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From Oxen to Slaves: A Brief History of the Animal-Powered Paddle Wheeler

By Donald Grady Shomette

During the joint reign of Roman Emperors Valentinian I and Valens, ca. 367 A.D., an anonymous Roman citizen set to parchment a remarkable treatise on military invention entitled *De Rebus Bellicis* ("On Military Matters"). Among the many innovations proposed in this extraordinary work, which described a number of fanciful devices designed to save the empire from the growing tide of barbarian invasions, was that of the *Liburna*, an oxen-powered seagoing battle ram, the first known vessel in history designed to employ paddle wheels as a means of propulsion. It was also the first vessel to utilize animal strength as a direct source of motive power for a vessel. The principle was simple. Three tethered oxen, walking on a treadmill, turned capstans, providing the force. The vessel was propelled by means of a simple pair of gears, which harnessed the power that rotated six paddle wheels

The Roman oxen-powered Liburna. *Bodelian Library, Oxford, England.*

By the time of the *Liburna* concept, the origins of the paddle wheel were already well lodged in antiquity. The earliest known mention of the paddle wheel is in a work called *Pneumatics*, written by Philon of Byzantium ca. 250 B.C., which described the principle of the undershot water wheel and of putting the energy of running water to practical use. Philon presented for the first time a practical application of the idea: a chain of buckets driven by an undershot water wheel with a series of spoon-shaped spokes arranged in a circle around the hub. In introducing this water-hoisting apparatus, he remarks that the wheel "can be applied to many other uses." And in describing one of the model water wheels he says it had around its rim "openings like the openings of water wheels without paddles," implying that water wheels with paddles were already well known.

The adoption of the paddle wheel for propulsion as presented in the *Liburna* plan was the first to reverse the use of the paddle wheel, to generate motive force *through* water instead of *from* water. Although it is uncertain whether the oxen-powered *Liburna* was ever built, there is some indication that it was used in the last days of the Roman Empire when it was reported that the legions of Claudius Caudex "were taken to Sicily in

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boats propelled by paddle wheels driven by oxen."

Paddle-wheeled water transport became common soon afterward, probably about the fifth or sixth century A.D. in the Far East. The earliest certain evidence is a record concerning Li Kao, governor of Hungchao, in 783 A.D.

> Li Kao, always eager about ingenious machines, caused naval vessels to be constructed, each of which had two wheels attached to the side of the boat, and made to revolve by treadmills. These ships moved like the wind, raising waves as if sails were set.

By the early 12th century, Chinese paddle-wheeled battle ships were being frequently employed in a naval arms race set in a protracted civil war. Much of the fighting centered on the control of strategic inland waters, rivers and lakes, for which paddleboats, powered by the legs of their crews and not dependent on the wind, were ideal. These ships increased in size, some approaching several hundred feet in length. Some were capable of carrying 700 to 800 hundred men apiece and were propelled by the energy of more than twenty men on treadmills or turning capstans. By the end of the wars, both sides had reportedly fielded thousands of such vessels, but with the end of hostilities, paddleboats in China soon went out of favor.

In the west, the concept of the paddle wheel for propulsion would have to await the dawn of the Renaissance before it would again be revived, and then only in a few early theoretical treatises on warfare. In the 13th century, the English inventor Roger Bacon toyed with the concept, while in 1328, Guido de Vigevano, advisor to King Philip V of Valois, produced a military treatise to aid an expedition to the Holy Land. Here we again see the use of paddle wheels for the propulsion of a purely military vessel. The vessel, probably a small boat, was to be held up by floats formed of casks but was also fitted with paddles moved by handles. Vigevano described the whole process of construction of the vessel, which was unique in that it could be broken down *en fagot*, or into bundles, and transported piecemeal on the backs of horses.

About 1405, in a treatise by Konrad Kyeser dedicated to Emperor Ruprecht of the Palatinate, we again see details for paddle-wheel ships as well as ships mounted on wheels moved overland by an internal crank, sometimes propelled by a horse-driven wheel.

A quarter of a century later, military vessels with four paddle wheels mounted on crankshafts and turned by four men covered by a protective roof festooned with portholes, are pictured in several treatises. The use of the paddle wheel to propel a vessel along was soon being explored, primarily for use on canals and rivers. In

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1450, one Renaissance engineer illustrated paddle wheels harnessing a river's current, which served to wind up a rope around their shaft. This rope, tethered upstream, pulled the vessel forward.

In 1472, Robertus Valturius, in a treatise published in Verona entitled *De re militari*, presents us with a work addressing an illustration by Matteo de Pastis in which two vessels are pictured, one with five pairs of paddles mounted on coupled crankshafts, presumably turned by human strength.

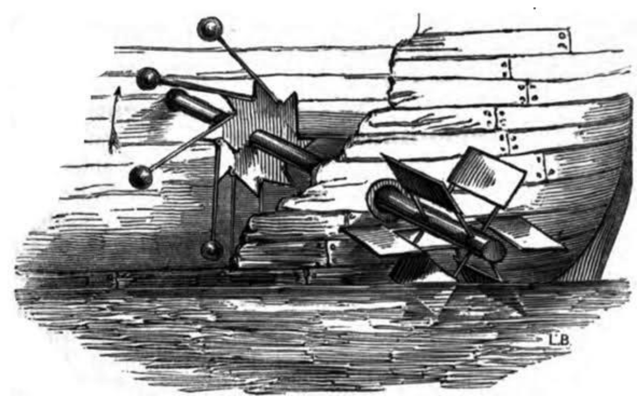
As the Renaissance took root, the concept of paddle-wheeled propulsion grew in popularity among such thinkers as Leonardo da Vinci, Marcus Pollio Vitruvius, and Agostino Ramelli. In 1500, Da Vinci, who is credited with such wonderful inventions as the water-powered clam dredge, land cars moved by wheels and cogs, and the double-hulled ship, also presents us with a paddle-wheeled vessel driven by humans. The paddle wheel had come of age, if not in practical terms, at least in the fertile minds of the Renaissance thinkers and artists. It can be no accident that in Raphael's 1514 masterpiece *Galatea*, we see a nymph supplementing dolphin power with an auxiliary paddle wheel.

Not since Roman times, however, had a paddle-wheeled vessel ever been fielded in the West. Indeed, not until 1543 would its first field test be undertaken, and then not by a theoretician but by a practical mariner. In that year, one Blasco de Garay submitted to Emperor Carlos V of Spain a plan to move ships without the aid of oars or sail. De Garay's plan called for outfitting the 109-ton ship *Trinidad* with paddle wheels to be turned by a windlass powered by twenty-five men. Under the command of Captain Pedro de Scarza, the experiment was successfully concluded in Barcelona harbor on June 17, with the ship reaching a speed of 3.5 knots.

Despite the success of *Trinidad*, the concept was considered little more than a curiosity. In 1552, a copy of the anonymous Roman inventor's 4th-century *Liburna* plan was published in Basle, Switzerland, but drew only minor interest. Not until 1576 would field experiments be renewed, this time by a Dutch admiral named Boisot, who constructed a double-hulled vessel called *Caste of Delft* for testing. The vessel was propelled by a centrally placed paddle wheel geared to a windlass turned by a dozen men. Its success is unknown, but presumably the effort was not ignored, for two years later the Englishman William Bourne published a work on propelling vessels by paddle wheels powered by oxen, horses, or men.

The military value of such innovative thinking was clear. In 1588, the Italian engineer Agostino Ramelli published a plan for a flat-bottomed amphibious boat equipped with wheels and paddle wheels on each side that were moved by a winch turned by a man inside the vessel. The vehicle was actually more of a composite amphibious assault ship and tank to be used in crossing defensive moats. When together linked with others of its kind, it provided a sheltered tunnel leading to breaches in enemy defense works.

Nearly a century would pass before the English would again enter the invention fray. In 1661, Edward, Marquis of Worcester obtained a patent to make "a boate that roweth, draweth or letteth, even against winde or streame," in which "the force of the winde or stream causeth its mocon." Two years later, he designed "a vessel of a great burthen as the river can beare, to go against the streame." The vessel was to be towed with a rope fastened upstream and worked by means of paddle wheels. It was clearly little more than a reiteration of ideas put forth nearly two centuries earlier. It is unknown if the vessel was ever built.



Detail of Blasco de Garay's Trinidad paddle assemblage. Museu Maritim de Barcelona, Barcelona, Spain.

In 1682, Prince Rupert of the Rhine, First Lord of the Admiralty of England (who may have been inspired by seeing a drawing of the Roman *Liburna* in a German manuscript copy of *De Rebus Bellicis*) built a horse-powered paddleboat, which drew 4.5 feet of water and was propelled by four, six, or eight horses. In a contest conducted on the Thames River, Rupert's vessel easily outstripped the king's royal barge, rowed by sixteen men. The Admiralty, however, considered the experimental vessel far too expensive for practical application. The concept was quietly shelved, and the experimental horse boat was employed thereafter as a navy towboat at Chatham.

The English persisted in their experimentation. In 1696, Thomas Savery obtained a patent for his "new invencon, for rowing of ships with greater ease and expedicon than hath hitherto been done." Savery's design called for propelling the ship by means of paddle wheels turned by men at a capstan. He pressed his concept with the Admiralty but was soundly rejected by the conservative-thinking high command of the Royal Navy. Undismayed, Savery published a pamphlet on his invention in 1698 in an effort to reverse the navy's opinion, but to no avail.

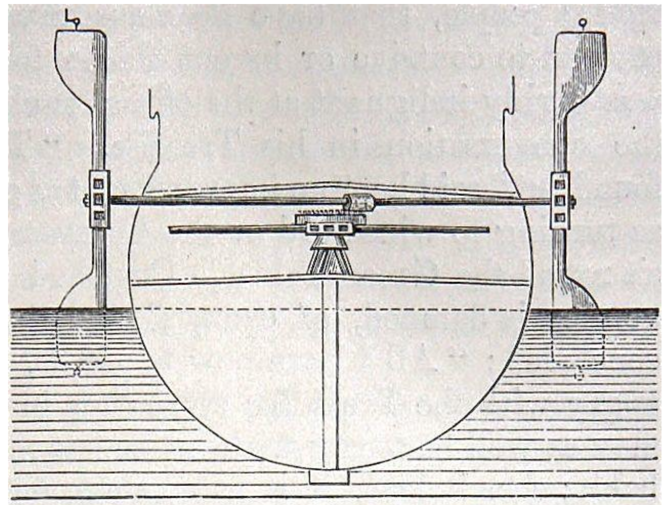
By this time, the French had begun to experiment with paddle wheelers and soon took a commanding lead not only in theoretical development, but also in practical application. In 1693, J. M. de Chazelles began experimentation with a paddle-wheel boat driven by manpower, and on February 12 successfully concluded his field tests at Marseilles. But his work, too, was largely ignored. In 1707, the French physician Denis Papin constructed a paddleboat driven by human strength and tested on the Fulda River in Germany. The tests were successfully completed, but again recognition was not forthcoming.

Seven years later, a French inventor named Duquet proposed a unique variant of an accepted power source: wind. His plan called for the mounting of turntable windmills on the deck of a ship to drive a pair of paddle wheels. Although the concept seemed sound, experimentation would not be carried out for another two years and half a world away in America. But the principle of paddle-wheel propulsion would continue to be sporadically toyed with by the French for years to come. In 1732, for instance, the Count of Saxe developed his own scheme for a vessel powered by horses turning paddle wheels located on the side of a boat. It was a plan that varied little from the horse-powered paddle-wheeled vessels that would one day be found on many rivers and lakes in America.

In 1753, the Swiss mathematician and physicist Daniel Bernoulli, an authority on hydrodynamics and ship propulsion, entered a competition sponsored by the Paris Academy of Sciences for the best manner of propelling boats without wind. Bernoullli proposed that vessels of 100 tons be fitted with six wheels six feet in diameter, with propeller blades of iron mounted on shafts on both sides of vessels at the stern to act in the water. Horses or humans could turn the wheels.

In 1785, Benjamin Franklin considered the use of paddle wheels immersed in water up to the axle at the stern of a vessel, and engaged the idea of using pumps to take water in at the bow and discharge it from the stern to move the paddles and the boat along.

The English again took up the contest in October 1786, when Patrick Miller, of Dalswinton, England, launched a tri-hulled ship named *Edinburgh* at Leith. This vessel consisted of three hulls held together by cross beams. Each hull had its own rudder. Three tillers were moved by a central management system. *Edinburgh* was fitted with two paddle wheels six feet in diameter and four feet wide. The ship was 73 feet 3 inches in length and 22 feet 6 inches abeam. Her paddles were operated by manual power. One of the unique improvements in design was the ability to raise



SECTION OF SAVERY'S PADDLE-BOAT.

Savery's paddleboat.
Library of Congress, Washington, D.C.

and lower the paddle wheels in the water. As a backup, in case the paddle wheels failed, Miller had three sails mounted on the ship. In June 1787, *Edinburgh* was successfully tested on the Firth of Forth, apparently along with a second vessel, an unnamed double-hulled paddle wheeler. The twin-hulled vessel was 60 feet in length, 14 feet 6 inches abeam, and also carried three masts. A five-bar capstan turned her single paddle. With five men at the capstan, she attained a maximum speed of four miles per hour. In 1789, Miller's paddle wheeler had the distinction of making the first known open sea voyage of a man-powered paddle wheeler when she successfully crossed the North Sea and Baltic Sea to arrive safely in Sweden.

At the very moment Miller labored with his invention on the Firth of Forth, an almost identical, albeit smaller, twin-hulled paddle wheeler was being developed across the Atlantic by the brilliant American inventor John Fitch and his collaborator Henry Voight. The Fitch-Voight team differed from their predecessors in that they designed and fielded the first commercially operated animal-powered paddle wheeler in history, a vessel operated on the Delaware River. The design employed a catamaran hull, with the paddle wheel mounted between the two hulls. It was initially powered by four oxen. Colonel John Stevens noted that when the vessel was first tested, "she appeared to get along with some reputation" against the tide.

Though unofficially acknowledged as inventor of the so-called "cattle" boat by the Director of the U.S. Patent Office William Thornton, Fitch soon parted ways with Voight after selling him the rights to the boat design for a bottle of ale. In 1791, Voight obtained a patent issued by the United States Government. Fitch, however, refused to surrender his claim and on April 11, 1795, sold 4/10 of the patent rights to his proposed paddle-wheeled cattle or horse ferry operation on the North and Raritan rivers to Colonel Stevens. Voight protested that he had full rights to the craft. Undismayed, Fitch pressed Stevens for financial support to open a regular ferry service on the North River and began to explore the concept of opening a cattle or horse boat link between Albany and New York City. Stevens was non-committal. Fitch, already deeply immersed in experiments with steam-driven vessels (as he had since 1787 an exclusive grant from the New York legislature to run steamboats on the Hudson), abandoned the cattle boat project altogether to focus entirely on the invention of the steamboat.

If the legend is true, Fitch's main objective in life—the fielding of the first steamboat in history—came to fruition in 1797 on the Old Collection Pond on Manhattan Island when he operated for the first time a steam-powered vessel. Onboard his new craft, according to later testimony, was a wealthy and powerful New Yorker, Chancellor Robert R. Livingston, and his inventor protégé, Robert Fulton. The rest is well known history. Fitch, of course, failed in his commercial aspirations for both the horse boat and the steamboat. And Robert Fulton, with Livingston's support, proceeded not only with the development and improvement of the steamboat, but with a very-nearly-successful scheme to monopolize steamboat transportation in America. Fulton's monopolizing efforts, however, produced one very important and unforeseen side effect: the wide acceptance and development of the animal-powered paddle wheeler, soon to be dubbed the "teamboat," as an alternative, less expensive mode of transportation on the rivers and lakes of North America.

As the concept of steam-powered vessels seized the public's imagination, the less glamorous teamboat appealed to its practical side. Shut off from the steamboat by the Fulton monopoly, independent inventors across the new nation began to embrace the teamboat as a viable alternative. Indeed, a deluge of patent applications flooded the infant U.S. Patent Office, and between 1793 and 1821 at least twenty patents for animal-powered vessels or component parts were issued.

Yet it was not until the spring of 1814 that the first documented horse-propelled ferryboat entered regular service between Brooklyn and New York City, specifically to compete with Robert Fulton's and William Cutting's New York and Brooklyn Steamboat Ferry Associates, which had been scheduled to initiate ferry service in the fall of that year. The St. Catherine Street Ferry teamboat had been constructed by one Moses Rogers, a veteran steamboat captain who, it has been argued by some, once briefly commanded Fulton's steamboat *Clermont*, and would later command the *Phoenix*, the first American steamer to make an oceanic voyage. In 1818 he would command the steamship *Savannah* on the first transoceanic steamboat voyage in history. It is thus not surprising, given his acknowledged smile by Dame Fortune, that Roger's teamboat, driven by eight horses walking a treadmill, was destined for instant success. On its first day of service, the Catherine Street Ferry made twelve runs between Manhattan and Brooklyn, averaging between eight and eighteen minutes each and carrying an average of 200 passengers each trip. Its incredible peak load was 543 people.

The success of the St. Catherine Street Ferry soon spawned many imitators. The first of these was the teamboat *Williamsburg*, which was constructed at the yard of Charles Browne and slid down the ways on June 14, 1814. *Williamsburg* entered service between Corlears Hook and Williamsburg, Long Island, soon after. Fulton's ferryboat had yet to light her boilers and was already in danger of losing the race for customers by default. Fulton's steam ferry *Nassau* did not finally begin in service until the following September. When it did, it garnered an immediate barrage of criticism in the press for its noisy engine, the dirty billows of smoke it generated, and its frequent breakdowns.

Fulton persisted, however, and aggressively pressed to expand his monopoly of the steamboat nationwide, forcing many potential competitors to fall back upon the increasingly popular teamboat as an alternative. In 1815, Colonel John Stevens, belatedly embracing Fitch's concept and forced to deal with Fulton's monopoly, launched his own tri-hulled, 90-foot teamboat ferry service between Hoboken, New Jersey and Manhattan. The three hulls were fastened together with spaces between them to accommodate paddle wheels.

The teamboat was literally off and running, its use spreading north along the Hudson, south into the Delaware, and west into the Ohio country. In 1816, the first teamboat operations began on the upper Hudson at Newburgh, and news of its success had soon penetrated to the Champlain Valley and into Canada. In late 1815, a Nova Scotia company, originally founded as the Halifax Steamboat Company to ferry freight and passengers between Halifax and Dartmouth, dispatched Robert Tremain to New York and Philadelphia to determine which mode of transportation was more efficient and profitable, the steamboat or teamboat. Tremain returned convinced that it was the teamboat. Such vessels could be built for less than $4,500, could operate effectively in waters with currents of over four knots and, unlike the expensive steam engines on Fulton's boats, required little upkeep. And, if necessary,

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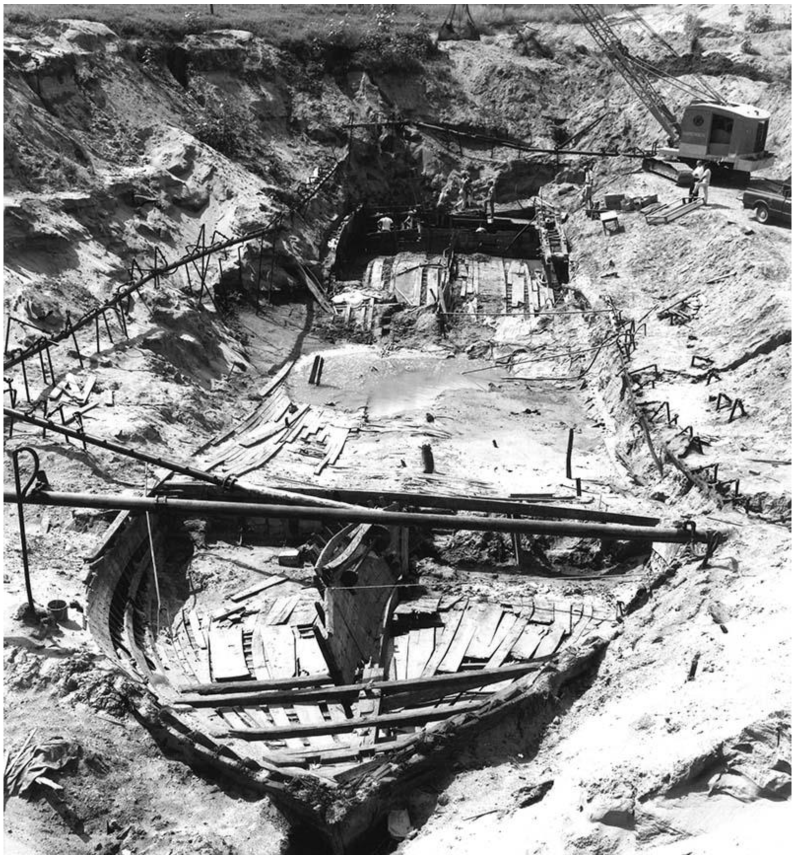
The *Bertrand*: Nebraska's Gift to Shipwreck Archaeology

by Daniel J. Lenihan

Terms like 'shipwreck archaeology' and 'maritime preservation' don't often elicit thoughts of Nebraska. But therein extend some of the deepest roots of maritime archaeology in the Americas—30 feet deep to be exact-—in a cornfield in the Desoto Wildlife Refuge, a mile or so from the present bed of the Missouri River. In 1968, two salvors, Jesse Pursell and Sam Corbino used a magnetometer to find the wreck of the steamboat *Bertrand.* The vessel had, 103 years earlier, hit a 'snag' (part of a sunken tree) and sank on April 1, 1865—just a few days before Lee's surrender at Appomattox. Before sinking, the steamboat was run into the mud bank so most passengers could step off without getting their feet wet. This was in sharp contrast to the horrific demise 26 days later of *Sultana,* another river steamboat, near Memphis. *Sultana* sank due a boiler explosion resulting in almost as many fatalities as RMS *Titanic* in 1912.



The paddle wheel steamboat Bertrand excavated in 1969 in the DeSoto National Wildlife Refuge upstream from Omaha, Nebraska. Original photo credit: Woodman of the World Magazine. Omaha, Nebraska.

Traditionally, we refer to vessels made for riverways and the Great Lakes as 'boats.' Riverboats are built for shallow water navigation. Their capacity tends to be concentrated above the water surface rather than in a deep hull. They carried cargo and passengers equal to seagoing vessels, while maintaining a shallow draft. The inherent problem with river travel is overcoming the current on the upstream leg of any two-way journey. Before the steam engine, downriver travel was often on raft-like craft that could be recycled as cut timber at journey's end. The physics of steam expansion enabled huge pistons to churn paddle wheels against the current, propelling large vessels upstream. The wheels could be mounted on each side of the hull or, like *Bertrand,* a single large wheel at the stern. This application of steam technology was particularly important to the eastern states, rich in rivers where steamboats greatly accelerated the nation's growth.

The remains of *Bertrand* were lost to memory after initial salvage attempts. It came back to public attention in the mid-20th century when found by Pursell and Corbino. But rivers aren't passive waterbodies; the Missouri had reshaped itself during the 103 intervening years, hence the overlying cornfield and thirty feet of silt and gravel. Also, the question of '*who owns antiquities'* was being redefined. The Antiquities Act of 1906 offered protection to remnants of the past on public lands, and in 1916 another act created the National Park Service (NPS), which became the nation's lead agency in historic preservation. Much of this whole mélange of law and policy was rearticulated in the 1966 Historic Preservation Act, only two years before *Bertrand* was found.

Treasure hunters were already tearing up the Spanish maritime heritage sites offshore of Florida, but the salvage of antiquities from *Bertrand* in Nebraska took on a different feel. There was little doubt this shipwreck was in U.S. waters, and the salvors were admittedly motivated by the potential for treasure—including mercury for refining gold; their interests were straightforward and easy to understand.

The conundrum presented by salvage versus archaeology was understandable. People were motivated to find lost things and hoped to profit from them. All federal agencies representing the public at large are expected to protect vestiges of the past for a public in the future. American archaeologists, however, considered themselves prehistorians. They were largely remiss regarding their responsibility to speak not only for

Bertrand excavation in progress. Large pipes are part of the system of well points used to keep the excavation dry. Original photo credit: United States Department of the Interior. Cecil W. Stoughton, 1969.

historical shipwrecks but post-Columbus sites in general. The Society for Historical Archaeology was created only a year before *Bertrand* was found (1967), partly to address this issue—it included an Advisory Council on Underwater Archaeology. But, from the perspective of this archaeologist, all these contradictions were addressed with reasonable grace and forbearance…in Nebraska.

The Midwest Archaeological Center (MWAC) of the NPS in Lincoln was given archaeological control of the excavation of *Bertrand*, but the principal investigator was an historical architect named Jerome Petsche, from the NPS Washington Office. *Bertrand*, over a hundred years old, was being excavated through General Services Administration contract with the U.S. Bureau of Sport Fisheries a (predecessor of U.S. Fish and Wildlife Service [USFWS]). They followed no precedents for

Artifacts from the Bertrand excavation. Below, the shirt shows the degree of preservation at the site. Original photo credit: United States Department of the Interior. Cecil W. Stoughton, 1969.

shipwreck excavation because, well, there weren't any. This is clearly not the way it would happen now—but it wasn't now, it was then. The individuals involved were dealing with glitches in law and practice concerning the historical value of shipwrecks in the U.S.—most of which were corrected by later legislation.

There were no models for shipwreck excavation in the U.S. and the disastrous consequences of that reality were already unfolding a few hundred miles away. Namely, with the Civil War gunboat *Cairo* on the Yazoo River near Vicksburg. *Cairo* was literally pulled apart by a combination of salvors and Civil War historians before NPS was given control. This was a different but related story. Put aside for a moment any thoughts of 'underwater archaeology' or the way it would be done today. What was remarkable, in the case of *Bertrand*, whose hull lay so far beneath the land surface, was that water flooded any newly opened cavity. To avoid flooding while heavy machinery, including bulldozers, removed soil overburden, Petsche drilled a system of well points (more than 200 of them) around the hull.

Model of Bertrand at the Steamboat Bertrand *Museum, Desoto National Wildlife Refuge. Image from Bill Whittaker, Wikipedia.*

Water was pumped out and away from the site before it hampered excavation. As long as the well points kept pumping, you were more likely to be run over by a historical architect on a bulldozer than have an underwater archaeologist swim by. Petsche, under the archaeological oversight of Wil Husted and the MWAC, led the excavation and delivered a complete report in 1974. It was all in keeping with the unfit mélange of inappropriate legislation they operated under. But within that context the salvors acted lawfully and the professionals acted…professionally.

The *Bertrand* excavation marked a turning point for archaeology in a maritime context. The principal investigator was a historical architect working on a comparatively intact shipwreck, but he stayed in communication with competent land archaeologists at MWAC. Petsche also acknowledged contacts given him by George Fischer, an NPS archaeologist then beginning to specialize in shipwreck work. Fischer also "…spent several days with us in the mud and 100-degree temperatures…"

From my perspective a half century later, it seems Petsche understood how to care for historic fabric, was equipped to map historic structures, was motivated to study what he didn't know, and had the energy and savvy to put together a timely project and write a useful report—*The Steamboat Bertrand: History, Excavation and Architecture*. Almost equally important, the Foreword and Preface of the *Bertrand* report were written by Secretary of the Interior, Rogers Morton, and Director of the NPS, Ron Walker. That was important. Key figures in historic preservation on an international level wrote of the importance of a shipwreck lying in the muck-filled former channel of the Missouri river in Nebraska.

Archaeologists, including me, are inclined to turn red at the thought of salvors and architects indulging in this sort of thing. How Nebraska and NPS and USFWS dealt with it are not simple things. It wouldn't be done that way now—but again, it wasn't now, it was then. It's a result that, in context, is hard to argue with. And the story didn't stop there. In June 2011, the remains of *Bertrand*, then residing in a USFWS visitor center was threatened by a flooding event. The USFWS was supported by the help of many citizen volunteers who rolled up their sleeves and quickly packed and removed the salvaged cargo to safer quarters.

Left alone in place or removed, shipwrecks like any material remains, never end up in truly stable environments—just different ones. Taking antiquities from where they have reached a certain level of stability means only that they were taken to someplace judged temporarily secure—consider the wealth of ancient ruins recently destroyed by ISIS in Syria. But history came alive to the USFWS and NPS and its many citizen volunteers who moved the threatened remains before the floodwaters arrived. When the Nebraska public buys into shipwreck archaeology with their sweat, it should be of note and pride to agencies and archaeologists alike.

Daniel Lenihan was the founding chief of the NPS Submerged Resources Center (SRC). He has published several books including Submerged Underwater Wonders of the National Parks: A Diving and Snorkeling Guide *and has co-authored three novels.*

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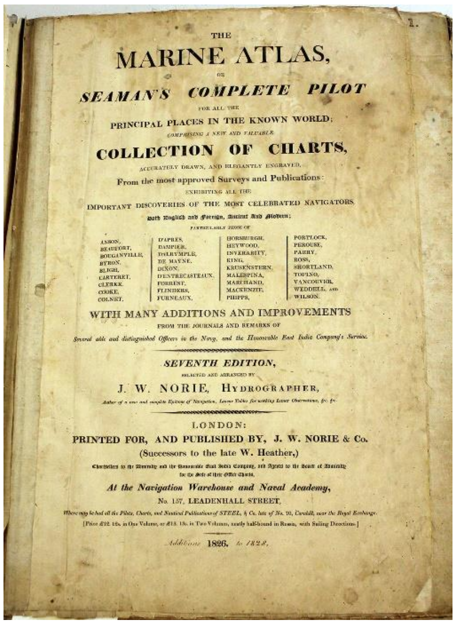
The Smithsonian, the US Navy, and Aquatic Avian Excrement

by Paul F. Johnston

A few years ago, an enormous package arrived at my office via the regular U.S. Mail. Loosely wrapped in brown paper, it had no return address. Opening one end revealed a huge, musty leather-covered book, reminding me of a conversation a year or two before with the US Coast Guard Academy library. That repository had an enormous double elephant folio atlas (book size of 50 inches or greater) of 40 early-19th century sea charts, bound into a single volume dating to 1828. The charts were out of date and of little interest to the Academy library. Would we be interested in a transfer?

The Coast Guard had an old appraisal from the original 1979 gift. It detailed the individual charts and the volume appeared to be complete. I checked downstairs with the Dibner Library, the Smithsonian's rare book library specializing in pre-1840 scientific publications, and they were interested. So, I asked the Coast Guard to send the volume to us at their convenience. Nothing happened for some time, and I forgot about the transaction.



Title page of the 1826 edition of the Norie Marine Atlas with additions to 1828. *Dibner Library, Smithsonian Institution.*

Its arrival reminded me of the earlier correspondence, and I took the book down to the Dibner, where we opened it more fully. It then spent the next year in the conservator's lab, with two maritime volunteers carefully rubbing ground-up pink eraser crumble over front and back surfaces of each blueback chart to clean it of the encrusted salt, stains, grime and inactive mold. It's comforting to know that the things we used and skills we learned in kindergarten are still relevant in today's world!

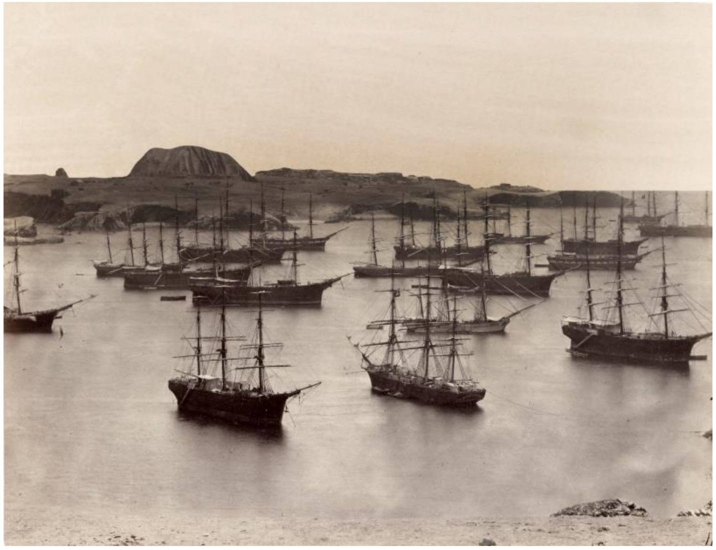
The last two charts in the book had the heaviest usage and wear, with fragments missing in the folds and gutters of the enormous pages. Some handwriting was discovered on those same two charts, which detailed the coasts of Peru and Brazil. The handwriting specified a few ship names, some longitudes and latitudes, and ownership of some islands by specific guano companies.

Figuring that tracking down the ships and the guano companies might lead to information about the original owner(s) of the *Atlas*, we started trying to decipher the handwriting. Immediately some ambiguities appeared, frustratingly in the ship names. However, our conservator had tracked down the bookbinder's ticket in New York and dated it to ca. 1856 from the way the company name was specified. She also had tracked down the chart paper watermark and ascertained that it was the same high-quality British paper used in the printing of Audobon's famous bird series.

At the same time, the Dibner librarian conducted some research and discovered that this turned out to be the world's only known copy of John Norie's *Marine Atlas* in a public institution! Single copies of hydrographer John Norie's charts in several editions were extant in various repositories. But this seventh edition, dating to 1828, was the only known bound copy in public hands. Not only was the volume unique, its charts were absolutely gorgeous, representing the pinnacle of the chartmakers' craft in the early 19th century.

Starting in the late eighteenth century, John William Norie (1772-1843) worked in a London shop selling navigation books, supplies, nautical charts, and instruments. A hydrographer, or scientist of waterways, he taught navigation as early as 1797. In that same year, his employer William Heather published the first *Marine Atlas*, a large bound volume of charts covering the world. When Heather died in 1812, Norie and a partner bought his business, renaming it J. W. Norie & Co. Among his prestigious clients were the British Admiralty and the East India Company, but his best customers were commercial sailors. Norie placed his own imprint on Heather's *Marine Atlas* chart plates and continued to update and publish them. Although Norie died in 1843, his influential book *Norie's Nautical Tables* remained in print as recently as 2007.

Some general background research into the handwriting and the area of the charts it was on revealed that beginning in the early 1840s, the three tiny Chincha Islands off the southern coast of Peru began international sales of their remarkable seabird guano as an almost miraculous fertilizer. What made the Chincha guano so valuable was its nitrate content, higher than any other natural substance known to mankind. The high concentration was caused by the islands' offshore



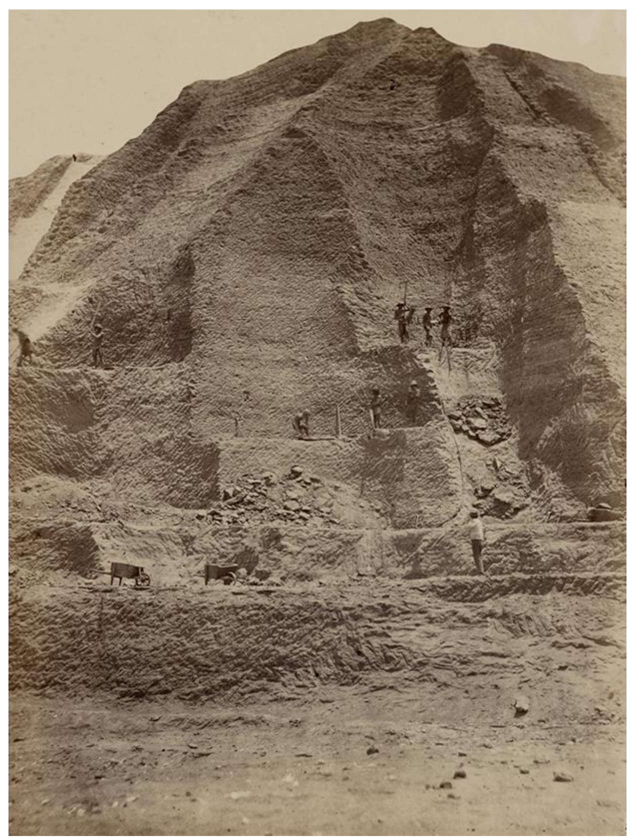
Ships waited as long as eight months at the Chincha Islands for a cargo of the world's richest guano fertilizer. Library of Congress.

location in the middle of the cool Humboldt current bathing them from the north. This chilly, nutrient-rich current kept the Chinchas completely dry. It also filled the local waters with limitless quantities of sardine-like fish, which in turn fed the islands' pelicans, boobies and guanay cormorants. With the offshore isolation, absence of natural predators and plenty of rich seafood, millennia of millions of seabirds had pooped on the islands, and their guano had accumulated to a depth of up to 200 feet in places. The dry air had dessicated the guano and prevented the washing out of the nitrates that made the fertilizer so highly prized. Other tropical islands situated around the Equator in the Pacific and Atlantic Oceans also had lots of guano, but rains had washed out the nitrates.

Germans, French, British and American ships began visiting the Chinchas for cargoes of guano from the early 1840s, and they also sought other guano islands in the remote Pacific and Atlantic islands they could claim for their own. So valuable was the stuff that in 1856 the United States passed the Guano Islands Act (48 U.S. Code Chapter 8). In effect, this law stated that American citizens could claim any guano island in the world as long as it wasn't claimed or occupied by anyone else. Any guano found thereon had to be sold at a low price to U.S. citizens, and American land and naval forces would protect their citizens' rights in this matter. In effect, our nation's first imperialistic claims to lands outside our continent were for bird poop. Or as any properly erudite and credentialed authority might say, "aquatic avian excrement."

Claims began to pour into the State Department, and suddenly the U.S. Navy's Pacific Squadron had a new and quite impossible task: defending American citizens' claims to remote, tiny Pacific guano islands. Many of these claims were conflicting and were—or appeared to be—for the same islands. While defending its citizens' rights in August 1857, the 22-gun warship USS *St. Mary's* visited New Nantucket and Jarvis Islands in the remote Pacific. Her commander Charles Davis collected 17 guano samples that were sent back to Washington, D.C. for analysis.

And this is how the Smithsonian first became involved in the guano business, for the Navy contracted with the Smithsonian's first Secretary, chemist Joseph Henry, to analyze the samples for fertilizer suitability. In late May 1857, Henry sent his analysis under a cover letter to Navy Secretary Isaac Toucey, together with the Smithsonian's invoice for $350.00 for services rendered. Henry's letter synthesized his findings: "…the deposits submitted to examination do not possess the peculiar characteristics of Peruvian guano…and are not equal to it in value…they might be considered as valuable as bone dust, but not generally. They differ from the latter in being almost entirely deficient in nitrogeneous matter, and therefore their importance for agricultural purposes depends upon their mineral ingredients…being the same as the inorganic matter of bones." In more modern language, as fertilizer the poop from these islands was crap, because the nitrates had dissolved out from the regional rain.



Indentured Chinese workers pickaxed the guano from the "Great Heap." Library of Congress.

Guano's properties were so respected that it was made into a homeopathic medicine for human consumption, suggested for use in 1854 for "violent headache as from a band around head. Itching of nostrils, back, thighs, genitals. Symptoms like hay-fever." Smithsonian Institution, National Museum of American History.

By the late 1850s, foreign ships visiting the Chincha islands were waiting up to eight months for their turn to load the precious guano. Some of the most famous American clipper ships, including *Great Republic*, *Challenger*, *King Philip*, *Red Jacket* and their ilk, made guano trips to the Chinchas to avoid deadheading back to the East Coast after dropping off California Gold Rush prospectors.

Once a ship arrived at the Chinchas, she'd anchor offshore to stay off the steep cliffs. At the height of the trade, ships would have boxing matches, rowing races and other diversions to pass the time until their turn. One American ship captain died while awaiting his cargo, and his body was packed in a barrel of guano to preserve it until his ship sailed home to New England. Meanwhile, Chinese miners pickaxed the acrid stuff from "The Great Heap" and used carts on tracks to get it to water's edge. There it went down a "shoot" (sic) to a lighter below, which rowed it out to the anchorage where a ship had offloaded its ballast. Suicide among the impressed Chinese miners was not uncommon, accomplished by throwing themselves over the high cliffs to the sea-whipped rocks below; some 90,000 Chinese were said to have mined the Chincha Islands.

The shifts for offloading the lighters into the ship holds were limited to 20-minutes to avoid poisoning and/or asphyxiation, and the loaders could emerge from the ship holds bleeding from every orifice in their heads. The off-duty crew would use sailcloth to cover the ship's living areas and any other cargoes, and then climb the masts to their highest points to avoid breathing in the billowing clouds of ammoniac guano entering the holds. Often the loading crews competed to see which could load their ship the fastest.

Believed to have been made by Chinese miners from different-colored seabird guano, this intricate example of guano art in a bottle commemorates an early 1880s visit by the Searsport, Maine, ship Henrietta *for a cargo of Chincha Islands guano. By the time of its single voyage to Peru, the islands were almost mined out. Penobscot Marine Museum.*

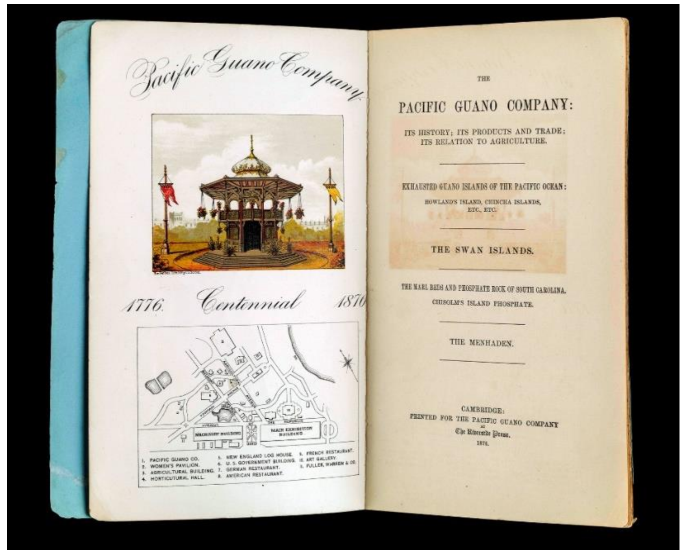
However, there was beauty among the miners as well, as seen by the bottles of guano art produced by the miners and sold to the foreign ship seamen as souvenirs. In this rare art form resembling sand art, different colored ground-up guano grains were poured into bottles with remarkably intricate and detailed scenes and designs. The Penobscot Marine Museum in Searsport, Maine has a beautiful example of the genre, commemorating a Chincha Island visit by the Searsport ship *Henrietta* in 1880. It was such an incongruous artifact of the grisly trade that the question arose as to how they knew it was guano and not sand art. It turned out that the ship's logbook recorded the 1880 Chincha Islands visit and the family of *Henrietta*'s captain had kept the bottle ever since! How many other museums have examples of this unique art form lacking strong provenance, and thus probably identified as sand art? There's an almost identical example at the Museum of the Atlantic in Halifax, Nova Scotia.

The Smithsonian's second Secretary Spencer Baird also was involved with the guano trade, but from a different side. As a naturalist and Commissioner of the US Fish Commission working out of the port of Wood's Hole, Massachusetts, Baird became acquainted with The Pacific Guano Company in the same town. With diminishing and very remote quantities of seabird guano available by the 1870s, the PGC had come up with the idea of eliminating the middleman in the production of fertilizer. After all, what was guano but anchovies processed by seabirds? Bypass the birds and the Pacific Ocean distances, catch the abundant East Coast menhaden, and grind it into fertilizer meal, maybe blend in a little guano for authenticity. Once the PGC figured out how to remove the oil from the menhaden meal, their fertilizer was pretty good. In 1875, Secretary Baird recommended that they display their wares at the 1876 Philadelphia Centennial. The only known sample of 19th century guano is a fist-sized chunk at the Woods Hole Historical Museum from Swan Island, a possession of the PGC.

By 1880, the known stock of rich, natural seabird guano had been mined out pretty much worldwide. However, around the same time, large nitrate and phosphate deposits were discovered on land, and some of the earliest were in Peru and Chile, which already had the infrastructure for mining and distributing guano fertilizer. Moreover, these terrestrial mines could blend their stocks to match different soils, yielding the first synthetic fertilizers. Soon, more deposits were found all over; some, like those in the vicinity of Charlestown, South Carolina remain active today. So, the transition from natural to synthetic fertilizers was relatively seamless, which is why we don't learn about it today. Although 'guano wars' were fought in South America between Chile and Peru, they didn't interrupt the flow of nitrate-rich fertilizer; that's why guano isn't in our history books.

Over the course of time, some 200 islands in the Atlantic & Pacific were claimed for their seabird guano by various interests, but of course they were impossible to track when claims might take six months or longer to get back to Washington, D.C. Claim jumping was common, and some claimants would simply discard any evidence of prior claims on a remote island; load a cargo of guano and plant their own claims. Who was out there to stop them?

Navigational precision was lacking in the 19th century, and many of the small bird-inhabited islands in the remote regions of the globe's waters were hard to pinpoint by longitude and latitude. The US Navy lacked the resources to verify, track and maintain dozens of American claims, and the Civil War and other priorities drew them away from the task. Many distant isles were claimed, and corporations were formed to mine the extract. Some had elaborate bylaws, fancy printed prospectuses, and annual reports. But the smart operators sold their guano island rights before ever even mining the remote island stuff, in an early sort of get-rich-quick Ponzi scheme. Most just vanished without extracting or shipping much—if any--actual guano.



The Pacific Guano Company of Woods Hole, Massachusetts, raised a pavilion at the Centennial Exposition in 1876. Dibner Library, Smithsonian Institution.

However, by the late 19th century the world had ample synthetic fertilizer, so the whole sordid industry died a quick, quiet and agriculturally painless death. But every level of American society was involved, from Congress, the Smithsonian, and the U.S. Navy, to the fast clipper ship captains and the farmers fertilizing their tobacco fields.

The United States still retains nine of the old guano islands, and the Fish & Wildlife Service maintains our sovereignty through occasional visits. And so ended our nation's earliest efforts at imperialism in the purest sense—in a cloud of countless squawking seabirds whose habitats once again are empty of any natural enemies or predators. Today, the government of Peru practices 'crop rotation' around the three Chincha Islands to sustain the guano industry on a very small scale. Today, you can buy Peruvian seabird guano on Amazon, and it still has a very high nitrate content.

Paul F. Johnston is Curator of Maritime History at the Smithsonian's National Museum of American History, and Secretary of the Council of American Maritime Museums.

This article originally appeared in a different format in Sea History. *Used by permission.* ⚓

Retracing Our Ancestors' First Ocean Voyages– Australasian Colonisation Research: Origins of Seafaring to Sahul (ACROSS)

by Helen Farr and Maddy Fowler

A multi-disciplinary team of researchers based at the University of Southampton, U.K., are investigating questions that have long perplexed archaeologists: how and why our ancestors first arrived in Australasia at least 60,000 years ago. Project leader, Helen Farr, has received funding for ACROSS—Australasian Colonisation Research: Origins of Seafaring to Sahul[1], a five-year (2018–2022) project aiming to understand why, after six million years of evolution, our human ancestors took to the sea. For the last 10 years Helen has been looking into the role seafaring played in global colonization by our ancestors.

If boats from tens of thousands of years ago are not preserved in the archaeological record, how do we know that seafaring happened? One of the earliest signs is the archaeological evidence of the first peoples in Australasia. What is exciting is that, depending on sea-level, human settlement of the region could have involved people crossing around 100 kilometres of open water. This is the first undisputed evidence that our ancestors must have used some sort of water transport as they moved out of Africa and colonized the globe. So, what does this mean for our understanding of the skills and technology of the ancestors of Australia's Aboriginal peoples and the story of the peopling of our planet?

Helen Farr discussing the role of seafaring in global colonization. Image courtesy of H. Farr.

The research we are undertaking is interdisciplinary and includes working with colleagues at the National Oceanography Centre, Southampton, to try to understand sea-levels from 60,000 years ago, the paleo-landscape and what the marine environment was like. Were there strong tides and currents, for example? Through an understanding of these factors, we will be able to better recognize the seafaring technology and skill that would have been necessary, as well as to consider intentionality, risk and our ancestors' desire to travel. The project aims to discover how important it was for people to cross into new lands, questioning whether it is human nature to want to travel over the horizon or whether other factors pushed the first seafarers to find new territory or resources.

Besides the marine environmental lines of investigation, ACROSS is working with British institutions including the archaeogenetics laboratory at the University of Huddersfield, in Yorkshire, and the Wellcome Sanger Institute (genomics and genetics), located in Hinxton, outside Cambridge. Access to archives of genetic samples provide another line of investigation into this story. Researchers on the team are looking at the whole genome as well as mitochondrial DNA. We hope this will reveal more about the timing of colonization and routing through the region, leading to new questions about where we should be looking for submerged archaeology.

The project also includes Australian and Island South East Asian partners including the University of Western Australia (Perth), La Trobe University (Melbourne), and the Australian Research Council's Centre of Excellence for Australian Biodiversity and Heritage (University of Wollongong, New South Wales).

Maddy Fowler, an Australian maritime archaeologist with a background in Aboriginal community engagement, has also joined the project. Maddy's role is twofold: first to provide advice for collaborating with Aboriginal and Torres Strait Islander peoples to undertake culturally appropriate and ethically aware research in Australia; and second, to collate oral traditions of Aboriginal peoples on their perceptions and descriptions of arrival in Australia.

The project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program (Grant Agreement No. 759677).

Helen Farr is Lecturer in Archaeology at the University of Southampton. Maddy Fowler is Senior Curator of Maritime Archaeology in the Cultures and Histories Program at the Museum of Tropical Queensland, Townsville. ⚓

[1] Sahul is the technical term for the Australian continent, including mainland Australia, Tasmania, New Guinea, Seram, and neighboring islands.

Hurricane Damage Assessment: Pickles Reef Barrel Wreck Site

by Dennis Knepper, James Smailes, and David Shaw

MAHS has been working in the Florida Keys since June 2010 documenting shipwreck evidence in the Florida Keys National Marine Sanctuary (FKNMS). We have concentrated on a small reef known as Pickles Reef, doing survey work begun at the request of then State Underwater Archaeologist Roger Smith, who asked MAHS to sort out reports of several wreck sites on the reef. Most of the work has focused on a wreck known as the Barrel Wreck.

A major part of this research effort has included the annual MAHS Field School in Underwater Archaeology. For the 2018 season we had planned to work in a new (to us) part of the reef in order to locate and document a separate site, referred to as the Honeydipper, reported by local researcher Chuck Hayes.

In September 2017, however, Hurricane Irma stormed through the Keys causing widespread and catastrophic damage on land. FKNMS asked MAHS to re-visit the Barrel Wreck site to assess underwater damage. And thus, we returned to the site in June 2018 to carry out the survey.

As reported in previous articles in *MAHSNEWS*, the Barrel Wreck site consists of three main elements: the remains of a metal-hulled sailing ship; a group of cement barrel casts lying at one end of the metal wreck that documentary evidence strongly suggests were the result of a separate incident; and a widespread distribution of miscellaneous features lying north and west of the metal wreck—fragments of hull plate, metal deck framing, a metal bulkhead, and additional barrel casts.

In the map we drew of the metal-hulled ship as it appeared in 2016—the last time we worked at the site—the northern end of the wreck appeared relatively intact, with two mast steps attached to a keel assembly and several sections of framing and exterior hull plates in various states of articulation. Extensive marine growth covered much of this part of the site, essentially cementing the features in place. The southern end of the wreck contained unattached metal objects, most of which appeared to be nautical and probably related to the wreck although disconnected from it. Barrel casts occurred in this area, a few lying on parts of the metal wreck, but many scattered in sand to the west and south.

To re-survey the site we used a combination of trilateration mapping and photogrammetry. MAHS employs baseline trilateration as its primary mapping technique. It is a relatively quick and accurate means of generating an overall site map and is the method we teach in the field school. To provide additional detail for this survey we supplemented the mapping with a photogrammetric study of the site conducted by Matt Thompson, a graduate student at Oxford University.

Field school participants conducting baseline trilateration on the Pickles Reef Barrel Wreck as part of the storm damage assessment. All photos by the authors.

Photogrammetry is rapidly becoming an important method of site documentation in terrestrial and underwater archaeology. It is particularly useful in underwater investigations due to the time constraints imposed by diving.

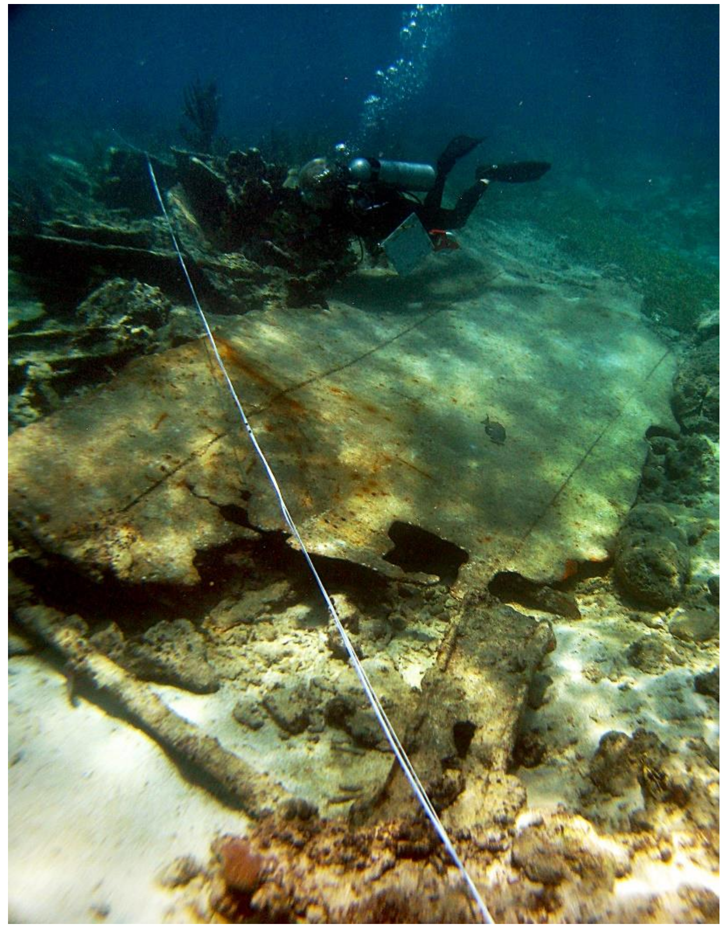
Much of the site appeared to be unchanged following the hurricane. Some scouring was apparent, with sand and loose rubble moved around by waves generated in the storm. But the intact parts of the wreck were still in place showing little or no serious damage, as were several the large features in the area west of the metal wreck, such as the section of deck framing and bulkhead noted earlier.

There were some substantial changes to the site, however, particularly in areas where loose material had been located. For example, a large section of hull plate was found at the south end of the metal wreck in an area that previously contained loose debris. The feature did not look familiar, and we're not sure at this point where on the site it may have originated.

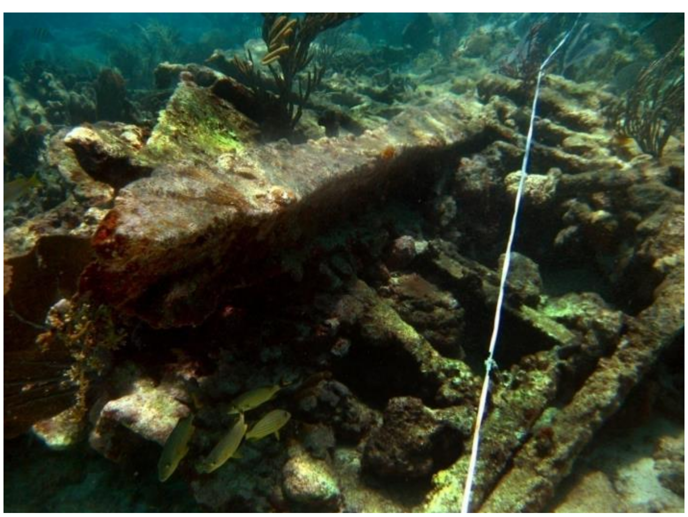
The south end of the keel assembly had been damaged somewhat. The feature was originally thought to have been a single metal I-beam. Following the storm, the beam was seen to have a laminated structure that was separating longitudinally along several joins, presumably after being battered and exposed by wave action. The frames attached to the assembly were still intact, although some of the rubble between the frames had been scoured away.

Some of the gorgonians on the site were shown to be very sturdy. Two in particular appeared in photographs prior to the hurricane, one on one of the mast steps along the keel assembly at the north end of the wreck, another on a hull section nearby. Following the storm both were still in place, seemingly none the worse for wear.

In the end, the damage assessment conducted by MAHS volunteers showed that substantial changes had occurred at the site as a result of the passage of Hurricane Irma in 2017. However, the majority of the metal wreck, being cemented in place, appeared relatively unaffected by the storm. Most of the alteration documented at the site was to small, loose or unattached features such as barrel casts and miscellaneous metal fragments. Photogrammetry results will be added to the MAHS Sketchfab web page. ⚓



A large section of hull plate now lies at the south end of the metal wreck. The feature did not appear to be part of the site prior to passage of the storm.



The south end of the metal wreck showing the keel assembly and attached frames. Left, prior to the storm the keel appears to be a single metal beam; right, after the storm the laminated nature of the assembly is evident.

(*Paddlewheelers*: continued from page 5)

the teamboat could be easily converted to steam power.

Moses Rogers was commissioned to produce a working model of the vessel. Soon, construction work based upon Rogers' plan was underway. On November 8, 1815, with the launching of the teamboat *Sherbrooke* at Halifax, the Halifax Steamboat Company officially changed its name to the Halifax Teamboat Company: the teamboat had arrived in Canada. A specially designed receiving wharf was constructed at both terminal points of the route (a practice that would become common at teamboat landings across North America), and by 1817 the vessel was in full operation. It would continue in service for the next fifteen years. During its life, the treadmill of *Sherbrooke* would be the subject of considerable testing with a variety of livestock, including cattle, horses, and mules. The company would even experiment to determine which types of feed produced the strongest and most durable animals.

By 1817, teamboats services were being employed as far south as the Potomac River where John Shreve's horse-powered ferryboat *Union* ran between Georgetown, D.C., and Alexandria, Virginia, with occasional excursions to Mount Vernon, successfully competing with the Fulton steamer *Washington* for short haul service. At the ferry landing in Alexandria, the elegant Teamboat Hotel was erected to welcome travelers offloading from the splendidly attired ferry. The spread of the teamboat was relentless. By 1819, vessels were in operation as far west as Maysville, Kentucky, and were soon thereafter to be found at many frontier river crossings.

There were, of course, occasional accidents. In 1821, when a drunken passenger fired a small rocket onboard the St. Catherine Street Ferry, the frightened horses became unmanageable, causing the vessel to lose power and to drift south to Governor's Island before being rescued. One of the horses was nearly dragged to death on the treadmill. On many such vessels, passengers whose feet became lodged in gears and rollers or were trampled by horse hooves lost not a few toes. Cruelty to the livestock by the teamsters and passengers was common. Yet such incidents were nothing compared to the horrendous loss of life from accidental boiler explosions and fires that plagued the early days of steamboating.

Patent applications for newer and improved teamboats continued to produce refinements in design. Typical of the lot were designs for a boat and treadmill submitted by Barnabas and Jonathan Langdon in 1819. The Langdons, who had been working on such exotic inventions as steam-powered fire engines, produced a design similar to the unpatented Rogers design, and one which was already widely adopted as the standard, particularly on the Hudson. A description of one such vessel, recorded in 1815 by Dr. Benjamin Silliman of Yale University, documented a teamboat plying between Albany and Troy, New York:

> The ferryboat is of most singular construction. A platform covers a wide flat boat. Underneath the platform, there is a large horizontal solid wheel, which extends to the side of the boat, and there the platform, or deck, is cut through and removed, so as to afford sufficient room, for two horses to stand on the flat surface of the wheel, one horse on each side, and parallel to the gunwale of the boat. The horses are harnessed, in the usual manner for teams – the whiffle tees being attached to stout iron bars, fixed horizontally at a proper height, into posts, which are a part of the fixed position of the boat. The horses look in opposite directions, one to the bow, and the other to the stern; their feet take hold of channels or grooves cut in the wheels, in the direction of radii; they press forward, and, although they advance not, any more than a squirrel, in a revolving cage, or than a spit dog at his work, their feet cause the horizontal wheel to revolve, in a direction opposite to that of their own apparent motion; this, by a connection of cogs, moves two vertical wheels; one on each wing of the boat, and these, being constructed like the paddle wheels of steamboats, produce the same effect, and propel the boat forward. The horses are covered by a roof, furnished with curtains, to protect them in bad weather; and do not appear to labour harder than common draft horses, with a heavy load.

It was not long before the vessel type was being adopted in the Champlain Valley. On October 21, 1821, Charles McNeil of Charlotte, Vermont, and H. H. Ross of Essex, New York, secured the first charter from the Vermont Legislature to begin teamboat operations and ferry service between the two towns. *Eclipse* was a vessel probably quite like that patented by the Langdons, who were residents of Crittenden, Vermont. *Eclipse* would soon be in competition with at least six steam ferries, and many smaller sloop and ferry services. Despite the competition, the company remained in operation for decades, hauling cattle, sheep, horses, and team vehicles. By the 1840s, many ferry routes on Lake Champlain had adopted the use of vessels such as the "superior Horse-Boat *Eagle*" and Ashabel Barnes' teamboat *Gypsy*.

The development of the American teamboat did not go unnoticed in Europe. In 1823, the French Government dispatched Jean Baptiste Marestier to America to observe and report on the progress being made in the field of steamboat development. In his superb study, published the following year, which still stands as a classic in analytic reporting, Marestier produced not only a thorough analysis of the steamboat in America, but as a sidelight, architectural plans and elevations of a double-hulled horse boat and reception facility. Marestier's notes on the teamboat were succinct:

> Horse operated boats are so closely related to double-hulled steamboats that they are naturally described together. Both are designed for crossing rivers and they are constructed on the same principles. They differ only in the nature of their power and size of the platform. Horses replace the steam engine and, in order to provide a circular track for the horses, the deck projects outside the hulls.

The vessel shown in Maretier's plan was 79 feet in length, 39 feet in width, with each hull being 10 feet in width and a distance between them of 10.8 feet. Within a month of the publication of his report, a near duplicate vessel was in operation on a lake in Switzerland.

By 1824, the first teamboats employed for military use were being fielded on the Missouri River by the U.S. Army, which built and deployed them for service as troop transports and freight haulers. The vessel type was becoming common everywhere: teamboats could now be found at such diverse places as Wheeling, Virginia, on the Mississippi River, in the Wisconsin Territory at frontier settlements such as Prairie du Chien, and in mountain lakes of the east such as Lake Winnipesauke, New Hampshire. In Canada, the teamboat concept was also widely embraced and, occasionally, on a grand scale. In 1833, twenty-two horses reportedly powered one large teamboat running across the St. Lawrence between Longueil and Montréal.

In the Deep South, black slaves occasionally powered the teamboat. Indeed, several patents had been granted specifically for human-powered paddle wheelers. One such patent had been granted to William Sprague as early as 1795 and was boasted as a vast improvement over the Fitch design. Variations in the design of the human-powered propulsion system soon began to turn up with some frequency. Some, such as B.S. Doxey's slave-powered ship, patented in 1821, were merely improvements on the original *Liburna* design. Others, such as M. Battel's paddle-wheel towboat, also patented in 1821, powered by men at oars, which turned a system of chains, gears, and cogs attached to the paddle wheel shaft, were more fanciful than practical.

Some inventors in the Deep South, who never bothered with such niceties as patents, experimented on their own. One such inventor was Charles Heyward, member of a prominent South Carolina family of planters, who designed many of his own boats, such as small, steam-powered launches, hand-cranked paddle wheelers, and sailing skiffs. His most unusual craft, similar to Duquet's 1714 proposal, was called the *Contrary*, a paddle wheeler powered by four sails. The sails were set along a circular base and connected to a crank that turned the paddle wheels. The vessel, which was actually built and fielded, proved unstable and subject to capsizing in the wind, as Heyward attested to in his diary.

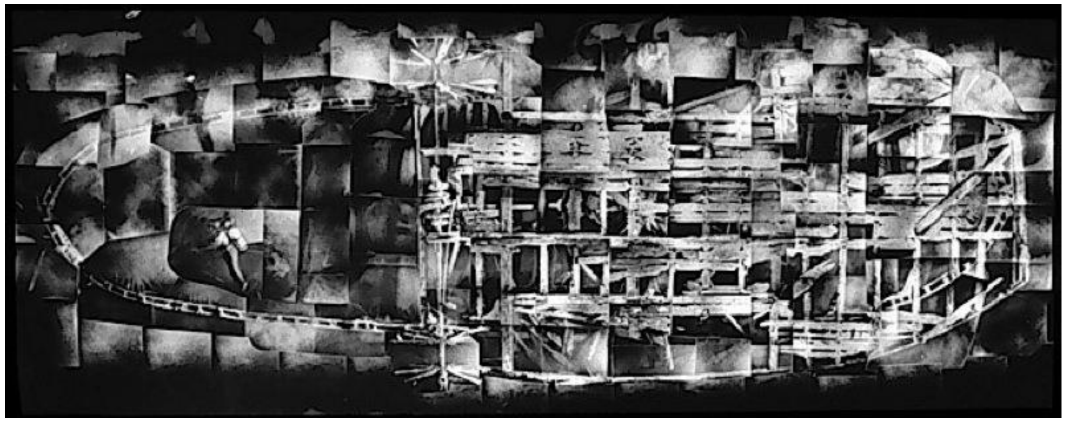
The all too brief heyday of the horse ferry, however, had arrived. Indeed, as one wag wrote in a Long Island newspaper: "Thus in a few years we have witnessed the wonderful improvement from sails to steam, and from steam to animal power."

The teamboat was soon being adopted beyond the border of the United States and Canada. By the 1820s, at least one inter-island horse-powered ferry was in operation between the West Indian islands of St. Kitts and Nevis.

By 1825, when Edward Church, a compatriot of Fulton, arrived in Switzerland to build the first steamboat on Lake Geneva, the *William Tell*, a popular teamboat "of elegant form but somewhat bizarre" in appearance was already in service. The Lake Geneva teamboat featured a catamaran hull, with the paddle wheel mounted between the hulls, and was powered by four horses sheltered beneath a gaily colored and ornamented circus-like tent topped by a bright Swiss pennant. Built of oak and larch at a cost of 75,000 francs, it measured 70 feet in length and 26 feet in width. Unfortunately, the vessel was so slow—it was said that a rowed barge could pass it without any trouble. Rivalry between the steamboat and teamboat on the lake was preordained. On July 22, 1828, after less than three years of competition with the Church steamer, the teamboat was offered for sale. There were no takers, and three months later it was announced the boat would be auctioned off. A funeral eulogy was written by Peter Senn: "*De l'escargot du lac, l'existence est a bout, il allait lentement, il ne va plus du tout*" (The lake snail is at an end, it traveled slowly, it goes no more).

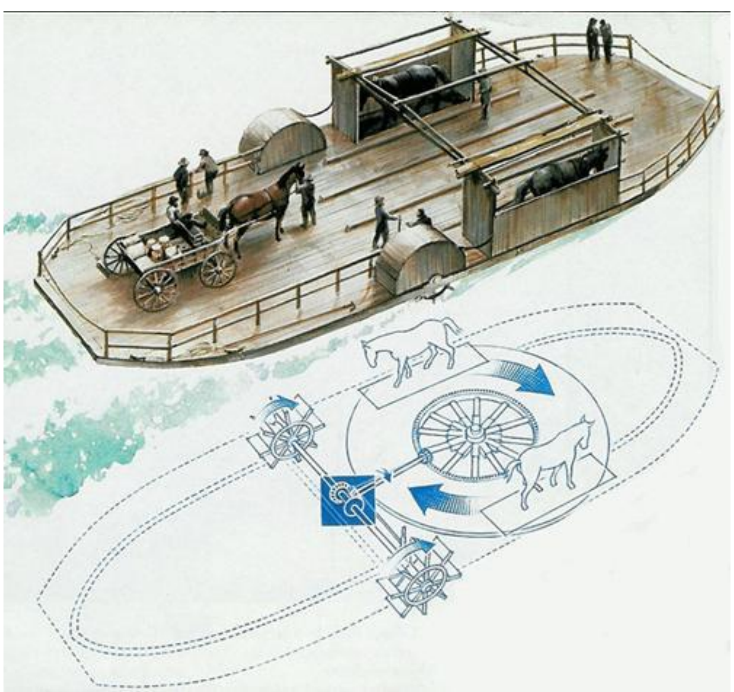
And so it was in the United States as well, although the vessel type continued to maintain ground against the steamboat in many regions of the nation until the 1850s. By the end of the Civil War, however, unable to complete with the size, elegance, carrying capacity, and speed of the ever-improving steamboat, the teamboat in America was destined for extinction. Surviving only in remote or very rural backwaters in the heartland of the nation, the descendants of the colorful *Liburna*, after 1,600 years of experimentation, had finally been overtaken by superior technology. A very few, such as the teamboat at Cassville, Wisconsin, saw a brief transition from horsepower to gasoline engine. Others continued in use in economically depressed areas such as the Mississippi Delta regions. But the end had finally arrived.

In 1921, a single blind mule powered the last known teamboat ferry in America. Built of yellow poplar by Thomas Fisher of Carthage, Tennessee, it was last owned by Hailey Conner before being sold to the Smith County, Tennessee government. Ironically, the boat had for years regularly crossed the Cumberland River to Rome – Tennessee, that is. The price of a crossing had been fifty cents. After its replacement with a steam ferry, the Rome teamboat and its breed soon slipped from memory.



Photomosaic of the Burlington Horse Ferry. Image by Scott Chapman Hill, with Dennis R. Floss and Milt Shares.

In 1983, the physical remains of the only teamboat discovered to date was found in Burlington Bay, Vermont, in forty feet of water by a pair of amateur underwater archaeologists, James Kennard and Scott Hill. The following year, armed with a small grant from the U.S. Department of the Interior and assisted by Donald Mayland and a body of talented volunteers, the team returned to the site to produce a dramatic photomosaic of the entire shipwreck.



Reconstruction of the Burlington Horse Ferry. Illustration by William H. Bond, National Geographic Society.

In February 1988, while serving as principal investigator of a developmental experiment in shipwreck location and survey, I first visited the Burlington teamboat wreck. The project, undertaken by the National Geographic Society, and co-directed by Emory Kristoff, noted photographer of the *Titanic*, was initiated to determine the feasibility of conducting remotely managed sub-ice investigation techniques employing off-the-shelf, short baseline sector scanning sonar mounted on remotely operated vehicles in Lake Champlain during the winter. An additional experiment, managed by the society's technical chief, Claude E. "Pete" Petrone, utilizing a standard ground penetrating radar system, was also undertaken to locate sites through the ice and freshwater column and to assist in the remote sensing operation. A comprehensive scale model of the entirety of the vessel remains was constructed from the Kennard-Hill-Mayland mosaic by our expedition sonar expert, Commander Robert Gwalchmai of the Canadian Navy. The model can now be viewed at the Lake Champlain Marine Museum at Basin Harbor, Vermont. A few months later I returned to the site accompanied by Hill to conduct a hands-on photo recordation of the wreck for an article in *National Geographic Magazine* (October 1989). It was only a beginning.

Now, thanks to the many years of dedicated archaeological recordation and research on the Burlington Teamboat Wreck under the capable direction of Arthur Cohn of the Lake Champlain Maritime Museum, Dr. Kevin Crisman of Texas A&M University, and many, many others, a long-ignored chapter of maritime history has finally been resurrected for all to see, including the construction of wonderful life size reproduction of a vessel that once challenged the very Age of Steam upon the waters.

Donald Shomette is a writer, historian, marine archaeologist and cultural resource manager living in Dunkirk, Maryland. Long a supporter of MAHS, he was instrumental in the development of the MAHS Introduction to Underwater Archaeology course. ⚓

MARITIME ARCHAEOLOGICAL AND HISTORICAL SOCIETY

Statement of Ethics

The Maritime Archaeological and Historical Society is organized for the purpose of enhancing public awareness and appreciation of the significance of submerged cultural resources and the science of maritime archaeology. In pursuit of this mandate, members may come into contact with unique information and cultural material associated with terrestrial and underwater sites containing evidence of the history of humankind. To protect these sites from destruction by commercial salvors and amateur souvenir hunters, the Society seeks to encourage its members to abide by the highest ethical standards. Therefore, as a condition of membership and pursuant to Article 2, Section 1 (A) of the bylaws, the undersigned executes this statement of ethics acknowledging adherence to the standards and policies of the Society, and further agrees as follows:

1. To regard all archaeological sites, artifacts and related information as potentially significant resources in accordance with federal, state, and international law and the principles and standards of contemporary archaeological science.
2. To maintain the confidentiality of the location of archaeological sites.

   To excavate or otherwise disturb an archaeological site solely for the purpose of scientific research conducted under the supervision of a qualified archaeologist operating in accordance with the rules and regulations of federal or foreign governments. Artifacts shall not be removed until their context and provenience have been recorded and only when the artifact and related data have been designated for research, public display or otherwise for the common good.

4. To conduct oneself in a manner that protects the ethical integrity of the member, the archaeological site and theSociety and prevents involvement in criminal violations of applicable vandalism statutes.
5. To observe these standards and aid in securing observance of these standards by fellow members and non-members.
6. To recognize that any member who violates the standards and policies of the Society shall be subject to sanctions and possible expulsion in accordance with Article 2, Section 4 of the bylaws.

Signature ______________________________ Date ________________

MARITIME ARCHAEOLOGICAL AND HISTORICAL SOCIETY
PO Box 44382, L'Enfant Plaza, Washington, D.C. 20026

Application for Membership

Membership in the Maritime Archaeological and Historical Society is open to all persons interested in maritime history or archaeology whether or not they are divers. Members of MAHS have first preference for enrollment in all courses and other activities and projects of the Society. To join MAHS, please sign the Standards of Ethics above and send it to MAHS along with your check and this application form.

Name (print) ______________________________

Address ______________________________

City ______________ **State** ________ **Zip** __________

Phone
(H) ____________ **(O)** ______________ **(FAX)** ______________

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Skills (circle): research/dive/video/communications/writing/first aid/other:

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Please mail this form along with your check to: MAHS at PO Box 44382, L'Enfant Plaza, Washington, D.C., 20026

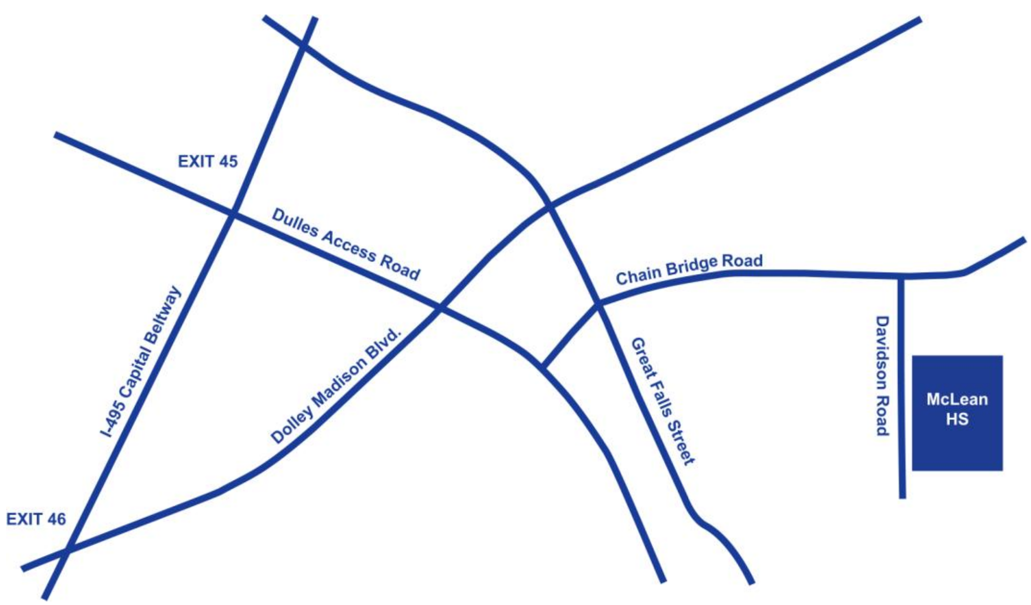
General membership meetings of the Maritime Archaeological and Historical Society are held on a bi-monthly basis, the second Tuesday of each month. Meetings are held at 7:30 p.m. at McLean High School, in McLean, Virginia, except in August and December. Meetings in August and December are held at other locations for special events and holiday parties

Please join us and bring a friend. The school is located on Davidson Road, just inside the Capital Beltway (I-495) – use Exit 45, coming from Maryland, or Exit 46, coming from Virginia.

Check the website www.MAHSNet.org for e-mail advisories about any schedule changes.

Renew Now!

It's time to renew your membership in MAHS. It's easy. Just complete the application form on the inside back cover and sign the Ethics Statement, enclose a check for your dues, and mail! Thank you!



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