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RESEARCH

The Offshore Oil Exploration Industry and Archaeology in the Gulf of Mexico

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Abstract
After several decades of technological, political, and legal buildup, the United States offshore oil and gas industry broke through shortly after the conclusion of World War II. Under the regulation and administration of the U.S. Department of the Interior, the industry quickly became a significant driver of the U.S. and world economies, and Gulf of Mexico reservoirs remain the largest source of offshore domestic oil and gas supply. Offshore exploration activities also have resulted in a significant majority of underwater archaeological discoveries in the Gulf of Mexico. Federal archaeologists began oversight of offshore oil and gas activities in the 1970s, and since that time technological advancements have enabled exploration into ever deeper waters of the Gulf, along with a concurrent broadening of the ability to identify and investigate archaeological resources submerged on the Outer Continental Shelf. To date, hundreds of shipwreck discoveries have occurred, and collaborative projects between government and industry archaeologists have further documented over three dozen wrecks which are considered eligible for listing in the National Register of Historic Places. The interaction between the offshore oil and gas industry and underwater archaeology has significantly deepened our knowledge of Gulf of Mexico and U.S. maritime history, and this relationship should continue to yield significant discoveries well into the future.

Keywords Gulf of Mexico · BOEM · BSEE · Shipwreck · Nineteenth century · World War II

History of Offshore Oil and Gas Development

The modern offshore oil and gas industry in the United States, and the world, came to life in the early morning hours of 4 October 1947. A little after dawn on that warm fall day, Kerr-McGee Oil Industries, Inc.'s *Drilling Rig 16* struck sweet crude oil 1600 ft below the muddy shelf off Louisiana's coast. Though drilling for oil over water had its origins several decades earlier, this well—operated jointly by Kerr-McGee, Phillips Petroleum (now ConocoPhillips), Stanolind Oil & Gas (now BP), and the State of Louisiana—was

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unique. Situated 12 miles off the shoreline of Terrebonne Parish, Louisiana, in 18 ft of water, the exploratory well named Kerr-McGee-Phillips-Stanolind State of Louisiana, Ship Shoal Block 32, No. 1, was the first well to be drilled out of sight of land. The ribbons of heavy greenish-black fluid that first streaked into the well's drilling-mud return pit were no flash in the pan either; oil continued to flow out of the Ship Shoal Block 32 field for the next 37 years. By the time it was abandoned in 1984, the expanded field had produced 1.4 million barrels of oil and 307 million cubic ft of gas from 30 wells (Schempf 2007, p. 27). With Kerr-McGee's initial successful discovery, a new era of global energy production had begun.

By the time Ship Shoal Block 32 was drilled, the American oil and gas industry was already over 70 years old and had included several successful efforts of drilling in areas covered by water. The first commercial oil field was tapped near Los Angeles in 1875, and by 1897 prospectors were drilling "offshore" of Summerland, California, from wooden piers built out from the beach. Most of these piers ranged out 300–500 ft, with the longest stretching 1200 ft (Schempf 2007, p. 10). Over-water drilling in Louisiana began a few years later when the Gulf Refining Company drilled from fixed wooden platforms in Caddo Lake, northeast of Shreveport. Companies continued building on the knowledge and technological advancements gained from Summerland and Caddo Lake and expanded to the U.S. Gulf Coast in 1916, drilling into the shallow tidal areas and marshy lakes of Goose Creek, Texas, about 20 miles southeast of Houston. These wells were not considered "offshore," but Louisiana once again raised the stakes in 1937 by developing the Creole field off Calcasieu Parish, using fixed platforms in Gulf waters exceeding 20 ft deep. The Creole field was a harbinger of the successes to come at Ship Shoal Block 32 and the substantial profits available to those companies willing to press their luck in ever deeper waters off the Louisiana coast. Over its three decades of production, the Creole field delivered almost 4 million barrels of oil (Schempf 2007, pp. 30–31).

Subsequent explorations in the late 1930s off McFaddin Beach, Texas, and Sabine Pass, Louisiana, were ultimately unsuccessful but did continue the incremental technological advancements enabling drilling farther from shore. This progress, and oil production in the Gulf of Mexico generally, came to a halt, however, with the U.S. entry into World War II. As labor and materials (particularly steel) were diverted to national defense efforts, the resulting resource shortages proved difficult for the oil industry to overcome. Additionally, security concerns about German U-boats prowling the Gulf of Mexico led to the entire nascent offshore drilling frontier being abandoned. These setbacks notwithstanding, the Nation's overarching reliance on oil was, of course, about to be fully embedded due to the needs of the war effort. The unrelenting demands for petroleum products became, quite literally, the lifeblood of the Allied forces. In addition to the massive amounts of fuel needed daily for sea, air, and land combat operations, petroleum-based products were also needed for ancillary uses such as laying runways, extracting toluene for TNT, producing synthetic rubber, and providing lubricating oil for all the varied machinery of war (Penney 2008). As Charles Wallace, a Louisianan in the Air Corps put it:

> [I]t took a convoy of trucks just to haul the [aircraft fuel] for us to fly to Germany and fight that war. It took fuel for the boats to get there. It took fuel for the trucks to haul it to where we were. And then each day, when we took off, it was 100 airplanes. And each one of [the planes] burned 1,000 gallons of gas, so that was 100,000 gallons of gas every day, just for our base. Not for everybody, just at our base. Sometimes we went twice, that meant 200,000 gallons of gas used up. So

> that kind of depleted…I don't say it depleted, but it worked our reserves here in this country. (Penney 2008, p. 44)

Consequently, though there was no longer any oil being extracted out of the Gulf of Mexico, there was a virtual around-the-clock stream of crude and refined petroleum floating across the Gulf in the holds of tankers headed to ports on both sides of the Atlantic. This necessity, and the resulting U-boat "Happy Times," led to a substantial amount of Allied vessel tonnage being sunk in U.S. waters in the early years of the war. It also seeded the Gulf seafloor with a significant proportion of the archaeological resources that would later be discovered, ironically but appropriately, as offshore oil and gas exploration expanded into the late twentieth and early twenty-first centuries.

Another by-product, so to speak, of the wartime demand for oil was the development of Federal Government oversight of the domestic supply. In December 1942 the Petroleum Administration for War (PAW) was formed to initiate and enforce policies designed to coordinate petroleum supplies for defense and civilian needs, including rationing when and where necessary. Several industry committees were formed to support this mission, including the Foreign Operations Committee and the Petroleum Industry War Council. The PAW was placed under the charge of Secretary of the Interior Harold L. Ickes and vice-president of Standard Oil of California Ralph K. Davies (Penney 2008, p. 44). This organizational structure also established Department of the Interior (DOI) administration of the Nation's oil reserves, a Departmental function that continues to this day.

With the victorious end to the war the PAW was no longer needed, and it was terminated on 8 May 1946. President Truman had been impressed with the successful government-industry coordination of the wartime petroleum program, however, and he wished to see the relationship continue. Truman again placed the Secretary of the Interior in charge of federal administration of U.S. petroleum activities. The foundation for these responsibilities had been laid two years prior when President Truman issued, on the same day, Proclamation 2667 and Executive Order 9633. Proclamation 2667 asserted that "the Government of the United States regards the natural resources of the subsoil and seabed of the continental shelf beneath the high seas but contiguous to the coasts of the United States as appertaining to the United States, subject to its jurisdiction and control." Executive Order 9633 further asserted that "the natural resources of the subsoil and sea bed…[be] reserved, set aside, and placed under the jurisdiction and control of the Secretary of the Interior…." (Priest 2008b; Truman 1945a, 1945b). However, once the peacetime motivations for oil production shifted from patriotism to profits, any goodwill engendered towards the Federal Government during the war quickly dissipated, and battle lines were once again drawn around access to oil.

Now the controversy centered on whether the Federal Government or the states maintained rights to oil underneath submerged lands. Established international law dating back to the eighteenth century had granted nations sovereignty of their coastal seas out to 3 nautical miles, which was determined to be the maximum range of a smooth bore cannon (Priest 2008b). In the U.S., this area historically was placed under the stewardship of each state, and with that understanding California began issuing oil exploration leases off Summerland in 1921. The Gulf Coast States soon followed suit, though Texas and Louisiana immediately claimed ownership of an even larger area of the seafloor. Texas, which had formerly been an independent republic, claimed its boundary out to three marine leagues (10.35 miles) based on its inherited Spanish claims and titles and the agreements in place when it joined the Union. Louisiana, somewhat more creatively, claimed that the modern

range of artillery was 27 miles, and passed legislation claiming that boundary in 1938 (Priest 2008b, p. 69).

Up until this time the U.S. Departments of State and Interior had tacitly, and sometimes explicitly, assumed state title out to 3 miles. Beginning in 1937 Secretary Ickes challenged this assumption and throughout the war he continued to aggressively advocate for *federal* title to all submerged bottom lands out to 3 miles. At the conclusion of the war, and with the authorities vested in Proclamation 2667 and Executive Order 9633, the government committed to pursuing a legal and legislative solution. What followed were several years of bitter legal and political disputes over states' rights, collectively known as the Tidelands Controversy, which would require four Supreme Court decisions and two acts of Congress to resolve. Though, as with most intertwined arguments over states' rights and accusations of federal overreach in the Gulf South, the issue never fully retreated into settled history.

In June 1947, and then again, twice, on 5 June 1950, the U.S. Supreme Court decided in favor of the government on three separate cases against California, Texas, and Louisiana, respectively (Priest 2008b, pp. 74–76). Each of these landmark rulings conferred paramount rights over the submerged lands beyond the Nation's coastline to the Federal Government. Significantly, however, they did not rule on the issue of who actually held title to these lands, nor did they anticipate the coming dispute over where to draw the coastline. Political opportunists both in the states and in Congress quickly jumped into this breach, setting the stage for several more years of rancor and controversy.

Those in favor of "quitclaiming" back to the states the existing leases and rights within 3 miles gained a White House ally with the election of Dwight Eisenhower in 1952. The following year, on 22 May, Eisenhower signed the Submerged Lands Act (SLA). The SLA did not recognize any specific state claims to natural resources, but it did quitclaim to states all lands seaward of the low tideline out to three geographical miles and invited the Gulf Coast States to demonstrate in court any congressionally approved claims out to three marine leagues. Those arguments would not be decided until another Supreme Court decision, on 31 May 1960 (*United States v. Louisiana, Texas, Mississippi, Alabama, and Florida* 1960). The Court ruled that both Texas's and Florida's Gulf Coast boundaries extended to three marine leagues (10.4 geographical miles) based on Texas's recognized claims when it joined the Union and on congressional approval of the boundary asserted in Florida's constitution when it reentered the Union after the Civil War. Louisiana, Alabama, and Mississippi were granted jurisdiction only out to a boundary of three geographical miles. Louisiana, in particular, put up the loudest opposition to the 3-mile boundary, mostly through the efforts of Leander Perez, the notorious Plaquemines and St. Bernard Parishes district attorney and political powerbroker. In 1954 Perez had engineered passage of a state law that defined the coastline in such a way as to set Louisiana's boundary up to 37 miles (60 km) into the Gulf of Mexico in some areas, and he had tried to argue at other times that it extended as far as 60–70 miles (97–113 km) offshore. "Judge" Perez was to Louisiana politics of the day what Boss Tweed was to Tammany Hall, however, and his tenacity on the boundary question was less about benefiting Louisiana citizens than about protecting the massive personal fortune he had amassed from directing coastal oil leases to his friends and family. Perez's self-interested but, ultimately, failed backroom negotiations and political extortion arguably cost the state tens of billions of dollars in oil revenue (Priest 2008a, pp. 98–99; Priest 2008b, pp. 80–83).

Three months after he had signed the SLA, President Eisenhower signed a second piece of landmark legislation with the Outer Continental Shelf Lands Act (OCSLA, 7 August 1953). OCSLA authorized the Secretary of the Interior to administer mineral leases on the Outer Continental Shelf (OCS) and to implement regulations designed to meet the

requirements of the Act. This legislation cemented federal regulatory oversight of oil and gas development on the OCS.

Jurisdiction for implementing this regulatory program was initially designated to the Bureau of Land Management (BLM) and the Conservation Division of the U.S. Geological Survey (USGS), the two DOI agencies also responsible for administering minerals leasing of onshore federal lands. BLM issued leases and pipeline rights-of-way and prepared official leasing maps; USGS oversaw all aspects of operational activities as well as collecting fees and royalties.

On 13 October 1954, a little over a year after OCSLA became law, BLM held the first federal OCS lease sale in Washington, DC. The U.S. offshore oil and gas industry had been born almost 7 years to the day earlier with Kerr-McGee's discovery in Ship Shoal Block 32. With the 1954 lease sale, it began walking and talking. BLM collected $129.5 million in high bids from 23 companies during that lease sale and issued leases on 417,221 of the 748,000 acres offered. By the 1970s the industry was at a full sprint and that much money could be bid on a single lease block (Priest 2008a, p. 97). Even by 1963, Shell had successfully tested a drilling rig in a depth of 300 ft (91 m), and the industry as a whole was spending a total of $1 million a day on nearly 90 drilling operations (Priest 2008a, p. 112). The offshore oil industry quickly became a tentpole of the U.S. economy, and the royalties it generates are a principal revenue source for the federal treasury, second only to taxes collected by the IRS. The Gulf of Mexico OCS is the largest oil-producing area in the country, contributing one-third of crude-oil production and over 40% of refining capacity (Watts 2014). As of August 2017, the Gulf OCS leasing program had generated over $66 billion in lease tract bonus bids and over $147 billion in royalties, and the Gulf of Mexico OCS housed approximately 3000 active wells and 22,000 miles of active pipelines.

Regulatory oversight of the OCS leasing program resided under BLM and USGS until 1982, when these responsibilities were merged into a new federal agency, the Minerals Management Service (MMS). MMS maintained this role until 2010, when the Macondo well blowout and *Deepwater Horizon* tragedy initiated an agency reorganization. The revenue collection functions were moved to the Office of Natural Resources Revenue (ONRR) and MMS was renamed the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE). On 1 October 2011, BOEMRE was split into the Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE). Generally, BOEM reviews applications to install infrastructure on and commence production of a company's lease (including a review of the associated environmental impacts), and BSEE monitors the safety and environmental protection procedures of ongoing operations.

Archaeology in the Gulf of Mexico

The current BOEM and BSEE archaeological resource protection programs are built primarily on the legal mandates of OCSLA (1954), the National Historic Preservation Act, as amended (NHPA 1966), and the National Environmental Policy Act (NEPA 1969). OCSLA states that permits for OCS oil and gas exploration activities "shall be issued only if…such exploration will not…disturb any site, structure, or object of historical or archaeological significance" (43 U.S.C. § 1340(g)(3)). Section 106 of NHPA (54 U.S.C. § 306,108) requires federal agencies to consider the effects that proposed federal or federally funded undertakings may have on historic properties that are included in or eligible for

inclusion in the National Register of Historic Places (NRHP)." Section 110 of NHPA further mandates that federal agencies establish a preservation program and assume responsibility for the preservation of historic properties that may be affected by activities under the jurisdiction of that agency. NEPA's primary purpose is to require federal agencies to consider the impacts of their activities on the environment and to provide information about these potential impacts to the public before any final decisions are made. NEPA expressly includes cultural resources as part of the human environment and grants the government responsibility "to preserve important historic, cultural and natural aspects of our national heritage" (Section 101(b)(4)).

In order to comply with the mandates of NHPA and NEPA, the protection of archaeological resources during OCS oil and gas activities began in December 1973 with the inclusion of an archaeological lease stipulation on all leases issued in Gulf of Mexico Lease Sale 32. These archaeological lease stipulations required that an archaeological survey must be conducted and a report submitted prior to permit approval of any lease activities. In November 1994 the archaeological lease stipulation was given the full weight of federal regulations in 30 CFR parts 250, 256, 280, and 281[1]; however, in the intervening years the archaeological survey requirements had been gradually limited to only those leases that were determined to be within an area of high probability for containing historic shipwrecks or prehistoric archaeological sites. Such areas of "high probability" were established through a series of baseline studies that examined known shipwreck locations, archival reports of wrecks, historic shipping routes, regional sedimentation rates, and submerged archaeological site preservation potential. Those areas requiring an archaeological survey are communicated to lease holders through the periodic release of Notices to Lessees and Operators (NTLs), which further include guidance to oil companies on data collection and reporting methods. BOEM has continually expanded the list of lease areas that are considered high probability through a combination of updated baseline studies and empirical data from oil and gas industry archaeological surveys, and the resulting evidence has called into question the validity of using a probability determination of any kind for the Gulf of Mexico OCS. Rather, BOEM has found that the archival information informing the baseline studies is biased towards later nineteenth- and twentieth-century wrecking events that were more likely to be documented in the historic record, or towards wrecks that sank closer to shore and therefore had a higher likelihood of survivors who lived to recount their stories. Older shipwrecks, or those that happened far enough at sea to preclude any survivors, are correspondingly underrepresented in the historic record. In fact, as oil and gas exploration in the Gulf of Mexico has steadily moved farther from shore and into deeper water, industry surveys have routinely discovered historic-period shipwrecks in areas that were not previously identified as high probability within BOEM's NTLs. As a result, BOEM now considers all leaseable areas of the Gulf of Mexico to have an equal probability for containing historic shipwrecks.

Permitted activities requiring an archaeological survey generally include the drilling of exploration and production wells, installation of production platforms and well caissons, pipeline rights-of-way, and the decommissioning and removal of pipelines and platforms at the end of their use-life. Consistent with the intent of Section 106 of the NHPA, these surveys must cover the entire Area of Potential Effect (APE), which often includes the placement of construction vessel anchors, permanent mooring anchors, and debris

[1] With the division of MMS into BOEM and BSEE, the regulations were separated by each agency's respective responsibilities into 30 CFR part 250 (BSEE) and 30 CFR part 550 (BOEM).

clearance and clean-up trawling following platform removals. Depending on water depth, APEs can extend several thousands of feet from a central wellbore, platform, or pipeline location. With few exceptions, the surveys conducted in support of these activities are not done solely for archaeological purposes. Operators are also required to conduct surveys to identify shallow hazards and seabed-founded areas of environmental sensitivity, including existing pipelines, debris, hard-bottom biological habitats, and shallow biogenic gas pockets or faults that could create seafloor instabilities and endanger the placement of oil and gas infrastructure. Archaeological surveys are typically conducted simultaneously with shallow hazard surveys since both utilize the same standard suite of remote-sensing survey instrumentation, e.g., magnetometers, side-scan sonars, sub-bottom profilers, multibeam swath echo sounders, and Remotely Operated Vehicles (ROVs). Oil companies typically submit the archaeological survey reports (which are produced by third-party archaeological survey contractors) for BOEM review prior to or concurrent with an application for a permit to conduct one or more of the above-mentioned activities. From 2011 to 2016, BOEM's archaeologists in the Gulf of Mexico OCS Region in New Orleans, Louisiana, reviewed an average of 760 such permit applications per year, though that does not reflect the number of unique archaeological surveys conducted during each of those years. A single lease block survey may be used for multiple permitted activities provided the survey covers all areas within each activity's APE.

As with any marine archaeological survey, the remote-sensing data are often inconclusive and the resulting analysis is dependent upon the subjective interpretations of the surveying and reviewing (BOEM/BSEE) archaeologists. Rather than confirming shipwreck locations (or distinguishing potentially historic wrecks from modern ones), surveys typically identify magnetic anomalies and/or sonar targets that are indicative only of potential shipwreck locations. Since it is impractical and cost prohibitive to require that operators conduct a full Phase II NRHP eligibility assessment of each identified anomaly or sonar target, BOEM routinely allows companies the option to simply avoid these areas by a predetermined distance during their activities. If avoidance is not possible due to the engineering requirements of the project, then further investigation of the potential archaeological resource(s) is required. As a result, BOEM and BSEE maintain a database of thousands of magnetic anomalies and sonar targets that have had avoidance requirements placed on them in conjunction with oil and gas activities. BOEM and BSEE consider all of these remote-sensing targets to be potentially eligible for listing in the NRHP, until and unless additional direct investigations confirm or refute their eligibility. As described at the beginning of this chapter, the OCS usage rights claimed by the Federal Government in the SLA and OCSLA did not include actual title to the seafloor or any cultural resources contained therein. Therefore, BOEM's and BSEE's jurisdiction, as it pertains to NHPA and NEPA, extends only to the oil and gas activities those agencies permit (as well as to OCS renewable energy development and marine mineral extraction, both of which are also regulated by BOEM and BSEE).

In addition to the magnetic anomaly and sonar target database, BOEM and BSEE also maintain a database of known and reported Gulf of Mexico shipwrecks. This database was initially created as part of one of the above-mentioned baseline studies, which was funded by BOEM (then MMS) and completed in 2003 (Pearson et al. 2003). One objective of that study was to create a relational and spatial database of shipwreck information that could be viewed in a Geographic Information System (GIS) as a tool to aid BOEM archaeologists in identifying shipwrecks and potentially significant remote-sensing targets located during high-resolution geophysical surveys conducted by the oil and gas industry. The resulting database included over 2000 Gulf of Mexico shipwrecks that were either known from

remote-sensing surveys or other direct investigations, or that had been reported in the historic record. Each shipwreck in the database is assigned a Reliability Factor of 1 through 4, 1 being Very Reliable and 4 being Unreliable (Pearson et al. 2003, Vol. I, pp. 2–24):

The database is continually updated as new survey and archival information is received that either adds to or clarifies the information already within it. As of 2023, the database now contains over 3000 entries, approximately 400 of which have a Reliability Factor of 1, though the majority are modern wrecks such as fishing trawlers or oil field support vessels. Because the database contains sensitive information of historic shipwrecks, it is restricted from public access and is shared only with archaeological professionals working in support of BOEM and BSEE activities.

The BOEM/BSEE shipwreck database is emblematic of the outsized role that oil and gas exploration has had in the advancement of Gulf of Mexico maritime archaeology. Of the over 400 shipwrecks with a Reliability Factor 1, approximately 70% were located as a result of an oil and gas industry survey. Additionally, based on BOEM's analysis, at least 39 wrecks that have been confirmed through direct diver or ROV investigation are eligible for listing in the NRHP. Only two of these were not discovered during an industry survey: the USS *Hatteras*, a Union Navy gunboat sunk off of Galveston after being ambushed by the CSS *Alabama* in 1863, and discovered by treasure hunters in the 1970s[2]; and *New York*, a packet-steamer that sank during a hurricane en route from Galveston to New Orleans in 1846 and discovered by treasure hunters in the 1990s (Gearhart et al. 2011). Since their discoveries, however, the only archaeological investigations to take place at either *Hatteras* (Arnold and Hudson 1981; Arnold and Anuskiewicz 1995; Enright et al. 2006; Evans et al. 2013) or *New York* (Gearhart et al. 2011) were through projects sponsored by BOEM's (and its predecessors') archaeology program.

Studies such as Pearson et al. (2003) and those that were conducted at the USS *Hatteras* and *New York* are a product of BOEM's Environmental Studies Program. The need for environmental studies to compliment OCS oil and gas development was established within OCSLA at the outset of the federal OCS leasing program. Combined, these studies have investigated over 40 individual shipwreck sites (or reported potential sites), 24 of which were determined to be eligible for listing in the NRHP. The additional Gulf of Mexico shipwrecks that BOEM has determined are also NRHP eligible, including some that are described elsewhere in this volume, were investigated through separate collaborative projects between BOEM, oil and gas companies, offshore survey service-providers, and other federal agencies. These studies represent the largest collective contribution to Gulf of Mexico archaeology, and they are a direct result of the coordination between industry and federal regulators towards offshore oil and gas exploration.

As previously mentioned, the earliest Gulf of Mexico archaeological studies focused on establishing a historic context for archaeological site potential on the OCS and determining where significant properties may occur in order to inform BOEM survey requirements. The first of these, by Coastal Environments, Inc. (1975), generated models for predicting the locations of prehistoric and historic archaeological sites, identified probability zones of site occurrence, and compiled a list of over 1900 known and reported vessel losses on the OCS, dating between 1500 and 1945 AD. Garrison et al. (1989a) expanded this work, revising the boundaries of the highest probability shipwreck zone

[2] *Hatteras* is a Texas State Historical Landmark (Texas Site 41GV68) and was the first Gulf of Mexico shipwreck to be listed in the NRHP. It is also the only Civil War shipwreck within federal waters of the Gulf of Mexico OCS.

(Zone 1) using updated historical research and OCS shipwreck discoveries since the completion of Coastal Environments, Inc.'s study. Garrison et al. (1989a) also examined the effectiveness of different remote-sensing survey methods and whether the resulting data could reliably differentiate between cultural resources and modern debris. These objectives were again revisited in Pearson et al. (2003) which produced, in addition to the aforementioned shipwreck database and GIS analytical tool, a further updated analysis of OCS shipwreck site potential and a comparison of contemporary marine magnetometer technologies and survey line spacing.

The federal OCS archaeology program began direct site investigations and NRHP evaluations in the 1980s, first—through a partnership with the Texas Historical Commission—on the USS *Hatteras* (Arnold and Hudson 1981), and then on an eighteenth-century ballast pile off the Chandeleur Islands, Louisiana (Garrison 1989a, 1989b). Though neither of these sites were discovered through OCS oil and gas exploration activities, and the Chandeleur Islands site is located in state waters (Site 16SB202), both are indicative of the temporal, cultural, and functional variety of historic archaeological resources present in the Gulf of Mexico, and they each have informed BOEM's management strategies towards site identification and protection relative to oil and gas activities.

Later studies focused on shipwreck sites that were discovered as a direct result of OCS oil and gas exploration surveys. Several NRHP-eligible sites were documented as a result of these studies, including the nineteenth-century Navy gunboat USS *Castine* (Enright et al. 2006), an early twentieth-century tow boat (Evans et al. 2013), and five casualties of German U-boat operations during World War II (Enright et al. 2006; Evans et al. 2013) (Fig. 1).

For the first 20 years of its existence, the OCS archaeology program was focused on the relatively shallow-water, near-shore areas of the Gulf of Mexico OCS. This was primarily due to the analysis of the early baseline studies (Coastal Environments, Inc. 1977; Garrison et al. 1989b), which posited that the significant majority of northern Gulf of Mexico shipwrecks (at least 80%) would be located within 10 km (6 miles) of shore, based on site preservation potential and the locations of seaports, straits, shoals, reefs, and maritime shipping routes. As drilling technology continued to evolve, particularly following the financial incentives realized by passage of the Deep Water Royalty Relief Act in 1995, oil and gas exploration activities steadily expanded into ever deeper waters of the central and western Gulf. And with every step farther out to sea, new shipwreck discoveries soon followed.

The oil and gas industry's increased focus on deepwater exploration spurred a concurrent advancement of marine survey technology including deep-tow survey systems, improved ROV and AUV capabilities, and precision acoustic positioning systems. These technological developments in turn provided the means for archaeologists to both discover and investigate shipwrecks in deep water. Spurred by development-led surveys and subsequent site investigations, the largest assemblage of known historically significant shipwrecks in the northern Gulf of Mexico OCS have been discovered in deepwater areas exceeding 200 m (656 ft).

These discoveries range in age from the late-seventeenth century to the mid-twentieth century, though few of their identities have been conclusively determined. Unsurprisingly, many of these wrecks date to the nineteenth century, during the historical period that witnessed the most dynamic sustained maritime activity in the Gulf of Mexico. Several of these nineteenth-century discoveries have been the subject of detailed BOEM or industry-funded site investigations, which have contributed substantially to the regional archaeological knowledge of this period, as well as to the refinement of deepwater investigation and excavation methods.

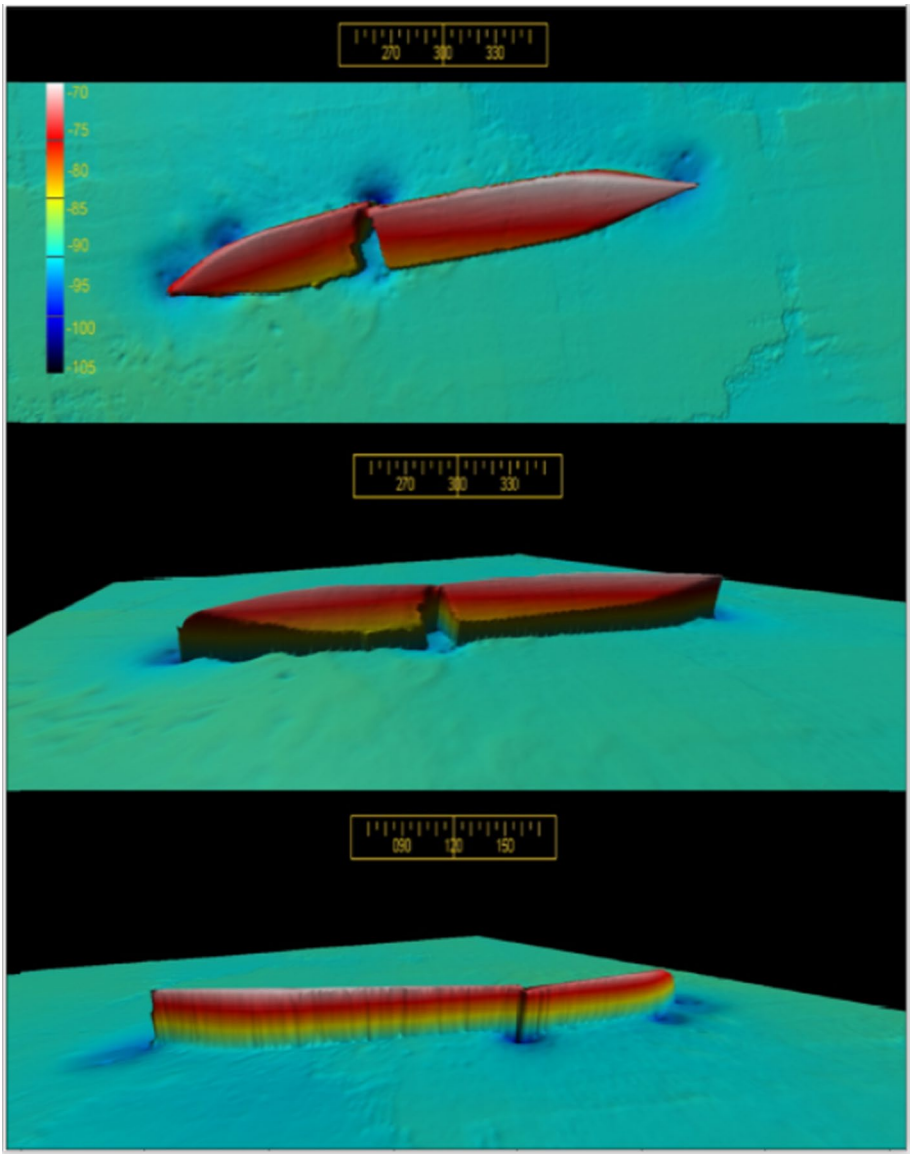

Fig. 1 Multibeam sonar image of World War II casualty *Cities Service Toledo* (Evans et al. 2013; courtesy of BOEM)

One such example from the early nineteenth century, and perhaps the most well-known, is the Mardi Gras Shipwreck (Louisiana site number 16GM01). The site was first recorded and reported to MMS as a potential shipwreck during a pipeline right-of-way remote-sensing survey in 2001 and confirmed as a shipwreck the following year during a pre-installation ROV survey of the Mardi Gras Pipeline System (giving the shipwreck its colloquial name). In 2007, Texas A&M University conducted an excavation of the site in coordination with MMS archaeologists, and hypothesized that the site dated to between 1780 and

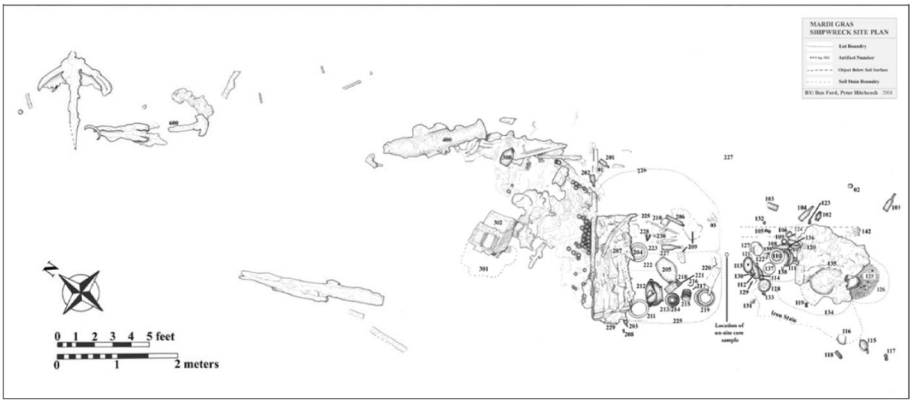

Fig. 2 Site plan of the Mardi Gras Shipwreck (Ford et al. 2008; courtesy of BOEM)

1820 and was an armed merchantman (Ford et al. 2008; Fig. 2). Subsequent research and artifact analysis has narrowed the date range to 1808–1820 and instead pointed towards its probable use as a privateer (Horrell and Borgens 2017). Artifacts recovered from the site originate from Great Britain, France, Mexico, and the United States, complicating a determination of the nationality of the vessel itself but exemplifying the international character of maritime activity and trade in the Gulf of Mexico at the time. In total, over 925 artifacts were recovered and conserved including significant diagnostic assemblages of navigation instruments, a cookstove, glass and ceramic vessels, personal items, and weaponry including a cannon, small firearms, edged weapons, artillery shot, lead shot, and gunflints.[3] The Texas A&M and MMS researchers estimate that only approximately 10% of the total site has been excavated, however, leaving a substantial number of unanswered questions and future research opportunities regarding the Mardi Gras Shipwreck's function and nationality. Located roughly 40 miles (64 km) off the Louisiana coast and at an approximate depth of 4000 ft (1220 m), this was, at the time, the deepest archaeological excavation to take place in U.S. territorial waters.

An additional assemblage of industry-discovered, wooden-hulled shipwrecks was investigated in a multidisciplinary BOEM study of deep-water archaeological sites and biological habitat in 2008–2009 (Brooks et al. 2016). In addition to three World War II shipwrecks, that study documented the remains of four wooden-hulled and copper-sheathed merchant sailing vessels, each of which was given a naming designation based on either its general geographic location, bathymetric contour, or a diagnostic feature of the site: the Viosca Knoll wreck; the Ewing Bank Wreck; the 7000 Foot Wreck; and the Green Lantern Wreck (Fig. 3). The level of preservation and presence of extant artifacts were highly variable between sites and, as with the Mardi Gras Wreck, no determination of vessel origin, cargo, or identity has yet been conclusively determined. However, an analysis of the vessel construction details, as well as the observed and recovered artifacts place each of the wrecks between the latter half of the nineteenth century and the early twentieth century. The vessel hulls range in size from 50×15 ft (15×5 m) for the smallest (the 7000 Foot

[3] All artifacts are currently in curation at the Louisiana Office of Cultural Development, Division of Archaeology, in Baton Rouge.

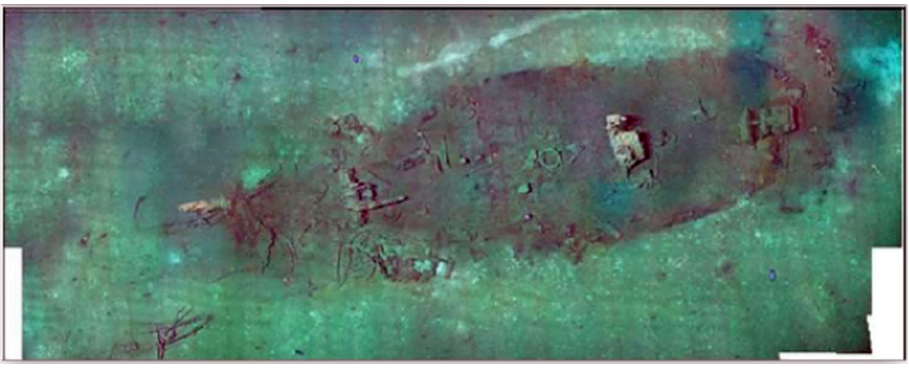

Fig. 3 Sonar mosaic of the 7000 Foot Wreck (Brooks et al. 2016; courtesy of BOEM)

Fig. 4 Navigation lantern recovered from the Green Lantern Wreck (Brooks et al. 2016; courtesy of BOEM)

Wreck) to approximately 130×26 ft (40×8 m) for the largest (the Viosca Knoll Wreck). Artifacts recovered during the study include a sheathing sample and post-1876 ceramic water filter (Viosca Knoll Wreck), a ship's compass with a patent date of 1875 (7000 Foot Wreck); a late-nineteenth-century ceramic vessel (Ewing Bank Wreck); and an unmarked bell, wooden sheave, early-twentieth-century dining fork and ironstone plate, and a navigation lantern (Green Lantern Wreck) (Fig. 4).[4] Though each of the four wrecks remains

[4] All artifacts are currently in curation at the BOEM and BSEE facility in New Orleans, Louisiana.

unidentified, the extensive historical and archaeological analysis, conducted by C&C Technologies (now Oceaneering International), has provided substantial data to support a National Register of Historic Places nomination for each site based on their association with a transitional period in Gulf of Mexico maritime commerce. Additional archaeological investigations are likely to also yield valuable information on the construction characteristics and shipboard life of mid- to late-nineteenth-century merchant sailing vessels (Brooks et al. 2016).

Apart from nineteenth-century wooden-hulled sailing vessels, perhaps the most significant contribution to the Gulf of Mexico archaeological record from oil and gas exploration is in the discovery of both Allied and Axis vessel casualties from World War II. Between May and September 1942, the Gulf of Mexico was arguably the most dangerous body of water in the world as German U-boats decimated Allied vessel tonnage. In total, 56 Allied vessels were sunk in the Gulf of Mexico during the war, against only one U-boat casualty (U-*166*). Since approximately 85% of oil supplies for the U.S. East Coast originated from Texas or Louisiana ports, nearly all of these unlucky vessels were tankers on their way to load or unload a petroleum cargo in some form. As a result of the continued, modern-day centrality of the Gulf of Mexico to the U.S. petroleum economy, 17 of the Allied U-boat casualties have been discovered to-date during oil and gas industry remote-sensing surveys. Twelve of these wrecks, plus the U-*166*, have further been the subject of subsequent archaeological investigations (Fig. 5) (Enright et al. 2006; Church et al. 2007; Evans et al. 2013; Brooks et al. 2016).

Combined, there are 183 known and as-yet-undiscovered World War II wrecks in the Gulf of Mexico off the U.S. East Coast. As a group, these wrecks of German U-boats and Allied merchant and military vessels were listed in the National Register in 2013 as part of the multiple properties listing, *World War II Shipwrecks along the East Coast and Gulf of Mexico* (Marx and Delgado 2013). Among the Gulf of Mexico wrecks, nine have to date been individually listed to the NRHP as contributing properties to the multiple properties nomination. Though all of these wrecks are eligible under NRHP Criteria A and D due to their associations with wartime activity, a few are also notable for elements of their

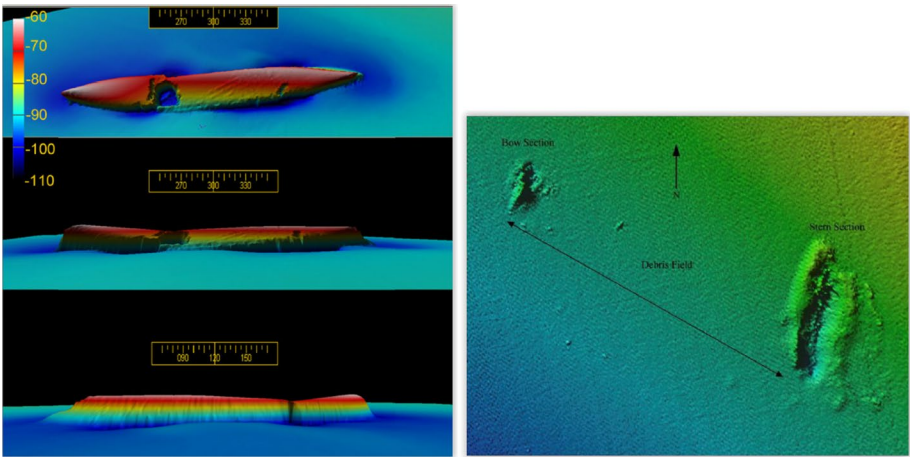

Fig. 5 Left: Multibeam sonar image of the World War II casualty *R.W. Gallagher* (Evans et al. 2013; image courtesy of BOEM). Right: Multibeam sonar image of *U-166* (Brooks et al. 2016; image courtesy of BOEM)

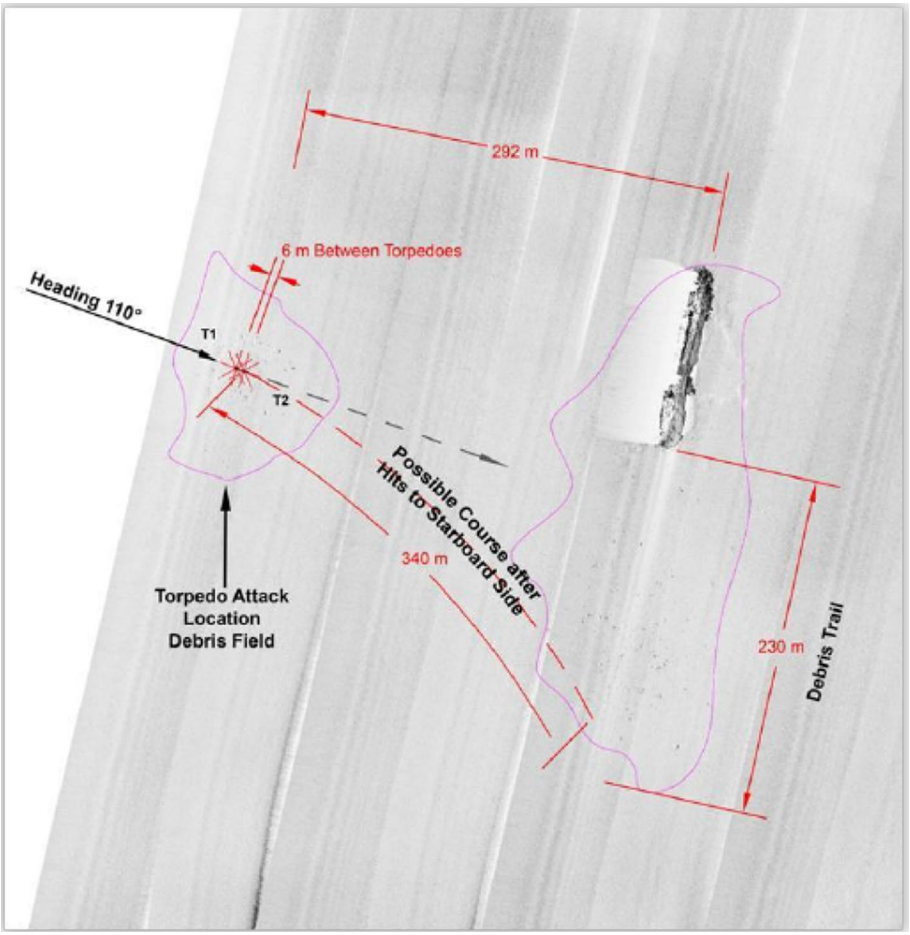

Fig. 6 Sidescan sonar mosaic of *Gulfoil* showing its estimated surface attack and sinking scenario (Brooks et al. 2016; image courtesy of BOEM)

construction. For example, the French-built tanker *Sheherazade* was the largest tanker in the world during its career (1935–1942; Enright et al. 2006), and *Gulfoil*, built in 1912, was the first American tanker to be constructed with the British Isherwood-style of longitudinal framing, which allowed increased cargo space and hull strength (Brooks et al. 2016, p. 473).

The discovery of these World War II sites has resulted not just in the documentation of nationally significant shipwrecks but also in the creation of management tools that can be used by government archaeologists to further protect other sites that may be located through future oil and gas surveys. By analyzing the debris patterns associated with the wrecks of *Virginia*, *Halo*, *Gulfpenn*, *Alcoa Puritan*, *Robert E. Lee*, and *U-166*, Church et al. (2007) were able to develop a formula for calculating the expected debris field radius of similar shipwreck sites as a function of vessel length and water depth. Brooks et al. (2016) built on this work by analyzing the discontinuous debris field associated with the tanker *Gulfoil* and the reported details of its attack and sinking by *U-506*. Using the combined archaeological and historical data sets, Brooks et al.

(2016) were able to recreate the possible debris field site formation process between the first torpedo impact and *Gulfoil*'s final disposition on the seafloor in 1750 ft (534 m) of water (Fig. 6). These analyses are important not only because of how they inform the archaeological interpretation of each site but also because of how they inform decision making towards the responsible management of these resources. Studies of this kind, along with others that have examined the efficacy of various remote-sensing survey instruments and methods (Pearson et al. 2003; Enright et al. 2006), have enabled archaeologists to continually refine the ability to both detect and preserve historic shipwrecks on the OCS. In essence, each shipwreck discovered because of oil and gas exploration has incrementally improved the understanding of archaeological site occurrence on the OCS and increased the potential of discovering additional sites.

It must be noted, however, that the relationship between oil and gas development and archaeology on the OCS is not without its missteps and cautionary tales. Since the inception of the federal leasing program, over 7000 production platforms and 44,000 miles of pipelines have been installed on the OCS. The seabed impacts associated with this infrastructure often span thousands of feet from a central well bore or pipeline corridor. For example, mooring anchors used for drilling rigs or pipeline lay barges often exceed 40 tons, deployed at distances ranging from 1000 to 12,500 ft (305–3658 m) and numbering 8–12 anchor drops each time the vessel is positioned. It is unreasonable to expect that the entirety of this impacted area was cleared of potential archaeological resources prior to construction. Despite the diligence of federal archaeologists, the expansion of offshore energy exploration has consistently outpaced the archaeological regulatory requirements, and there are several known examples of the consequences. Two of these illustrate the potential for impacts to an archaeological site when no pre-construction survey is required. The previously discussed Viosca Knoll Wreck (Church and Warren 2008; Brooks et al. 2016) and the World War II-era tanker *Gulfstag*, which exploded and sank in 1966 (Melancon and Blackmon 2011), were both discovered in the vicinity of wells that had been drilled prior to any archaeological survey requirement for the lease block. In both cases, evidence indicated that drilling vessel mooring anchor lines had dragged across each wreck, damaging hull structure and site integrity (Fig. 7).

A third example is that of the Mica Wreck, a two-masted schooner dating to the first half of the nineteenth century and lost in deep-water in the Mississippi Canyon Area (Atauz et al. 2006). In 2001, a post-construction ROV survey of the Mica pipeline discovered the wreck lying underneath the pipeline (Fig. 8). In this instance, a pre-construction survey was conducted by the pipeline company; however, the survey methodology permitted at the time was insufficient to resolve the shipwreck. As a result, the pipeline bisected the wreck across the midships section, splaying the hull outward where contact was made and lifting the bow and stern approximately 1 ft off the sediment due to the pressure exerted on the longitudinal timbers of the vessel (Atauz et al. 2006). Despite these impacts, the pipeline was left in place, as removing it posed an even greater risk for additional damage to the site.

The final known instance of industry-related damage to a site occurred at the Mardi Gras Shipwreck when, prior to any archaeological investigations, an ROV contractor made an unauthorized and unreported visit to the site. The contractor attempted to recover several significant diagnostic artifacts, including an octant, bottles, earthenware jugs, and creamware ceramics, all of which were lost or damaged during the recovery (Horrell and Borgens 2017). Though valuable archaeological information was destroyed during this unauthorized activity, the resulting Section 106 consultation between MMS, the contractor, the State of Louisiana, and the Advisory Council on Historic Preservation culminated in an agreement that funded the eventual data recovery efforts at the site (Ford et al. 2008, 2010).

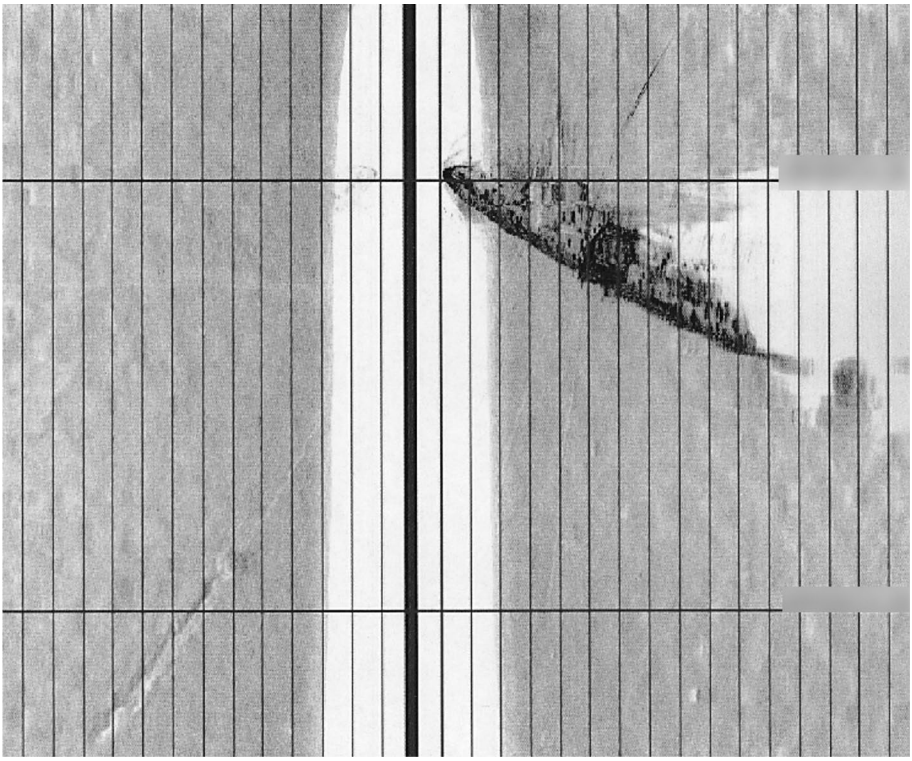

Fig. 7 Sonar image of *Gulfstag* showing evidence of an anchor drag scar (image courtesy of BOEM)

Conclusion

Oil and gas exploration on the Gulf of Mexico OCS began over 70 years ago, and for the last 45 years its continued development has arrived hand-in-hand with significant archaeological discoveries. Since establishment of federal oversight of these operations with OCSLA in 1953 and BOEM's archaeology program in 1973, the vast majority of historic shipwreck discoveries in the Gulf of Mexico have been a result of the combined and collaborative efforts between the oil and gas industry and federal regulators. To be sure, these discoveries would not have been possible without the economic incentives available to companies that pursue offshore development and the recognition in federal law that these incentives are conditioned on the simultaneous preservation of the Nation's cultural resources. This interconnected approach to the management of OCS mineral resources has resulted in the discovery and preservation of hundreds of Gulf of Mexico shipwrecks and, to date, at least 10% of these discoveries are known to be eligible for listing in the National Register of Historic Places. Each of these discoveries adds critical archaeological evidence to confirm, supplement, illuminate or, often, question the time-worn historical narratives that have informed our current understanding of the Gulf of Mexico's long and varied maritime history. They provide a tangible connection to the stories that are otherwise available to us only through history books and dusty archives. Each of them also allows archaeologists, industry, government agencies, the public, and other stakeholders to better understand how modern-day human activities affect the discovery and preservation of

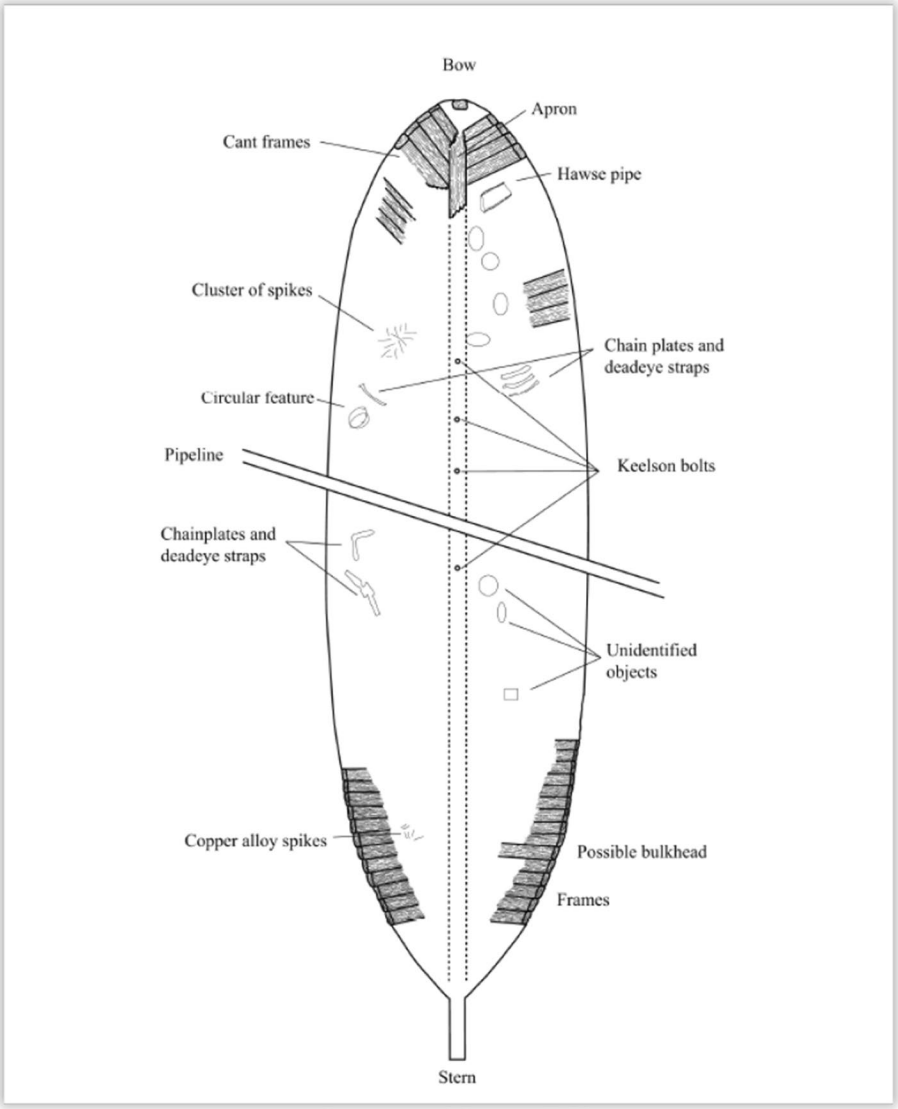

Fig. 8 Site plan of the Mica Wreck and the bisecting pipeline (Atauz et al. 2006; image courtesy of BOEM)

these historic resources. As the technological capabilities and deep-water aspirations of the oil and gas industry have progressed, government archaeologists must continually examine and evolve how to manage the protection of these sites. BOEM's and BSEE's policies, NTLs, and archaeological studies are the embodiment of these management responsibilities and, because they reflect over 40 years of experience on the OCS, many of these practices have been adopted by other federal and state agencies. Even the rare examples described above of oil and gas industry damage to shipwrecks have each resulted in archaeological data collection that would not otherwise have taken place, and a corresponding strengthening of requirements to better ensure the discovery and protection of sites not yet known. In

other words, the connection between the offshore exploration industry and archaeology in the Gulf of Mexico should be considered not just as a collection of individual discoveries resulting from a forced partnership between industry and the government. It also represents a shared history, in and of itself, one that has contributed immeasurably to advancing the knowledge of, and science behind, the study of our Nation's submerged archaeological resources. And with each successive exploratory step into undeveloped areas of the Gulf of Mexico's seafloor, new discoveries of our past await.

Author Contributions Douglas Jones is the sole author of this manuscript.

Declarations

Conflict of interest The author declares no competing interests.

References

Arnold JB III, Anuskiewicz RJ (1995) USS *Hatteras*: site monitoring and mapping. In: Underwater archaeology proceedings from the society for historical archaeology conference, Washington, D.C., pp 82–87

Arnold JB III, Hudson J (1981) The USS *Hatteras*: a preliminary report on remote sensing data and litigation. In: In the realms of gold: the proceedings of the tenth conference on underwater archaeology. San Marino, California

Atauz AD, Bryant W, Jones T, Phaneuf B (2006) Mica shipwreck project: deepwater arcaheological investigation of a 19th century shipwreck in the Gulf of Mexico. New Orleans, Louisiana: U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. OCS Study MMS-2006–072

Brooks JM, Fisher C, Cordes E, Baums I, Bernard B, Church R, Etnoyer P, German C, Goehring E, MacDonald I, Roberts H, Shank T, Warren D, Welsh S, Wolff G, Weaver D (2016) Exploration and research of northern Gulf of Mexico deepwater natural and artificial hard-bottom habitats with emphasis on coral communities: reefs, rigs, and wrecks—"Lopelia II" final report. New Orleans, Louisiana: U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. OCS Study BOEM 2016–021

Church RA, Warren DJ (2008) Viosca Knoll Wreck: discovery and investigation of an early nineteenth-century sailing ship in 2000 feet of water. New Orleans, Louisiana: U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. OCS Study MMS 2008–018

Church R, Warren D, Cullimore R, Johnston L, Schroeder W, Patterson W, Shirley T, Kilgour M, Morris N, Moore J (2007) Archaeological and biological analysis of World War II shipwrecks in the Gulf of Mexico: artificial reef effect in deep water. New Orleans, Louisiana: U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. OCS Study MMS-2007–015

Coastal Environments Inc (1977) Cultural resources evaluation of the northern Gulf of Mexico Continental Shelf. National Technical Information Services (NTIS), Baton Rouge

Enright JM, Gearhart R II, Jones D, Enright J (2006) Study to conduct national register of historic places evaluations of submerged sites on the Gulf of Mexico Outer Continental Shelf. New Orleans, Louisiana: U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. OCS Study MMS-2006–036

Evans AM, Keith ME, Voisin EE, Hesp P, Cook G, Allison M, da Silva G, Swanson E (2013) Archaeological analysis of submerged sites on the Gulf of Mexico outer Continental shelf. New Orleans,

Louisiana: U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. OCS Study BOEM 2013–01110
Ford B, Borgens A, Bryant W, Marshall D, Hitchcock P, Arias C, Hamilton D (2008) Archaeological excavation of the Mardi Gras Shipwreck (16GM01), Gulf of Mexico continental slope. New Orleans, Louisiana: prepared by Texas A&M University, U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. OCS Report MMS 2008–037
Ford B, Borgens A, Hitchcock P (2010) The mardi gras shipwreck: results of a deep-water excavation, Gulf of Mexico, USA. Int J Naut Archaeol 39(1):76–98
Garrison EG, Giammona CP, Kelly FJ, Tripp AR, Wolff G A (1989a) Historic shipwrecks and magnetic anomalies of the Northern Gulf of Mexico: reevaluation of archaeological resource management zone 1. New Orleans, Louisiana: U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. OCS Study MMS 89–0024
Garrison EG, Giammona CP, Jobling J, Tripp AR, Weinstein EN, Wolff GA (1989b) An eighteenth-century ballast pile site, Chandeleur Islands, Louisiana: an instrumental and archaeological study. New Orleans, Louisiana: U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. OCS Study MMS 89-0092
Gearhart II R, Jones D, Borgens A, Laurence S, DeMunda T, Shipp J (2011) Impacts of recent hurricane activity on historic shipwrecks in the Gulf of Mexico Outer Continental Shelf. New Orleans, Louisiana: U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation and Enforcement, Gulf of Mexico OCS Region. OCS Study BOEMRE 2011-003
Horrell CE, Borgens AA (eds) (2017) Historical archaeology. Special issue: the Mardi Gras Shipwreck: the archaeology of an early nineteenth-century wooden-hulled sailing ship. Society for Historical Archaeology, vol 51, No 3
Marx D, Delgado J (2013) World War II shipwrecks along the east coast and Gulf of Mexico. National Register of Historic Places Multiple Property Documentation Form. Washington, D.C.: On file with the National Park Service, National Register of Historic Places
Melancon MA, Blackmon R (2011) Historical and archaeological assessment of the T2-SE-A1 tanker S.S. *Gulfstag*. In: Offshore technology conference proceedings. Houston, Texas
Pearson CE, James SR Jr, Krivor MC, El Darragi SD, Cunningham L (2003) Refining and revising the Gulf of Mexico outer continental shelf region high-probability model for historic shipwrecks. New Orleans, Louisiana: U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. OCS Study MMS 2003-060
Penney L (2008) In the wake of war: World War II and the offshore oil and gas industry. In: Austin D, Priest T, Penney L, Pratt J, Pulsipher AG, Abel J, Taylor J (eds) History of the offshore oil and gas industry in Southern Louisiana. Volume I: papers on the evolving offshore industry. New Orleans, Louisiana: U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. OCS Study MMS 2008-042, pp 37–66
Priest T (2008a) Auctioning the ocean: The creation of the Federal Offshore Leasing Program, 1954–1962. In: Austin D, Priest T, Penney L, Pratt J, Pulsipher AG, Abel J, Taylor J (eds) History of the offshore oil and gas industry in Southern Louisiana. Volume I: papers on the evolving offshore industry. New Orleans, Louisiana: U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. OCS Study MMS 2008a-042, pp. 93–113
Priest T (2008b) Claiming the coastal sea: The Battles for the "Tideland" 1937–1953. In: Austin D, Priest T, Penney L, Pratt J, Pulsipher AG, Abel J, Taylor J (eds) History of the offshore oil and gas industry in Southern Louisiana. Volume I: papers on the evolving offshore industry. New Orleans, Louisiana: U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. OCS Study MMS 2008b-042, pp 67–92
Schempf FJ (2007) Pioneering offshore: the early years. Offshore Energy Center, Houston
Truman HS (1945a) Executive order 9633—reserving and placing certain resources of the continental shelf under the control and jurisdiction of the secretary of the interior. Online by Peters G, Woolley JT, The American presidency project. http://www.presidency.ucsb.edu/ws/?pid=60676
Truman HS (1945b). Proclamation 2667—Policy of the United States with respect to the natural resources of the subsoil and sea bed of the continental shelf. Online by Peters G, Woolley JT, The American presidency project. http://www.presidency.ucsb.edu/ws/?pid=12332
United States v. Louisiana, Texas, Mississippi, Alabama, and Florida, 363 U.S. 121 (1960)
Watts M (2014) Oil frontiers: the Niger Delta and the Gulf of Mexico. In: Barrett R, Worden D (eds) Oil culture. University of Minnesota Press, Minneapolis