantic Cable website, History of the Atlantic Cable and Undersea Communications https://atlantic-cable.com/CableCos/CandW/EATC/index.htm	The Eastern & Associated Telegraph Companies	1902
Map of the Mexican Central Railway and Connections Wikipedia Commons https://commons.wikimedia.org/wiki/File:Map_of_the_Mexican_Central_Railway_and_connections_in_1903_from_Poor%27s_Manual_of_the_Railroads_of_the_United_States_in_1903_(cropped).jpg	Poor's Manual of the Railroads of the United States	1903
The North Atlantic Ocean David Rumsey Historical Map Collection, Stanford Libraries, Stanford, CA https://www.davidrumsey.com/luna/servlet/detail/RUMSEY~8~1~306864~90076798:The-North-Atlantic-Ocean?sort=Pub_List_No_InitialSort%2CPub_Date%2CPub_List_No%2CSeries_No&qvq=w4s:/when%2F1905;q:The%20North%20atlantic%20ocean;sort:Pub_List_No_InitialSort%2CPub_Date%2CPub_List_No%2CSeries_No;lc:RUMSEY~8~1&mi=0&trs=2	George Philip	1905
Central America, the West Indies South America and Portions of the United States and Mexico Library of Congress Geography and Map Division, Washington, DC https://www.loc.gov/resource/g3301p.ct000852/	The United Fruit Company	1909
North and South, map of main-traveled routes: showing principal roads in the Northern and Central Western States, and their connections with the main-traveled highways of the South Library of Congress Geography and Map Division, Washington, DC https://www.loc.gov/item/2011587112/	American Automobile Association. Touring Information Board	1911
Southern Pacific Atlantic Steamship Lines 'Morgan Line' and Connections Internet Archive via Alamy Stock Images https://www.alamy.com/stock-photo-black-and-white-illustration-of-a-map-of-the-united-states-of-america-173103759.html	Sothern Pacific Company	1915

Map Title, Host or Location, URL	Author(s)	Date
General map of transcontinental routes with principal connections Library of Congress Geography and Map Division, Washington, DC https://www.loc.gov/item/73692230/	American Automobile Association	1918
Southern Railroad Lines Wikipedia Commons https://upload.wikimedia.org/wikipedia/commons/4/47/1921_Southern_Railway_map.jpg	Southern Railway	1921
Map of principal transportation lines of the United States. [For New York: United Y.M.C.A. Schools Extension Division by Rand McNally & Co Library of Congress Geography and Map Division, Washington, DC https://www.loc.gov/resource/g3701p.ct002021/?r=0.356,0.475,0.538,0.333,0	Rand McNally and Company	1921
United Fruit Company Steamship Service Smithsonian Libraries and Archives, Washington, DC https://www.si.edu/object/siris_sic_14695	George C. Wheeler	1924
Steamship Routes of the World David Rumsey Historical Map Collection, Stanford Libraries, Stanford, CA https://www.davidrumsey.com/luna/servlet/detail/RUMSEY~8~1~201418~3000561:Steamship-Routes-of-The-World-?sort=Pub_List_No_InitialSort%2CPub_Date%2CPub_List_No%2CSeries_No	Rand McNally and Company	1924
Map of the World David Rumsey Historical Map Collection, Stanford Libraries, Stanford, CA https://www.davidrumsey.com/luna/servlet/detail/RUMSEY~8~1~310765~90080518:Nippon-Yusen-Kaisha-map-of-the-worl?qvq=w4s:/where%2FWorld%2Fwhen%2F1926;lc:RUMSEY~8~1&mi=0&trs=14	Nippon Yusen Kaisha	1926
Trade Route Chart of the British Empire British Library, Maps Collection, London, GB https://www.bl.uk/collection-items/trade-route-chart-of-the-british-empire	The War Office	1932

Map Title, Host or Location, URL	Author(s)	Date
Le front de l'Ocean David Rumsey Historical Map Collection, Stanford Libraries, Stanford, CA https://www.davidrumsey.com/luna/servlet/detail/RUMSEY~8~1~321374~90090539	Mercier, Jacques	1939
Map of Banana Trade Routes: Caribbean Countries Showing Principal Banana Shipping Ports New York City Municipal Archives, New York City Department of Records & Information Services, New York, NY https://www.archives.nyc/blog/2019/2/1/one-banana-two-banana-three-banana-four	WPA Writers' Project	1940
Merchant Ship Wall Charts Appendixes NN, OO, PP, QQ, RR, SS in History of Convoy and Routing [1945], US Naval Administration in World War II, #11. Washington, DC https://www.history.navy.mil/research/library/online-reading-room/title-list-alphabetically/h/history-convoy-routing-1945.html	Naval History and Heritage Command	1945
United States of America. Pergamon World Atlas David Rumsey Historical Map Collection, Stanford Libraries, Stanford, CA https://www.davidrumsey.com/luna/servlet/detail/RUMSEY~8~1~205736~3002560:United-States-of-America--Pergamon-	Polish Army Topography Service	1967

4 Historically Significant Shipwrecks in the Gulf of Mexico

Hundreds of years of vessel navigation in the Gulf of Mexico (Gulf) have left the seafloor littered with thousands of shipwrecks. In the shallows along the Northern Gulf coastline, in the deep-water canyons off the Mississippi River Delta, and under the open ocean passages to the Yucatan Peninsula and the Straits of Florida is tangible physical evidence of the often-fatal hazards of seafaring. Despite centuries of advancements in vessel engineering, mapping accuracy, navigation and communication technology, safety systems, and weather prediction, the fact remains that a boat that takes on too much water will sink. Whether due to natural disaster, warfare, mechanical failure, or simple human error, the risks faced by modern sailors differ only in degree, not in kind, from those faced by the 16th century mariners who first explored the Gulf's waters.

Since the late 1970s, the Bureau of Ocean Energy Management's (BOEM's) Archaeology Program has enabled not only the discovery but also the documentation of a substantial number of these shipwrecks. Primarily as a result of the remote-sensing surveys that are required of oil and gas operators, BOEM has mapped the locations of over 400 wrecks and hundreds more side scan sonar targets and magnetic anomalies that indicate possible shipwrecks, but which have never been further investigated. Textual research of primary and secondary source documents has identified approximately another 2,200 reported shipwrecks (Coastal Environments, Inc. 1977; Garrison et al. 1989b; Pearson et al. II: 2003), though that number is likely only a fraction of the vessels that have been lost in the Gulf.

Of those vessels that *have* been discovered, BOEM has been the principal agent of any archaeological investigations that followed. In fact, over seven dozen wrecks in the federal waters of the Gulf have been documented, to some extent, by professional archaeologists; BOEM was directly involved with all of them. These investigations resulted from BOEM-funded efforts through its Environmental Studies Program, through collaborations with other state and federal agencies, or through regulatory oversight of Outer Continental Shelf (OCS) oil and gas operations in fulfillment of the agency's responsibilities under Section 106 of the National Historic Preservation Act of 1966 (NHPA).

Section 106's implementing regulations require each federal agency to consider the potential effects of its undertakings on historic properties, and to implement reasonable and good-faith efforts to identify those properties within the area of potential effects. Historic properties are any prehistoric or historic district, site, building, structure, or object (e.g., shipwreck) that is listed on the National Register of Historic Places (NRHP), or that is eligible for listing based on meeting one or more of the NRHP's eligibility criteria and retaining sufficient historic integrity. Section 110 of the NHPA further requires agencies to assume responsibility for the preservation of historic properties under their jurisdiction and to establish a program to identify, evaluate, protect, and nominate to the NRHP those properties that meet the criteria. It is with these responsibilities in mind that BOEM and the Bureau of Safety and Environmental Enforcement (BSEE) and their predecessor agencies (US Geological Survey [USGS], Bureau of Land Management [BLM], Minerals Management Service [MMS], Bureau of Ocean Energy Management, Regulation and Enforcement[BOEMRE]) have endeavored to catalog and study the myriad archaeological sites that collectively chronicle the Gulf's 500 years of nationally- and internationally-significant maritime history.

To date, BOEM has documented 40 shipwrecks that are potentially eligible for listing on the NRHP and has successfully nominated 12 of them. These 12 wrecks, discussed further below, are the only shipwrecks in the Gulf that are currently listed on the NRHP. Historically significant wrecks that BOEM has documented range in age from the late 17th century through the World War II era, though Spanish wrecks dating as far back as 1554 (Arnold and Weddle 1978) and 1559 (Smith 2018) have been discovered in Texas and Florida state waters, respectively. Because the minimum age for NRHP listing is typically 50 years, the wrecks of vessels from the 1970s could be considered eligible today. As noted above, BOEM's database of remote-sensing targets likely identifies the locations of many more potentially eligible shipwrecks that have never been sufficiently documented.

4.1 Known Shipwrecks from the Seventeenth and Eighteenth Centuries

Potentially the oldest discovered shipwreck in BOEM's inventory is the vessel known as the Onion Bottle Wreck. It was first identified on sonar during a 2012 oil and gas survey in the DeSoto Canyon area and confirmed as a shipwreck during a remotely operated vehicle (ROV) test dive later that year. The ROV recorded a mostly buried wooden-hulled vessel with an assemblage of diagnostic wine bottles, known as onion bottles, which provided both a colloquial name and the suspected age of the vessel. The Onion Bottle Wreck is currently the only discovered wreck in the Gulf that potentially dates to the 17th century. Confirmed 18th-century shipwrecks are similarly underrepresented in BOEM's database and include only the Spanish frigate *El Nuevo Constante* that sank in a hurricane in 1766 (Pearson 1995) and a wreck in Louisiana state waters that is a possible contemporary of the Onion Bottle Wreck. In the mid-1980s fishermen discovered a possible shipwreck off Chandeleur Island; a subsequent BOEM study with Texas A&M University (Garrison et al. 1989a) identified a ballast pile containing several 18th-century Swedish-made cannons. Those guns came from the same foundry and are of a virtually identical design and caliber as cannon recovered from the 1718 wreck of Blackbeard's *Queen Anne's Revenge* (originally a French vessel named *Concorde* that Blackbeard captured) off Morehead City, North Carolina. A recent BOEM study (Watts et al. 2019) confirmed that wood hull remains are extant under the Chandeleur Island ballast pile, and that the wreck likely dates to the first quarter or early second quarter of the 18th century, chronologically linking the vessel to the French establishment of New Orleans in 1718 and making it potentially the oldest known shipwreck in Louisiana coastal waters.

4.2 Known Shipwrecks from the Nineteenth Century

The largest assemblage of known historic shipwrecks in the Gulf date to the 19th century. Twenty-one such vessels have been discovered to date, representing a range of types and uses, including early US period armed merchantmen or privateers, mid-century passenger steamboats, a casualty of Civil War naval combat, and late-century commercial sailing vessels. Perhaps the most well-known is the Mardi Gras Wreck, discovered in 2001 during a pre-installation survey for Okeanos Gas Gathering Company's Mardi Gras pipeline in the Mississippi Canyon area. The Mardi Gras Wreck is a suspected armed schooner dating between 1808 and 1820 (Figure 12), a time when the Gulf was a frontier of frequent international territorial conflict between the US, England, France, and Spain, as well as Latin American nations seeking their independence from Spain. The wreck itself reflects this cosmopolitan period in history, with over 900 recovered artifacts originating from Great Britain, France, Mexico, and the US. The exact identity and function of the vessel remains unknown, but current analysis indicates that it was likely either an armed merchantman or, more likely, a privateer. An archaeological investigation conducted by Texas A&M and BOEM in 2007 (Ford et al. 2008; Horrell and Borgens 2017) excavated only approximately 10% of the site, leaving a substantial amount of information remaining to be collected. At the time, that investigation–at over 4,000 ft–was the deepest archaeological excavation ever undertaken in US waters.

Figure 12. A six-pounder cannon from the Mardi Gras Wreck: (a) in situ and (b) during artifact conservation

From Ford et al. 2008.

A few hundred feet deeper and approximately 300 miles to the southwest lie three similar wrecks that also provide evidence of this contentious time in the Gulf's history. Monterrey Wrecks A (Figure 13), B, and C were discovered within five miles of each other during an oil and gas survey of the Keathley Canyon area in 2011, and visually confirmed the following year during an ROV expedition by the National Oceanic and Atmospheric Administration's (NOAA's) flagship research vessel *Okeanos Explorer*. In 2013 a team of archaeologists from BOEM, BSEE, NOAA, the Texas Historical Commission, and Texas State University further investigated the sites and recovered or observed artifacts that date the vessels to the same approximate time period as the Mardi Gras Wreck[14]. Evidence indicates that the three vessels, one of which was armed with naval artillery and small firearms, were likely travelling in convoy between Mexico and a Northern Gulf port when they all perished during the same storm. Some of the artifacts,

[14] See the BOEM Virtual Archaeology Museum, Deep Discoveries, https://www.boem.gov/environment/virtual-archaeology-museum .

including ceramic water jugs known as *cantaros* (Figure 14), are consistent with artifacts found in terrestrial archaeological sites in the Yucatan Peninsula, and the weaponry found on Monterrey A suggests that the vessels were either perpetrators and/or victims of illicit privateering activity.

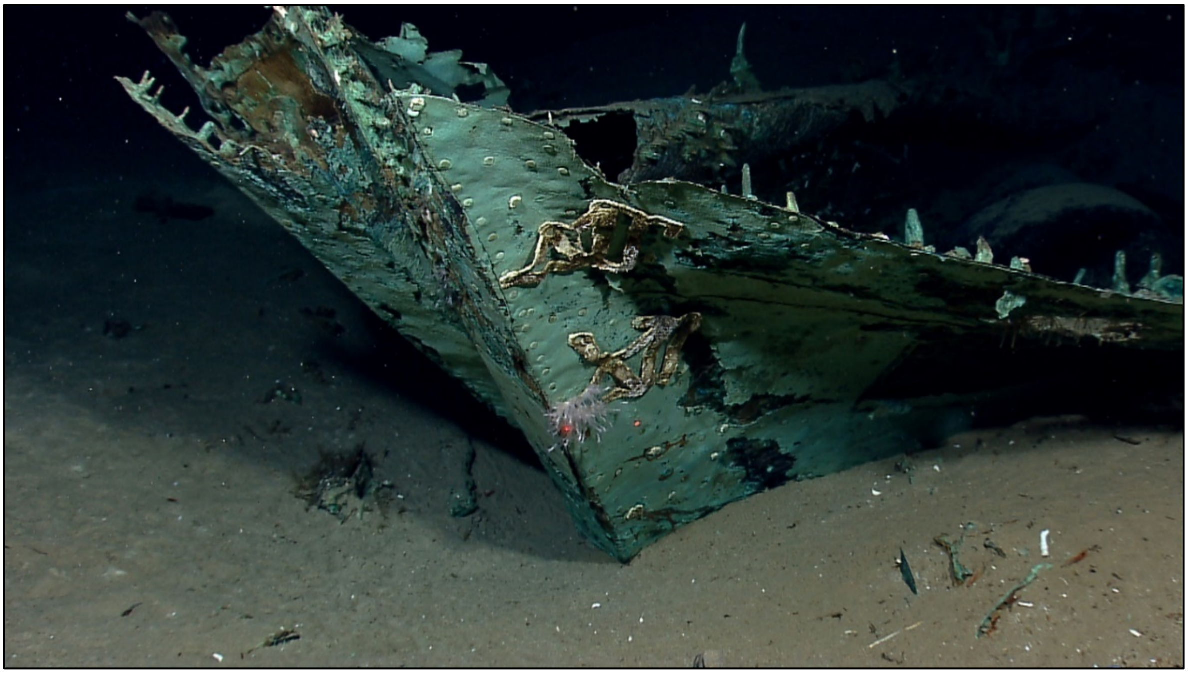

Figure 13. Bow of Monterrey A, showing lead Roman numeral draft marks over copper hull sheathing
Image courtesy of the National Oceanic and Atmospheric Administration.

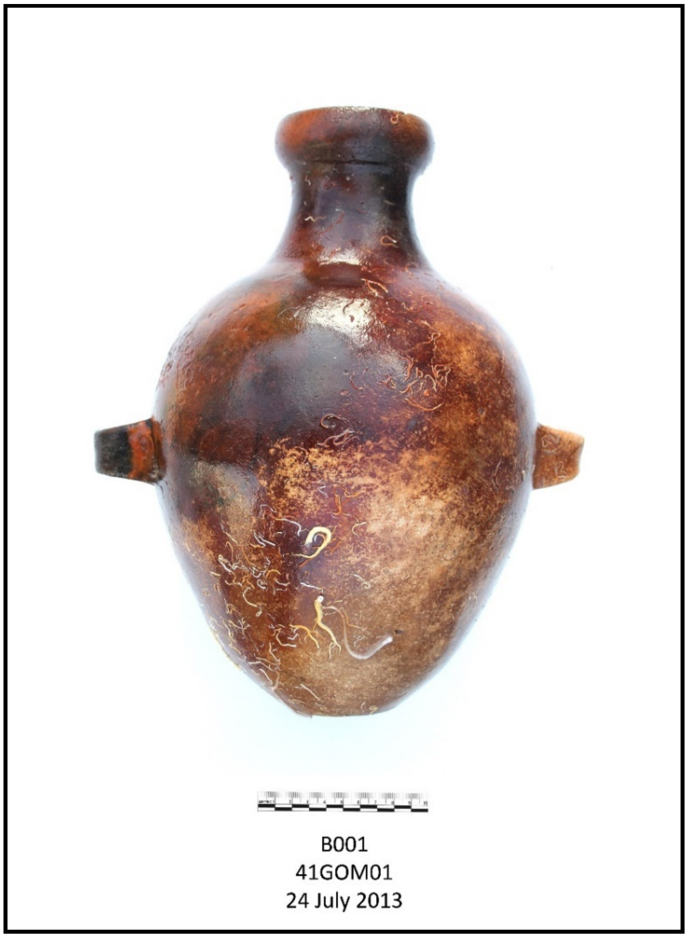

Figure 14. *Cantaro* recovered from Monterrey A

Image courtesy of the Meadows Center for Water and the Environment at Texas State University. Photo by Amy Borgens, Texas Historical Commission.

Several other wooden-hulled sailing vessels have been discovered in Gulf OCS waters, though the majority date to the middle or late decades of the 19th century and were primarily cargo-carrying merchantmen. After the trade disruptions of the Civil War, Gulf maritime commerce revived between coastal ports and along overseas routes to South American, European, Caribbean, and eastern US ports (Garrison et al. 1989b, II-23). Initially the coastal trade was limited to American-owned vessels, but as the century progressed trans-Gulf routes included more international craft, including those originating from British, Norwegian, Danish, Dutch, German, Italian, and Columbian ports. These changing traffic patterns and the development of the railroad system led to the establishment of Gulf ports such as Tampa, Florida (1885), and Port Arthur, Texas (1897) (Garrison et al. 1989b, II-23). Numerous wrecks from this time period have been discovered in the deep water approaches to the Mississippi River and the Port of New Orleans (primarily in the Mississippi Canyon and Viosca Knoll areas), directly correlating to where the bulk of recent surveys in support of offshore petroleum production and pipeline-laying activity have occurred. None of these wrecks have yet been definitively identified but most have been archaeologically investigated through completed BOEM studies or ongoing BOEM collaborations. Examples include:

- Mica Wreck (Atauz et al. 2006)
- Viosca Knoll Wreck (Brooks et al. 2016:359-384)
- Ewing Bank Wreck (Brooks et al. 2016:415-454)

- 7,000 Foot Wreck (Figure 15) (Brooks et al. 2015:385-415)
- Green Lantern Wreck (Figure 16) (Brooks et al. 2016:454-470)
- Site 15377[15]
- Sites 359, 407, 15429, 15470, 15711, and 15831.

Because their actual identities are unknown, all of the above given names are based on a wreck's site number in BOEM's Archaeological Resource Database, the oil and gas project that discovered it, its general geographic location, bathymetric contour, or a diagnostic feature of the site.

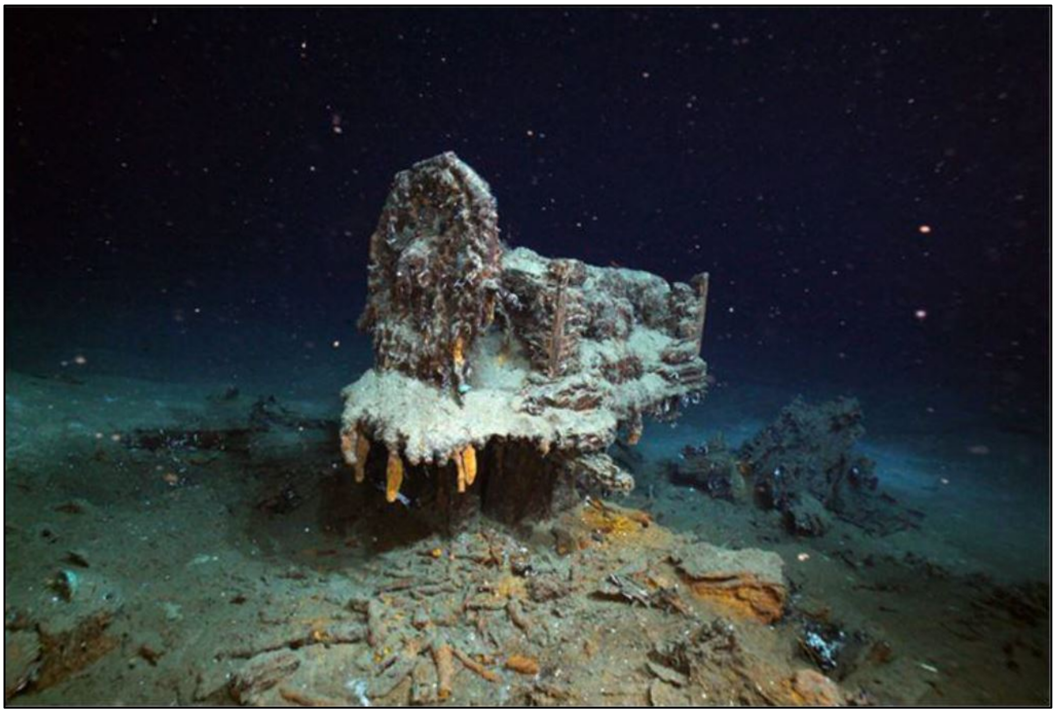

Figure 15. The 7,000 Foot Wreck's helm, showing the wheel, exposed wheel-box, and rudder case

From Brooks et al. 2016.

[15] See BOEM Virtual Archaeology Museum, Deep Discoveries, https://www.boem.gov/environment/virtual-archaeology-museum.

Figure 16. Navigation lantern recovered from the Green Lantern Wreck

From Brooks et al. 2016.

The steamboat era is also represented in the Gulf's archaeological archive. Three sidewheel-steamers have so far been identified, the first of which was the USS *Hatteras*, a Union Navy gunboat that was sunk off Galveston during a hostile engagement with the famed Confederate raider CSS *Alabama* in January 1863 (Figure 17). The site was found by treasure hunters in the 1970s, who attempted to arrest the wreck in Admiralty court but ultimately lost the judgement. *Hatteras* remains the property of the US Navy, as do the wrecks of all other US Government warships and military aircraft, as stipulated by the Sunken Military Craft Act of 2005 (10 U.S.C. § 113). Concurrent with the Admiralty court litigation, archaeologists with the Bureau of Land Management (BLM), the Texas Historical Commission, and Texas A&M began remote-sensing investigations of *Hatteras* (Arnold and Hudson 1981), and a three-year diver monitoring and mapping program reconvened in 1992 (Arnold and Anuskiewicz 1995). More recent BOEM studies have continued to periodically assess the site's current condition (Gearhart et al. 2011; Evans et al. 2013). Following the 1990s investigations, *Hatteras* was designated a Texas State Archaeological Landmark and became the first Gulf shipwreck listed on the NRHP.

Figure 17. "Destruction of the Gunboat Hatteras by a Rebel Cruiser off Galveston, Texas" (Schell 1863)

Courtesy of the Becker Collection, Boston College 2011; from Evans et al. 2013.

The second shipwreck to be listed on the NRHP was the Charles Morgan Line passenger steamer *Josephine*. Built in 1868 for Morgan's lucrative steam-packet service, in February 1881 the luxurious 250-passenger vessel was en route from the Florida Keys to New Orleans when it was struck by a severe winter storm and began to take on water. It eventually foundered off Biloxi, Mississippi, though all passengers and crew were able to safely escape. Among the survivors were 14 Italian sailors who had to prematurely disembark their second vessel in a row, after the lumber ship they had first set sail on had sunk off the Florida coast. The then-unidentified wreck was first reported to BOEM (then MMS) in 1997. Agency archaeologists subsequently surveyed, photo-documented, and conclusively identified it as *Josephine* (Irion and Ball 2001). The site was listed on the NRHP in 2000.

Josephine was not the only, nor the first, Charles Morgan steamship lost (and later found) in the Gulf or contiguous waters. *Mary* sank in state waters near Aransas Pass, Texas, in 1876 (Pearson and Simmons 1995); *New York*, one of Morgan's earliest vessels, met its end in a hurricane while on its regular route from Galveston to New Orleans in 1846. Seventeen of her fifty-three passengers and crew perished, including five children. Also on board was "thirty to forty thousand dollars in gold, silver, and bank notes" (*The Daily Picayune*, September 10, 1846), luring the eventual search and discovery of the wreck by a group of treasure hunters in 1990. That group claimed and won salvage rights to the wreck in Admiralty court (US District Court, Western District of Louisiana, Lafayette-Opelousas Division 2006);

however, in recognition of the wreck's historical significance they also reported their discovery to BOEM's archaeologists. A subsequent BOEM study documented the shipwreck's in situ remains and the collection of artifacts that the treasure hunting group had recovered (Gearhart et al. 2011).

4.3 Known Shipwrecks of the Twentieth Century

Twentieth century vessels–18 by current count–comprise the remainder of known NRHP-eligible shipwrecks on the Gulf of Mexico OCS. Notably, 13 of them are relics of the same historical cataclysm. In the months after Nazi Germany's U-boats first passed through the Florida Straights in April 1942, the Gulf acquired the gruesome distinction of being the deadliest body of water–at any point during World War II–within which to be a mariner aboard an Allied vessel. Between May 1942 and December 1943 German torpedoes sank a total of 56 merchant marine ships in the Gulf, primarily tankers headed to East Coast or European ports with petroleum cargos to aid the Allied war effort. The vast majority of these attacks came within the first four months of the U-boat offensive, 26 in May 1942 alone. BOEM studies have documented 12 of the Allied casualties, as well as U-*166* (Figure 18), the only U-boat lost in the Northern Gulf during the war (Enright et al. 2006; Church et al. 2007; Gearhart et al. 2011; Evans et al. 2013; and Brooks et al. 2016). Based on this cumulative research, BOEM successfully nominated nine World War II shipwrecks to the NRHP in 2018, including *Alcoa Puritan, Gulfoil, Gulfpenn, Halo, R.M. Parker, Jr., Robert E. Lee, Sheherazade, Virginia,* and U-*166*. Another seven World War II wrecks have been tentatively identified but not yet confirmed archaeologically, and BOEM has a current study underway to locate *Norlindo*, the first U-boat victim in the Gulf.

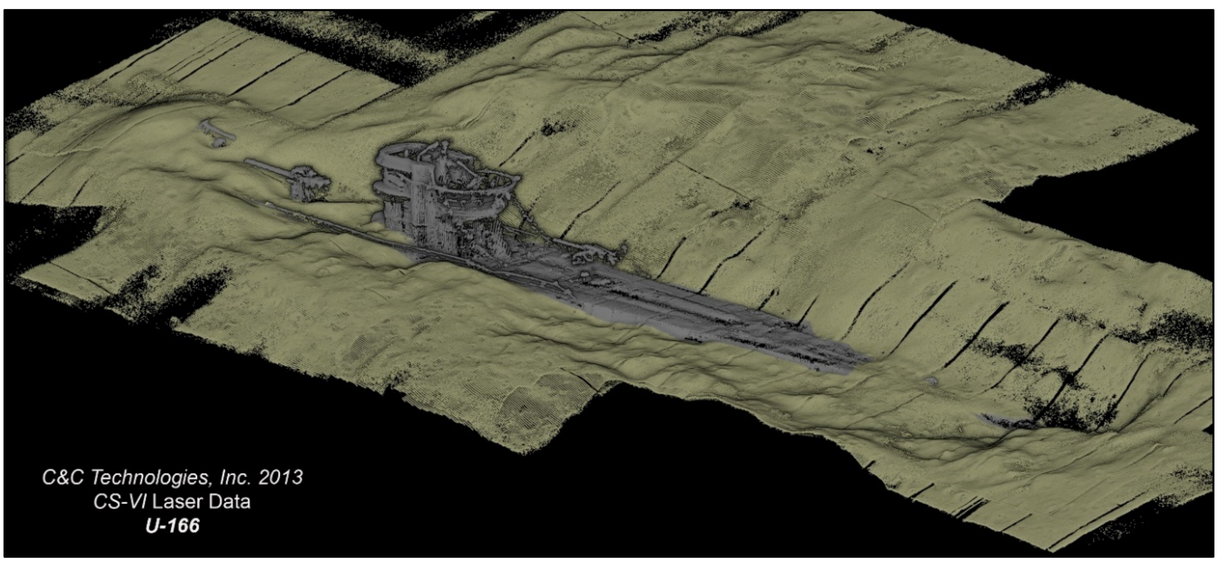

Figure 18. 3-D laser scan of U-*166*

Image courtesy of C&C Technologies.

The twelfth and final Gulf shipwreck currently listed on the NRHP also sank during World War II, but not because of it. The steam yacht *Anona*, built in 1904 as a pleasure boat for wealthy Detroit industrialist Theodore DeLong Buhl, was also listed in 2018 due to its archaeological potential and its architectural significance as a rare example of a steam yacht constructed by a master shipbuilder (Figure 19). *Anona* sank in the Viosca Knoll area in June 1944, though its days as a luxury recreational vessel had long passed. After decades of being sold between various owners, *Anona* was eventually put to humble work hauling cargoes of produce for the Pan-American Banana Producers Association. It was carrying potatoes from New Orleans to the British West Indies when its lower hull plates simply buckled, sinking the vessel in the Viosca Knoll area.

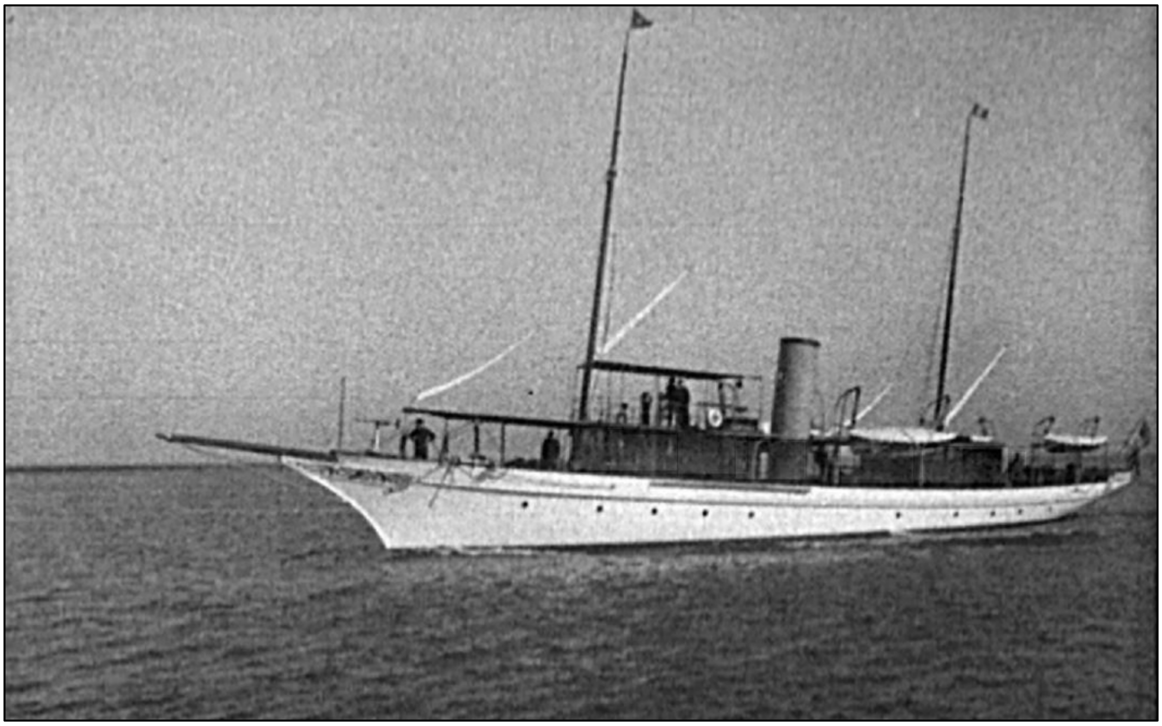

Figure 19. Steam yacht *Anona* circa 1906–1915

Courtesy Library of Congress Detroit Publishing Company Collection, from Church et al. 2007.

Though not yet listed on the NRHP, two additional 20th century wrecks of note are *J.A. Bisso* and *Castine*. *J.A. Bisso* was a Canadian-built tugboat, launched in 1906, that foundered in rough weather in the South Timbalier area while traveling from Sabine, Texas, to New Orleans in 1957. The wreck's remains were first documented during a 2013 BOEM study (Evans et al. 2013; Figure 20), and BOEM and BSEE are currently planning a return to the site in 2021 to evaluate recent changes to its hull integrity, after which a determination of its potential eligibility will be made. *Castine* was the former USS *Castine*, a US Navy gunboat built at the renowned Bath Iron Works (Bath, Maine) in 1892, during the Navy's early transition from wooden to steel-hulled warships. The USS *Castine* served with historical distinction in numerous naval conflicts during the Spanish American War and World War I, before being decommissioned, sold, and converted to a commercial fish-processing barge (Enright et al. 2006; Jones 2007; Figure 21). In December 1924, it sank in the Grand Isle area due to an undiagnosed explosion while under tow from New Orleans to the Sabine River. *Castine* received an official Determination of Eligibility from the Keeper of the NRHP in 2008.

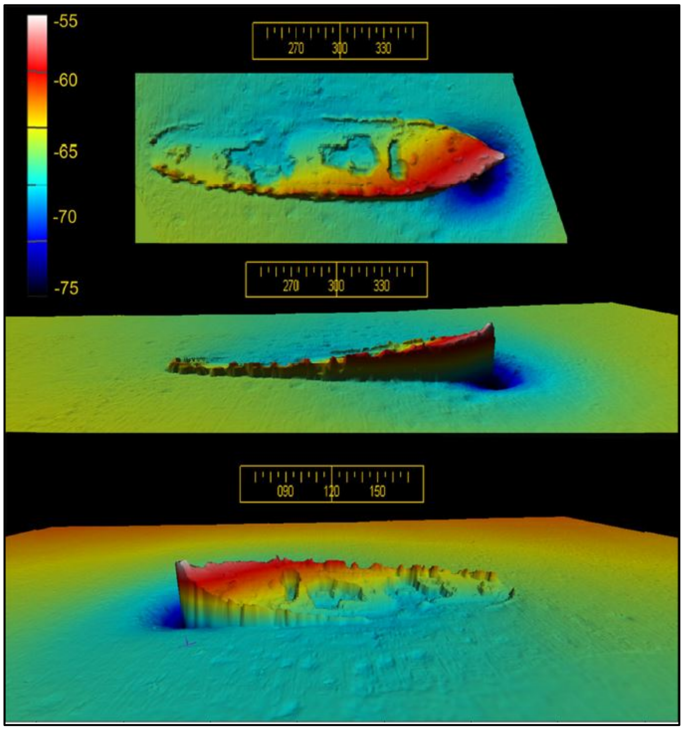

Figure 20. 3-D multibeam renderings of the wreck of *J.A. Bisso*

Image from Evans et al. 2013.

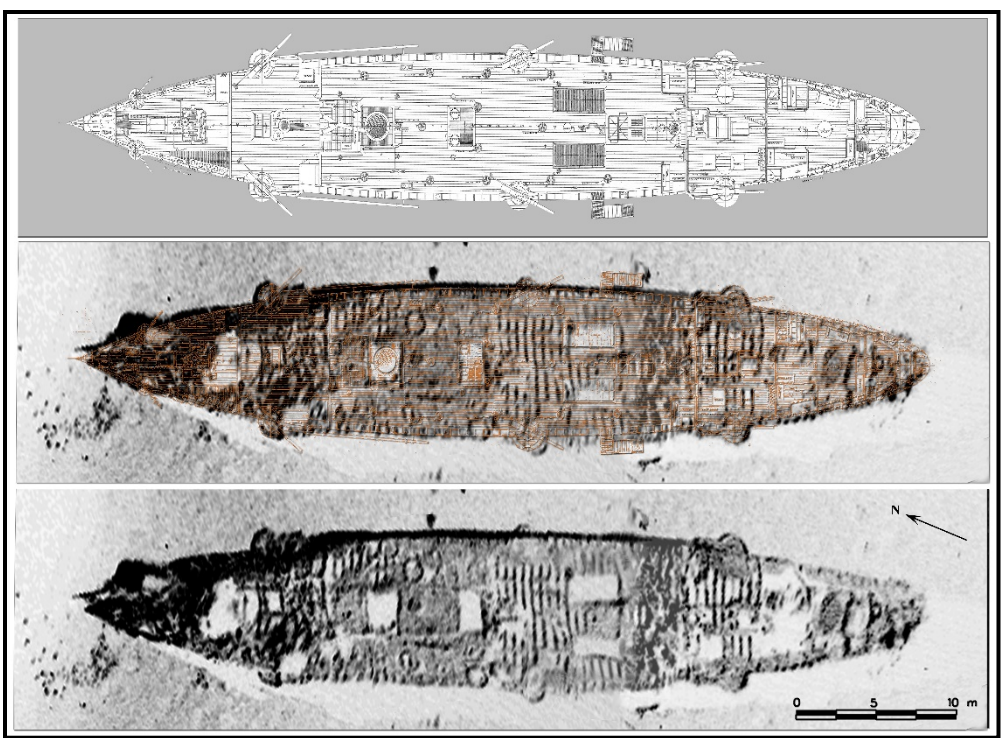

Figure 21. 1894 deck plan of USS *Castine* overlaid on a 2014 side-scan sonar image of the wreck

From Jones 2007.

4.4 Potential for Discovery

The history of archaeological discoveries in the Gulf is inextricably linked to the history of offshore oil and gas development in the US, particularly in the deep-water areas of the Gulf, where exploration and mapping activities are unlikely to have occurred for any other reason. BOEM’s and BSEE’s roles in regulating those activities, and their mandate under the National Environmental Policy Act to conduct environmental studies in support of responsible offshore energy expansion, have been the key catalysts for the volume of historical archaeological research conducted in the Gulf to date. Of the 40 known shipwrecks in the OCS that are either listed or considered eligible for listing on the NRHP, all but seven were first discovered as a result of oil and gas exploration. The only archaeological information collected from six of those sites involved the direct support of BOEM’s and BSEE’s archaeology programs. Opportunities to further advance the scientific study of archaeological sites that embody the Gulf’s maritime history are virtually limitless; there are enough discovered but undocumented shipwrecks to occupy the next several generations of marine archaeologists. That only a fraction of the OCS seafloor has yet been explored indicates that there is far more one doesn’t know about the Gulf’s archaeological potential than there is that is known. Every new survey brings the opportunity for new discoveries.

5 Conclusions

The Bureau of Ocean Energy Management (BOEM) and Bureau of Safety and Enforcement (BSEE) have issued regulations addressing requirements of the National Historic Preservation Act (NHPA) for Outer Continental Shelf (OCS) leases at 30 CFR 550.194 and 30 CFR 250.194. BSEE also issued regulations addressing archaeological resources in the context of pipeline rights-of-way at 250.1007 and 250.1010. The implementing regulations of NHPA at 36 CFR §800.4 require federal agencies to review existing information on historic properties within the area of potential effects, including any data concerning possible historic properties not yet identified, before approving an undertaking. The Secretary of the Interior's Guidelines and Standards for Archaeology and Historic Preservation encourages archival research first, before undertaking a survey to determine if significant resources could be affected by an undertaking.

Archaeological resources present on the OCS are likely to take one of two forms:

1. Native American pre-contact period sites dating from a period thousands of years ago when much of the world's oceans was trapped in glacial ice and sea-levels were far lower than they are today, or
2. historic shipwrecks following European contact with North America beginning in the 16th century C.E.

When and how humans first spread throughout the Western Hemisphere is a matter of considerable scientific debate, but the archaeological evidence from excavations has proven that they reached the Gulf area at least 14,550 years ago, possibly much earlier. During this period, more of the OCS would have been exposed as dry land. The current consensus is that the ancient shoreline would have been somewhere around the current 100-meter bathymetric contour when people first migrated into the Gulf region. Submerged landforms buried under Holocene sediments, such as preserved river terraces, point bar deposits, confluences of steam channels, etc., may contain preserved evidence of some of the oldest human occupations in the North America.

5.1 Methods and Models for Predicting Wreck Locations

For nearly 50 years, numerous attempts have been made by BOEM and its predecessor bureaus to develop guidelines for its compliance with NHPA and the reasonable and good faith effort required to identify historic properties effected by its actions. Previous attempts, such as that of Garrison et al. (1989b), centered on compiling a list of reported shipwrecks from a variety of mostly secondary sources and assigning a search area consisting of nine lease blocks centered around each presumed location. This approach suffered from multiple fatal flaws, including a) the historic record for vessels lost at sea is woefully incomplete, particularly as one goes further back in time; and b) locations of shipwrecks, even if reported, were vague to entirely inaccurate. As a result, there was no statistical difference where shipwrecks were likely to occur between designated "high probability" blocks and any other lease block (Person et al. 2003: 7–6).

Pearson et al. (2003) attempted to develop high, medium, and low probability areas based on densities of reported shipwrecks within 0.5-degree geographic units. They also attempted to assign a factor of one through four to describe the "reliability" of the reported position. This effort produced a database of over 3,000 reported shipwrecks classified by the perceived reliability of their reported position. Only shipwrecks with a position reliability of "one" or "two" were used in their statistical analysis. The model produced by Pearson et al. 2003 resulted in an expansion of high and medium probability areas near the coast but was heavily weighted toward more recent losses where there was some confidence in the reported position of loss. As a result, wrecks that were more likely to be historically significant and better preserved in deep-water areas of the Gulf were not represented.

Contrary to previous attempts to predict where shipwrecks might be discovered, oil industry surveys have found shipwrecks dating from as early as the mid-17th century to the modern era throughout the Gulf in all depths of water and in every lease protraction area where high resolution geophysical surveys have been required. To explain this phenomenon, the current research sought to examine the Gulf as a holistic seascape, to understand where ships were sailing, how they might have been lost, and where their remains may exist.

Five principal factors affecting shipwreck locations and subsequent patterning in their distribution were identified by Garrison (1989b). These included:

1. Historic shipping routes;
2. Port location;
3. Shoal, reef, sand bar, and barrier island locations;
4. Ocean currents and winds; and
5. Historic hurricane paths.

The federal waters of the OCS lack natural hazards to navigation, although those abound in State waters near the coast. The earliest Spanish navigators had no cause to approach the Northern Gulf coast where there were no ports and where sailors, even in the 18th century, were warned to exercise caution in approaching water less than 10 fathoms deep because of shoals and islands. To determine, then, where ships may have sunk on the OCS, one must first consider why they sank in open water.

Pearson et al. concluded that most marine casualties could be classified as weather-related, equipment-related, or due to human error (2003:4–30). Their analysis concluded that these factors included ships that had been abandoned, burned, capsized, collided, sunk in a boiler explosion, foundered as a result of weather or a failure of hull integrity, victims of warfare or piracy, intentionally scuttled, or swamped. These casualties cannot be tied to a specific place as a cause, but merely to where they happened to be at the time of the event.

An excellent example is the relatively modern wreck of the fishing trawler *Katmai,* whose remains were found in nearly 9,000 feet of water in the Desoto Canyon area in 2011. *Katmai* had mysteriously vanished in 1972 on its maiden voyage, a few days after it left Mobile, Alabama bound for Alaska. There was no explanation for its loss–no adverse weather was reported, no distress calls were received, no physical remains were found despite an intensive aerial search, and none of the four people aboard, including a child, survived to report it. A 2013 ROV investigation of the wreck failed to shed light on the cause of *Katmai*'s loss, and the vessel appeared to be perfectly intact. Like many of the estimated 3,000+ shipwrecks in the Gulf, its final resting place on the seafloor could not have been predicted or anticipated. It was found only because of an oil and gas survey conducted over the watery grave of Captain Oscar Joos, 43, of Kodiak, Alaska, his wife Carla, their daughter Cindy, 8, and crewman Clinton Norris, 37. This information was relayed to the US Coast Guard to notify next of kin, update records and close the investigation of the sinking.

5.2 Results: Mapped Routes Over Time

The BOEM-BSEE subject matter expert team examined where ships are reported to have sailed (i.e., vessel sailing logs and route maps), and, therefore, where they were likely to have sunk, while also recognizing a known loss of accuracy that increases as one moves further back in time. In so doing, 46 historic maps were collected that contained sailing route information (see Chapter 3) from the 16th through 20th centuries. This effort built on the work of Lugo-Fernandez et al. (2007) and incorporated the same methodology described in that paper for stretching them digitally over a modern projection system.

Using Esri™ ArcGIS software, the BOEM-BSEE GIS team georeferenced each map image using several control points (points that are easily identified in both data sets that have known geographical coordinates). The primary control points of Veracruz; Havana; and Tampa, Florida, were selected because their locations were known at the time the maps were created and they were easily identified on each map. Other features that were identifiable on the original maps, such as rivers, bays, and coastline segments, were used in the georectification. The newly georeferenced maps were placed over layers of accurate geographical themes. Using the process known as ‘‘rubbersheeting,’’ (manipulating one set of map data to match another known set of georeferenced data), the routes were interpolated by using the shapes of the routes in relation to their location on the original maps to the control points and features. The original errors in longitude, which resulted from early mariners’ inability to calculate longitude from astral observations of star positions as they could latitude, were corrected during this process. This allowed us to maintain proportionate geometry with the known coordinates of Veracruz, Havana, and other control points. Finally, all routes were projected using Albers Equal-Area Conic Projection and their distances were measured.

Using this method, 411 routes were mapped in ArcGIS, of which 358 crossed into the Gulf Region protraction areas. This, of course, represents only a small fraction of the thousands of ships that have plied these waters through history, but it provides a fair perspective of where ships had been traveling at various points in time. Of the 411 mapped routes, 131 of them were digitized from the remarkable work of Matthew Fontaine Maury on his 1852 *Wind and Current Chart of the North Atlantic*. Maury compiled the chart from hundreds of ships’ logs stored in the Navy’s Depot of Charts and Instruments (later the US Naval Observatory). He amassed a large quantity of navigational, hydrographic, and meteorological data from the recent voyages of Navy and commercial ships whose officers submitted the information on specially designed abstract logs created by Maury in return for free copies of the Wind and Current Charts.

It would be unfair to compare the renderings of ships’ routes from historical sources to the GPS-plotted routes of today. Mapping could be only as accurate as navigational capabilities of the age (see Chapter 3). Longitude, for example, often could not be judged to within 100 miles before the chronometer was perfected in 1761, which, even then, was not widely adopted by the Royal Navy until 1825, and much later by merchant fleets. Because of the high cost of these hand-crafted precision instruments, mariners continued to rely on celestial navigation and dead reckoning well into the 20th century. To account for this variation between printed sources and real-world actuality, buffers were applied to the digitized routes to get a better idea of where those ships and hundreds of others on a similar course may have traversed. This would account not only for navigational errors, but also for the fact that sailing ships, dependent as they are on wind direction, rarely sail in a straight line, but must often change course, or tack, to keep the sails at the proper angle to the wind. (For example, a square-rigged vessel could sail, at best, about 60 degrees into the wind.) In addition, ships sailing along their optimum course on a beam reach with the wind blowing 90 degrees to their heading would move a certain amount to the side as well as forward, a process called "leeway[16]." Thus, the course would have to be periodically corrected to account for the "course made good" from movement in the direction of wind and currents.

BOEM archaeologists determined an appropriate buffer of 30 nautical miles for the earliest map, equal to one-half degree of latitude, to account for the relatively primitive navigational instruments of the age. As instruments improved with navigational tools such as octants and sextants in the 18th and 19th centuries, the buffer was reduced to 20 nautical miles. As steam power freed mariners from the vagaries of wind speed and direction, a 10-mile buffer was adopted for those routes. This was based on the assumption that no course is going to be perfectly duplicated from one voyage to the next and that variation in navigation will still exist until the introduction of radio-positioning and satellite navigation later in the 20th century.

The four maps below illustrate the results of the search. They are presented in sequence for better comparison. Figure 22 depicts the earliest Spanish colonial routes through the Gulf in the 16th and 17th century between Veracruz, Mexico and Havana, Cuba. The route took advantage of prevailing winds and currents and passed through deep-water protraction areas of the OCS. Unless blown badly off course by a tropical storm or hurricane, shipwrecks from this period are most likely to be found in these areas and likely well-preserved.

Figure 23 illustrates the increased traffic of Spanish shipping transporting raw materials and precious minerals from Mexico to Spain in the 18th century and the seasonality of those routes. These routes suggest that the same basic pattern of shipping prevailed with some variation of routes both further to the north and to the south depending upon the time of year.

Figure 24 shows that ship traffic in the late 18th and 19th centuries increased dramatically with the expansion of commerce and foundation of new ports throughout the Gulf. Virtually no area of the OCS was untouched. This is especially true if one applies a reasonable buffer to the mapped routes of 20 nautical miles to account for variations in course and heading for the thousands of ships not represented on these contemporary maps. This evidence suggests that there was nowhere in the Gulf that ships did not sail in the 19th century and, thus, could have sunk virtually anywhere. This has proven true, time and again, as discoveries of historic wrecks persist, despite no records of a loss in the vicinity.

Figure 25 reflects more direct routes between major ports permitted in the 20th century by improved navigation and the expansion of steam and diesel locomotion, as well as increased trade with Latin America. A 10 nm buffer is applied to mapped routes to account for variation in routes that are to be expected before the introduction of satellite navigation in the 1990s. Again, significant portions of the OCS were blanketed by this traffic, apart from the thousands of undocumented voyages of commercial and recreational fishing vessels that also sailed these waters.

In conclusion, BOEM's analysis suggests that there is no portion of the Gulf OCS over which ships have not passed in the 500 years since Sebastian de Ocampo first penetrated its waters in 1508. Conversely, if ships could and did sail in these waters, they could also come to grief and sink there. BOEM archaeologists know that they have done so from the discovery of their remains on the seafloor when the

[16] Leeway is the sideways slip motion of any sailing vessel down wind, caused by the pressure of wind against the hull and sails. The prudent sailor–then as now–will measure the leeway angle and then account for the leeway by sailing a constant heading that offsets for it. In theory, the sideways slip motion will deliver the vessel to the destination in a straight and shortest line. In practice, leeway angle to the wind is difficult to calculate, changes according to wind direction and strength, and, given longer voyages, may result in a far different course sailed than originally intended.

proper technology was applied to detect them. As discussed in Chapter 4, 39 historic shipwrecks of national significance have been documented largely through the efforts of BOEM, BSEE, and the oil and gas industry. Experience has shown that most wreck-sites in deep water have no record of their loss in any archive.

The georectified map of the historic routes digitized for this study may be found online[17]. By selecting routes by century, users can compare historic routes to the modern seascape to observe where shipwrecks may have occurred within BOEM lease areas. This geospatial representation shows an *interpretation* based on hand-drawn maps from a 400-year period.

By making this available, BOEM is not endorsing the quality of those data or the interpretations based on those data or making any claims that it can be used in lieu of a geophysical survey to determine the presence or absence of an archaeological resource. BOEM will not assume any responsibility or liability for damages caused by errors or omissions in the original data set or in the interpretations of those data. These data are not intended to be used in a submission seeking approval from BOEM or BSEE or in any legal document, and they should not be used as such.

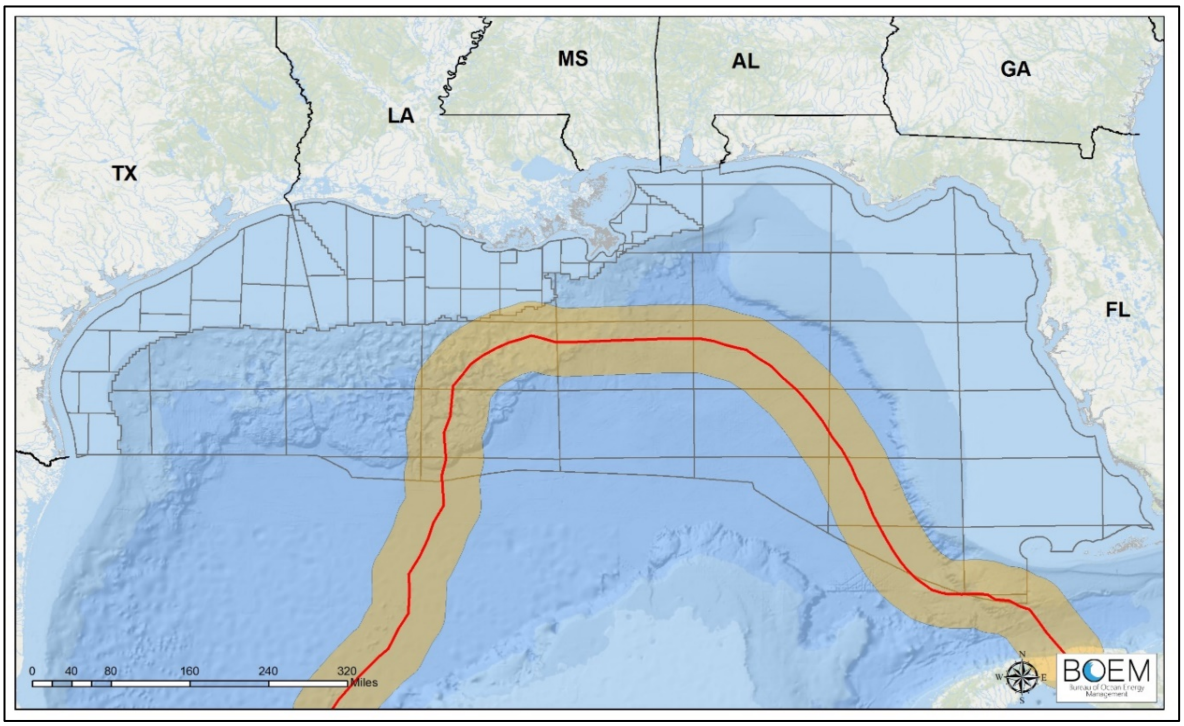

Figure 22. Documented 17th-century Spanish route with 30 NM buffer

[17] See the Historic Sailing Routes in the Gulf of Mexico Application at https://www.boem.gov/oil-gas-energy/mapping-and-data/map-gallery/historic-sailing-routes-gulf-mexico-application

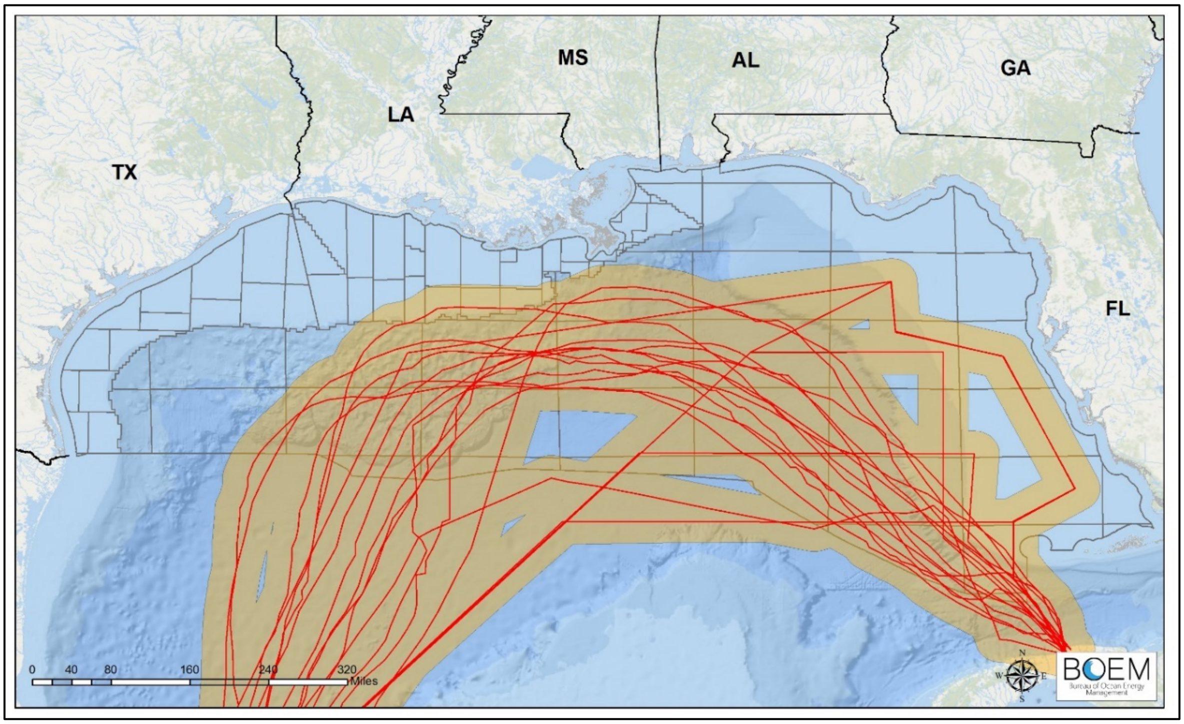

Figure 23. Documented 18th-century routes with 20 NM buffer

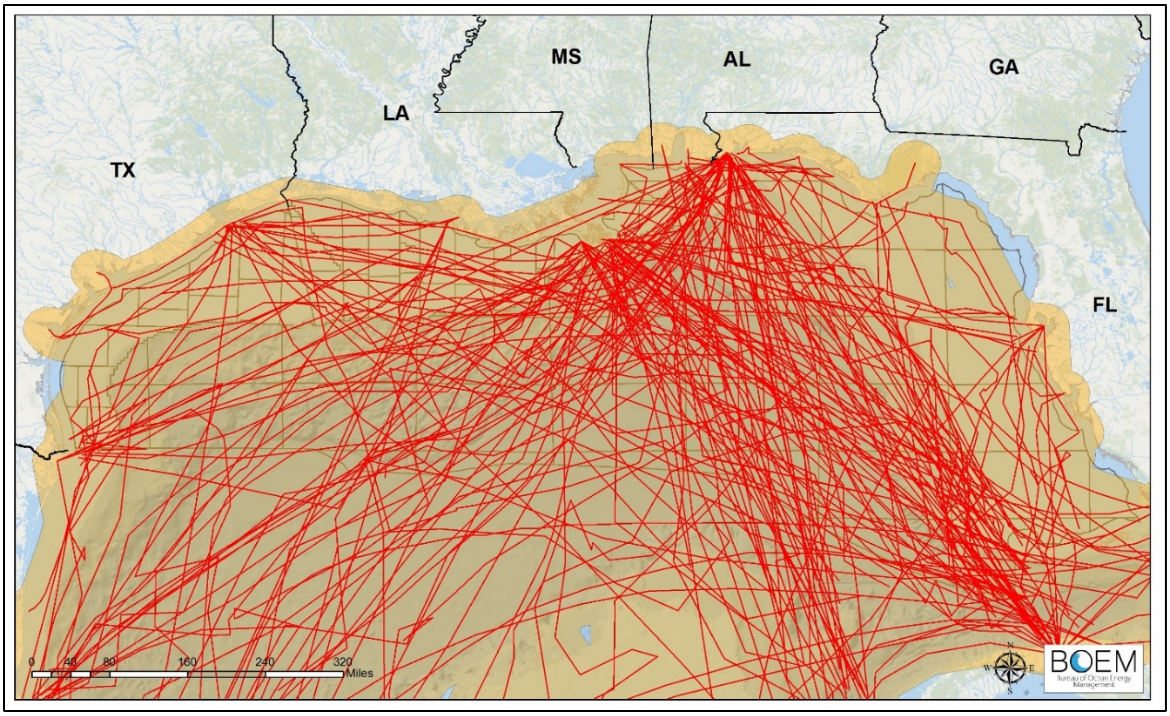

Figure 24. Documented 19th-century routes with 20 NM buffers

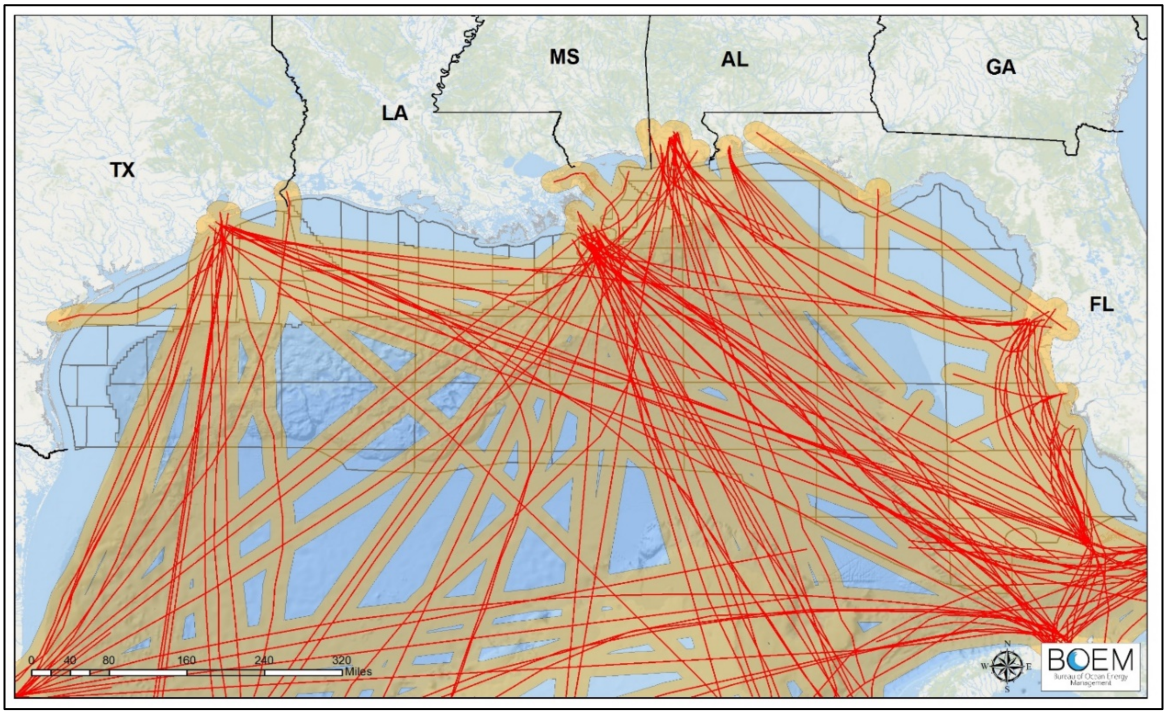

Figure 25. Documented 20th-century routes with 10 NM buffer

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