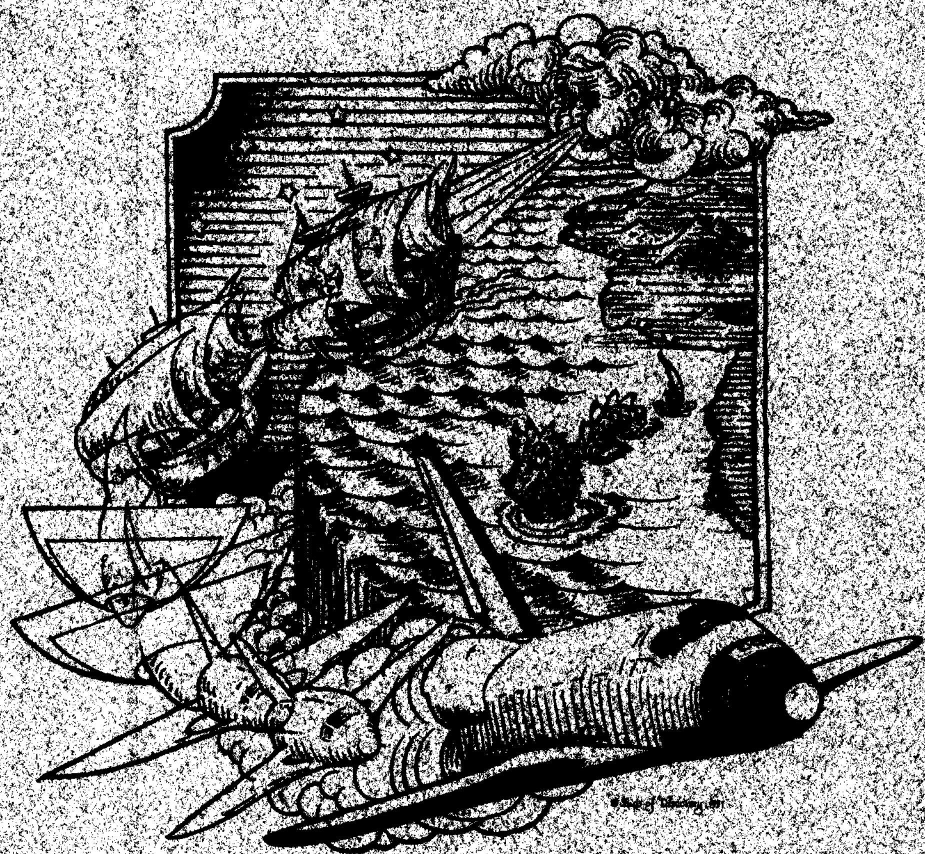
UNDERWATER ARCHAEOLOGY PROCEEDINGS FROM THE SOCIETY FOR HISTORICAL ARCHAEOLOGY CONFERENCE

DONALD H. KEITH AND
TONI L. CARRELL, Editors

1492 - 1992



500 Years of Change

Society for Historical Archaeology
Kingston, Jamaica 1992

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FOREWORD

DONALD H. KEITH

Introductory Remarks

There were a number of remarkable things about the 1992 Conference on Historical and Underwater Archaeology. It was the first conference held outside the United States since the Ottawa meetings of 1977, and (check this) it was one of the best-attended conferences ever held, attracting archaeologists from the U.S., Belize, Mexico, Cuba, Jamaica, Turks and Caicos Islands, Cayman Islands, Canada, Bermuda, Spain, Denmark, Sweden, Scotland, and the Netherlands. Fifty-six underwater papers were presented during the conference; 25 are printed in this volume. Abstracts of the papers were juried before the conference and the papers themselves were refereed before acceptance for publication.

As the cover suggests, the theme of the conference was "1492-1992: 500 years of Change." Two symposia, "Fifteenth- and Sixteenth-Century Ships and Maritime Trade," organized by Robert Grenier, and "Ships of Discovery and the Tide of History," presented by the staff of Ships of Discovery, were devoted specifically to this theme.

Robert Grenier's address to the plenary session entitled "The Northern Route and the Columbus Era," synthesizes and, for the first time, presents a synopsis of the results of a decade of historical and archaeological work by Parks Canada researchers. A truly seminal paper, Grenier's address reveals another instance of academic myopia among historians who have assumed that Europe's interests in and maritime trade with the New World during the 15th and 16th centuries was focused on its tropical regions. Dazzled by the glitter of gold and silver, historians have consistently overlooked the fact that more ships sailed for northern destinations than for southern ones, returning with cargos of whale oil and fish the net worth of which far exceeded the occasional, but dramatic, shipments of bullion and jewels from Central and South America.

An excellent symposium, which is unfortunately not represented in the Proceedings but may be published eventually elsewhere, was "Communicating Your Work: The Archaeologist as Storyteller." Organized by Peter Young, Editor of *Archaeology* magazine, the purpose of the symposium was to sharpen archaeologists' awareness of the importance of being able to communicate effectively with colleagues and the public alike through the available media: scientific and popular articles, films, lectures, and museum exhibits.

Credit for the overall success of the conference belongs to Doug Armstrong and his efficient team from Syracuse University. Local arrangements were capably handled by Jim Parrent of the Institute of Nautical Archaeology. Extra-mural activities during the conference included tours to Spanish Town, Seville National Historic Park, and the drowned city of Port Royal, which sank beneath the waters of Kingston Harbor in 1692.

As Program Chairman for the underwater archaeology portion of the meetings, I would like to thank all those who participated and, in particular, those who organized symposia and presented papers. The cooperation of presenters who followed through all the way, providing copies of their papers in the proper format on magnetic disk, is especially appreciated. My coeditor, Toni Carrell (who must have decided it was easier to do it herself than to teach me how) deserves most of the credit for compiling and editing the Proceedings. Our colleagues in Ships of Discovery, Denise Lakey, Joe Simmons and Jerry Goodale, assisted the editing and the correspondence process. Publication was made possible by generous donations from the sponsors listed on the previous page.

Since 1978, papers concerning underwater archaeology presented at the annual Society for Historical Archaeology meetings have been published in the Proceedings. Regular appearance of the Proceedings within the same year as the

Historical Archaeology has agreed to act as publisher. Our next major goal should be to improve the quality of the papers appearing in the Proceedings. Poorly written and researched papers, or those offering nothing new, should be eliminated in favor of well-written, significant contributions. Most importantly, all papers submitted should be juried by subject matter experts before being considered eligible for publication.

Finally, I would like to acknowledge the passing of Isaac Asimov, whose speculative fiction classic *Foundation* served as the inspiration for the symposium presented by Ships of Discovery. He was not an anthropologist, but anthropology could learn a lot from him.

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PLENARY ADDRESS

ROBERT GRENIER

The Northern Route and the Columbus Era

As we gather to commemorate the quincentennial of the controversial discovery or rediscovery of America by Christopher Columbus, I would like to register my sadness at the poor state of our knowledge, 500 years later, on the seafaring and shipbuilding techniques of the period. I would also like to reflect on the mistreatment and misconception associated with the role and importance of North Atlantic seafaring activities around the New Found Land, going back at least 500 years prior to the discoveries of Columbus.

Seafaring and Shipbuilding

It is a well known fact that we know more about shipbuilding techniques and concepts in Classical Greek and Roman times, as well as in the Viking Ages, than we know about ships of the Middle Ages and the Renaissance. Only in the last decade and a half have we started to discover and properly record, analyze and understand a few significant ships of these later periods, ships linked to the Age of Discovery and early exploitation of the New World. We can list the very limited remains associated with the Padre Island wrecks, the Molasses Reef wreck, the Highborn Cay wreck, a few Spanish Armada wrecks, the Studland Bay wreck, and, more recently, a late 16th-century wreck off Bermuda. Huge vessels like the *Mary Rose* and the wreck of a Genoese carrack in Ville-Franche, France, although helpful, are not truly indicative of the workhorses of the period, the 60- to 300-ton transatlantic merchantmen and fishing ships. These vessels were the ones needed to explore, carry men, food, supplies, and newly found resources to and from an expanding Europe.

Such were the three 16th-century Basque whaling ships found in Red Bay, Labrador, in the late 1970s and the early 1980s. One, believed to be the *San Juan*, but not yet positively identified, remains the most complete and best preserved witness anywhere of the importance of the mid-16th century in the evolution of shipbuilding. Although its unusual carved keel, made more or less in the Viking ship style and other carved features, exhibit the last, vanishing remnants of the old dugout boat building technique going back thousands of years, the overall building technique of the Red Bay vessel illustrates a developing stage of frame-first construction usually associated with modern times. This ship, with its free-floating frames, is still partially built with a shell first process. In this case, the shell first construction concept is applied through a system in which use of the outer shell to define the hull lines and hold the frames in place is replaced by a complex network of battens and batten-like planks. This ship illustrates extremely well some of the basic techniques used to build caravels and naos during the 15th and 16th centuries, techniques described by Portuguese and Spanish authors such as Lavanhia, Manuel Fernández, Palacio, and others. The presumed *San Juan* embodies the vision of Basil Greenhill, who wrote not long after its discovery in 1978:

> It is not generally realized in Europe and possibly may not be in Canada, that sometime in the 14th and 15th centuries there appears to have been a fundamental change in the European methods of shipbuilding which resulted in ships capable of undertaking the voyages of exploration in the late 15th and 16th centuries. There are reasons for believing that the area where this "revolution" originated may have been the Atlantic Coast of the Iberian peninsula. It is possible therefore that the wreck in Red Bay may have been built in this crucial period and region, and thus be of great importance to nautical archaeology. The structure of this ship may in fact be archaeologically more valuable than any of the cargo (1978, pers. comm.).

In fact, the so-called *San Juan* has exceeded Greenhill's expectations. Through the wealth of archaeological data recovered and transposed onto the 1:10 archaeological model, we can now perceive that the Basque shipwrights of the 16th century had already achieved a very high degree of sophistication and integration in and between the various components of the shipbuilding trades. It seems that the wood supplies had already been quite standardized in their shapes and sizes so as to simplify the accelerated cutting, shaping, and delivery of timbers as well as assembling the hull. Grouping various components of the wood supplies, as stated in some contracts, seems to correspond to related sequences in the installation of various hull components. These discoveries reinforce our early belief that 16th-century Basques were the Japanese of their time, allying clever designs and efficient processes to build better and faster at less cost.

This short and incomplete review was given to emphasize one sad fact: if such a find can reveal so much on the high technology of the period, on the refinements and advanced efficiency reached at the end of those Dark Ages, why do we have only one "*San Juan*" against so many Viking ships and against several Classical Age ships? Although a round table session held at the SHA meetings in Baltimore in 1989 demonstrated that the basic hull design of the so-called *San Juan* corresponds to Columbus-era ships found in the West Indies, we still don't have a single 15th- or 16th- century caravel find positively identified and analyzed to complete our knowledge. Probably the most significant discovery of the last decade for Columbus-era ships was made on land by the late John Sarsfield. He was the one who discovered in an obscure shipyard of Bahia, Brazil, that some of the Columbus-era techniques of designing caravels with *graminhos* were still being applied, passed down through the ages by oral tradition. I would like here to pay tribute to the late John Sarsfield's major contribution and to hope that someone will complete his unfinished task.

Nothing illustrates better the sad state of our knowledge on shipbuilding of the period than the so-called "replicas" of Columbus's three ships built by Spain for the Quincentennial.

These ships have been built as if nothing has happened since the fourth centennial in 1892. It would seem that no archival or archaeological discovery has been made over the last century. If you look at any photograph of the interior of the 1992 *Pinta* replica, you will actually see the interior of an 18th- to 19th- century ship, with double frames joined to one another and with knees unlike anything found on ships of the Columbus period. Unfortunately, these so-called "faithful replicas" are becoming the bible of Discovery Era ship construction. The Japanese are already building faithful replicas of the Spanish replicas of 1992. Model makers will soon copy them. These replicas negate decades of progress in marine archaeology and in the history of ship design, however limited and lacking this progress may have been.

If we can be sad about our limited knowledge of the ships of the Age of Discovery, I believe a sadder state of affairs exists about the general perception of the role and place of the New Found Land or Island of Bacallaos prior to and after the Age of Discovery.

The New Found Land or the Island/Terra de Bacallaos

When was this New Found Land or Cabot's Terra de Bacallaos really known and who was there first? Let's agree here that this term designates in a loose way a large territory comprising the island of Newfoundland and its surrounding waters, including a large portion of Labrador and the Gulf of St. Lawrence.

Archaeological evidence has shown the presence of a Viking or Norse site at L'Anse-aux-Meadows, on the northern tip of the Great Northern Peninsula of Newfoundland, dating from about A.D. 1000. This site offered evidence of eight mud-walled structures, including a forge. Whether this area is the one known as Vinland or not is irrelevant. Knowledge of the existence and location of this land would have spread throughout the Norse world and outside for the next centuries.

Indeed, a few but telling artifacts suggest continued Norse presence and activity on the southern tip of Baffin Island and also on Devon Island in the 12th and 13th centuries, according to Robert McGhee of the Canadian Museum of Civilization in Ottawa (1991).

Such a presence would precede by a century or two the one described in Scandinavian texts. From then on, we can easily follow on maps the introduction of these mysterious islands across the Atlantic at the beginning of the 15th century. Even on much later maps, the now identified Newfoundland appears as a group of islands.

A few documents seem to indicate that by the early 15th century knowledge of Newfoundland's existence and location was spreading in the seafaring world. The most important and most telling document would obviously be the now partially rehabilitated Vinland map. This map, if proven true, would precede Columbus's discovery by nearly half a century. It clearly shows a complete and reasonably defined contour of Greenland and also a well-defined and well-located Vinland WSW of Greenland, which can easily be associated with a part of the actual northeast coast of Newfoundland.

Linked with this map are unconfirmed reports of trips by Columbus and John Cabot to the island prior to their official transatlantic discovery trips. Even if the trips by Columbus have never been taken seriously, it may be appropriate here to revisit an all too lightly discarded statement attributed to Columbus and published later by his son Ferdinand, of the effect of his having once sailed far north:

> I sailed in the year 1477, in the month of February, 100 leagues beyond the Isle of Tile, whose southern part lies seventy-three as some say, and it is not within the line that delimits the west, as Ptolemy says, but much further westward, and to this island, which is as large as England, go the English with their wares, especially those from Bristol, and when I was there the sea was not frozen, although there were tides so great that in places they rose twice daily 26 Braccia (a Genoese *braccio* is 22.9 inches) and fell as much (Morison 1951:24).

The date of 1477 corresponds generally with the period in which documents from Bristol describe attempts to reach Brazil Island across the Atlantic. It is also the period when Columbus gets involved in Portugal whose seafarers were involved in the North, particularly in Iceland and apparently in Greenland. For this reason, Morison states that the Tile (or Tule) mentioned here is Iceland. We believe that Tule or Ultra Tule, this elusive, ever moving Finisterre, could by then have been shifted to Greenland. At that time, the Basque had already been voyaging to Iceland for some time. As early as 1412, 80 years prior to Columbus's discovery, a fleet of 20 Basque ships was signalled on the coast of Iceland (Gad 1971:161). Such a large fleet could easily imply a much earlier Basque presence, even in the late 14th century. By that time, the Greenland Norse settlements were having difficulty with resupply and were forced to rely more on foreign ships. There are reports of Basque and Portuguese presence in Greenland a number of years prior to Columbus's discovery in 1492. So if Tule was then in southwest Greenland, Morison's rejection of the 50-ft. tides can no longer be easily accepted. "Such [tides] can be found only two or three places in the world... It would be time and effort wasted to find an explanation to this" (Morison 1951:25).

What Morison ignored at the time, as even most people do today, is that there are tides exceeding 50 ft. exactly west of and within a loose 100-league range of the southern tip of Greenland. These unofficial highest tides in the world were identified only a few years ago by two Canadian hydrographers in the Bay of Ungava, in Labrador, in the Koksoak river. This location is more or less on the estimated Norse road to Vinland, only a few days sail from Greenland. Even if we reject as far fetched that Columbus went that far-as some like Pedro Bilbao in his article "Was Columbus in Canada?" (1966) would like to think-I believe that such a detailed statement made then could indicate that there was knowledge of such enormous tides and that this knowledge could have been reported to Columbus, if not observed by him. I believe we can give more credibility to this passage as a sample of the detailed descriptions available to the western seafarers about Labrador/Newfoundland prior to 1492. How such knowledge could assist Columbus in developing his project is another question.

A little-known French document, written around 1516 by seafarer Antoine de Conflans, gives us additional insight into the general acceptance among seafarers that Newfoundland and its crafts were a long standing part of the maritime realm of northern Europe and almost taken for granted. In his review of the seafaring world of northern Europe, written in a simple, concise way, Antoine de Conflans describes quite accurately the birch bark canoe of the New World as if it were as much a part of the northern European watercraft collection as the boats from Ireland described above (Mollat and Chillaud-Toutée 1982:23). Finally, when de Conflans mentions the New World, he seems to associate Les Terres Neufues or Newfoundland with older, pre-Columbian discoveries. He lists the Columbus discoveries last, as the "autres Isles trouvees," or the "recently discovered islands or antillas" to use the words of M. Mollat and F. Chillaud-Toutée (1982:22, note 52).

From the highly hypothetical Irish monk tales to the proven Norse-Viking arrival in Newfoundland to the subsequent exchanges of information between the Icelandic/Greenland settlers and the Basque, Portuguese, and Bristol merchants, it is obvious that the New Found Lands or Terra de Bacallaos became well entrenched in the conscience of western European seafarers some time before 1492. Thus, it is possible that Labrador/Newfoundland played a role in the development of the Columbus design.

Socio-Economic Impact of the New Found Land

What about the socio-economic role played by the New Found Land versus the New World associated with the West Indies and the Gulf of Mexico?

In a paper presented at a symposium held in St. John's, Newfoundland, "Newfoundland in the Consciousness of Europe in the 16th and early 17th Centuries," professor David Quinn, a specialist on the Age of Discovery, made the following statement:

> "Newfoundland, the fishery of the Banks, the inshore cod fishery, the whale fishery on its northern flank, may in the end prove to have been for Europe during the sixteenth and seventeenth centuries as valuable a discovery as the gold and silver of the Spanish empire" (1982:9).

A comparison of the relative place in time and the importance to the western world of the so-called discoveries of the New World by Columbus and of the New Found Land by unknown seafarers or fishermen may enable us to place both in a better perspective.

Anthony Parkhurst, an English seafarer surveying the Newfoundland waters for the English navy in 1578, establishes, in the *Principal Navigations*, the number of European ships around Newfoundland as being between 350 and 380: 150 from France, 100 from Spain, 50 from Portugal, 30 to 50 from England, and 20 to 30 Basque whaling ships, for a total of 380 ships (Hakluyt 1965[1589]:674). These figures are found to be excessive by some, including Pierre Chaunu, although he does not explain why. On the other hand, we find them to be below the true figures.

Antoyne de Montchrétien, in his *Traité de l'economie politique* (1615), gives a figure of over 600 ships leaving for Newfoundland from Normandy and Brittany alone (cited in Turgeon 1986:529, note 21). Robert Hitchcock, in *A Politique Platt, for the Honour of the Prince*

(1500), gives a figure of 500 ships for the overall French fleet around Newfoundland (cited in Quinn 1982:24). John Smith, in *The Description of New England* (1616), states that "New Found Land, doth yearly fraught neere 800 sayle ships..." (quoted in Quinn 1982:25). If we think that these figures are exaggerated, let's consider the findings made a few years ago by Canadian archivist, Monique Bois, studying the Tabellionage de Rouen in France for the Canadian Archives. The documents revealed that for the year 1555 alone, 94 departures for Newfoundland were registered locally (1984:23). We can safely assume that the real number of departures from Rouen in 1555 well exceeded 100 ships since not all departures were properly recorded. In the same year, the Spanish fleet to the West Indies and the Gulf of Mexico totalled 83 ships according to Chaunu (1955:520). So, the total of ship departures for Terra-Nova from a single French harbor could exceed in a single year the total number of departures of the fleet from Spain to the New World. To put these comparisons in perspective, at least 50 French harbors sent ships to Newfoundland every year, according to Charles de la Morandière (1966). With the six main harbors, we can reach a conservative figure of over 225 departures a year, not counting the 44 other harbors mentioned by La Morandière. These figures for a part of France alone greatly exceed the number of departures recorded by Chaunu for the entire Spanish fleet to the New World. Is it possible that France alone sent to Newfoundland waters close to three times the number of ships that Spain sent to the West Indies?

Seeing how much Parkhurst has underestimated the number of French ships, it is reasonable to assume that the same mistake applies to the number of ships from other nations, including England. Could it be that the total figure of 800 ships listed by John Smith for all nations sailing to Newfoundland, a number long thought to be far fetched, is closer to the truth? We believe so.

The total tonnage involved in Newfoundland waters was much superior to the tonnage sent to the West Indies by Spain. Using a deflated average of 80 tons for the Newfoundland ships, which is approximately one-half of the real average tonnage of the Bordeaux-Newfoundland fishing ships at the time of Parkhurst's survey (based on the 153-*tonneaux* average given by Laurier Turgeon for 1575), and using the grossly deflated number of 350 to 380 ships recorded by Parkhurst, we still have a total tonnage for Newfoundland that is almost double the average annual West Indies tonnage of 16,036 *toneladas* given by Chaunu for the period of 1571-1580. By using Turgeon's recorded average of 153 *tonneaux*, the tonnage in Newfoundland waters is nearly four times the tonnage sent by Spain to the West Indies (Turgeon 1986:530, note 24). By doubling the minimum figure given by Parkhurst, which seems reasonable following the above analysis, then the difference in favor of the Newfoundland tonnage is staggering.

What was the value of this huge annual harvest of fish, whale oil, and furs compared with the cargo of gold and silver from the south? Here I leave it to Quinn to conclude:

> The conquest of the Spanish Indies is dramatic and colorful, was written about extensively at the time and ever since, while Newfoundland has remained, relatively, a backwater in the world history, something to be taken for granted perhaps, but not assessed as being in any of major significance for European development as a whole. Europe was aristocratic in this age; fishing and fishermen were decidedly not (Quinn 1982:9).

Quinn's statement joins with of another great historian of the Middle Ages and the maritime world, Michel Mollat: "Un lourd héritage de mépris p se sur les gens de mer. Ils sont incompris, laiss s au bas de l'échelle sociale, voire exclus, partageant avec les bergers une sorte de réprobation sociale" (Mollat 1983:32).

When asking how one could gauge the relative effect of bullion versus calories and the nutriment provided to Europe between 1500 and 1650, David Quinn could only state: "...I do not know; I am brave enough to guess that the balance might well go either way, and possibly in favor of Newfoundland produce" (1982:9).

In the sixth century of the post-Columbus era, I hope we can answer some of these questions and redress some of these deficiencies. I hope that marine archaeology, establishing itself as a true discipline, will provide the data to replicate in a reliable way a typical caravel of the Age of Discovery. Only finding a complete one, *Wasa*-like in its state of preservation, would solve the problem entirely. I particularly hope that the fishermen, their daily life and trade, their ships and boats, become the focus of major efforts by marine archaeologists. These poor and smelly "miners of the sea," to use Marc Lescarbot's description of Newfoundland fisheries, were the real architects who laid the foundations leading to the Age of Discovery. We know so little of their trades and crafts, and even less of their lives. For me, discovering more about the daily lives of seafarers and fishermen of the Middle Ages and the Renaissance is the biggest challenge facing marine archaeology for the coming century.

As for Newfoundland/Labrador, I believe that its revenge is forthcoming. The wealth of archaeological data provided by a single site in Red Bay is only a small indicator of things to come. If the figures for 16th-century ships referred to above are to be trusted, the number of historical wrecks should follow accordingly. The future of marine archaeology in the study of ships of discovery and of the early exploitation of America may well shift to Newfoundland/Labrador. The paradox of the neglected and unknown attic of the world should reverse itself, and its archaeological riches may well produce the best data on the men, their ships, crafts, and family life during this fascinating era of mankind. I welcome my warm water colleagues to this rich and so hospitable part of the world.

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SYMPOSIUM

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Ships of Discovery and the Tide of History

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Ships of Discovery and the Tide of History

Introduction

> There is a tide in the affairs of men,
> Which, taken at the flood, leads on to fortune:
> Omitted, all the voyage of the life
> Is bound in shallows and in miseries.
> On such a full sea are we now afloat,
> And we must take the current when it serves,
> Or lose our ventures (Shakespeare, *Julius Caesar*, 4.3.218-224)

Humanity is indeed afloat on a full sea. Whether the future holds shallows and misery or ever-increasing physical and spiritual prosperity depends largely on correctly reading—and predicting—the tides of history.

The following is a synthesis of the underlying concepts in the symposium presented by the staff of Ships of Discovery in which the stories of two hypothetical voyages were told simultaneously: one that may have been, and one that yet might be. The story of the voyage that might have been was based on archaeological evidence provided by the earliest shipwrecks discovered in the New World, as well as a new interpretation of the historic record. The voyage that might yet be parallels the voyage that might have been.

The format selected for this symposium, a highly visual experiment in speculative fiction was, needless to say, something of a departure from normal conference fare. Space and format restraints prevent it from appearing between these covers in its entirety.

Metanoia—Something New from Something Old

Archaeologists would like to believe that their discipline contributes to understanding the past. If, as it has been suggested, the future is the past, happening over and over again now, then archaeology has the potential to play a very important role in understanding the future as well.

It is, perhaps, easier to see the changes that have taken place over the last 500 years than to see what has *not* changed. Technology has changed beyond recognition. The effects of improved technology have altered the cultural and physical landscape almost beyond recognition. But certain constants in human nature appear to be either immutable or so slow to respond that 500 years is simply not a sufficiently long interval to detect change.

Almost two centuries ago, flush with the apparent successes of scientific theories in explaining observable natural phenomena, scientists reasoned that the universe might be completely deterministic. Perhaps, they thought, there is a set of natural laws that, once discovered, would enable scientists to predict everything—even human behavior. There was only one problem: finding a starting place. The principal could not work unless it were possible to know the exact state of the universe at one point in time (Hawking 1988:57-58). More recently, this caveat has been recognized as a fatal flaw. First the uncertainty principle, then the broad-ranging chaos theory were used to explain science's apparent inability to understand or predict complex micro phenomena, such as the position and velocity of sub-atomic particles, or macro phenomena, such as the weather.

Most anthropologists would reject the proposition that human behavior is predictable in any but the most general sense. Hence, main-stream anthropology typically carries little currency among practitioners of economics, political science, urban planning, insurance, marketing, and futuristics, despite the fact that success in these specialized fields depends on the ability to correctly predict human behavior.

In apparent contrast to this view, Isaac Asimov, in his speculative fiction classic *Foundation* (1951), describes a universe of the future in which "psychohistorians" have reduced human behavior to mathematical functions which can be used to predict—and even to steer—the future of humanity. Using non-mathematical concepts, psychohistory is defined as "that branch of mathematics which deals with the reactions of human conglomerates to fixed social and economic stimuli" (Asimov 1951:17). But Asimov also recognized an irreducible element of uncertainty in the future, unpredictable even to the sophisticated and complex mathematical models of psychohistory.

While predicting the future with precision is beyond the capabilities of modern science, recognizing simple principles and patterns is not. One such set of principles is that by which large-scale exploration of physical space is accomplished. One such pattern can be discerned in the events leading to the maritime exploration of the world half a millennium ago and those of the present day verging on the exploration of space.

1492 - 1992

There are striking similarities between the worlds of 1492 and 1992. Five hundred years ago Spain embarked on the maritime exploration of the Ocean Sea. Today, it is the exploration of the final frontier, space, that confronts us. The Spain Columbus knew had just emerged from the *reconquista*, a centuries-long military territorial contest with the Moors. The world we know has recently seen the sudden conclusion of the Cold War and a dramatic shift toward what may be a new world order. In both worlds the end of constant military conflict left industries and individuals built and bred for war looking for alternative employment. At the end of the 15th century, meeting the challenge of the new frontier was not so different from meeting the military challenges once faced by the *reconquistadores.*

A realistic appraisal of what drove maritime exploration in the 15th and 16th centuries has been proposed elsewhere (Keith, Lakey, Simmons, and Myers 1989). The objectives were simple: to find something worth taking, get it back to the parent economy where it could be converted to wealth and power, and to insure that places where things of interest were found could be relocated and, if possible, "claimed." If this appraisal seems cynical, it should be remembered that strong incentives are needed to entice explorers to undertake missions during which they may be required to risk death as well as financial ruin. Operating outside their culture and realm of influence, explorers may be out of communication for extended periods during which they can be neither regulated nor protected by the parent culture. Faced with these conditions, it is not surprising that explorers become aggressively acquisitive.

Other important factors in the maritime exploration of the New World included: (1) creating in the parent society incentive for exploration, (2) building as soon as possible a permanent presence and secure base of operations within the New World itself, and (3) regulating exploration and exploitation. If these factors constitute a pattern, perhaps they will also be important considerations in the exploration of space.

Incentive

Creating incentive to explore in the parent society is critical. Exploration is often an expensive, risky enterprise requiring a great deal of organization and coordination. For example, Columbus's first voyage to the New World required resources that no single individual possessed—ships, experienced crews, provisions, advanced technical knowledge and expertise. Compared to the perceived risks, the potential rewards were attractive only to the government of Spain (the Crown). But after the initial investment was made and the enterprise proved possible, incentive to risk exploration burgeoned in the private sector. Six years after Columbus's first voyage, the original monopoly granted to Columbus by the Crown became an impediment. In 1498 the Crown apparently decided that the New World was too big for a single man to handle and became receptive to proposals from other would-be explorers. Spanish maritime exploration of the New World did not realize its potential until after the Columbus monopoly was neutralized and the Crown began to relinquish control, i.e., until exploration was "privatized."

A similar situation exists today: the frontier, of course, is space. The exploration of space, still in its infancy, is completely controlled and regulated by government agencies for whom military and scientific missions are paramount. The U.S. space program has long been in decline. Congressmen object to the costs. The press decries the physical risks to the astronauts. The general public is apathetic. Real space exploration is dull indeed compared to an episode of *Star Trek: The Next Generation*. Nothing seems to be happening up there.

Even as public interest and efforts are on the wane, private enterprise is beginning to show enthusiasm in the business potential of space. This is consistent with the pattern of 1492: now that government-sponsored programs have demonstrated the potential of space exploration, private enterprise will assume an increasingly larger role as incentives become more obvious and abundant.

A Permanent Outpost

Establishing a permanent presence in the area to be explored is the first step toward colonization, but it is also absolutely necessary for sustained exploration. Columbus was well aware of this. He virtually insured a swift, government-sponsored return to the New World following his first voyage when he decided to maroon more than 40 crewmen on Hispaniola after their ship, *Santa María*, ran aground and became a total loss. From 1494 on, there was a permanent Spanish presence in the New World. Contrary to the traditional wisdom of history, it is highly likely that ship masters and sailors living in and operating out of Santo Domingo were the first Europeans to explore much of the New World. No place in the Caribbean was more than a few day's sail from Santo Domingo, whereas voyages from Spain required weeks just to cross and re-cross the Atlantic.

Space exploration has not yet achieved a foothold on the other side of the frontier although planners fully recognize that this habitat in space is essential to further exploration. Mariners sailing from Spain to the New World were penalized by distance and the time it took to cross the Atlantic. Similarly, Earth's "gravity well" penalizes astronauts who have to leave from and return to the surface of the earth to do their exploring. The cost in fuel, safety, and operational complexities is simply too high.

The lesson from 1492 is clear: serious exploration of space depends on establishing a permanent human presence and base of operations outside the thrall of earth's gravity. Until that is accomplished, earth's astronauts will be little more than tourists in space. Those who advocate exploration of space using unmanned probes are merely forestalling the inevitable. The indispensable value of humans in space was most recently demonstrated by the skill and resourcefulness of the astronauts aboard NASA Space Shuttle mission STS-49.

Regulation and Private Enterprise

Regulation is desirable. Columbus—and indeed Old World immigrants in general—have been taken to task for the numerous calamities that have befallen the Americas, their human and animal inhabitants, and their very ecosystems as a direct result of "the encounter." Without doubt, much suffering and hardship could have been avoided if Europeans had used restraint in the exercise of their powerful technology. The Crown's efforts at regulation seem to have been limited to making sure that the proper taxes and royalties were paid.

Privatization without regulation invites rapaciousness. This is an important lesson to take into space: people at risk in a hostile, foreign environment do not stop to consider the long-term consequences of their actions. The introduction of contagious diseases into populations with no natural immunity had terrible consequences. That lesson has been learned. We will be guarding against microbial and viral infection as we push into space. It will be regulated. But there are other disasters for which we (fortunately) have no precedent, and therefore (unfortunately) will be unprepared.

Conclusion

Archaeology is fortunate indeed to occupy a pivotal position in the here and now, squarely between past and present. Archaeologists and historians are obliged to uncover and interpret the past. But perhaps their mandate could also include extrapolation of the past's lessons into the future—or at least not forbid it. The problem, of course, is to decide what *really* happened in the past because

> . . . truth is a matter of the imagination. The soundest fact may fail or prevail in the style of its telling; like that singular organic jewel of our seas, which grows brighter as one woman wears it and, worn by another, dulls and goes to dust (Leguin 1964:17).

The purpose of the symposium was to offer a perspective of what *really* happened in the past, to point out some of the many similarities the events of 1992 have in common with 1492, and, using a combination of fact and intuition, to predict a possible future in which our species is drawn into the sea of space by the tide of history. Perhaps the proof that this is what we ought to do lies in the past—as does the key to how to do it properly.

The wisdom of Shakespeare's words, written as fiction four centuries ago, seems appropriate advice for future action. The form that action should take can be gleaned from the correct interpretation of the archaeological and historical records laid down a century before him during the great European Age of Exploration and Discovery.

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SYMPOSIUM

CHRISTOPHER F. AMER, ORGANIZER

Small Craft Studies in South Carolina

CHRISTOPHER F. AMER

The Hunting Island Vessel: Preliminary Excavation of a Nineteenth-Century Fishing Boat

In 1969, during beach replenishment operations on the foreshore of Hunting Island State Park, South Carolina, the remains of a small wooden boat were discovered. The site was reported to the South Carolina Institute of Archaeology and Anthropology (SCIAA) and given a site designation of 38BU157.

A preliminary examination of the site was conducted by the Institute's Underwater Archaeology Division staff in 1987 after the wreck was exposed by high tides and storm activity (Figure 1). At that time the vessel was found to be partially buried in the foreshore and lying on its port side at a forty-five degree angle, bow out to sea. Only the port side, which was buried, remained intact (Newell 1987:2). Initial observations led to the conclusion that the wreck is that of a 7 m-long fishing boat with a "live well," suggesting a 19th-century origin for the vessel. Two grant proposals subsequently submitted to the South Carolina Department of Archives and History to record and preserve the vessel in 1989 and 1990 were not funded.

Since 1987, the site has continued to deteriorate through normal wave action, storm activity, and the hands of collectors. The boat's pump tube was removed by a collector during a period when the site was exposed in the winter of 1988-1989. That winter, a combination of unusually high tides and a severe storm hastened the disintegration of the site by dislodging several of the vessel's timbers and scattering them along the beach while further burying the remaining structure. The "heel," that timber which makes the transition from the keel to the stempost, was recovered several hundred meters along the beach resting against an early 20th-century house foundation.

Historical references recording a boat being wrecked in that location have not been found. Research into the 19th-century fishing industry on the Atlantic coast has revealed much contemporary literature on the industry (Collins 1891; Goode 1884, 1887; McFarland 1911) as well as descriptions of, and references to, the types of vessels used (Baumer 1988; Chapelle 1951, 1973). However, few examples of "welled" fishing vessels exist; the smack *Emma C. Berry* at Mystic Seaport is a notable example

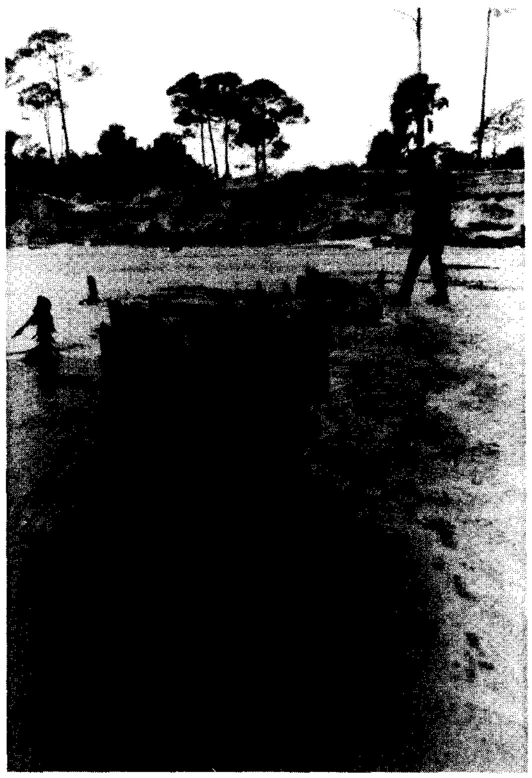

FIGURE 1. The Hunting Island Vessel in 1987; stem in foreground and live well bulkheads amidships.

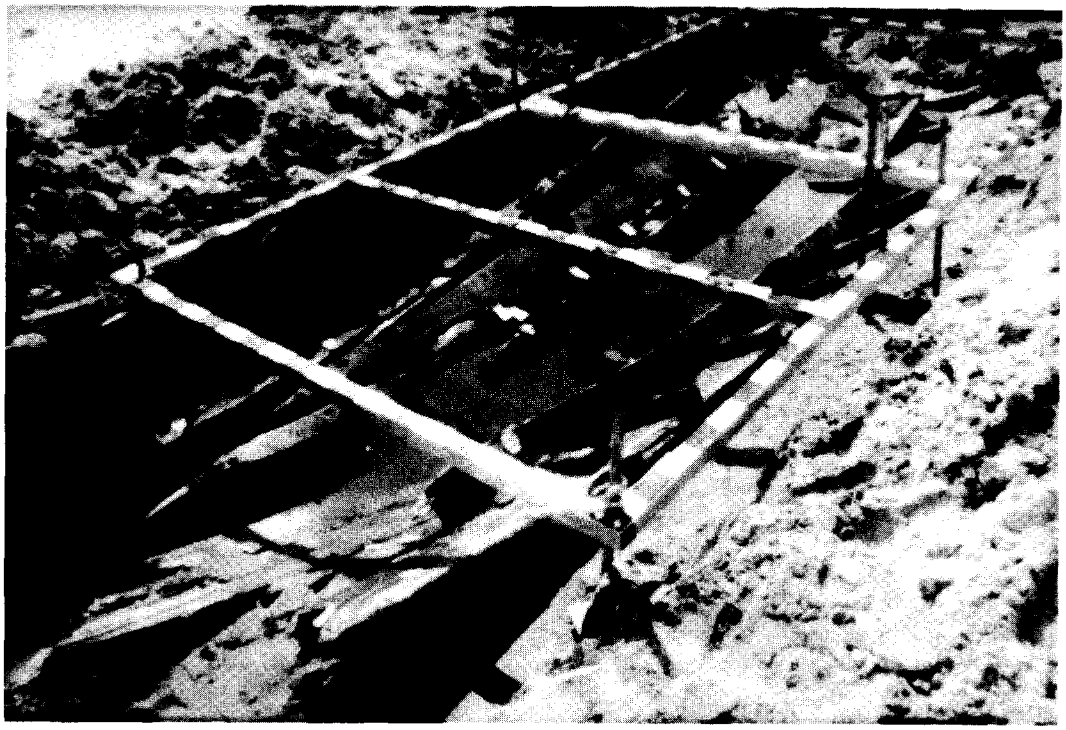

FIGURE 2. Remains of the port side of the vessel in 1991; torn planks of the bow in the foreground and holes in the hull planks for the live well at top center.

(Ansel 1973). According to David Baumer, who has done extensive research on the subject, this site is possibly the only known welled fishing boat to be recorded in an archaeological context (David R. Baumer 1990, pers. comm.).

During 1990 plans were made to relocate the site and record the remaining structure, particularly that of the live well. In the fall of 1990, as part of SCIAA's response to a public notice for yet another beach renourishment project on the island, Underwater Archaeology Division staff marked the site to protect it against accidental destruction during removal of beach debris prior to deposition of sand. It was evident that the site would very soon be extensively covered by sand from the renourishment project, north of the site, via deposition by the ambient currents moving sands from the north to the south.

In the Spring of 1991, a four-person team from the Division worked for three days to relocate, uncover and record the site. Of the 7 m-long boat examined in 1987, only a 4.5 x 2 m section of the central port side remained. This section, which was lying horizontally, was fairly intact up to the gunwale. Working against the encroaching tide, the crew was afforded less than five hours per day during which the site was relatively dry.

During the brief time allowed, the crew tagged timbers with sequentially numbered plastic tags, triangulated, measured, and photographed loose timbers and other artifacts in situ, and prepared the site for mapping. A levelled 2 x 2 m grid was used to map the site in plan and from which elevations of hull components were taken (Figure 2). Using this information, a site plan was produced that includes a

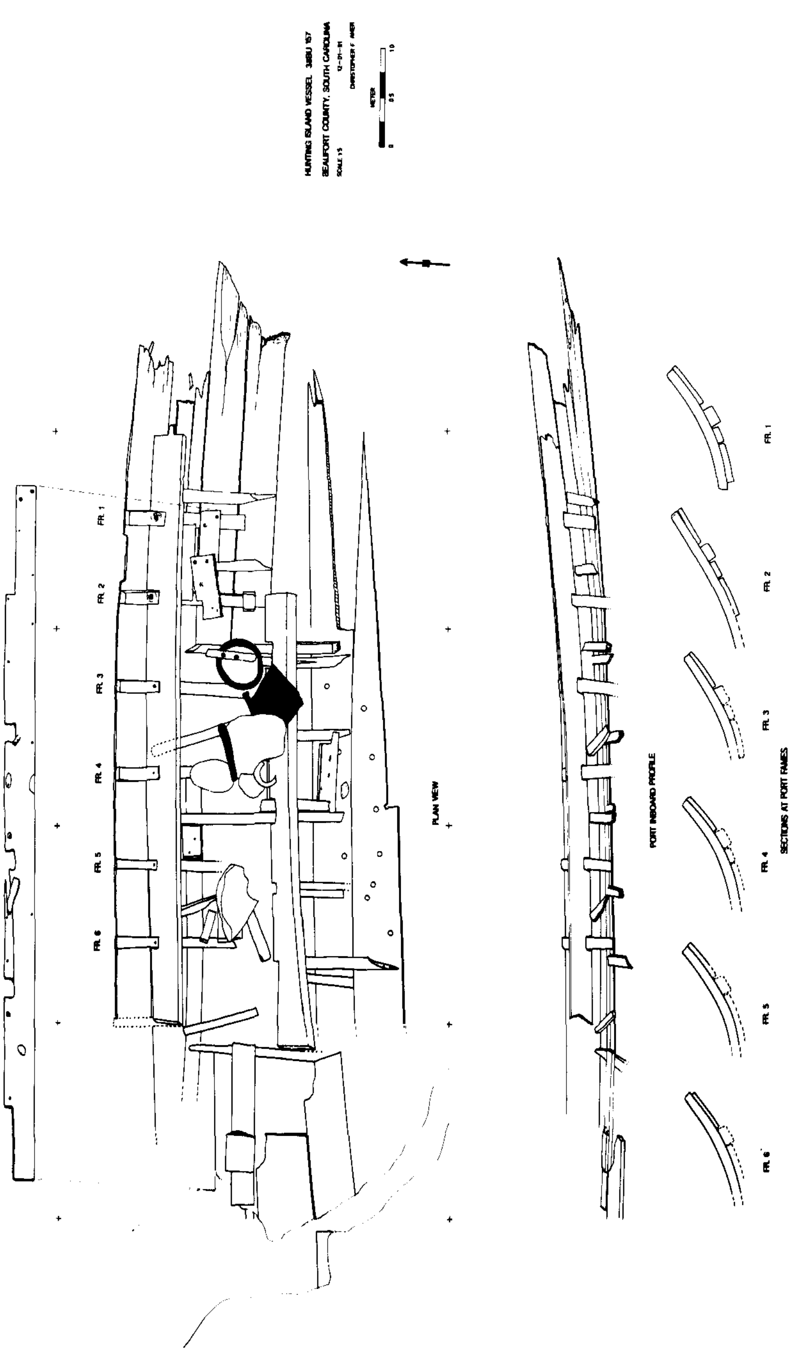

FIGURE 3. Site map of the hull remains as found in 1991; bow is to the right.

plan view, inboard elevation of the extant port side, and hull curvatures at each of the frames (Figure 3).

Results

Due to the paucity of hull remains present on the site during excavation, the hull could not be reconstructed with any degree of certainty. Interpretation of the site relies heavily on the presence of the live well and associated artifacts as well as observations made during the 1991 excavation of the site and those made during the brief 1987 site visit.

The Hunting Island Vessel had a keel that was 19 cm sided and moulded 36 cm. The curved stem was 6 cm sided but flared out to over 17 cm at the aft side of the apron to accept the inward-curving hull planks. In 1987, 15 sets of frames were visible along the hull's length - 10 sets of double floor timbers and 5 single frames. Single component floor timbers were 6.3 cm sided, half that of double floor timbers, and were moulded 7.5 cm. Single component frames were located within the live well and at the vessel's extremities. Futtocks averaged 6-7 cm sided and moulded 4-5 cm at the timber heads and ranged in length from 60-70 cm. Room and space averaged 43 cm at the turn of the bilge. Nine deck beams were visible along the length of the hull (Figure 1).

Hull planks ranged in width from 7 cm to over 21 cm and varied in thickness from 2-3 cm. The hood ends of the planking in the stern once ended in a widely flared transom. A single wale, placed high on the hull, was 8 cm wide and 5 cm thick.

The presence of a live well suggests that the wreck was a "well smack," a type of fishing vessel that incorporated a live well. The live well was a new development in the American East Coast market fisheries during the 1830s-1840s that allowed the catch to remain alive during transportation to market thereby ensuring a fresh product. These vessels were an integral part of the Southern offshore hook and line fisheries that supplied fresh fish and seafood to southern Atlantic coastal markets from the 1830s through the latter half of the 19th century. Charleston and Savannah were the largest of the southern Atlantic coastal markets that were controlled by Connecticut fishermen who spent their winters fishing for these and other southern markets (Baumer 1988:1, 11-14). Before the Civil War, markets in these two centers received virtually all the catch from southern Atlantic commercial fishing to keep a steady supply of fresh fish for the southern labor force then being employed in agriculture. By the 1880s Charleston had become the principal port for the southern offshore fishery. The industry was also undergoing a small boom in the South as live wells were the most efficient means of storing fish (Fleetwood 1982:147-148). However, as ice was becoming commonly available during the latter quarter of the 19th century, and at a steadily lower price than before, keeping the catch on ice slowly became the preferred method of transporting fish rather than keeping them alive (Baumer 1988:15).

In the southern market fisheries there were two principal types of fishing; offshore or from 10 to 20 miles out, and shore fisheries in the rivers, sounds, and tidal marshes (Fleetwood 1982:147). These methods necessitated the use of specific types of vessels especially suited to the environment in which they were used. For offshore use the smack was the principal vessel. These sailing boats, which varied from 10 to 30 tons, generally were fitted with a live well and were called a well smack (Baumer 1988:2; Fleetwood 1982:148). Although the origin of the well smacks lies along the New England shores, the influence of these vessels spread southward and they were, no doubt, copied by local shipwrights and constructed of local materials. Unlike the offshore fishing craft, the boats in use for the shore fisheries were varied, using traditional area small craft types, including the dugouts often fitted with live wells (Amer 1990; Baumer 1988:15-16).

Live wells, used in fishing smacks of the American market fisheries on the East Coast, were generally of two types, the "decked well" and the "box well." Both types involved having a watertight structure within the hull of the vessel that allowed seawater to freely enter through holes drilled in the bottom of the boat, thereby enabling the fish to remain alive during the trip to market. Decked wells were characterized by having a watertight bulkhead at either end, with a deck laid over them. Box wells generally were pyramidal in shape and were not decked (Baumer 1988:17-20).

The evidence indicates that the Hunting Island Vessel was fitted with a decked live well spanning seven frames in the middle third of the vessel's 7 m length. The central three floor timbers within the well were single timbers, as at the vessel's extremities. Elsewhere however, the boat was framed with doubled floor timbers to increase each frame's sided dimension. Watertight bulkheads, which once extended from floor timber to deck beam, were placed 2.58 m apart and defined the fore and aft extent of the well. Each bulkhead was 7.6 cm thick. The boat's bilge pump was placed against the aft side of the well's aft watertight bulkhead. Holes in the hull planks, measuring 2.5 cm, allowed sea water to enter and circulate within the live well. All that remains of the well structure now are the holes and a number of loose timbers whose function has yet to be determined (Figure 2).

A pulley block, a single sheave, and some lengths of hemp rope found near the forward end of the well indicate the presence of running rigging and hint at a possible location of a mast. Several concreted iron artifacts may be hull fittings or artifacts associated with standing rigging. Cobbles, 20-45 cm in diameter, found within and aft of the well location, suggest this was the method of ballasting the boat. The vessel's rig could not be determined from the available evidence. However, many of the smacks used in the offshore fishery industry during the 19th century were either sloop or schooner rigged (Fleetwood 1988:148).

The well area also contained two ceramic sherds and a number of iron artifacts, including two pots associated with food preparation. These indicate a late 18th- or early 19th-century provenance, while the presence of the live well on the wreck suggests a period of use after the 1830s.

Having established the vessel's function and a time period during which the boat could have been used, further questions need to be addressed. First, was this vessel built along the shores of New England as the majority of these vessels were, or was it crafted of local timber by local shipwrights? Species identification of the hull timbers, when complete, may provide an answer. Second, how did the vessel arrive at its present location? Even forty years ago the shoreline of Hunting Island was more than 100 m seaward of its present location. During the 19th century it would certainly have been even farther seaward. Yet the wreck lies only 30 m from the present-day dunes. Did the boat come to an untimely demise as the presence of artifacts associated with day-to-day shipboard life suggests—possibly at the hands of a hurricane like the "Great Storm" of 1893 that deposited a trio of lumber carriers along the South Carolina coast? Or was it dragged into what was then the interior of the Island and abandoned? Perhaps we'll never know. Or perhaps the answer lies with the rest of the wreck, which is no doubt now buried elsewhere in the shifting sands of this barrier island.

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The Brown's Ferry Vessel: An Interim Hull Report

In 1971, sport diver Hampton Shuping discovered the brick-filled remains of a wooden vessel in the Black River, above Georgetown, South Carolina. Artifacts associated with the wreck suggested a colonial date; and in 1976, the vessel and cargo were excavated by the South Carolina Institute of Archeology and Anthropology (SCIAA) under the direction of Alan Albright, the State Underwater Archaeologist. The hull itself was raised and transported to a storage pond until conservation began in a purpose-built facility in Columbia, South Carolina (Albright and Steffy 1979). Conservation in polyethylene glycol was completed in 1990, and the vessel now awaits transportation to its final home, the Rice Museum in Georgetown, where it will be reassembled for display.

The cargo, approximately 25 tons of building bricks probably destined for Georgetown or Charleston, was also recovered, along with a small selection of ceramics and other finds, in addition to a large quantity of debris from the 18th through 20th centuries (including two automobiles) that had accumulated over the site. The amount of debris has complicated the dating of the vessel, but those artifacts most closely associated with the hull consistently date to the mid-18th century. Unfortunately a firmer date is not possible; the timbers of the hull were sampled for dendrochronological analysis, but the results were inconclusive. Wood analysis did reveal that the hull is built entirely of local timber, primarily cypress, pine, and live oak.

At the time of its excavation, the Brown's Ferry vessel was the earliest American-built vessel yet discovered, with the possible exception of the so-called *Sparrowhawk* from Massachusetts. Despite the discovery in the 1980s of craft of earlier date, such as the Hart's Cove, Water Street, and Lyons Creek vessels, and the Quebec bateaux, little is known about the technical aspects of North American ship- and boatbuilding in the colonial period. Moreover, many of the other colonial finds seem to be more or less in the mainstream of European

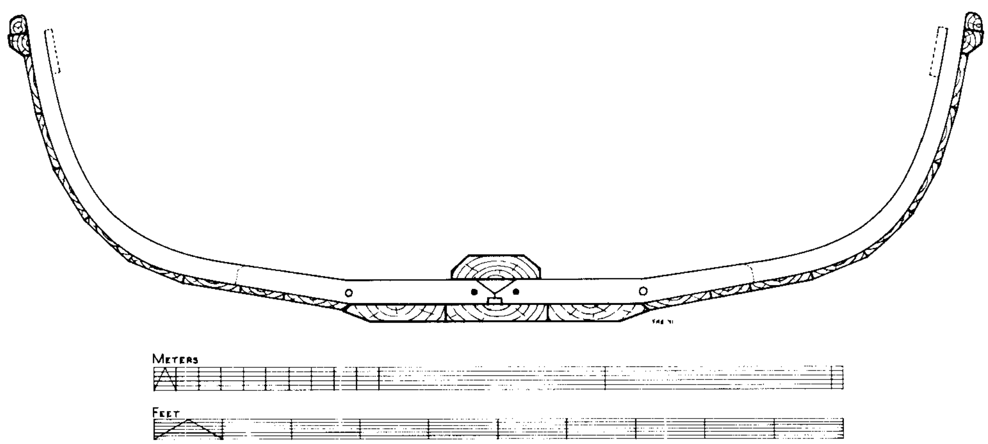

FIGURE 1. Brown's Ferry Vessel construction section amidships, from aft.

boatbuilding, representing the dominant clinker and carvel traditions, while the construction of the Brown's Ferry vessel is unique, possibly mixing Old World methods of design and construction with elements ultimately derived from Native American craft. Oddly, while the Brown's Ferry vessel is the earliest example of a distinctly "American" boatbuilding tradition (with the possible exception of the Quebec bateaux) and bears some conceptual resemblance to later American vessel types (particularly the gundalows of New England and the goelettes of the St. Lawrence), it seems to be something of a dead end in the South. Approximately two-thirds of the primary structure of the vessel survives with most of the missing material lost at the stern. Both sides were preserved to nearly their full height amidships although a large section of the starboard side had broken off at the turn of the bilge and lay alongside. A long section of the wale also survived from the starboard side. The lower portion of the stem was still in place, but little of the sternpost and its associated structure remains. Nothing survives of the deck, except a possible knee, but a windlass and its bitts were recovered from the bow. Most of the timber was in good condition at the time of recovery, but there was extensive gribble damage to the exterior surfaces of the bottom and lower side planking. After conservation, the softwood components (bottom, keelson, and planking) are in remarkably good condition, but the live oak frames and posts have twisted, shrunken, and checked rather badly in places.

Scantlings strongly indicate that the vessel was built using Imperial measurements, with most timbers finished to dimensions in whole or half inches. As reconstructed, the vessel was 50 ft. 3 in. (15.32 m) long exclusive of the missing rudder, with a moulded beam of 13 ft. 7 in. (4.14 m), extreme beam of 14 ft. 2 in. (4.32 m), and a sheer height of 4 ft. (1.22 m) amidships. The recovered cargo suggests a maximum deadweight capacity of 25 tons, but this leaves very little freeboard.

The principal feature of the hull, in both shape and structure, is the bottom (Figure 1). This is a flat, lanceolate platform originally approximately 46 ft. (14 m) long and 4 ft. 5.5 in. (1.36 m) wide, made up of three, straight, pine planks from 3-3.5 in. (7.6-8.9 cm) thick and up to 18.75 in. (47.6 cm) wide. The irregularities in plank thickness are all accommodated on the interior surface, leaving steps of up to 0.5 in. (1.3 cm) between adjacent planks. Steffy (1979) suggested that the bottom planks were aligned by 0.75 in. (1.9 cm) edge dowels, but careful probing of the seams revealed no trace of such dowels. The stem and sternpost assemblies are fastened directly to the upper surface of the bottom, and a bevel for the garboard is worked in the upper, outboard edge.

The stem is made up of three live oak timbers (Figure 2): the stem proper, a light false stem, and an apron—all but the false stem treenailed to the bottom. The preserved portion of the stem is a relatively broad (moulded up to 15 in. (38 cm), straight timber with a narrow rabbet cut into the after edge. Its lower end sits in a shallow rebate cut in the upper surface of the bottom and hooks over the forward end of the bottom. The false stem was originally moulded up to 4.5 in. (11.4 cm) and sided 3 in. (7.6 cm) but has deteriorated badly. The apron is a large knee spanning the stem-bottom joint and continuing up the inner face of the stem to an undetermined height. In addition to supporting the stem, the apron acts as the primary nailer for the hooding ends of the planking. The upper portion is relatively light, moulded 3-4 in. (7.6-10.2 cm) and sided 6.75-8 in. (17.1-20.3 cm), but the lower portion attached to the bottom is a broad foot (sided 19.25 in./48.9 cm at the after end) that also supports the forward end of the keelson, two frames, and a step for a bitt. The three components are fastened together by two iron forelock bolts 1 in. (2.5 cm) in diameter and numerous iron spikes.

Very little of the sternpost survives as it lay at or above the surface of the mud, but the basic structure appears similar to that at the bow. A straight post (now missing) was reinforced by a stern knee with a broad foot attached to the upper surface of the bottom. Only the lower portion of the stern knee remains, but enough

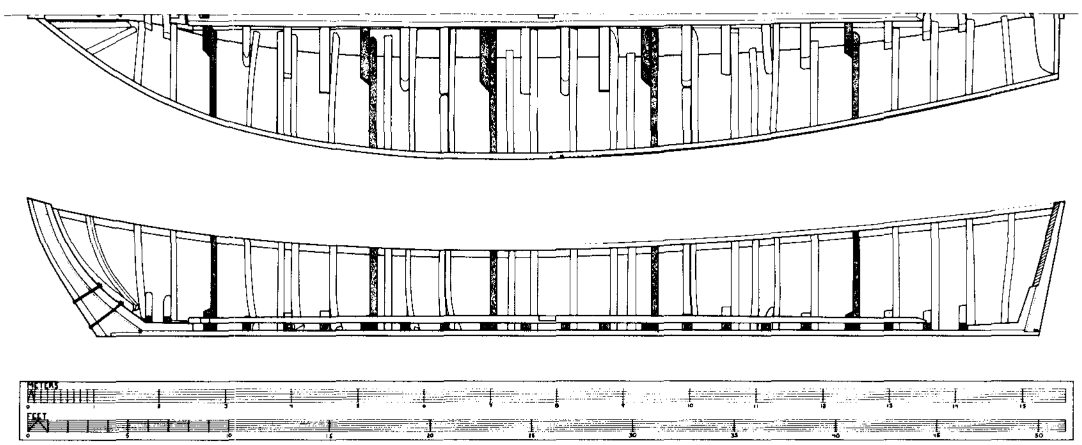

FIGURE 2. Framing plan; the shaded frames have the futtocks and floor timbers fastened together.

of the after face survives to indicate a sternpost rake of approximately 15° from the vertical.

Twenty frames, numbered consecutively from the stern, are treenailed to the bottom, with two smaller frames fastened to the upper surface of the apron (Figure 2). Each consists of a roughly symmetrical floor timber and two futtocks; except for the forwardmost frame, the futtocks are set behind their respective floor timbers. The floor timbers are sided from 4-6.5 in. (10.2-16.5 cm) and originally moulded a nominal 4.5 in. (11.4 cm), but reduced in places by joggling to fit the uneven surface of the bottom planks. Each floor has a rectangular limber hole cut near the centerline. Futtocks are less regular than the floor timbers, often preserving

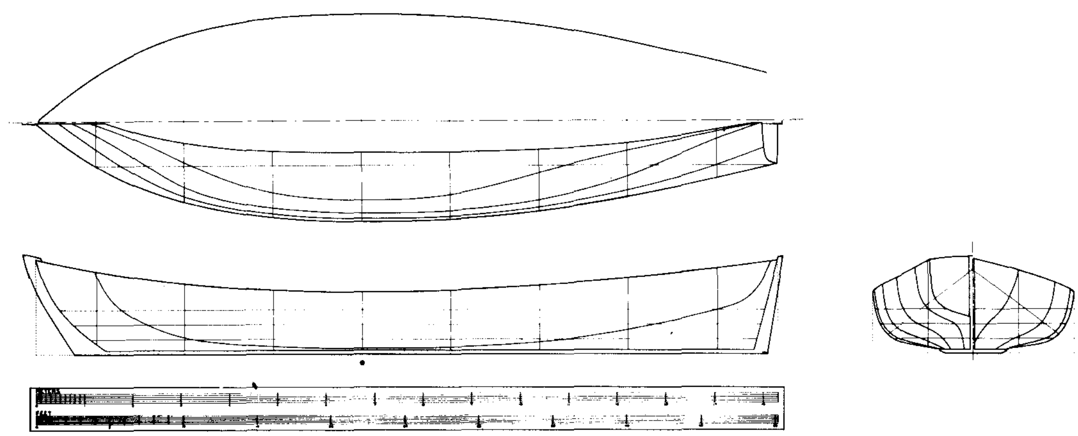

FIGURE 3. Preliminary line drawing.

sapwood and even bark in places, but are slightly smaller in scantling, sided from 3.5-5 in. (8.9-12.7 cm). Five frames, including the midship frame (Figure 2), have floors and futtocks fastened together by two nails and a treenail at each joint; the other futtocks are free.

In addition to the regular framing, there are a number of free, intermediate futtocks that may be later additions. These are arranged in pairs in every third room, beginning forward of frame three. Two of the regular frames (numbers 8 and 14) are reinforced by second futtocks in line with the floor timbers. It is possible that these are actually the lower ends of standing knees to support beams.

Most of the frames are clamped to the bottom by a cypress keelson 36 ft. 4.6 in. (11.08 m) long, sided up to 15.75 in. (40 cm), and moulded up to 4 inches (10.2 cm). The timber is essentially rectangular in section but with deep chamfers on the upper edges (Figure 1). The forward end is fastened to the upper surface of the apron, but the after end rests atop the second frame from the stern. At nearly every frame, the keelson is fastened through the floor timber to the bottom by a pair of treenails; the second frame has no fastenings, several frames toward the stern have only a single treenail, and the keelson is fastened to the ninth frame by a pair of iron spikes. Two rectangular maststeps are cut directly into the keelson, one at the forward end, atop frame 20, and the other aft of amidships, between frames 11 and 12.

The hull is planked with pine 1.125-1.25 in. (2.9-3.2 cm) thick. The planking is arranged in 8 strakes on either side, each strake comprised of 2 to 4 planks up to 11.25 in. (28.6 cm) wide. Planks meet in butts which are staggered but roughly symmetrical from side to side. In the preserved portion of the hull, the strakes are continuous, without stealers or drop strakes. Each plank is typically fastened to each frame by one nail and one treenail, but there are exceptions. The planks (except for the garboard) were backed out with an adze to fit the curvature of the regular frames rather than the frames dubbed flat to take the planks. The free intermediate frames, on the other hand, were dubbed to fit the planking. The forward ends of some of the upper planks were kerfed with an adze to facilitate bending them into the bow. The lower edge of the garboard is bevelled to fit the "rabbet" formed by the bevel in the upper edge of the bottom. The seams appear to have been caulked, as indicated by the impressions of caulking irons, but no remains of caulking material seem to have survived.

The hull is strengthened by a cypress wale 4 in. (10.2 cm) wide and 3.5 in. (8.9 cm) thick, with a broad chamfer along the lower edge. A section 24 ft. (7.32 m) long survives from the starboard side, but the after end is badly eroded. It is irregularly nailed or treenailed to most frames, and two large iron bolts are preserved at frames 4 and 12. At the mainmast step, there is a pair of eroded vertical holes, 5.5 in. (14 cm) apart, bored through the wale; these are probably the attachment points for the mainmast shrouds. A rail 3 in. (7.6 cm) square is nailed to the upper surface of the wale. Nails for this rail are preserved far enough aft in the wale to suggest that there were no raised bulwarks in the stern.

The sequence in which the Brown's Ferry vessel was constructed can be deduced with some confidence from the preserved remains. The bottom was the starting point, as a panel assembled from straight, heavy planks. Once this panel was laid up and temporarily fastened or clamped together, it was cut to the lanceolate shape that determined the shape of the rest of the hull. The posts were attached and the rabbet/bevel worked in the upper edge. With the backbone complete the midship frame (number 13) was gotten out, fastened together, and treenailed to the bottom at its widest point. Unlike the other frames, the midship frame was not joggled to fit the bottom but the bottom fayed to the frame. The shapes of the other made frames, numbers 4, 9, 16, and 20, were determined and the frames gotten out and erected on the bottom. With these 5 key frames and the posts in place, the garboards and probably the wales could be added. Besides providing more attachment area for the other frames, the garboards and wales offered clear indication of the deadrise at each frame and the location of the heads of the frames. As the shape of each frame consists essentially of a single, unchanging bilge curve combined with the deadrise at the bottom, little more information was necessary to determine the shapes of the remaining timbers. Once framing was complete, the keelson could be fastened in place and the rest of the plank hung.

The final shape of the hull is surprisingly graceful for a river barge, in spite of the flat bottom (Figure 3). There is a small amount of deadrise outboard of the bottom, even amidships, with full but moderately soft bilges. Towards the ends, the deadrise increases significantly, forming a chine at the garboard seam and contributing to hollows at the forefoot and skeg. The full bilges are carried well forward and aft but rise appreciably, with no tumblehome. The entrance is fine, with some hollow, and the run is quite long and fine. The rake of the stem is moderate in the surviving portion, contributing to the fineness of the entrance. At the stern, the vessel was originally reconstructed as a double-ender with a curved sternpost (Steffy 1979), but the length of the preserved portion of the wale and the full curvature of frame 4, most of which survives, indicate a straighter run of the upper strakes into a flat stern. The details of shape and structure are unknown because so little of the stern survives, but the shape of frame 4 suggests a deep, narrow transom.

It is curious that such a complex shape should be found in a river vessel ending its life carrying bricks. The design effectively negates two of the normal advantages of flat-bottomed construction: increased carrying capacity for a given draft and simplicity of construction. The bottom flat is relatively narrow, and the moderately soft bilges combined with the long, fine run further reduce carrying capacity from the potential maximum. The refined shape also requires large quantities of compass timber and the determination of changing frame shapes over the length of the hull. In many ways, the Brown's Ferry vessel is less a flat-bottomed boat than a conventional round-bottomed boat with a very wide, flat keel. It seems likely that the heavy, flat bottom's primary purpose was functional, to serve as a broad foot when the vessel took the ground for loading and unloading at the relatively undeveloped port facilities along the rivers of colonial South Carolina (Nylund 1988).

There are strong indications that the shapes of the key frames were determined by whole moulding. The curvature of the bilge is constant in all of the preserved frames except those in the extreme bow but rises and narrows along fair lines. The substantial hollow in the ends is typical of cruder forms of this design method as is the development of curves that can be difficult to plank in the bow. In the case of the Brown's Ferry vessel, the hollows may have improved lateral resistance in such a shallow hull by presenting more vertical surface to water at the ends, but it is difficult to say whether such an effect was intentional.

The construction falls conceptually into a boatbuilding tradition in which the bottom, rather than the shell or skeleton, is the primary element of design and construction. Many boats built in this tradition, mostly flat-bottomed, inland craft, are known from northwestern Europe, particularly England and the Low Countries, from the Roman Period onward. The so-called "celtic" vessels of England and the Rhine, medieval cogs, and Dutch vessels of the Renaissance are all "bottom-based" in their design and construction (Hocker 1991). The concept was brought to the New World by European settlers and flourished on the inland waterways of the colonies. A large number of bottom-based vessels are known from New England and Canada: bateaux, dories, gundalows such as the Revolutionary War gunboat *Philadelphia*, and the goelettes of the St. Lawrence. In each case, the bottom is an essentially flat panel made up of straight planks and sawn to shape. This panel, temporarily fastened together on trestling, is stabilized by the addition of heavy floor timbers. The rest of the vessel is built on this structure using conventional clinker or carvel construction, but the basic structural concept behind the process is neither a "shell" nor "skeleton" philosophy but a separate, distinctive idea based on the bottom as the primary element.

That said, it is entirely possible the Brown's Ferry vessel is not the product of a European bottom-based boatbuilding tradition transferred directly to the Carolinas but the combination of conventional European carvel construction with Native American elements. Early travelers through the Carolinas and Georgia report the widespread use of dugouts of Native American type and "periaugers," vessels larger than dugouts but still based on a log bottom (Fleetwood 1982). Where a single tree was not large enough, a completed dugout might be split longitudinally and a central plank or planks inserted. In such an environment, it seems likely that the Brown's Ferry vessel is the ultimate development of the periauger that is still recognizable as such. The flat bottom made of three heavy planks is the vestigial remnant of the dugout-derived log base, but the remainder of the vessel is squarely in the European whole moulded, carvel tradition. The reason such craft appear to be a dead end in the later Carolinas may be that, once wharves and piers were more widespread, there was less need for the heavy bottom and it disappeared, leaving an otherwise conventional boat. Where flat-bottomed boats continued to be used, they were not of the Brown's Ferry type but more typical straight-sided, hard-chined craft, such as the ubiquitous rice barge.

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The Brown's Ferry Vessel Project: Assessing the Conservation of a Mid-1700s Merchantman from South Carolina

Introduction and Project Background

The Brown's Ferry vessel is a coastal and river merchant craft of the mid-1700s. It was discovered in the Black River in 1971 by Hampton Shuping, a sport diver. Shuping immediately informed the South Carolina Institute of Archaeology and Anthropology (SCIAA) of his discovery and relinquished his lawful equity in the vessel as a gift to the people of South Carolina. The importance of the Brown's Ferry vessel was quickly recognized by the Institute's staff as it is the only known vessel of its type from that time period. Key personnel were directed to determine the advisability and costs of the vessel's eventual conservation and reconstruction. Advice was sought from eminent researchers in the United States and four foreign countries. In each case, the suitability of the Brown's Ferry vessel for conservation and reconstruction, and its historical importance was affirmed.

In August 1976, the vessel was removed from the Black River and placed in a farm pond for security reasons. This was a result of other recreational divers hearing of the vessel's existence and their insistence on taking home a piece of the boat for their mantles.

Having received widespread support and encouragement as to the merit of the vessel, and realizing that the vessel would not last indefinitely in its new surroundings, it was a short step for the Institute to actively seek to build and staff a conservation facility. The facility's mandate was to treat the Brown's Ferry vessel, and upon the completion of that project to treat other artifacts recovered from within and without the State of South Carolina. Funds for this project were derived from state, federal, and private sources. In 1981, the conservation facility was operational.

At this point, I would like to point out that there have been four Institute conservators who have worked with the vessel since 1976. They are in chronological order, Kate Singley, Curtiss Peterson, Bruce Thompson, and Jonathan M. Leader. Credit for the devising of the initial conservation technique that was employed on the Brown's Ferry vessel, which I will be discussing immediately below, belongs to Singley. As I continue this paper, please keep in mind that I am the caboose on a very long train.

After careful consideration, the treatment of choice for the Brown's Ferry vessel was immersion in a 65 percent (65%) aqueous solution of polyethylene glycol (PEG 1450). The solution was to be built up to this final percentage incrementally over a 24 to 36 month period of time. The reality is that the solution used reached 50 percent in 1987 and was held at that level until 1990. Polyethylene glycol (PEG) has been thoroughly discussed in the conservation literature over the last twenty plus years and little time will be taken in this paper to discuss it in any detail. At the time the project started, PEG was the conservation material of choice. Indeed, it still is for projects of this size and complexity. What is important is that at that time no one had ever treated an entire craft, through immersion, composed of different types of wood at a single time. Prior to this project, vessels composed of different woods were either disassembled for individual treatment and then reassembled or sprayed and painted with various weights of PEG. Results from these other techniques were uneven and often prohibitive in their expense. It was believed that immersion would result in a decrease of the time, conservation expenses, and opportunities for warping or other damage to the vessel. No one was sure what the final results would be, although the expectations were high.

The wood preservation tank used for the treatment has an area of 6,600 ft^3. and was completed in 1981. It measures 8 ft. in height, 15 ft. in width, and 55 ft. in length. It is composed of reinforced concrete brick. The floor is canted at a gentle 6 in. slope that empties into a sump for pumping purposes. Circulation of the PEG solution alternated every 12 hours between the two ends of the tank through special inlets and outlets that were controlled by electric timer switches. During this circuit, the solute passed from the tank, was filtered, reheated by passage through a gas boiler to 125°F and reintroduced to the tank. The machinery functioned 24-hours-a-day for eight years with only a few glitches caused by clogged filters, a burnt out motor, and a burst pipe. It was originally planned that the tank would be placed into the ground to facilitate movement of the vessel into and eventually out of treatment. Unfortunately, this was over-ridden by the university's Facility Planning Department due to the underlying soil composition. Placement of the tank on the surface of the ground, with its lip at 8 ft. above ground, tends to complicate work at the facility, although we have managed to adjust. Clearly, in-ground placement is to be preferred for tanks of this size where possible.

The tank was originally lined with hypalon, a synthetic rubber, as a cost cutting move. Assurances were given by the manufacturer that their product would perform in a satisfactory manner under the proposed conditions. It failed and was replaced by the more costly stainless steel liner originally suggested by the conservator. Stainless has proven impervious to PEG and will require only a small amount of cleaning prior to the next project. During the time that the hypalon liner was being replaced by the stainless steel, the unconserved boat was stored outside the tank under an awning with a sprinkler system. Damage was incurred to some of the live oak futtocks and frame supports at that time from excessive heat and sun. Southern climates preclude the use of outside sprinkler systems as appropriate conservation technique for wooden artifacts.

A monorail system for moving objects into and out of the tank and an extraction unit for reclamation of the PEG from solution were planned for the facility by Peterson and Thompson respectively but were not implemented due to budgetary constraints. We do intend to eventually implement these enhancements and consider them to be essential at this level of work.

The vessel itself is made of three types of wood: pine, cypress, and live oak. Sacrificial pieces of these woods were placed within easy reach of the tank's edge and sampled periodically for depth of penetration. In 1989, samples analyzed by David N. S. Hon, Director of the Forestry Laboratory at Clemson University, demonstrated that maximum penetration by the PEG had been achieved. It was now time to finish the project.

In late June 1990, a stress failure occurred in the circulation piping returning fluid from the conservation tank to the boiler. This resulted in a significant loss of solution, which in turn changed the equilibrium of PEG in the tank. Quick action on the part of Harold Fortune, the Institute's conservation technician, stemmed the total loss of fluid, and the vessel's saturation level was maintained at the same level as prior to the accident. The situation was further complicated as my predecessor had already left the position and I had yet to take it.

Finishing the Brown's Ferry Vessel

I became conservator at the Institute in July 1990. Fortune had managed to maintain the vessel unassisted for a month. Clearly, the time had come to remove the fluids from the tank and finish the conservation. With that said, the first order of business was determining if there already existed a detailed plan for finishing the vessel. A search of the files and conservation notes revealed that no executable plan had been devised. This was not surprising, as the individuals involved had not known precisely what the finished product would be. I determined to finish the vessel in three stages encompassing several tasks each. The first stage consisted of draining and recapturing the remaining 25,000 gallons of PEG, fabricating a wooden support to facilitate reconstruction, and monitoring the vessel during its initial controlled period of drying. The second stage comprised the gentle cleaning, recording, and reassembly of the vessels structural members. The final stage in this process was to be the reconstruction of the vessel in its place of exhibit and the manufacturing of an accurate scale model of the Brown's Ferry vessel as it probably looked. None of these tasks was expected to be easy, and they have not been.

The PEG portion of the first stage required negotiation with the South Carolina Department of Health and Environmental Control as to the method to be employed in the reclamation of the PEG. It was determined that there are no companies involved with the reclamation of PEG and the best that we could legally do was dispose of the excess material in a safe manner. This was particularly painful as PEG is expensive and reusable. As I have already mentioned, an extractor will be installed before the next project.

Fred Hocker of Texas A & M University kindly provided plans for trestles that were made from pressure treated 4 x 6 and 4 x 4 pine. Three rabbet joints were cut in the horizontal 4 x 6 members to receive the rabbeted 4 x 4 legs. The horizontal members varied from 3-10 ft. in length depending upon their predetermined support position under the vessel All the rabbet joints were accomplished on a short-bed 10 in. circular saw. Due to Hurricane Hugo and continuing rebuilding efforts, no other saws of appropriate size and bed configuration were available at the time. Gussets of 1-in. plywood were screwed into both the horizontal member and the outside legs to give additional support. One-in. carriage bolts secured the legs to the cross members. All the trestles were produced outside the tank and were preassembled to speed their placement under the boat. Under no circumstances is it suggested that anybody duplicate the use of a short-bed 10-in. circular saw for this type of work.

A steel "I" beam frame with dependent nylon ratchet straps had to be specially constructed to allow a 10-ton crane to safely raise the vessel from its floor position to the trestle top. This work was exacting, and we were fortunate that the Crane Company, originally called the Wilhoit Company, that moved the vessel to the original holding pond and then into the tank, twice, were available to do this job.

Once the vessel was in place on the trestles, the treatment tank was converted into a temporary curation facility. An environmental control unit, purchased by the University Facility Planning Department, assisted in the drying of the vessel, and happily this went without a hitch. The tank was maintained at a stable, relative humidity of 50 percent and a temperature of 75° F. Stage one was thereby brought to a successful conclusion.

Stage two was immeasurably assisted by the loan of Fred Hocker to the Institute's conservation team. The exacting recording of measurements and structural features is a primary part of vessel research, conservation, and reconstruction. The reason for this is simple. Early vessel technology went unrecorded, and all that we presently know of this vital area is derived from this painstaking work. Hocker is an expert on the archaeological recording of vessels and oversaw this portion of our tasks. One hundred fifty- six loose pieces of the ship, some being 20 ft. long, were painstakingly drawn at a scale of 1 to 10. The attached portions of the vessel were also completely drawn to this scale. Graphed mylar sheets were used in the place of graph paper for sketching, tracing, and the recording of measurements because the poly ethylene glycol quickly reduces standard papers to a soggy mass.

Prior to all this activity, the boat and the loose pieces were carefully hand cleaned of excess PEG and river mud that had been redeposited from the woods' interior during treatment. Luckily, volunteers were easily recruited from the Institute staff for this particularly messy job.

The task of reassembling the boat, in stage three, was necessary for several reasons. First, a portion of one side of the Brown's Ferry vessel was detached by its shifting cargo of twelve thousand bricks when it sank. Secondly, additional portions of the vessel were gently detached when it was first raised from the Black River to protect them from undue stress. These loose parts were treated at the same time as the vessel but were placed on special shelving within the tank. Finally, other vessel parts became loosened or detached during treatment and needed reattachment. Reattachment of these parts requires skill, large quantities of stainless steel rod, washers and nuts, and a lack of additional movement to the vessel. This means that final assembly of archaeologically conserved vessels should only be done at the place of exhibit. The Brown's Ferry vessel is scheduled to go to the third floor of the Rice Museum's Kaminsky Building this year. This will necessitate the peeling back of the roof and the placement of the vessel in its exhibit area with a crane. Final assembly of the vessel will be done as part of a "living exhibit." We look forward to this opportunity to educate and interact with the public as conservators. In addition, all stages of the work done on this vessel have been taped by Public Television and will become a permanent part of the exhibit.

Finally, the production of scale models reconstructing the vessels form and accoutrements is extremely important. They provide possible views of the vessel before its sinking and subsequent damage. The process of making an accurate scale model that incorporates the data derived from the conservation and recording of the Brown's Ferry vessel will be undertaken by Fred Hocker who will complete a model reconstruction at Texas A & M and present it to the museum for exhibit and ongoing research.

Summary

The Brown's Ferry vessel represents a unique and irreplaceable part of South Carolina's maritime heritage. In May 1979, the Brown's Ferry vessel was nominated to the National Register of Historic Places. Part of the nomination procedure for this prestigious registry is the definition of the importance of the property being considered. The Brown's Ferry vessel was accepted at the highest national level.

The conservation of the vessel is now complete except for the final reconstruction that will take place at the Museum in Georgetown, South Carolina. Overall, the project has been a success. The vessel is conserved with a minimum of damage. The warpage that has been identified existed prior to treatment or resulted from the prolonged exposure of the boat to the weather while the hypalon tank liner was replaced with stainless steel. Nonetheless, several caveats must be heeded by conservators engaged in complex, large scale, multi-year projects of this sort. They are:

1) Insist on long term planning documents that clearly outline the responsibilities (or lack thereof) for all the entities involved.

2) Develop interim goals with specific dates for completion and disseminate them widely.

3) Stand your ground as to essential materials or tools necessary for the task at hand, but moderate this with the next point,

4) Be flexible in the face of change. No long term project will remain untouched or unaltered. Personalities, not documents, often determine a successful conclusion to long term projects.

5) Do not hide your set-backs from the archaeological and conservation communities. We all know that things go wrong with monotonous regularity. It may be more fun to speak of triumphs, but advancement of our professions comes from unabashedly confronting our lost opportunities and mistakes.

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Investigation of the "Wreck of the Ten Sail," Cayman Islands, British West Indies

Introduction

With support from the Cayman Islands National Museum and Texas A & M University, an investigation has been initiated into an historic event that is woven into the fabric of Cayman Island folklore as the "Wreck of the Ten Sail." The late 18th-century disaster involved ten ships of a 59-ship convoy that sailed from Jamaica and wrecked on the eastern reefs of Grand Cayman while in route to various ports in England, Ireland, and Scotland.

Until recently, the calamitous event survived largely as a local Caymanian legend, but research clearly indicates that the incident has historical importance that goes beyond the bounds of Cayman's own national interest. Its occurrence during a tumultuous period in world history provides us with insight into the broad geographical distribution of war, knowledge and trade at the close of the 18th century.

The French Revolution had commenced in 1789, and by 1793 France had declared war on Britain. At sea the capture of each other's naval and merchant ships as prizes was a frequent happening, and hostilities extended to their New World possessions. In November 1793, the French frigate *l'Inconstante* was captured off the coast of Hispaniola by His Majesty's Ships *Penelope* and *Iphigenia*, commanded by captains Samuel Rowley and Patrick Sinclair. The French captain, Joseph Riouffe, had been mortally wounded in the engagement. The prize was taken from Hispaniola to Jamaica and put into His Majesty's Service as HMS *Convert* under the command of newly commissioned Captain John Lawford.

As a British ship of war, *Convert*, a fifth-rate frigate of 36 guns, was to escort and protect the produce-laden winter convoy of merchantmen to Europe. Ironically, the greatest danger was not to be the French, for on February 8, 1794, *Convert* wrecked together with nine of the merchant fleet on the perilous eastern reefs of Grand Cayman.

Previous Research

Until 1979 little archival research had been conducted into the true account of the "Wreck of the Ten Sail." Two Cayman Islands' Government-sponsored histories, one by George Hirst in 1910 and the other by Neville Williams in 1970, contain brief descriptions of the event. While the two versions bear some resemblance to historical fact, even the name of the naval escort, given as HMS *Cordelia*, and the date as 1788, are not correct. The accounts are based almost completely upon an oral history narrative that Commissioner Hirst recorded prior to 1910. While the story is extremely valuable as the traditional version told to Hirst by a man whose grandfather was alive when the disaster occurred, there are also contemporary 18th-century accounts that have survived and which are housed in archival repositories in Europe and the Caribbean. Among such documents is Captain Lawford's letter to Admiral John Ford, which describes the incident.

Several important archival documents relating to the wrecks of HMS *Convert* and the nine ships in that convoy were discovered by Roger Smith, project director for The Cayman Islands Project. Smith led an archaeological survey conducted by the Institute of Nautical Archaeology for the Government of the Cayman Islands in 1979 and 1980. These documents provide details about the shipwrecks, the shipwreck victims, and islanders who responded to the episode (Smith 1981).

Archaeological evidence of the shipwreck disaster was also found by the 1980 survey. Although the investigation was a general reconnaissance to find and record shipwrecks located around all three of the Cayman Islands, in excess of a month was spent exclusively surveying the reefs of Grand Cayman's East End. During that time more than 25 sites associated with shipwrecks were recorded. Based on material evidence ranging from ceramics and glass to cannons and anchors, it was determined that these sites varied in date from the late 18th century until mid-1960. Although in depth analysis of sites was not among the goals of the general reconnaissance, the project concluded that several of the sites were likely to represent remains of *Convert* and the merchant convoy. In fact, one site was characterized by buried cannons. It was known that at least two guns had been previously removed from the site for display on land, but the project plotted locations of five others, one of which had been removed from the site and dropped half way across the sound towards shore. The transported cannon, identified as French, bore inscriptions on the base ring and trunnions to denote its foundry, weight, number, and the date 1781. The project recommendation was that the site should not be further disturbed until adequate conservation facilities and personnel were in place on the Island.

During the 1980s, under the auspices of Indiana University, Charles Beeker conducted research into shipwrecks located on Grand Cayman's East End. In correspondence with individuals in Britain and France, more archival clues emerged. Of particular interest is the identification of the foundry where the East End Sand Cay cannons were cast and confirmation that they are in the style of a 12-pounder used on French frigates of the period. The evidence suggests that the cannons are likely to be the original ordnance provided for armament of *l'Inconstante* and lost by the frigate when it wrecked under the name *Convert.* During a series of field school projects in which novice students were taught fundamentals of underwater archaeology by experienced nautical archaeologists, the cannon site was further examined. Beeker's group explored the area with metal detectors and plotted the positions of at least six probable guns, most of which were buried magnetic features. They also mapped locations from which additional cannons had recently, and unfortunately, been removed for ornamental display on land.

Current Research

In 1990 the present investigation into the wrecks of HMS *Convert* and the nine ill-fated ships of the merchant convoy was initiated. Major goals of the project include: 1) to provide a thorough and accurate historical account of the significant, but largely forgotten, event; 2) to place the incident in its true historical and geographical context; 3) to locate archaeological sites that are likely to be associated with the disaster; 4) to map major site features; 5) to recover, conserve, and analyze artifacts encountered during archaeological survey and testing; and 6) to determine the nature and magnitude of the physical remains so that informed decisions can be made for further investigation and effective management of the archaeological resources.

Methods that are being employed to achieve the stated goals of the project entail archival work in Jamaica, Britain, and France; archaeological survey, mapping, and testing of shipwreck sites scattered over the reefs of Grand Cayman's East End; and oral history interviews with older Caymanians whose parents and grandparents told them the story of the "Wreck of the Ten Sail."

Archival Research

In February 1991, a very fruitful archival research trip was made to British repositories, including the Public Record Office and the National Maritime Museum in London where material was found about the merchantmen as well as about the frigate. Significant data about the capture of *l'Inconstante* and the subsequent sale of the vessel and its stores was obtained from the Island Record Office in Jamaica. Finally, vital information was obtained through correspondence with three archives in France, including the Archives de France, the Service historique de la Marine, and the Archives du Port de Rochefort, which is the port where the frigate was built. One archive even provided an illustration of a ship that was constructed according to the same design as *l'Inconstante*.

The wealth of archival material that has been found not only provides historical data to illuminate the shipwreck event but also provides concrete facts that facilitate archaeological field work. Examples of documents that have been examined include logbooks of His Majesty's ships, French and British muster rolls, Captain's letters, Admiralty correspondence, court martial records including the acquittal of Captain Lawford, inventories of *l'Inconstante* after its capture from the French and of the stores saved after wrecking as HMS *Convert*, periodical data concerning the frigate and the merchant ships before and after they wrecked, ships registers, Lloyd's List, Lloyd's Register, port records, and additional French and British official correspondence.

Archaeology

As background archaeological work, a general survey of cannons presently located around Grand Cayman, on land, was conducted in December 1990. Of approximately 30 guns which were photo documented, measured, and history-of-salvage detailed, nine are almost identical cannons that were taken from the Sand Cay site located on the inside of the reef at East End. Three are known to have been raised in the 1970s and today are located in the front yards of private residences. At least four of the remaining six were lifted in the 1980s, despite recommendations to the contrary. Two remain in front of private residences, and the other four are now in public ownership. All of these cannons had inscriptions at the time of salvage which have since largely exfoliated with layers of rust corrosion. Although previously none had been adequately conserved, one gun is now being treated through electrolysis, and efforts to acquire and conserve the others are being made. Today, the cannon site is being more carefully monitored and protected by the government.

Between late July and early November, an archaeological survey for the *Convert* site and the other merchant ships was conducted on the East End reef. It is the windward side of the island so sites are often scattered outside and over the reef and into the sound at East End. The work was concentrated in an area extending from south of East Channel to Colliers Channel because archival records specify that the event occurred on the northeast end of Grand Cayman and because, during the 1980 survey, 18th-century material was found primarily in this zone. All previously recorded sites were relocated and reassessed, and other sites and important features were discovered.

Results of previous archival and archaeological work were useful in planning the survey. For example, *Convert* was known to have been a 36-gun frigate of 930 tons. It is unlikely that its armament was substantially changed when it was converted from French to British service. So, by comparing the inventory of *l'Inconstante* with the official salvage account of *Convert*, one can hypothesize about what might be found, keeping in mind that further salvage undoubtedly occurred by members of the local population. Three sites have been located that may be associated with the frigate. First, there is the well known area from which French cannons have periodically been "mined." The site lies within a sand bar several hundred meters on the inside of the reef near the East Channel. Although it is known that nine 12-pounders have been salvaged previously, the ship carried 26 such guns, as well as six 6-pounders that were not salvaged at the time of wrecking. Our crew gridded the area and conducted a controlled metal detector survey. Additional magnetic features were isolated, increasing the total of probable cannons remaining on site from 6 to 13. The anomalies were plotted, and their locations compared favorably with previous mapping. Naturally, the area is a prime site for testing, but delays in permitting prevented the work from being carried out in 1991. So, the work is planned for next season.

The second site is located several hundred meters to the northeast of the cannon site and may represent a spillage trail towards it. It extends from on top of the reef west/southwest over an area exceeding 100 m. The zone is characterized by minimal sediment near the reef, to more depth of sand and rubble covered with turtle grass towards shore. There is a surprising absence of major shipwreck features on the adjacent outside reef; but because the reef is a high energy zone composed of dead coral rubble that builds and shifts, it is possible much is buried. A 100 x 140 m area was divided into 20 x 20 m grids and a controlled surface collection was carried out. Each grid was covered with two metal detectors and the iron, lead, pewter, and cuprous metal artifacts were plotted on a master map. Although the iron artifacts were heavily encrusted, many were identifiable. Among items recorded on the site are: bar shot, cannon balls, pig-iron ballast, scattered shingle ballast, remnants of rigging, copper and lead sheathing, a probable swivel gun yoke, lead musket balls, numerous copper and iron fasteners, possible tools, ceramics, glass, bricks, tiles, and personal items including a couple of pewter spoons.

The third site that may be associated with the frigate is located to the north of the other two, on the outside of the reef. It is characterized by an anchor, a concentration of pig-iron and iron-slag ballast, numerous large copper fasteners, and other features. Some of the iron-slag ballast is located in scour pits seaward of the reef and is also present on top of the reef. However, there is very little other shipwreck material extending to the shore from the reef. Nevertheless, our discovery of the pig-iron ballast in October was very exciting because we had been searching for it all season. We knew from archival documents that as a French ship the frigate carried pig-iron ballast and it is likely that it still carried such ballast when, as *Convert*, it wrecked.

The nine merchant ships were smaller than the frigate, ranging in tonnage from about 150 to 376 tons. Several were moderately armed, and at least one carried ten 4-pounder cannons. It is known that attempts to salvage the merchant ships were mostly unsuccessful because they carried perishable cargos like rum, cotton, sugar, and wood. Nevertheless, it is likely that some of the hardware like guns and anchors would have been retrieved. Therefore, it is not surprising that sites that are most likely to be remains of the merchant wrecks are not extensive. Most are characterized by concentrations of ballast, fasteners of iron and sometimes copper, minimal glass and ceramics, and occasionally an anchor. Artifacts, including ballast samples, are currently being analyzed in hopes that they can provide further information about the merchantmen.

Oral History

The "Wreck of the Ten Sail," as it is known by oral tradition, is still alive in the folklore of the Cayman Islands. Today, there are "old heads" who relate different versions of the story, and one East End resident, who recently died, pointed out the grave of a person who perished during the shipwreck. Interviews have been conducted and the stories have been recorded. The accounts often vary from the historical record, with elements of pirate ships as well as local heroism and reward, but some include possible facts about families who were descended from shipwreck deserters. The stories add insight into the continuing effect of the disaster on the local population and enhance our understanding of the historical event.

Conclusion

As a result of the current investigation, significant new archival, archaeological, and oral history data have been discovered which shed light on the history of HMS *Convert* and nine merchantmen that wrecked on the perilous eastern reefs of Grand Cayman in 1794. Some questions have been answered and others have emerged. It is our present aim to continue the inquiry in order to further clarify the picture.

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A Brief History of Underwater Salvage in the Dominican Republic

Introduction

The Comisión de Rescate Arqueológico Submarino (Underwater Archaeological Recovery Commission), established by the Government of the Dominican Republic in 1979, has as its stated goals "the development and execution of salvage programs and preservation of cultural goods found in Dominican waters or in maritime areas under the economic influence of the Republic" (Borrell 1983).

Since 1979, and until recently, the majority of underwater research in the Dominican Republic has been a cooperative effort of the Comisión de Rescate and various "for-profit" salvage groups. The result of these joint ventures has been a high yield of cultural material displayed in the Museo de las Casas Reales (Royal Houses Museum) as well as a modicum of historical research that has also been made available to the public.

Nuestra Señora de Guadalupe and *El Conde de Tolosa*, two "quicksilver" galleons carrying mercury for the Spanish Crown, met their fate in Samana Bay on August 24, 1724. The precious liquid was essential to the amalgamation of both gold and silver extracted from New World mines. The Museum of the Royal Houses and the Dominican Department of National Parks requested Caribe Salvage, headed by Tracy Bowden, to negotiate a contract for specialized salvage work of these galleons, a project that was initiated in 1976.

The most widely known shipwreck in the Dominican Republic is *Nuestra Señora de la Pura y Limpia Concepción*, the Capitana of the 1641 fleet, salvaged by Burt Weber and Seaquest International in 1978. *Concepción*, heavily laded with assorted treasures, broke up on the Abrojos reef after a September hurricane stripped it of the fore and main masts, causing the vessel to drift for nearly a month before running aground.

Founded in 1985, North Caribbean Research, headed by Richard Berry, possesses the largest search and salvage area in the Dominican Republic. While the concession is nearly 100 mi. long, stretching eastward from the Haitian border to Puerto Plata along the north coast, North Caribbean Research has, to date, explored a little over 15 mi. of coast. However limited their search may remain, they have already discovered over 30 shipwrecks, ranging from the 17th to 19th centuries.

The Pan-American Institute of Maritime Archaeology

During the summer of 1991, The Pan-American Institute of Maritime Archaeology (PIMA), a non-profit scientific and educational research institute based in Houston, Texas, conducted the first systematic underwater archaeological excavation in the history of the Dominican Republic. The site, commonly referred to as the Monte Cristi "Pipe Wreck," owing to the large number of clay tobacco smoking pipes that formed a significant portion of the ship's cargo, is tentatively dated to mid-17th century. Four research objectives for the Monte Cristi Shipwreck Project were previously outlined in the 1991 Society for Historical Archaeology Conference on Underwater Archaeology Proceedings (Hall 1991:84-87). An overview of accomplishments during the 1991 excavation season includes:

a. exposing, recording, and sampling of various hull components;

b. excavation, recordation, stabilization and conservation of numerous cargo elements;

c. discovery that many artifacts, obscured by concretion, were passed over by previous salvage attempts;

d. successful integration of over 30 volunteers in an underwater archaeological excavation. The Monte Cristi Shipwreck Project totaled over 1,200 diving hours during 1991 with a perfect safety record; and

e. establishment of PIMA as a credible, nonprofit, scientific, and educational institution.

Because the hull and cargo remains of the vessel were more extensive than previously thought, it is currently estimated that three additional field seasons (1992-1994) are necessary to complete the excavation phase of the project. It is presently anticipated that the excavation, conservation, and interpretation of the site will culminate in a single volume, final publication by the year 2000.

Methodology

The vessel, located in 15 ft. of water off the small Island of Cabra, is situated in the relatively sheltered bay of Monte Cristi. The site is covered with turtle grass (*thalassia testudinum*), and divers found it necessary to remove the overgrowth so that sediments covering the wreck could be handfanned away.

In order to properly excavate the vessel, a grid system of 22 interconnected squares, each measuring 2 x 2 m, was placed over the site. The grid, made of 3/4-in. schedule-40 PVC pipe, was less than desirable but proved sufficient, especially when considering the cost of transporting equipment internationally. A baseline was laid over the keel of the vessel, running from north to south. Grids were marked in 10 cm increments with alternating bands of black and white. All artifacts were assigned a specific quadrant (1 m-square designation) and those of particular diagnostic value (representing a singular or complete artifact) were measured precisely.

The Site

The site of the Monte Cristi vessel is characterized by five large concretions (Figure 1). The most southeastern of these appears to be a single slab of iron, covered with a thick crust of calcium carbonate. The remaining four structures suggest a conglomeration of iron and assorted artifacts (Figure 2). The majority of ship's wood present on the site is directly beneath, or in the near vicinity of, these concre-

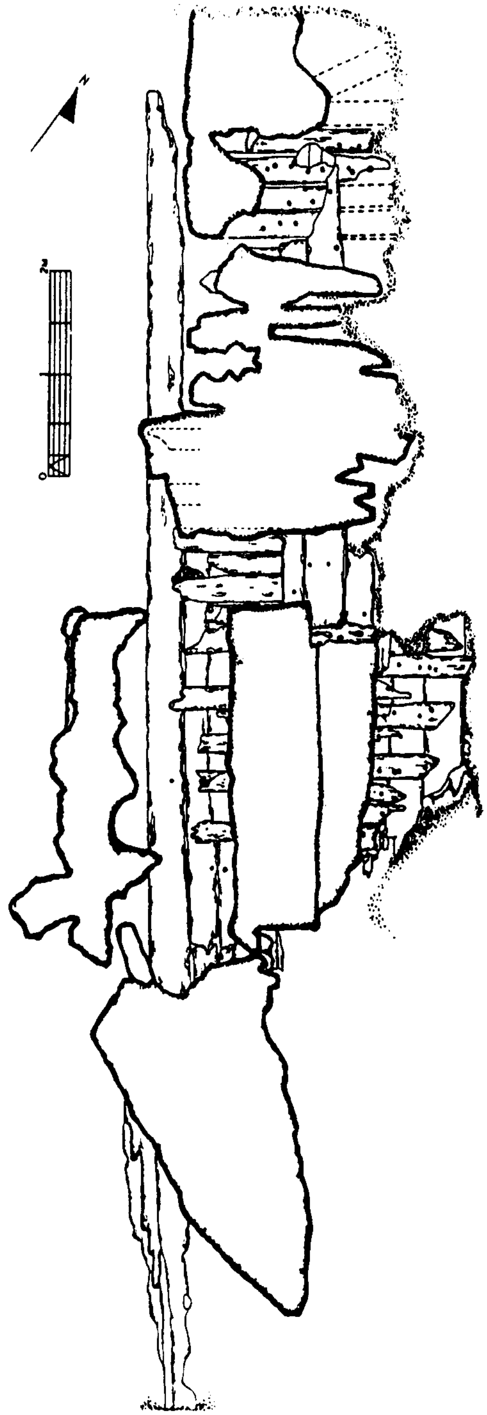

FIGURE 1. The 17th-century merchant vessel at Monte Cristi Bay, Dominican Republic, is characterized by five large "concretions" that overlie the extant hull of the ship. The keel is the most predominant feature of the site. Drawing from PIMA archives.

tions, suggesting that their weight was sufficient to bury the bottom of the hull and partially protect it from biological attack. It is currently unknown if these iron pieces formed a component of the ballast or were part of the ship's cargo.

The keel is the most obvious feature of the site and had been exposed for many years prior to the 1991 excavation. This is attested to by the high degree of biological damage that is evident for the length of the timber. The western side of the keel (bow, stern, port, and starboard have yet to be assigned to the vessel) was characterized by an "L"- shaped rabbet, but it is not known if this represents its original form or merely the result of damage due to exposure. The garboard strake is only partially attached to the keel on the eastern side of the vessel, suggesting that it may have broken under the weight of one of the large iron concretions.

Evidence of keel joinery survives in two scarfs, one at the northern extremity of the keel, the other intact but obscured by the large, iron, triangular concretion at the southern end of the site. There is no keelson, and evidence for one on the ship originally is, at present, incomplete. Twenty-three frame timbers were uncovered. These were composed of floors and first futtocks, although the method of joinery between the two elements is uncertain, once again due to the large, overlying concretions that prohibited thorough examination. Three lengths of ceiling planking were found overlying a short span of frames.

At least seven runs of bottom planks have survived on the eastern side of the keel. A fibrous "matting," mixed in a resinous matrix, was found to separate the bottom planking from its relatively thin, softwood sheathing. Preliminary examination in the field suggested this

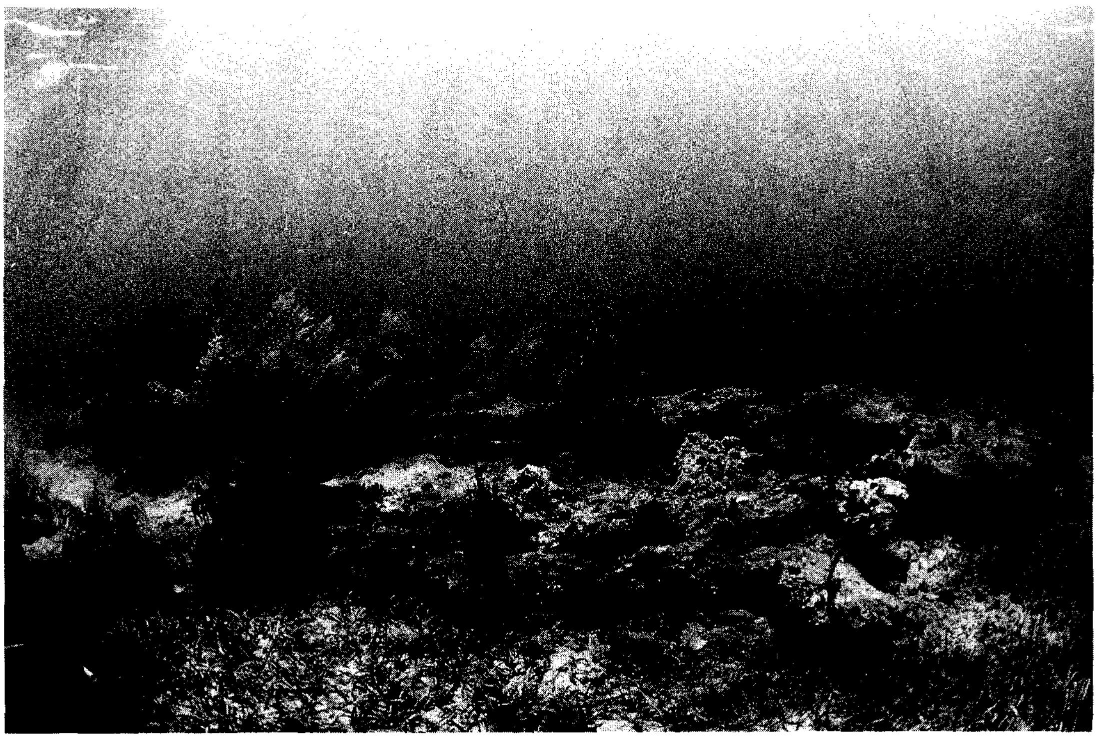

FIGURE 2. Looking east prior to excavation. The ship's keel lies behind and runs parallel to the concretion in the foreground. Photo by Eugene Rowe.

material was animal hair, but further, although incomplete, study indicates a still unidentified plant fiber. Preliminary analysis of the hull timbers reveal the ship's keel, frames, and treenails are all of *Quercus sp.* The vast majority of the timbers west of the keel remained undiscovered through excavation, which has led us to believe that these structures have either: 1) disappeared as the result of the wrecking process; 2) vanished through exposure over the past three and one-half centuries; or 3) lie buried deeper beneath the substrate than archaeologists were able to penetrate during the excavation season.

Results

Over 4,500 artifacts were raised from the wrecksite of the Monte Cristi vessel. Preliminary conservation was initiated for each object. This procedure, more often than not, consisted simply in making sure these materials remained wet and well packed after recording. Fundamental chemical treatments were implemented for those artifacts in need of immediate attention, and experimental chemical and mechanical cleaning was initiated as per the discretion of the chief conservator. The majority of artifacts were stored at the Fortaleza Ozama Laboratory in Santo Domingo where complete conservation treatment is to begin in April 1992.

By far the largest single category of finds aboard the ship was clay pipes. Although the majority of pipes were represented by broken stem fragments and an occasional bowl, a spectacular find was made at the close of the season: unbroken bulbous-bowled pipes lay beneath

FIGURE 3. Entire bulbous-bowled clay smoking pipes bearing the mark "EB," the characteristic stamp of Edward Bird, an Englishman who manufactured his wares in Amsterdam, Holland, between 1630 and 1665. These pipes, pictured beneath the vessel's keel at the southeastern end of the site, appear to be arranged in an order suggestive of the way they were packed for shipment. Photo by Alejandro Selmi Colominas.

the keel near its southernmost extremity (Figure 3), apparently in the manner in which they were packed for shipment.

The second largest artifact group was ceramic sherds characterized by Rhenish stoneware, white-glazed ware, and blue-and-white delftware.

A number of metal artifacts were also found, the best preserved of which were copper alloy (Figure 4). This collection includes: a mouth harp; a set of nested weights of Nuremberg manufacture; latches from two, separate nested-weight sets; a pair of navigational dividers; and a hawk's bell.

Numerous iron fragments, as well as concretions bearing molds of suspected iron artifacts, were recovered. Miscellaneous artifacts include a three-legged cooking vessel of unknown composition (obscured by concretion), two pewter spoons, one pair of tweezers, a partial lice comb, a pair of scissors, pewter tankard fragments, three coins (two of silver, one of copper alloy), eleven musket balls, and numerous glass sherds, brass tacks, and iron nails.

The majority of faunal remains aboard the ship were represented by mammalian bones, most of which belong to the *artiodactyla* (sheep or goat). Chicken bones have also been found. Fish bones, recovered at the wreck level, will be analyzed to see if they represent intrusive remains of indigenous species or a northern Atlantic food stuff (i.e. herring) that was carried as stores.

Botanical remains, comprised mainly of various seeds and leaves found within the confines of the extant hull and cargo, are currently being studied. These, and other artifact distributions, are currently being studied to see if pat-

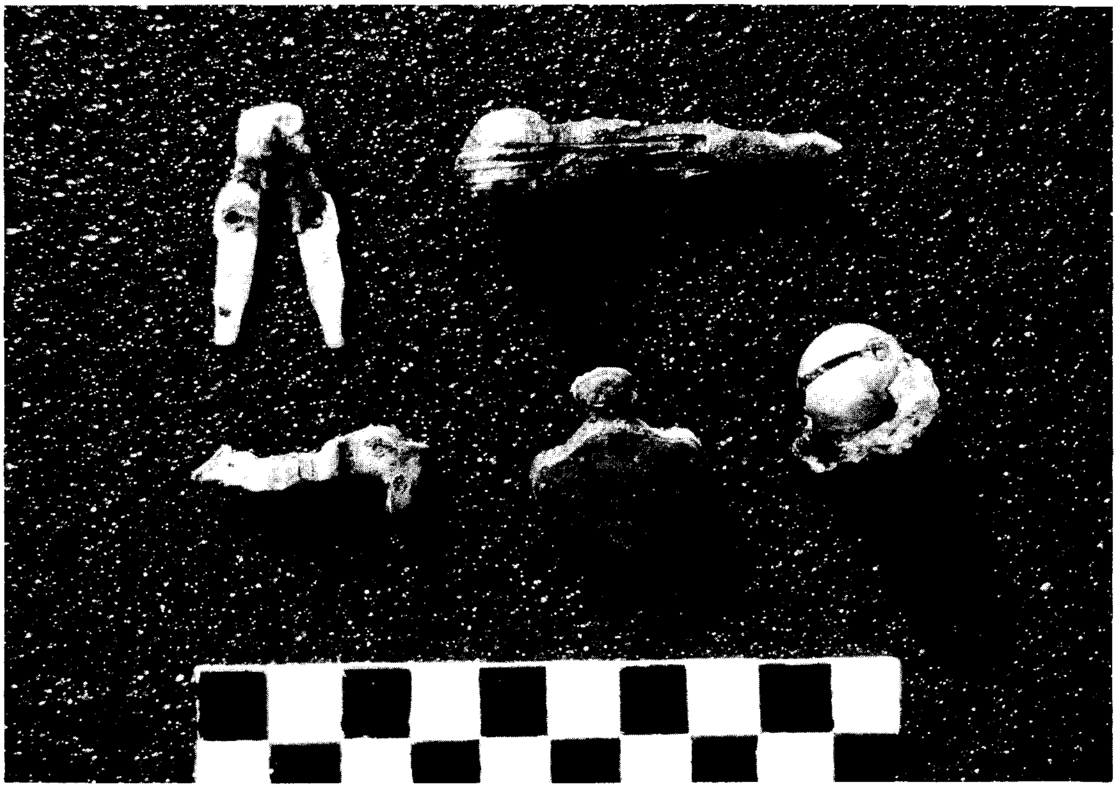

FIGURE 4. Copper alloy artifacts from the 17th-century Monte Cristi vessel. From left to right (upper row) a latch to a nested weight set of Nuremberg manufacture, a pair of navigational dividers; From left to right (bottom row) additional latch to a nested weight set, a possible decorative finial, and a hawksbell. Photo by Amanda Jane Sutherland.

terns emerge that will enable the determination of trends in vessel lading and its position on the sea floor.

It is currently suspected that the Monte Cristi vessel is of northern European construction, perhaps Dutch or English. Clay pipes recovered from the ship are of Amsterdam manufacture, while a single set of nested weights is characteristic of Nuremberg production. What the vessel was doing on the north coast of the Hispaniola during the middle to late 17th century remains an enigma, as does its construction and demise. However, the theory that the ship was engaged in an illicit trading venture, perhaps with buccaneers, is still viable.

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SYMPOSIUM

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Advances in International Underwater Archaeology

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The Danish National Record of Marine and Maritime Sites

The Record of Marine and Maritime Sites is part of the National Record of Sites and Monuments (the Danish abbreviation is "DKC") which is a computerized register of geographically localized sites from prehistoric, medieval, and later periods. The DKC was initiated as a project in 1980 to computerize the handwritten and manually updated Parish Records and maps. These Parish Records are compiled through several nationwide surveys dating back to the beginning of the 17th century and from reports on casual finds of about 130,000 sites and monuments. Some of the surveys included recording of prehistoric finds along the coast, a stretch of about 7,000 km (the total land area is 44,000 sq. km).

Although only one-third of the known land sites are at present fully recorded, the DKC functions as the central databank for much administration and planning on the part of museums and other authorities and, of course, the National Museum. Furthermore, the legislation about government-subsidized museums ensures that all new archaeological finds or activities on land or sea are reported to the DKC.

Whereas surveying and registration of prehistoric sites on land has a long history, systematic recording of marine sites has just begun through a joint venture between the DKC and the Ministry of the Environment, who is responsible for the cultural heritage on the seabed. The sites and monuments are divided into "land" and "sea" registers according to the present location of the sites within or beyond the daily high tide mark on the shore.

A *marine* site is defined as the physical evidence of human action found in the sea. Oral traditions about phenomena in the sea can also be defined as a "site." Finds in inland waters or constructions on land that extend into the sea are defined as *maritime* sites, being the physical evidence on land of human exploitation of the sea, rivers/streams, or lakes.

The Danish coast has always been subject to an ongoing change of the sea level and mechanical forces from the wind and sea. This means that many prehistoric settlements or other finds that originally have had no maritime connections at all are now situated on the sea floor, and conversely medieval wrecks may be found several kilometers inland.

As a result of the long Danish tradition of archaeology, we think of ourselves as having a fairly good knowledge of the distribution or location of different types of land sites. Compared to this we know only a fraction of the sites on the sea floor. Being a seafaring nation, research into maritime subjects such as shipping and fishing, naval history, etc., has a long tradition among Danish historians, and many of the results and data from this work are highly amenable to computerization. However, research on a large scale into the nature and location of marine sites is, to date, very limited. This is, of course, in the nature of things as a survey of the bottom of all Danish waters is very hypothetical and electronic equipment still cannot detect the whole range of various sites. On the other hand, studies of land sites in relation to the coast, the coastal area itself, and other factors, have proved a profitable way to discover and predict marine sites. For instance, most of the known Stone Age settlements on the sea floor have been found in shallow water near the present coastline, but the discoveries are due to modern activities, such as scuba diving. Recently systematic surveys in search of stone age maritime settlements have been initiated resulting in many finds at specific depths following the study of prehistoric coastlines and

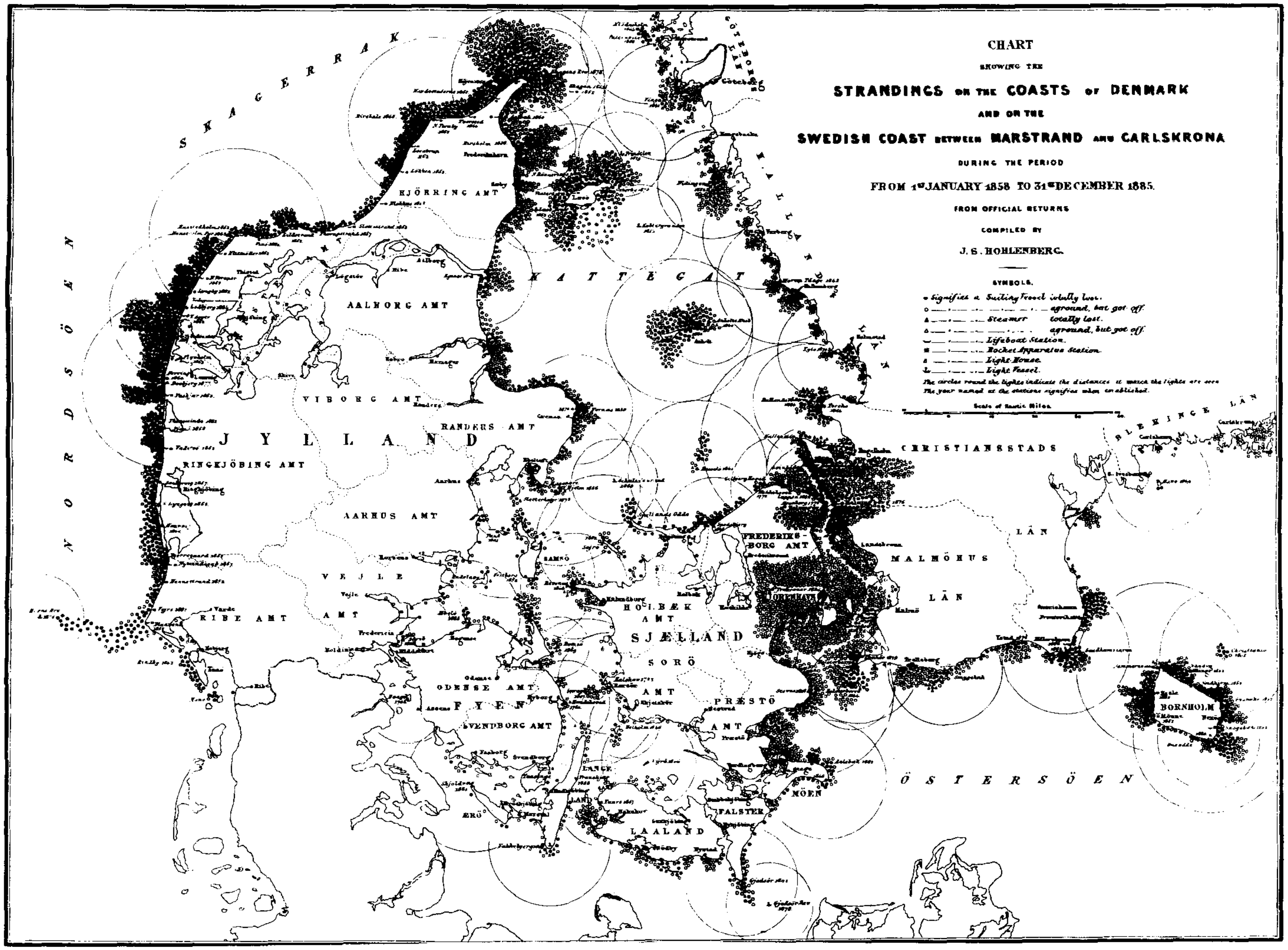

FIGURE 1. Map of strandings. From J.S. Hohlenberg, 1887. Filled in symbol = total loss. Open symbol = grounding.

riverbanks. The potential area for the oldest Stone Age settlements on the present seabed, however, is much larger (some 20,000 sq. km^2).

Another study of finds in relation to natural conditions is shown in Figure 1, which is a chart from 1887. Of the 6,300 reported strandings from 1858 to 1885, 2,800 were total losses. The chart is an excellent example of early maritime research on a large scale accompanied by very useful statistics. Of course, one cannot use such a chart to predict the area of strandings or the number of wrecks in Danish waters from prehistoric times to the beginning of official indexes of strandings/losses. But as an indication of the potential areas where wrecks can be found from the late period of sailing ships and early period of steamers, the chart is invaluable. This chart and various lists of losses are used as references, and actual wreck positions are taken from the charts that have been published for centuries by the Hydrographic Department. These positions are being checked systematically by amateur or professional divers, the former contributing much information on wrecks.

Another large project is carried out by interviewing Danish fishermen about their knowledge of the sea floor and, if possible, digitizing their fishing charts with markings for different seabed obstructions. In the earlier days of small fishing vessels and manually-hauled nets much information about obstacles that could damage the nets given to the authorities who willingly blasted and levelled many historic wrecks to secure the traffic. Today the big and powerful trawlers are capable of making a clean bottom and not only of fish. It is no problem to land 3- to 5-ton anchors from historic wrecks on a trawler deck, so what is left now as "obstacles" is really of a solid nature. Due to deep rooted suspicion towards any kind of governmental inquiries in these days of hard competition on fishing quotas, it is not surprising that it is mostly retired fishermen who are willing to produce their charts!

Maritime records on computers have existed for many years in seafaring nations, held by libraries or research institutions or private salvage companies. These records are almost exclusively on ships or wrecks from the last four centuries; whereas national records of all kinds of archaeological and historical sites exist only in a few institutions or are just being established. Such records may be designed in many ways depending on the needs. To satisfy multipurpose use in both research and administration requires a lot of analysis and systematization, which in most cases is incorporated into relational databases. As technology and databases develop and change constantly, it would be out of the scope in this paper to go into detail about that. What might be of more general interest is the fundamental principles in the Danish system.

First of all, it was resolved that for the future evaluation of the database the original texts from the Parish Records or from other first-hand records should be copied as historical documents for whatever systematization was to be done with the information. Additional information might be extracted from other archives, and this means that the database is not meant to replace all the archives or the total amount of information to be found, but it does give the data necessary to produce surveys, evaluate each site and the original information, and indicate the institutions and archives where more details can be found.

In Figure 2, all data from sites are classified through the identification of the site and storage of data within the system. Data are then divided in two main groups. One contains data about a "case." Each case (number) is defined by logically connected events and actions on the site. Such data are grouped according, first, to data on *Where* the site is located, that is the geographical position, place names and so on, and then a block of data on *When*, *Why*, *How* and by *Whom* a site/monument was found, and what later actions took place at the site and in the various institutions. A text block is connected to each case, including a short description of the ship's last voyage, weather conditions and so on. Data on pictorial documentation and data on *artifacts* found on a site are

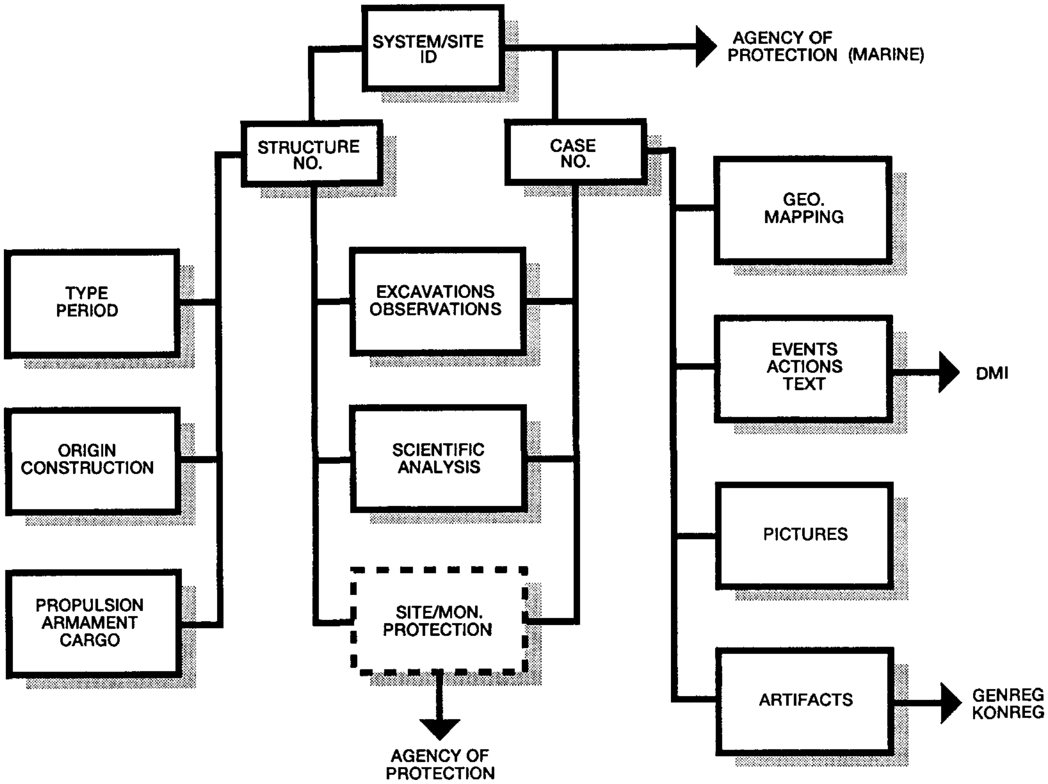

FIGURE 2. Conceptual systematization of data.

recorded. Data on inventory numbers link with two other large databases on artifacts (*Genreg, Konreg*).

The other main group of data deals with the physical *structures* and features on a site. Data are classified in groups related to the classification type-code and the archaeological or historical dating in terms of period and phase. Ships or wrecks are classified in a very simple system according to primary function, such as fishing, cargo, passenger, naval, special or leisure, combinations, and type of propulsion. This classification system can be supplemented with other designations of vessel types, for instance, an English classification system of naval vessels.

The next block contains data about the *origin/construction*, the building place of a ship, either as known from written records or estimated from techniques or materials. This includes the classification of the main elements of construction: keel, frame, hull/planking, stern/stem, and the materials used. Then there is a block of data on *propulsion*, *armament*, and *cargo*, which is classified as well for such things as the type of rigging and engine, the number of battery decks, the number, caliber in length and bore and material of the guns and cannons, and their designations.

All classification of data in the left or right side of the diagram is done by curators who are trained as archaeologists or historians, and this classification is based on all the available information about a site. The middle row of data groups combines independent observations of the structures or features on the site, for instance, the excavator's own *observations*, measurements, designation of types or references to documentation. *Scientific analyses* of various aspects of a find are recorded including radiocarbon dating, pollen analysis, art/style, historical dating, or analysis of zoological remains. The data on *statutory protection* are entered and updated by entered and updated by the Ministry of the Environment, which holds the "sensitive" data about the site to grant or reject applications to exploit natural resources, details of criminal activities, etc.

These groups of data are placed in the structure this way because they may change in the course of time, and it is important to know exactly when this happens. A wreck breaks down; hence the observations, measurements and statutory protection may alter, or applications of new methods may give another dating of the same structure.

The database on land sites is well under way, and the retrospective recording of archival information is expected to be completed in nine years. It is very difficult to estimate the completion of a similar recording of marine sites. At the moment about 3,000 located prehistoric sites are known and from the list of losses and verified positions some 5,000 wrecks from the last three centuries are recorded. But no one really knows the relation between what is actually left on or in the bottom of the sea and in the archives. From lists of sea floor obstructions and random sampling in archives, some 30-40,000 sites are expected to be found.

Through the development of computer techniques, especially graphics, and access to the amount of data on land topography, soil, and other factors, GIS or other geographical information systems are going to revolutionize the study of localization of historic and prehistoric sites. We should be able to create almost the same conditions in the study of maritime life and localization of marine sites. Detailed information about topography and geology of the seabed, currents, weather conditions, and seafaring in past centuries exist already as data or information that is easy to computerize. The question is rather how to raise the funding to do more of the basic work. The legislation ensures registration of most of the sites that have to be protected, and public interest in our maritime heritage is kept alive through the discoveries, such as the Viking or medieval ships. These finds have worked as fine levers for the funding of specific investigations on the sea floor, not least through publication of the results. The land register has in many ways proved the tedious work of establishing a database worth the effort, and new knowledge from research into this database is going to be published. The same conditions applied to a marine register ought to ensure its creation and necessity.

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The European Origin of Small Water Craft on the North American Continent: A Swedish-American Example and a Proposal for Research

Keelboats of the Delaware River and Their Swedish Connection

In October 1981, Richard H. Hulan, at the National Council for the Traditional Arts, Washington, D.C., wrote to ask me about possible connections in earlier times between American and Scandinavian boat building traditions. He had, for several years, been of the opinion that one of contributions to American material culture made by the 17th-century Swedish settlement in the Delaware River valley was the introduction of boat types, familiar in central Sweden. He had the view that these in Delaware had developed into so-called "keelboats." Hulan had collected substantial pictorial material on Durham boats and keelboats from the 19th century. These were used for river transports of bulk cargoes, such as iron ore, timber, and flour far into the 19th century. Pictures he enclosed showed several types of boats: flat, barge-like vessels, some with a keel, and clinker-built. These traits dominated Scandinavian building of smaller and middle-sized transport vessels for many years.

Hulan also sent me, as one example of a keelboat, a postcard photo of an "iron-ore boat," excavated from the mud of Batsto Lake, New Jersey, in 1957. Later, the ship was exhibited in the restored historic village of Batsto. The vessel was described as 43 ft. long and 11 ft. wide. In the text to this postcard, it was described as 150 years old and once used to bring bog-iron

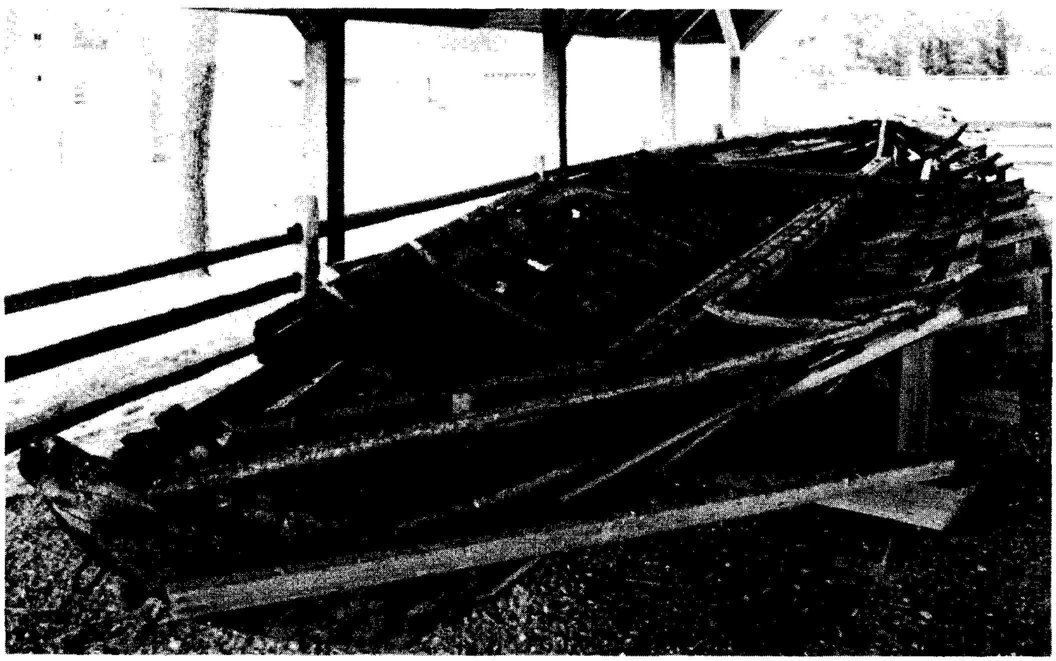

FIGURE 1. Postcard photo of "Iron Ore Boat" excavated from Batsto Lake in 1957, exhibited at the restored historic village of Batsto, New Jersey. The Scheller Co., Hackettstown, New Jersey.

to the Batsto furnace. He mentioned that there was a report on the site's excavation and it was tentatively dated to the early 19th century (Figure 1). The possible Swedish connection, according to Hulan, was based upon the place name Batsto, an 18th-century iron-making village. The name is a corruption of the colloquial Swedish term for *bastu* or *badstuga*, a sauna house in modern language. He also mentioned that many of the Swedes from New Jersey, as well as across the Delaware in Pennsylvania, were blacksmiths and worked at early forges and foundries at least as early as the 1720s (Swedish National Maritime Museum, Official correspondence 1790/81).

The letter from Hulan and my reply was the only contact we had concerning the subject. I left it until I came to attend the SHA meetings in 1986. At that time, I began to discuss with my American colleagues the possibilities of studying the transference of boat building traditions from the Old to the New World. It became clear to me what a huge and interesting research opportunity it was when viewed as a general topic.

Swedish Boat Type Comparison to the Delaware Keelboat

As has been shown by Baldwin (1980), keelboats and barges on American rivers were of several types and built in differing building traditions that originated in different areas in Europe. This means that there were several "roots" for this type of boat, some of which may be Scandinavian. I have collected a few pieces of evidence of possible Swedish influence represented by the iron-ore boat in New Jersey, and perhaps other American keelboats.

Clinker-built transport vessels, rigged with one mast and one large square sail, were used in the bigger Swedish lakes from the 17th to 20th centuries. In central and western Sweden, several types of river or lake vessels were used

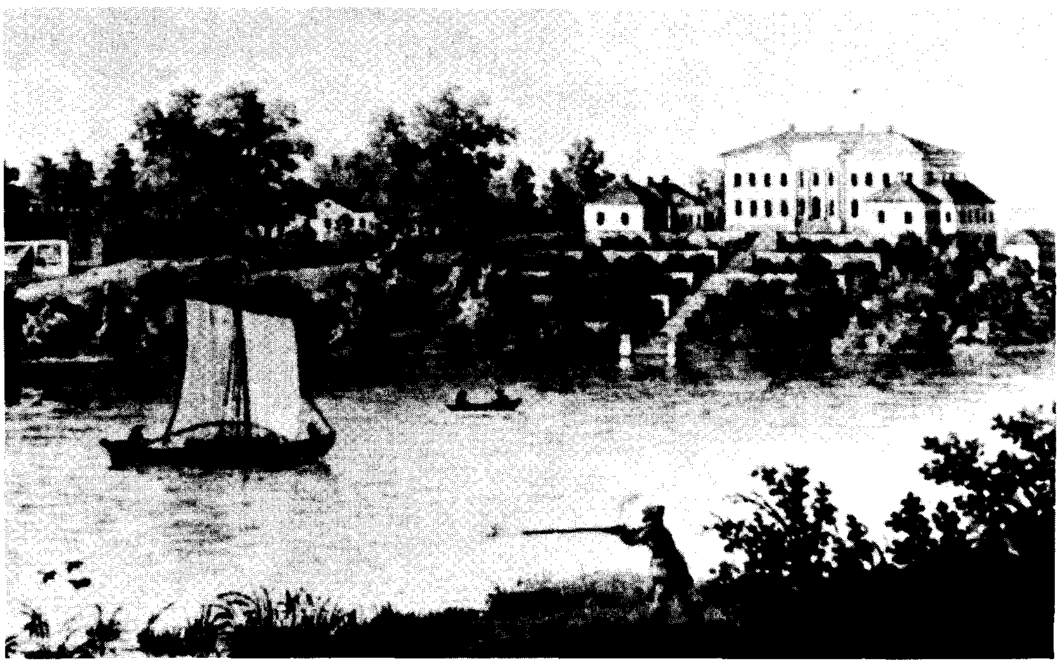

FIGURE 2. *Råbock* under sail at Stjernsund Castle, at Lake Vättern (Malmquist 1986).

to transport heavy bulk cargoes, i.e. ore, iron, copper, limestone, timber, bricks, or grain. Their origin is not clear, but their use grew in the 17th century with the rapid development of the iron-mill industry and copper works. Strongly-built transports were needed to move heavy cargoes of ore, iron, metal, and limestone for the blast-furnaces located along the rivers and lakes. Examples of such vessels are the *råbock* in Lake Vättern (Figure 2) and the river boats used in Göta Älv in western Sweden (Claesson 1945). Another example is the *mälar-jakt* and its forerunners on Lake Mälaren. These ships took cargoes of iron and metal to Stockholm for shipment abroad. A wreck of one of these vessels from the 17th century has been found and investigated in the Arboga å River, where it empties into Lake Mälaren at the town of Kungsör (Fredberg and Mäkelä 1982).

Another type of inland transport vessel, rigged with square sails on one or two masts, was used on Lake Runn at Falun in Dalarna County where copper works have been in use since the Middle Ages. These ships were used to transport copper, coal, or wood (Figure 3). An example of this type, dating from the 17th century, has been found in the town of Falun. The remains are of a sturdily-built, clinker vessel about 18 m long, with a wide and flat shape.

Evidence of bigger clinker-built boats or barges, without rigging, are located in the county of Gästrkland. Similar to the American keelboat, they too were used for river transport of bulk cargoes to the Swedish iron mills. At the beginning of this century, the artist and architect Ferdinand Boberg drew an example of this type of ship at the Gysinge Iron Mill at Daläven River (Figure 4).

In this regard, rigged, coastal transport vessels also shared many traits with their inland contemporaries. The different types of well-

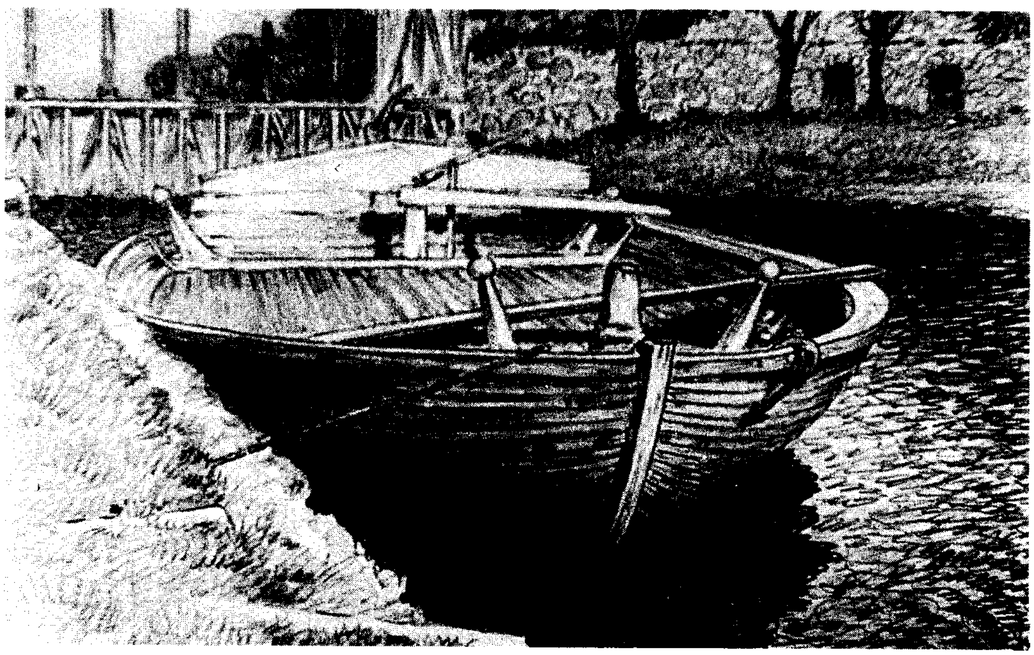

FIGURE 3. Rigging plan and part of lines plan dated to about 1800 of a ship used for copper transport on Lake Runn, Dalarna County (Svedberg 1986).

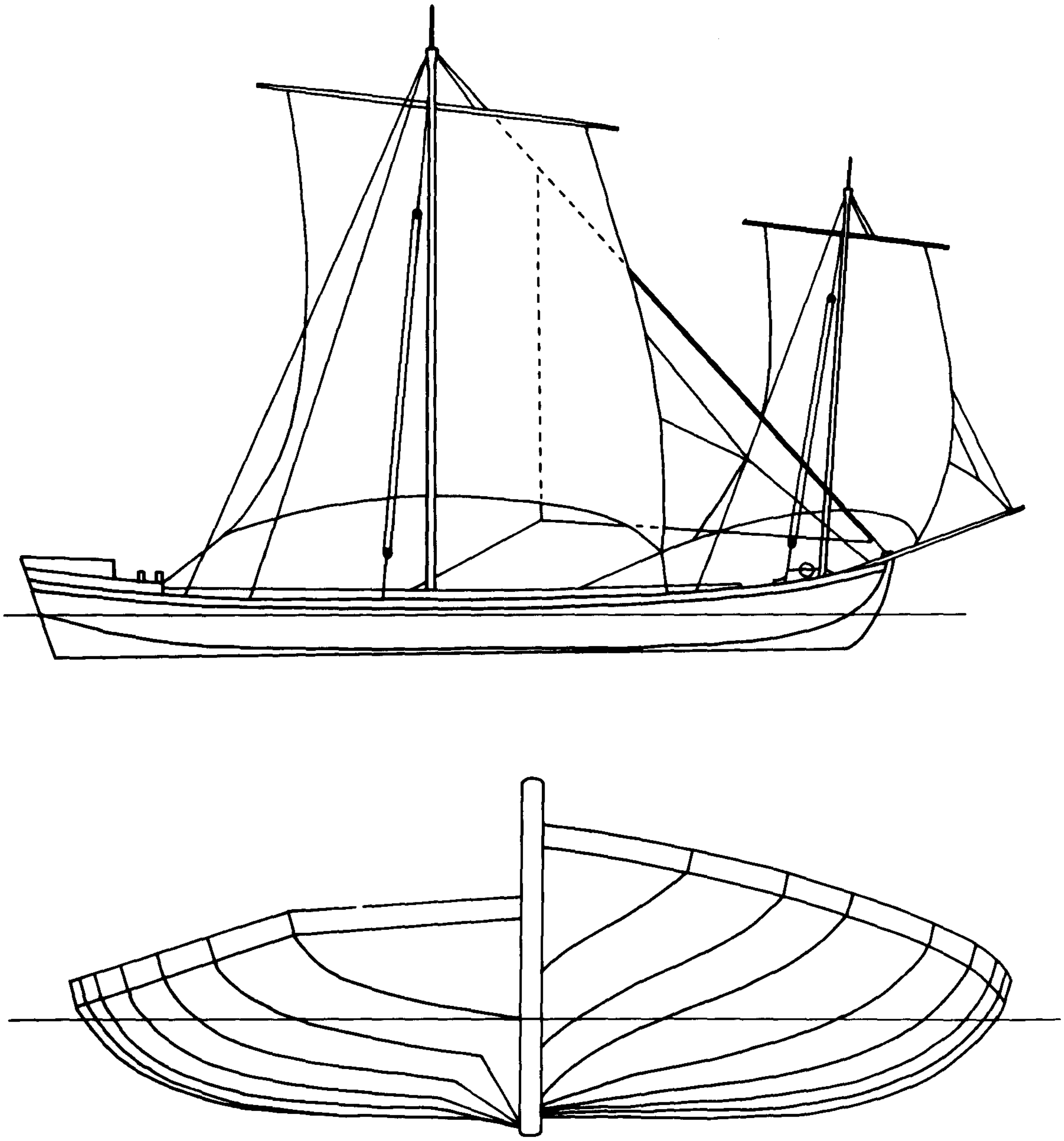

FIGURE 4. Barge at Gysinge Iron Mill at Dalävern River, Gästrikland County. Drawing by Ferdinand Boberg 1928. (Archives Swedish National Maritime Museum)

known small or medium-sized bulk carriers in the Stockholm archipelago are of a type generally called ***roslags-skuta***.

A Basic Ship Type in Scandinavian Shipbuilding

The one-masted, clinker-built, double-ended transport vessel is one of the basic ship types in Scandinavia. It has been built and used extensively for more than 1,000 years in Sweden. The oldest archaeological find of this type of cargo ship in Sweden is the Äskekärr ship, dated to the 9th century. It was excavated in 1933 from the Göta älv River, the largest in western Sweden.

Vessels for Inland Water Transport in Perspective

Iron and copper are two of the main export products of Sweden. It is estimated that iron and copper production was carried out on an even bigger scale in the late iron age. As the main districts of iron and copper production were situated inland, the many rivers, streams, and lakes were used to transport products. This means that exported goods had to be moved in inland vessels before reaching the coastal harbors. Inland shipping constitutes one of the really important trades in Swedish industrial history, and the ships used in that trade played an important role in our society and economy.

Vessels found in the boat-graves from the late Iron Age (about 600 - 1000 AD) at Vendel and Valsgärde may have been involved in this type of inland trade. These grave fields are supposed to have belonged to clans or families that controlled the iron trade and transportation from the production centers in Bergslagen to Lake Mälaren (Arwidsson 1942, 1954, 1977; Bengt Skönbäck 1991, pers. comm.). The burial boats are about 10 m long, double-ended, clinker-built vessels, mainly rowed in sheltered waters.

The historical inland transport system has not been investigated archaeologically to any degree in Sweden. Generally, one could say that this is one of the many fields of maritime archaeology that is still open. Often, such seemingly "grey" subjects are put aside in archaeology for the pursuit of spectacular or nationalistic finds. I judge the potential for the study of this topic to be excellent, using marine archaeological sites, preserved watercraft, and historical sources.

Scientific Approaches

As has been shown in this short paper, there is a group of vessels used for heavy transport on inland waters in Sweden. The basic type—heavy, clinker-built and rigged with one mast—shows a strong parallel to the description of some American keelboats. In other words, we have not only a European boat type and what seems to be the transference of the type to Delaware, but also evidence of an ethnic continuum through emigrant Swedes and the same use of the type in North America.

It would be useful to follow up this hypothesis in a number of ways. One is to define and compare the material remains of building traditions existing in archaeological remains of Swedish vessels of the type, such as the bog-iron boat from Batsto. This can be done through systematic recording and analysis of the surviving material record. As one possible approach to this, I would like to refer to an article presented in *Aspects of Maritime Archaeology and Ethnography in Northern Europe*, published by the National Maritime Museum, London. That article provides a model for the systematic study of boat remains (or preserved vessels) through the registration and analysis of the type characteristics and the elements of the building technique (Cederlund 1984). Another way to further this research is through ethnological literature on traditional boat building techniques in Sweden and North America. Investigations may clarify the relationships between the vessels in Sweden and Delaware.

A Proposal for Research

Smaller, traditional vessels, what we often call local craft, have been fundamental to communications and transportation throughout the world, and still are in many cultures. The vessels represent a varied spectrum of building techniques, types, and sizes. The different items in this spectrum are regularly very characteristic of the culture or building tradition in which they have been developed. From the methodological point of view, it is not difficult to record, register, and structure the elements of the building techniques of these vessels. This would provide a temporal and regional guide to the traditional boat building techniques they represent.

When European immigrants landed in North America in centuries past, many brought with them boat building skills that they quickly put to use. As time passed, new waves of immigrants spread over the new continent, also bringing with them shipwright skills and craftsmanship. These different traditions adapted and intertwined, even adding indigenous techniques. It seems worthwhile to try to initiate cooperation between researchers in Europe and North America on this subject. In so doing, we would widen our understanding of the process and influence of acculturation from the Old World to the New.

This research concept has a strong archaeological connection. The flow of ship technology westward has existed for five centuries, requiring that the subject be studied from several sources. One is, of course, archaeological remains from the post-medieval period. Projects could be developed in Europe, the USA, and Canada. The planning and coordination could be managed and results presented at meetings arranged for this, separately or within international conferences, such as the SHA, ISBASA, MSCA, ICMM, etc.

This proposal may presuppose access to resources by which to fund the investigations and the meetings for this work. However, it seems to me that the proposed research could have a value as an expression of international cooperation—a value that could make organizations that fund international cultural programs responsive to applications for funding this work. This and other questions could be addressed at conferences in the future.

Conclusion

In conclusion, there is widespread interest in local watercraft in Europe and in North America. Research is often carried out voluntarily and with dedication. It is an involvement in a central process in the development of human society, namely transportation and communication. The elucidation and interpretation of cultural mechanisms in the transference of craftsmen's skills in boat building, and the use of boats on the European and North American continents, can help us understand the impacts of cultural movements from one continent to another. I would like to suggest that research on the origin and transference of small craft building traditions be examined in a symposium at the next meeting of the SHA in Kansas City in 1993.

For those interested in participating or contributing ideas to the broader study, please contact me in Sweden or contact: Allen R. Saltus, Jr., Archaeological Research, Inc., 18358 Broussard Rd., Prairieville, Louisiana 70769, USA.

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Integrating Archaeological and Historical Records in Dutch East India Company Research

The Dutch East India Company, VOC., was founded in 1602 by the amalgamation, under government pressure, of various overseas trade companies. It was a decentralized company with branches in six important cities in the Netherlands. Each of these branches had its own administration, warehouses and shipyards. The central direction of the company consisted of a board of 17 directors, 8 of which were appointed by the City of Amsterdam.

Marketing of creamware wreaked havoc in the pottery industries of England and the continent.

The capital of the company was provided by private investors. The financial structure of the enterprise was as complicated as its organization. Separate accounts were kept in the different branches and in Asia. These accounts were kept in four-year cycles, while each year fleets were equipped and sent out as if each was a separate undertaking. The returning ships and their cargoes were again dealt with separately by each local branch of the company.

The seventeen directors and also the directors of the local branches were expected to participate with a sum of £6,000 in the company. Later this sum was reduced to £3,000 for the directors of the smaller branches. Many private investors participated in the company, but they had very little real influence in the running of the company. Their acquiescence was assured by a yearly 12.5 percent dividend throughout the two centuries of existence of the company.

The VOC. built a trade network through large parts of Asia, based on ca. 250 trading stations. Many of these were just local offices where a representative of the company, aided by local personnel, engaged in import and export trade. In some cases, like in Ceylon, Malaya, and various places in the Indonesian archipelago, the company's settlements included fortifications, garrisons, and territorial control. Personnel in Asia numbered about 35,000.

The connections between Europe and the Asian network were maintained by a fleet of ocean-going armed merchantmen, called retourschepen, while the inter-Asian routes were plied with a great variety of Asian craft under the company's flag but also with the company's large European ships. Between Holland and Asia, a total of 5,000 ship movements have been counted during two centuries, while 3,300 ships undertook the return voyage. On the route between Europe and Asia and in Asia the company lost about 250 ships in the two centuries of its existence.

The history of the Dutch East India Company has been written under the influence of different prevailing ideologies. Throughout the 19th and in the 20th century the image of the Dutch East India Company was stamped by an imperialistic belief, a belief in the value of colonies and dependencies. This ideology in Holland was mainly inspired by the British example. Within this imperialistic attitude there was little appreciation of the merits of the overseas trade company. In the second half of the 18th century, when the English East India Company was changing from a trade company into a colonial government, British propaganda helped to create a negative image of the Dutch East India Company which had remained mainly a trade company. About 80 percent of its turnover was derived from trade and no more than 20 percent came from exploitation of rents, taxes, and such.

The negative appreciation of the role of the VOC. as a trade company in Asia persisted into the anti-colonialist vision that developed after the Second World War. In the eyes of the colonialists, the imperfections of the VOC. had led straight to the establishment of colonial rule, which represented, in their view, a higher stage in development. Although anti-colonialists reversed this judgement, the linear view of the East India Company and colonial history persisted for some time.

Recently, however, with the healing of the post-colonial trauma, there is a tendency to look at the Dutch East India Company as an early example of an intercontinental manufacturing, trade, and transport company. Parallels on a management and a technical level with modern business are obvious, and the question of survival of such a large organization in changing technological, economic, and political circumstances remains as relevant as ever.

In this climate of renewed interest the study of the Dutch East India Company was given added impetus by the development of underwater archaeology and particularly the archaeology of shipwrecks of Dutch East Indiamen. Since 1965, about 50 wrecks of Dutch East Indiamen have been localized and excavated in Europe, Africa, and Asia. Whatever the scientific standards in these various excavations may have been, and they certainly varied from excellent to near zero, they all produced prodigious amounts of hitherto unknown material. This material added something entirely new to the records that had been available so far: unsorted material sources of information found within the strict context of a particular ship. This material was produced in great quantities and could be identified and classified with the aid of other historical records in the archives of the Dutch East India Company. Thus, object-oriented research in the archives helped to identify artifacts, but it also helped to select records with a particularly heavy load of material information, such as inventory lists (***equipagelijst***) (Figure 1), lists of victuals and bookkeeping records, which previously had only been studied on a more abstract level by economic historians.


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Te A M S T E R D A M,

By N I C O L A A S B Y L, Drukker van de Ooſt-Indiſche Compagnie.

Met Previlegie. 1788.

FIGURE 1. Equipage list for the Dutch East Indiaman *Amsterdam* from the company archives.

The further study of the administration of the company gave a better insight into the production side of the enterprise. The company possessed some of the largest pre-industrial complexes in the Netherlands in its shipyards in Amsterdam and Middelburg. It also employed a multitude of subcontractors for the supply of things that could be bought cheaper on the open market than produced. The complex relationships of the company with its suppliers, but also with its work force, has become an important new subject for study.

A multi-disciplinary group of historians, archivists, archaeologists, and museum people has been engaged in the study of the Dutch East India Company's shipyards in Amsterdam and Batavia, the present-day Jakarta. The integration of the historical and archaeological record has led to some publications but also to the construction of a literal model.

The renewed interest in the ships of the Dutch East India Company led to two full-scale replica projects in Holland, one of a 17th-century East Indiaman, *Batavia,* in Lelystad, and one of an 18th-century East Indiaman, *Amsterdam*, in Amsterdam. In both cases, the actual building of the ship had already started before thorough research in historical and archaeological records became possible.

The very special situation existing in present-day Dutch East India Company research, with the availability of very detailed archival records, the ever increasing amount of archaeological records and finally the availability of material records, such as contemporary ship models, draughts, and non-technical images allows a detailed scrutiny of historical material reality.

An example of such detailed scrutiny is the study of *Hollandia*'s artifacts. *Hollandia* was wrecked in 1743 off the Isles of Scilly. After initial efforts by the Dutch East India Company to retrieve at least the treasure aboard, the wreck was forgotten until it was rediscovered by Rex Cowan in 1973. Over the years, a considerable number of objects were raised from the wrecksite and studied and reported on by archaeologists Peter Marsden and Howard Pell, as well as by Rex and Zelide Cowan (Cowan and Cowan 1975).

Many of the recovered artifacts were sold at auction and bought by museums and private collectors. What remained, about 3,000 objects, were acquired by the Rijksmuseum in Amsterdam together with the archaeological records. Because the objects were spread over a large surface of the sea bottom by the sheer violence of the disaster, little could be deduced

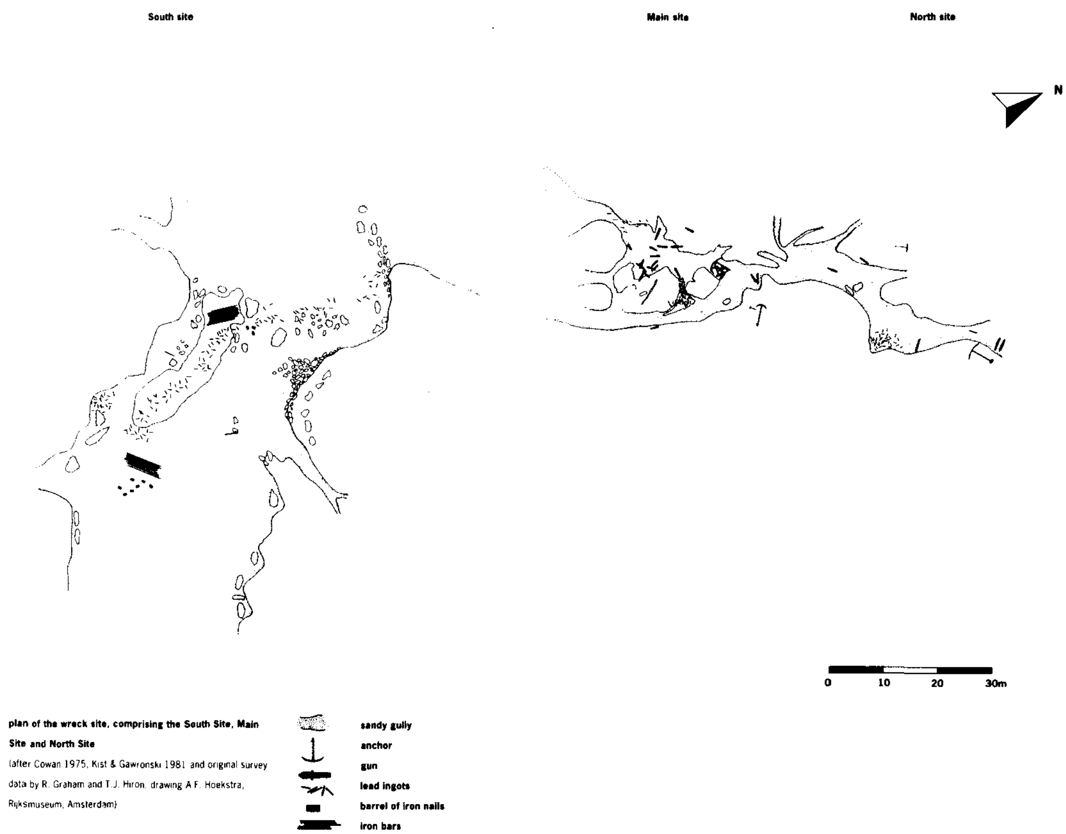


FIGURE 2. Plan map of the *Amsterdam* wreck site.

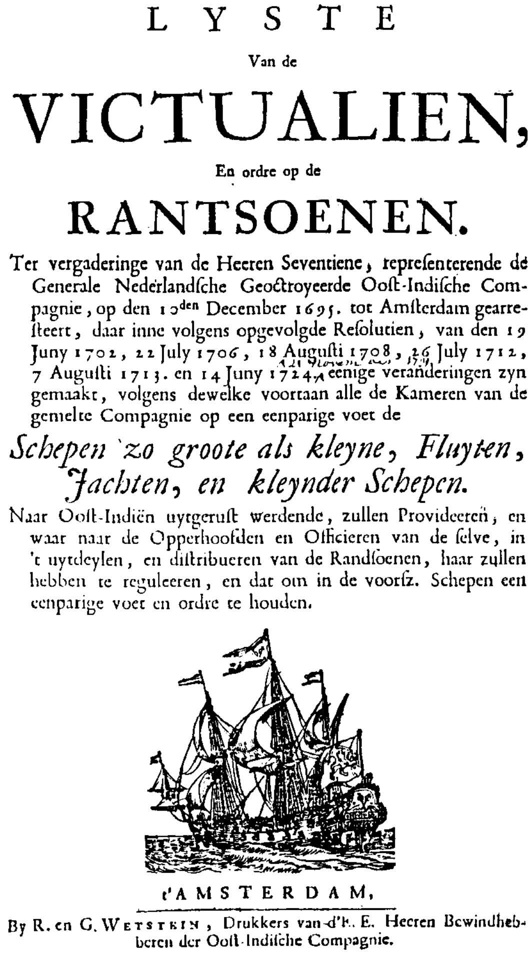
from their context (Figure 2). It proved useful to develop another method to bring order in the raised objects.

After analysis of the material and manufacture of the objects, they were ordered in a functional system which was then compared with a similar functional system derived from historical East India Company records, in this case, the *Equipagelijst* (list of equipment issued to each vessel of the Dutch East India Company), the *Lijste van victualien en ordre op de rantsoenen* (list of victuals and regulations for the distribution of victuals) (Figure 3) and the *Ordre en Instructie voor de Chirurgijns* (orders and instructions for the ship's surgeons). The historical records also provide the nomenclature of the company.

These two functional systems could be compared and the attribution of historical terminology allowed further reference to the company's bookkeeping providing information about the manufacturers, quantities and prices of equipment, and also the difference between equipment goods and cargo.

This two-pronged historical-archaeological method was applied on a much larger scale in the *Amsterdam* project. The East Indiaman *Amsterdam* was beached during a strong southwesterly gale in 1749 near Hastings; the ship settled in deep mud in a very short time and remained more or less inaccessible until 1969. In that year the wreck was damaged by a contractor engaged in the construction of a sewage system. After an exploratory excavation by Peter Marsden in 1969 showed the great promise of the wreck, nothing much happened until 1984 when the VOC-ship *Amsterdam* Foundation succeeded in mounting a combined Anglo-Dutch underwater excavation. Two more seasons of excavation followed in 1985 and 1986.

From the start in 1984, the *Amsterdam* research project was conceived as an historical-archaeological project. Historical hypotheses concerning shipbuilding, equipment, and functional arrangements on board the ship served as a starting point for archaeological research. The differences between the model built from his-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Ter vergaderinge van de Heeren Seventiene, repreſenterende de Generale Nederlandſche Geoctroyeerde Ooſt-Indiſche Compagnie, op den 10den December 1695. tot Amſterdam gearreſteert, daar inne volgens opgevolgde Reſolutien, van den 19 Juny 1702, 22 July 1706, 18 Augusti 1708, 26 July 1712, 7 Augusti 1713. en 14 Juny 1724 eenige veranderingen zyn gemaakt, volgens dewelke voortaan alle de Kameren van de gemelte Compagnie op een eenparige voet de

Schepen zo groote als kleyne, Fluyten, Jachten, en kleynder Schepen.

Naar Ooſt-Indiën uytgeruſt werdende, zullen Provideeren, en waar naar de Opperhoofden en Officieren van de ſelve, in 't uytdeylen, en diſtribueeren van de Randſoenen, haar zullen hebben te reguleeren, en dat om in de voorſz. Schepen een eenparige voet en ordre te houden.

t'AMSTERDAM,

By R. en G. WETSTEIN, Drukkers van d'E. E. Heeren Bewindhebberen der Ooſt-Indiſche Compagnie.

FIGURE 3. List of victuals and regulations for their distribution from the Dutch East India Company archives.

torical records and the real life data from the archaeological situation were further investigated to arrive at a more detailed and comprehensive reconstruction. This involved participation of a variety of specialists who helped to solve many problems but who also asked many new questions. In this way, problems were dealt with again and again from different angles, creating very detailed reconstructions. These reconstructions can first be used to write the material history of the Dutch East India Company and then, because the ships were the principal tool of the company, it is through them that procedures and practices of the company can best be studied.

In the case of *Amsterdam*, a considerable amount of technical documentation was found in the East India Company archives because the company went through a process of technical and procedural innovation in the period 1740-1750. Not only was the design of the standardized East Indiamen completely renewed by ordering a set of draughts from an English shipwright, which incorporated the latest ideas from Holland, England and France, but the sailing regulations and operation procedures were all rewritten in the light of contemporary expert opinion.

The archival material comprised draughts, reports, and resolutions and could be amplified with some very detailed technical models which were made for the company in the course of the design process. Thus, it was possible to start the excavation of the East Indiaman *Amsterdam*, working from a highly detailed theoretical model derived from a wide variety of sources. Almost immediately the excavation of the wreck showed discrepancies between the historical and the archaeological data. In some cases entirely new questions were raised about the way the ship was actually built, questions that would never have been asked working from one category of sources alone. On the level of functional and procedural matters the interaction between historical and archaeological records proved particularly fruitful. In this case, iconographic and written sources, such as orders and instructions for ship's officers, could be combined to create a hypothetical image of a situation or a procedure on the ship, such as the treatment of the sick, or the arrangements in a given compartment of the ship for the distribution of food. Then these hypotheses could be tested in the archaeological situation and later often expanded because the comparison of the various records nearly always led to a much more detailed picture.

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Functional Classifications of Artifacts of VOC-Ships: The Archaeological and Historical Practice

In the past 30 years, some 33 wrecks of VOC-ships - Dutch East Indiamen - have been excavated, some completely, some partially, some scientifically, and others commercially. Despite the different approaches, the underwater archaeological research has provided a new and important source of information about the VOC—the material remains of the ships and their contents. The archaeological finds give information about many different subjects, such as the construction of the ship, living and working conditions on board, equipment, personal possessions, environment, etc.

The contribution of archaeology to the study of the VOC lies in the confrontation of the archaeological finds, which represent material reality, with historical data about the ships and the shipping activities of the company. Archaeological data provide the opportunity to test historical assumptions about the physical appearance of these ships but more importantly contribute, in conjunction with the historical data, to a more refined and detailed reconstruction of the role and the use of these vessels within the company. The development of historical research into the practical aspects of the performance of the VOC has been strongly stimulated by the achievements in the field of underwater archaeology (Bruijn et al. 1987).

Comparison of the scientific publications on these wrecks—not considering auction catalogs and salvage account—shows a striking lack of standardization in the presentation of the finds. To understand this situation we have to look more closely at the classification problems of this specific group of archaeological material. There are two interrelated questions: the use of functional topologies that reconstruct the use of the artifacts on board and the application of historical data about the material assemblage of a VOC-ship and its contents. In the following, I will discuss this matter in relation to the catalog of the finds from *Hollandia* (1743) (Gawronski et al. 1992).

The practice of archaeological classification implies more than merely ordering the finds of an excavation. Above all, classifications reflect interpretations of archaeological data. Depending on the questions of research, they may have different levels of abstraction. For example, a simple system of ordering finds is grouping according to material type or site location. A more complex classification is a typology on the basis of the function of an artifact. In the case of finds from a shipwreck, this feature can be distinguished into the general function of an artifact and its specific use on board the ship. Through this functional classification the archaeologist aims at defining the functional relationships between the separate finds. Knowledge about the functional coherence of the artifacts on board is prerequisite for a reconstruction of the original three-dimensional layout of a ship.

VOC-ships represent rather complex functional material assemblages that consist of many thousands of different artifacts and various material elements. This material complexity is partly the result of the advanced technology involved in the construction and equipment of seagoing vessels in the 17th and 18th centuries in the Netherlands. However, the main reason lies in the multifunctional tasks that they fulfilled in the trading, production, and shipping activities of the VOC. These vessels were the main instruments for the VOC to perform her tasks as an intercontinental trading company during two centuries. The East Indiamen were direct products of this organization, representing a kind of microcosmic image of the multiple activities of the VOC in economical, cultural, social, and technological aspects.

This historical background has direct implications for the classification of archaeological material of such a shipwreck. Several levels of questions can be formulated for the functional classification of VOC-ships. Reconstruction of the vessel as a coherent multifunctional material entity is the first and most basic step in interpreting the archaeological data. On the second level of reconstruction, the interpretation moves away from the ship itself and focuses on the historical context of the VOC-ship, that is to say, the company itself that built, equipped, loaded, and used the vessel. Now the archaeological find is interpreted as a product of the company. In this way the realistic data derived from the material culture of one specific shipwreck contributes to generalizations about the procedures and methods by which the VOC practically functioned. On the third level of interpretation, this approach is extended to the larger context to which the company belonged; thus, the archaeological find is linked to the economic and social system of the city where VOC actually produced the ship. This stepwise approach not only adds a new dimension to the material reconstruction of the ship but also provides a tangible contribution to the historical-economical image of the VOC.

In applying classifications with these functional aims, a sharp distinction should be made between their practical and their theoretical value. The interpretation of the archaeological record has certain limitations as the material assemblage has been changed and disturbed in the course of time on the seabed. On a practical level, a classification of finds reflects the state of knowledge and at the same time the lack of knowledge that is yielded by the archaeological site. On the other hand, the classification can be used as a theoretical model, a blueprint of how the ship was constructed and how all the artifacts inside were originally related to each other.

In the case of VOC-ships, such a theoretical framework can be developed on the basis of historical data. The archaeologist is in a unique position, having access to the original administrative archive of the VOC. Despite the obvious financial and legal nature of this archive, these documents can provide data that are directly relevant for questions about the material characteristics, the manufacture, and the use of these vessels. Using instructions, minutes of board of director meetings, or series of bills in the archive, factual information is given on the nature and quantities of, for example, building materials for ships, tools, raw materials, and victuals on board or items belonging to cargo shipments, etc. Data about prices, manufacture, and origin of these items enable synthesis of the archaeological finds with the socio-economic system of production and trade of the VOC. The documents also provide insight into the original terminology and the functional organization that the Company applied in the construction and equipment of the vessel.

The classification model of the material network of such a ship and its contents, which can be suggested from this multifunctional historical point of view, consists of six main categories: ship, cargo, armament, equipment, personal possession, and environment. These can be subdivided into subcategories of artifacts that fit within a certain functional context on board. For example, equipment is split up into groups of tools of the cooper, the carpenter, the locksmith, or the cook. By filling in this functional framework with the original terminology from written sources, an historical nomenclature is created as a guideline for the identification of the archaeological finds. Such a complex and refined historical model, however, gives an abstract image of the ship that has to be translated into archaeological reality. It should serve as a test for archaeological assumptions rather then a ready-made system for ordering the archaeological finds.

The various existing classifications clearly show that such a distinction between practical and theoretical use of the functional feature is lacking. This leads to discrepancies in the way the feature "use on board" has been applied and finally results in deviant classification structures and categories, as is the case with the find catalogs of, for example, *Hollandia*, *Lastdrager*, *Campen*, and *Zeewijk* (Gawronski et al. 1992). Also, when functional categories are more clearly defined, classifications can show discrepancies. For example, concepts as “cargo,” “armament,” or “equipment” are used in the catalogs from *Amsterdam*, *Vergulde Dreack*, *Batavia*, and *Kennemerland* with different mean-

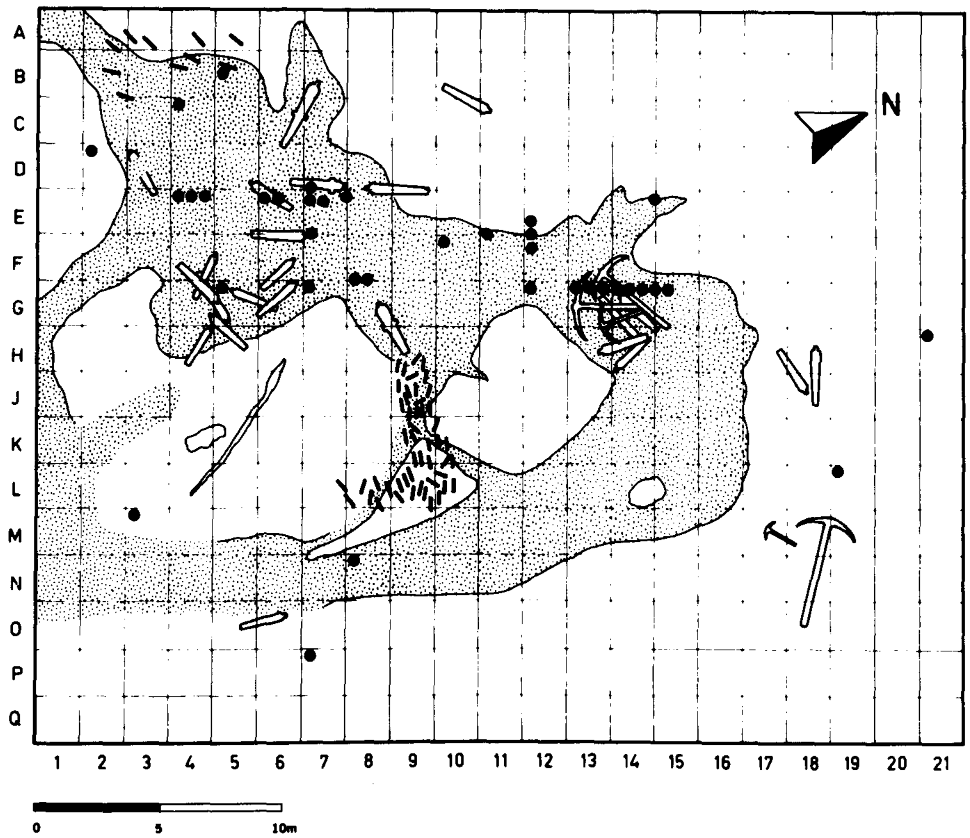

FIGURE 1. Distribution of parts of the fire engine.

ings. When should a thimble be called personal possession, cargo, or a piece of equipment? The use of different criteria for the identification of a certain given artifact produces different catalogs that structurally look alike.

Most importantly, the aim of the archaeological classification should be to present the finds in a coherent way, structured according to the same standards of functional description. More consistency can be achieved by recognizing the individual state of material preservation of a given shipwreck and its limitations for refined functional interpretation. In practice the archaeological database should be structured independently from the historical model. However, further historical research in this field is necessary to fill in the reference model more accurately.

In the *Hollandia* catalog a structure is proposed for functional ordering of finds that are extremely damaged and fragmented. *Hollandia* sunk in 1743 off the Scilly Isles after striking a rock (Cowan et al. 1975). The wreck is widely dispersed over the rocky seabed. The site does not contain any remains of the ship's hull, and the finds' distribution is strongly affected by the current. The location of parts of the fire engine illustrates this random pattern (Figure 1). Due to this state of preservation, the exact functional identity of an artifact within the context of the ship can only be established in practice for a limited number of finds. A classification based on use on board is therefore not useful as a consistent structure for the catalog. In the *Hollandia* catalog the finds are ordered according to the more general function of an artifact as a tool, container, or utensil without direct relation to the specific functional context on board the ship.

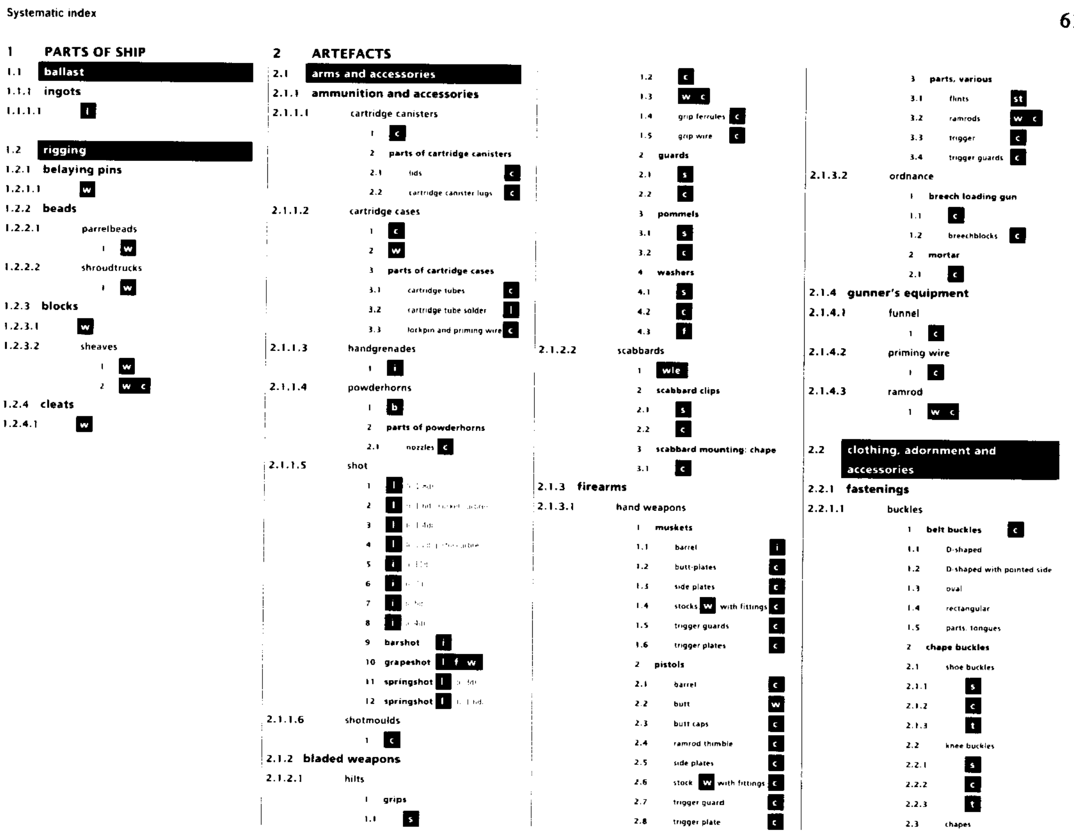

FIGURE 2. Systematic index used to classify artifacts from *Hollandia*.

The catalog is structured into three hierarchical levels that are partly based on Chenhall's system for classifying man-made objects (Blackaby and Greeno 1988). On the first level, there are four main sections: parts of ship, artifacts, parts of artifacts, and non-artifactual remains (Figure 2). These are subsequently subdivided into alphabetical series of functional categories, such as rigging, arms, consumption, lighting, tools, fittings, and faunal remains. Finally, on the third level, these categories are filled in with the names and materials of the finds. This cataloging system is rather basic but allows a consistent ordering of the collection. This can serve as a starting point for further comparison of finds from other wreck sites.

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The Shipwreck At Ulu Burun, Turkey: 1991 Excavation Season

Between June 1 and September 21, 1991, the Institute of Nautical Archaeology completed its eighth excavation campaign on the Late Bronze Age shipwreck at Ulu Burun near Ka in southern Turkey (Bass 1986; Pulak 1988; Bass et al. 1989; Pulak 1990).

The ship's rich and varied cargo comprised primarily raw materials, the bulk consisting of the ingredients for bronze: nearly ten tons of copper ingots, mostly in the four-handled shape typical of the 14th- and 13th-century B.C. Mediterranean, and more than half a ton of tin ingots cast in approximately the same shape. Other raw materials included more than a ton of terebinth resin in Canaanite amphoras; cobalt-blue glass ingots; logs of African ebony, spruce, or larch; hippopotamus teeth and a section of elephant tusk; ostrich eggshells; murex shell opercula; and fruits, grain, and spices (pomegranates, figs, olives, almonds, coriander, nigella [black cumin], sumac, barley, and wheat, all identified by Cheryl Haldane); some of the last probably represent provisions for the voyage. Manufactured cargo comprised fine Cypriot export wares packed in *pithoi* (large storage jars); faience *rhyta*, mostly in the form of a ram's head; glass and faience beads; and sea-shell rings. Seals (Kassite [?], Assyrian, Syrian, and Mycenaean), a boxwood diptych, bronze weapons, some pottery, jewelry of Canaanite and Egyptian designs, and pan-balance weights, on the other hand, were almost certainly personal effects of those on board, while cooking wares,

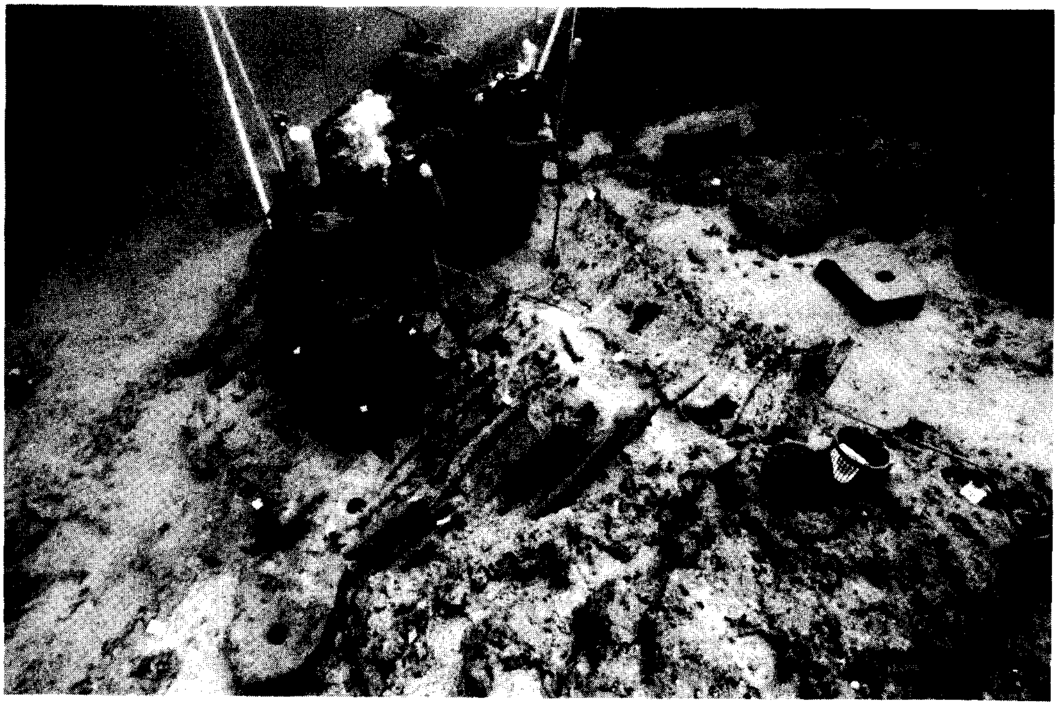

FIGURE 1. Measuring stacked copper ingots for possible reconstruction of the ship's hold that held nearly 350 such ingots.

stone mortar and grinding trays, bronze tools, and fishing implements represent items for shipboard use.

We learned in 1991 that the site is archaeologically richer and larger than previously realized. There are, for example, closer to 350 copper ingots than the 200 estimated earlier. Those in a short row newly identified at the deeper end of the site will be crucial to the reconstruction of the ship's size and shape (Figure 1).

It appears that the ingots in each of the deeper four rows overlapped one another like roof shingles in layers that stretched from one side of the hull to the other. The direction of overlap alternated from layer to layer, apparently to prevent slippage of ingots during transit, with one exception where the direction of overlap does not alternate. Whether this irregularity represents simply a mistake on the loader's part or an intentional change cannot yet be determined. On average, there are 12 ingots per row, the bottom layer of which was placed on a bed of brushwood--or dunnage in nautical terminology--to protect the hull timbers from the cargo of metal ingots. Additionally, except where displaced after wrecking, all ingots were found with their "mold side" down, perhaps to provide a better grip between ingots by assuring that no two smooth (i.e., mold) sides faced each other, to allow for the viewing of ingot marks (which are almost always placed on the side opposite the mold side), or to facilitate handling by providing a natural purchase for fingers around the ingots' beveled edges.

Many fragile artifacts that had become wedged between the copper ingots could be removed only after hours of delicate chiselling under water. Our efforts, however, were rewarded by the discovery of a new adze type and a collared axe. A scrap bracelet of silver and a bronze dagger (Figure 2) found here are similar to those discovered previously. Both the dagger and collared axe are of Syro-Palestinian types. Here, too, were part of an ivory hinge similar in design to that of the unique Bronze Age diptych found in 1986. Whether the new hinge reveals the presence of a second wooden

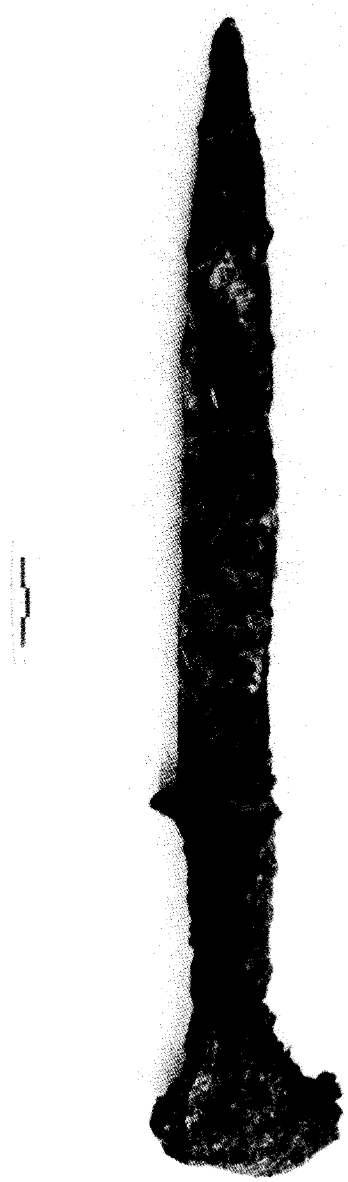

FIGURE 2. Bronze dagger of Near Eastern type similar in shape to one found previously with hilt inlays of ebony and ivory.

diptych or is merely a box hinge cannot be ascertained until its remaining pieces are recovered.

The area of the site directly under the first row of ingots, although not excavated fully, proved to be a natural catchment for numerous objects that had rolled or fallen down the steep slope. Many bronze caldron parts uncovered here complement an array of similar pieces found during the 1990 campaign. It is almost certain that a number of large bronze vessels were stored in this part of the ship at the time she sank. Also found were six hematite and bronze pan-balance weights, faience beads, glass Mycenaean relief beads or pendants, an ivory scepter complete with its decorated disc-shaped finial, ostrich eggshell fragments, what may be a piece of ebony furniture, pilgrim flasks, a stirrup jar, and a collection of Cypriot export wares that includes at least five White Shaved juglets.

Many disc-shaped glass ingots, mostly of deep cobalt-blue color, had been recovered previously from the shallower, or upslope, end of the wreck, which we believe to have been the aft section of the ship's hold. In 1991, some 30 glass ingots in various states of preservation were found as a group just downslope of the deepest row of copper ingots. It is possible that glass was also stored in the forward part of the hold, but because these ingots appeared somewhat scattered, and several had broken upon impact, it seems more likely that they had rolled down the slope, perhaps kept together inside a basket. Several ingots in this group are only half as thick as the others and are of a turquoise color rather than the usual cobalt blue. Samples will be analyzed by Robert Brill, Chief Research Scientist at the Corning Museum of Glass, to determine the colorant used.

A small catchment area, to the northeast of the boulder-like rock-outcrop located centrally on the site, continued to yield diverse artifacts. The assemblage found here suggests that most objects slid down from areas higher up the slope. Among them were faience, glass, and agate beads; a nested set of three bronze bowls in graduated sizes; a bronze netting needle and several lead fish-net sinkers; a fragment of an

FIGURE 3. Hippopotamus tooth (incisor), one of twelve found, represents an important source of Late Bronze Age ivory in the Eastern Mediterranean.

ornate ivory disc and a section of what may be a scepter or spindle; crescentic pendants of lead; and Cypriot pottery. Of the eight pan-balance weights found in this area, two are of zoomorphic forms, in the shape of lions. This brings the total of zoomorphic weights found on the site to 14. Raw materials include hippopotamus teeth (12 found so far; Figure 3), ostrich eggshell fragments, quadrants of tin ingots in the four-handled shape, fossilized shell, and more glass ingots.

Farther down the sloping seabed than the last row of copper ingots, several concreted stone weight-anchors were chiselled free for raising; altogether, six anchors were removed from this general area (an additional anchor was raised from the row of anchors higher up on the slope [Figure 4], in the probable region of the mast step). Excavation between and under these anchors—an area that we believe to have corresponded to the ship's bow—yielded mostly faience and glass beads, ballast stones, the upper half of a Mycenaean flask, a bronze spearhead, and a dagger.

At a depth of about 55 m, we encountered wreck spillage of ballast stones and two Canaanite amphoras of a type that contained olives elsewhere on the wreck. Here, too, were two *pithos* bases, bringing the total number of such large jars on the ship to at least nine. Two White Shaved juglets and fragments of other Cypriot pottery found near one base suggest that it had held Cypriot export wares, as had two *pithoi* found in earlier campaigns. This suggests that the Ulu Burun ship carried at least three storage jars filled with Cypriot export pottery.

Excavations on the southeastern side of the wreck focused primarily on an area that had yielded surface finds of Cypriot pottery, most of which appeared to be lying under a *pithos* raised earlier. Finds include nearly three dozen agate beads, some fluted faience beads, a small hippopotamus tooth, sea-shell rings, and more Cypriot bowls and juglets, mostly broken from having rolled down the rocky slope. More agate beads as well as a lump of gold, and a cut section of a gold ingot-ring of a type found in

FIGURE 4. Stone weight anchor, one of 24 found on the Ulu Burun shipwreck.

1990, came from a pocket just upslope of this deposit.

Less than a few meters downslope lay another *pithos*, the only intact one remaining on the site. The sediment inside, collected for sieving, revealed surprisingly few organic remains and only one small sherd, possibly that of a White Shaved juglet. The scattered sherds of yet another *pithos*, found at a depth of 57 m, were mapped, chiselled free, and removed to a shallower area for raising at a later date. Excavations in its immediate vicinity failed to produce Cypriot pottery, although we did find a wall-bracket of possible Cypriot type about 1 m farther down the slope. Until this area is completely excavated, it will be difficult to learn if this *pithos* had also held Cypriot wares.

For students of early seafaring, the hull and anchors of the site will be of greatest importance. Until now, we have not known how shipwrights constructed seagoing vessels during the time of the 18th Dynasty in Egypt or those of semi-mythic Greek heroes. Already, preliminary examination of the hull remains has revealed that this vessel was built in a technique similar to that of later Greco-Roman ships, that is, in the shell-first method of construction where the ship's planks were edge joined with mortise-and-tenon joints held fast with wooden pegs, a joining method much like that of the Kyrenia ship of a millennium later. Based on the cursory examination of cargo disposition, we estimate the Ulu Burun ship was about 15 m long, and carried at least 15 tons of cargo. This figure does not take into account the weight of the ship's anchors, ballast, and cargo that have perished. The 24 stone weight-anchors found lying in rows across the Ulu Burun ship are similar to those found built into walls of buildings, perhaps as votive offerings, at Kition on Cyprus and at Ugarit and Byblos, but until now no Bronze Age stone anchor of this type had been associated with a ship.

The *terminus post quem* for the wreck is given by a gold scarab of Nefertiti, while that of the *ante quem* is suggested primarily by the preliminary study of Mycenaean pottery on board. It appears, depending on the chronology used, that the Ulu Burun ship sank sometime during the latter part of the 14th or, perhaps, early in the 13th century B.C. A more precise date, at least for the felling of the trees used in the hull rather than for the demise of the ship itself, may be possible when the hull remains are excavated and submitted for dendrochronological sequencing.

The vast distances over which goods were transported in the Late Bronze Age, however, is remarkably demonstrated by the diversity of finds at Ulu Burun. The composition of the cargo suggests that the ship had sailed from a Canaanite port on this particular east-west voyage, but her home port and the nationality of her crew remain unknown, although the presence of a Mycenaean aboard is suggested by some of the personal effects.

While only representative artifacts from the site have been submitted for various analytical tests, results so far affirm our earlier contention that the Ulu Burun wreck holds great potential for provenance studies of raw materials and chronological sequencing of Canaanite, Cypriot, and Mycenaean pottery. Eighteen four-handled copper ingots and one plano-convex or "bun" copper ingot have been subjected to atomic absorption analysis by Robert Maddin of Harvard University (Maddin 1989). His results suggest that the Ulu Burun ingots probably did not derive from Cypriot ores as we know them today. More recent lead-isotope analysis, by Noel Gale at Oxford University, of four four-handled, five bun, and one slab ingot from Ulu Burun, on the other hand, suggests that all but two in bun form are of Cypriot ores (Gale 1991:227-231). Although definitive conclusions about the source of most Ulu Burun ingots must await further analysis of additional artifacts, it does appear that at least those in four-handled form originated in Cyprus. Several Ulu Burun tin ingots are being tested for lead-isotope ratios by Asl|han Yener of the Smithsonian Institution Conservation Analytical Laboratory. Results are pending, but her lead-isotope ratios of a lead fish-net sinker and a tin-alloy pilgrim flask from Ulu Burun suggest that the metal came from the Taurus Mountains of Turkey (Yener et al. 1991:558, 574), while three other fish-net sinkers point to the Laurion district of Greece for their source of lead (Sayre et al. 1992). After the completion of fieldwork in 1992, we will begin the systematic sampling of all artifact categories.

We anticipate completing the excavation at Ulu Burun in 1992, although unexpected finds may demand a brief season in 1993.

Acknowledgements

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The Seagoing Vessels on Dilmun Seals

Introduction

During the second millennium B.C. two of the great civilizations of the ancient world, the Harrappan and Mesopotamian empires, were engaged in an extensive trade network (Figure 1). Part of this trade was conducted over the Persian Gulf sea routes and included the people living on the islands of present day Bahrain and Failaka as well as the Arabian littoral of Kuwait and Saudi Arabia. This region possesses a culture distinct from that of Mesopotamia and is identified as the land of "Dilmun" mentioned in cuneiform texts (Bibby 1971:214-229). Middlemen merchants on both the islands of Bahrain and Failaka exchanged trade goods between Mesopotamia, the southern Persian Gulf, and the Indus Valley (Piesinger 1983:639).

Danish archaeological excavations on the island of Failaka, from 1958 to 1963, unearthed

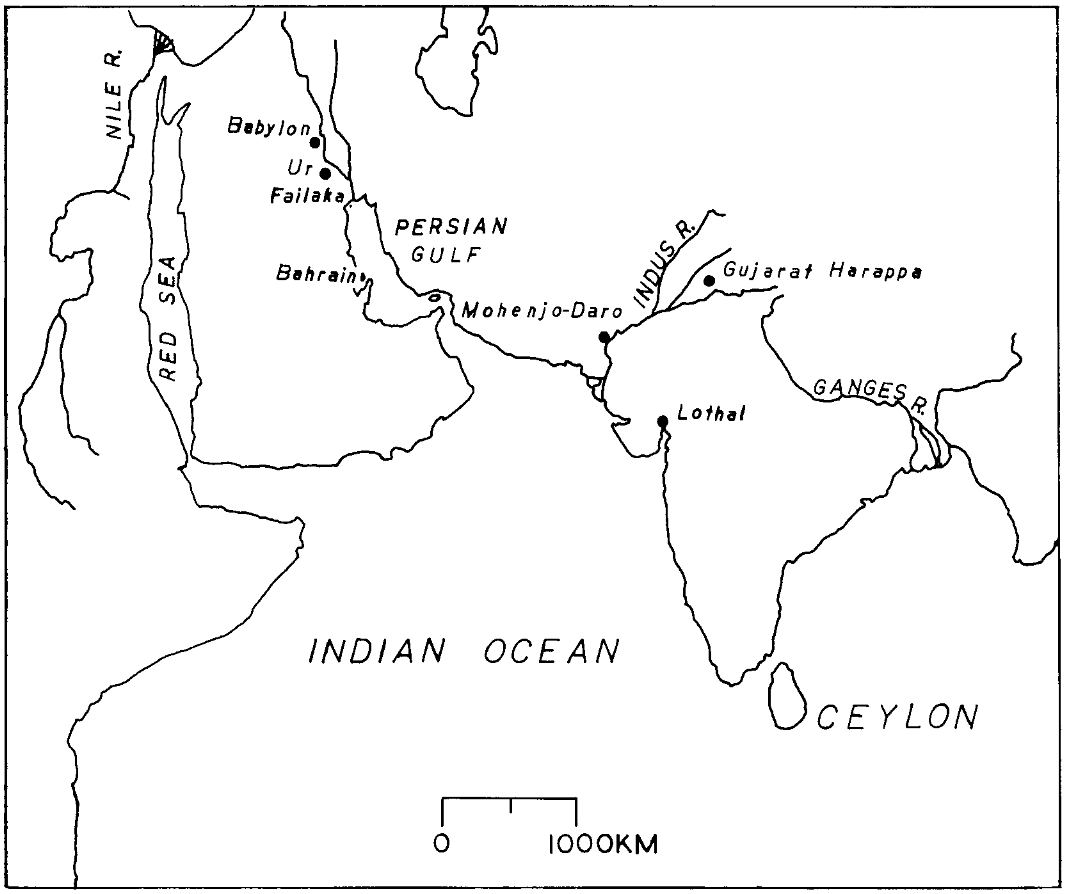


FIGURE 1. Map of the Persian Gulf, Red Sea, and Indian Ocean showing the areas of Mesopotamian, Harrappan, and Dilmun influence.

a number of Dilmun-type seals (Kjaerum 1983:8). Dilmun-type seals date to the early second millennium B.C. and differ in motif and shape from both the cylinder seals of Mesopotamia and the square seals of the Indus Valley. Nine of the excavated seals bear engraved portrayals of watercraft. The watercraft represented on Dilmun seals could be coastal and seagoing vessels because Dilmun's merchants were recognized as maritime traders. Thus, these representations show characteristics of Persian gulf seagoing craft in the second millennium B.C.

The Two Watercraft Categories Depicted on the Seals

One category of watercraft engraved on the seals is that of a raft, probably constructed of lashed bundles of reeds, while the other category represents a vessel either dugout derived, plank-built, or a combination of these two constructions.

Depictions of rafts can be distinguished from wooden-built craft by their double-ended construction with Figureheads at both ends, the presence of lashings, and the curved shape of the bottom and ends. The wooden watercraft type has a distinct bow and stern, with the Figurehead only in the bow, a more angular shape with a straighter bottom, and a sharp transition at the bow and stern of the boat.

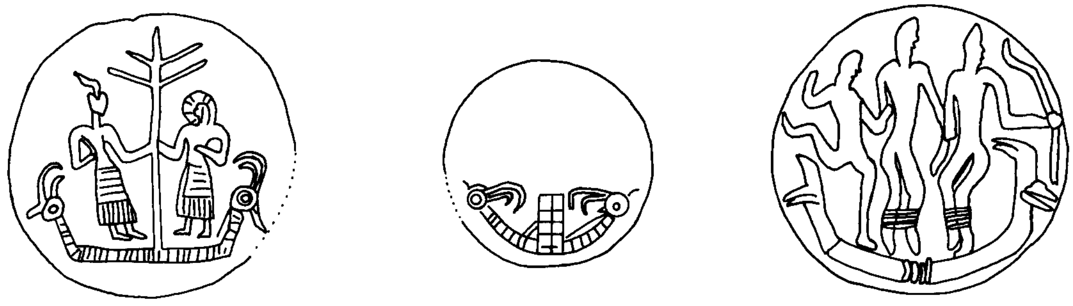
Both types, reed raft and wooden craft having a true hull, have the common motif of the horned Figurehead, and when a mast is present in the Figures it is always centrally-placed. The unfurled sail is relatively high and narrow and is constructed from several sections. These features have technological analogies with the depictions of second millennium B.C Egyptian vessels and with traditional Persian Gulf watercraft.

Reed Craft

The vessels depicted on seals 156, 175, and 262 have the appearance of reed rafts although depictions of rafts on seals 156 and 175 are highly stylized (Figure 2). A combination of features suggest reed rafts: the presence of vertical lines to depict lashings, the low flat hull shape having little freeboard, centrally-placed mast or sail, and the double-ended shape with horned Figureheads.

The best example of the reed raft type is seen in the engraving on seal 262. This portrayal is of a watercraft having a curved bottom rising abruptly to form a vertical stem and stern and is double-ended with little freeboard. Four vertical marks amidships suggest lashings and both ends are adorned with horned Figureheads.

It remains to be seen if trade connections between Mesopotamia, the Arabian coast, and the Indus Valley could be successfully main-



156 **175** **262**

FIGURE 2. Depictions of reed rafts on Dilmun seals. Not to scale. (Drawing by Robert Neyland after photographs found in Kjaerum, 1983).

tained with reed craft. Some reed craft are capable of achieving distant sea-voyages. The *shashah* is built entirely of reed bundles and has made voyages of 85 to 170 km (Bowen 1952:213). Pliny related that reed vessels with a Nilotic-like rig took twenty days to sail from the Ganges River to Ceylon (Pliny 1877:52). More recently, in 1978, Thor Heyerdahl sailed the reed boat *Tigris* from Iraq to the Red Sea (Heyerdahl 1978:806-27).

With access to timber and bronze tools it seems likely that boat builders would have built boats of wood, either dugouts, plank-built boats, or a combination of the two. Geological evidence indicates periods of more rainfall during the second millennium B.C. (Larsen 1983:201). The existence of a wetter climate is proof of a potential timber resource and palm trees are a common motif on many of the Dilmun seals (Carter 1972:24). Historical evidence also indicates available timber in the area, either grown or imported. A cuneiform text dating to 2450 B.C. reports that Dilmun vessels transported a cargo of wood from the mountains as a tribute to Ur Nanshe, the founder of a dynasty in Lagash (Piesinger 1983:640).

Hulls of Wood

Six representations, on seals 263, 264, 265, 266, 343, and 351, may depict boats built of wood (Figure 3). The angular hull shape and

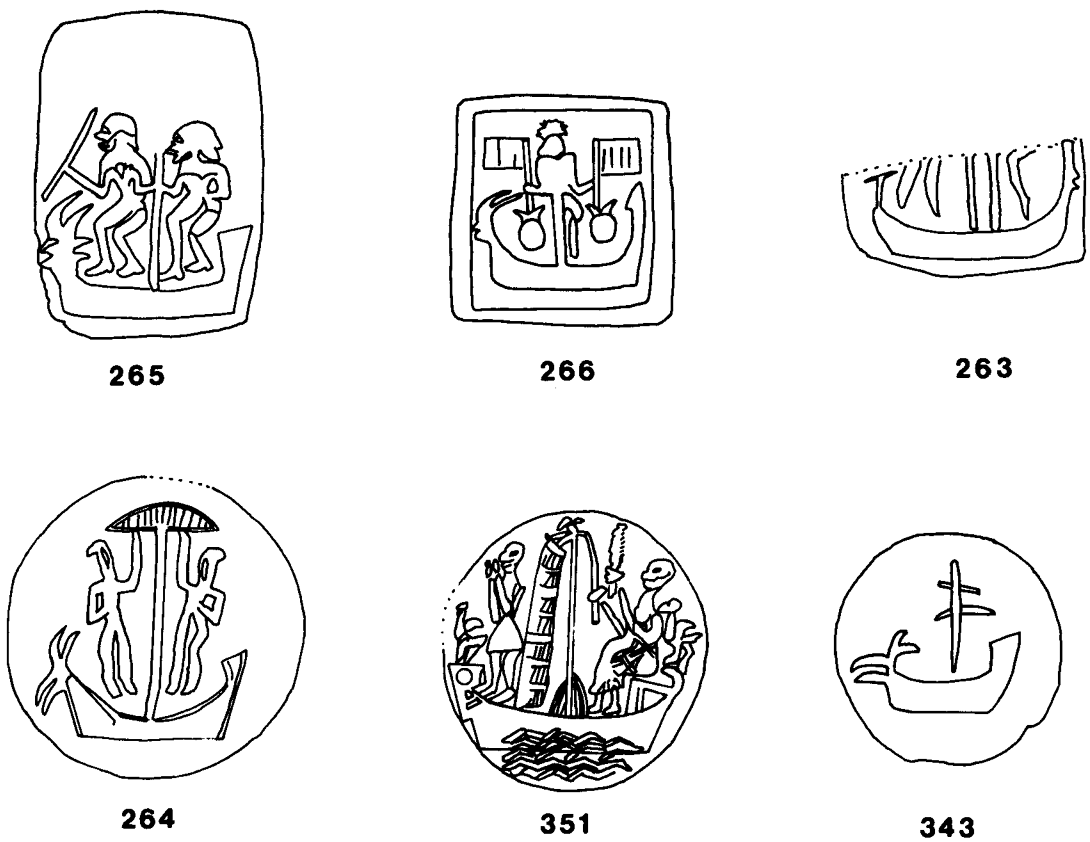


FIGURE 3. Depictions of watercraft having a probable wooden construction. Not to scale. (Drawing by Robert Neyland after photographs found in Kjaerum, 1983).

vertical ends are an indication of true hulls built of wood rather than reed (Johnson 1980:176-177). There is also a relative increase in freeboard and the use of lashings is absent. Like the previous examples of reed watercraft, these also show horned Figureheads but in this class of boat they are located on only one end, presumably the bow. The engravings on seals 264, 343, and 352 show the stem and stern of the vessels joining the hull at a well-defined angle of 75-80° and the ends of the boats in seals 265 and 266 have angles approaching 90°. The best parallel for this angular hull shape is found in hulls built of wood.

The boats on the seals have a straight lower hull line fore to aft and thus have been described as flat bottomed (Johnson 1980:182). This assumption is misleading for a dead-flat from stem to stern does not indicate a flat half-breadth section and not all Arabian craft are flat-bottomed. In silhouette, these hulls resemble later Arabian craft, both dugouts and planked boats. Extended dugouts of the Persian Gulf region, such as the *huri*, *saranga*, and *balam*, begin as dugouts, but due to the addition of upper strakes and repairs to the hull, become more plank-built than dugout during their lifetime (Bowen 1952:198; Greenhill 1971:112-113). Thus it is not easy to distinguish between dugouts, extended dugouts, and plank-built boats.

One argument favoring the boats on the seals as planked craft rather than dugouts is the lack of any curve to the bottom. The transition from bottom to ends forms a distinct angle, and the sharp rise of the stem and stern continues upward in a straight line rather than in a curve as do the ends of many dugouts. In the dugout building tradition of the Persian Gulf the hull is expanded by first softening it with fire; the sides are then forced apart, resulting in a hull with a low gently curving sheer and slightly rising ends that form low overhangs (Greenhill 1971). Three of the engravings, on seals 263, 266, and 343, do have slight, partially curved ends. Although curved and uplifted extremities may help in identifying a dugout built in this manner, this hull shape is not always the rule for dugouts from this part of the world. For example, the extended dugouts from East Africa have straight angular ends (Nishimura 1931:211).

Figureheads

All of the boats on the seals have Figureheads representing a horned creature, such as an antelope or goat-like animal. A tradition using antelope or goat Figureheads became widespread throughout the Persian Gulf and Red Sea, continuing from ancient times to the present. Horned Figureheads are present in the petroglyphs from Egypt's eastern desert and either antelope or goat heads were displayed as crude Figureheads on the dugouts of Africa's Lake Victoria (Nishimura 1931:212-215; Winkler 1939:pls. XXXV, XXXVI, XXXVII, & XXXVIII).

S. M. Zwemer, traveling to Bahrain in A.D. 1900s, wrote that the craft he saw there had a Figurehead called a *kubait* (Zwemer 1900:101-102). This was covered with the skin of a sheep or goat that had been sacrificed when the boat was launched. The goat Figurehead was part of a magical belief in which an animal was sacrificed at the launching of a new boat, perhaps to incorporate that animal's spirit in the boat or to appease the spirits of the water. A sheep or goat was the customary sacrifice for a boat-launching ceremony; the animal was decapitated and skinned, and the flayed skin was lashed over the stem (Hornell 1970:278). This custom continued into this century in coastal regions of the Persian Gulf, Red and Arabian Seas, and eastern Africa.

Sacrificial animal heads were supplanted by symbolic ones representing the spirit of the animal (Bowen 1955:31-33). Persian Gulf boats such as the *batil* and the *baqqarah* have identical stylized decorations on both the stem and stern, and the carved round oculus found on Arabian craft today can be traced to these ancient traditions. Seal 351 has an exceptionally stylized Figurehead which bears a resemblance to more recent Arabic Figureheads like that occurring on the stern of the *baden*. This Figurehead is decorated similarly to later Figureheads which have an oculus, two bands, and a trapezoidal shape (Bowen 1955:32).

The birds at both ends of the watercraft on seal 351 are too realistic to be Figureheads and appear to be separate from the boat. There are two possible explanations for their presence. One is that they represent birds used for fishing. Today, in this region, birds are still trained for this employment (George F. Dales 1989, pers. comm.). The second explanation for the birds is that they represent shore-sighting birds (De Graeve 1981:179). There is mythical and historical evidence to support the latter theory. This method of navigation is depicted on a Babylonian cylinder seal, and it was used in the myth of the Babylonian Noah, Ut-Napishtim, during the flood (Barnett 1958:230; Frankfort 1939:pl XI). The Old Testament Noah also made use of birds, the raven and the dove, to search for land as did Phoenician sailors who made use of the crow when out of sight of land (De Graeve 1981:179). The Hindu legend, ***Sutta Pitaka***, attributed to the 5th century B.C., tells how merchants sailing on overseas voyages carried with them several shore-sighting birds to be used in locating land when their position became doubtful (Hornell 1946:142). Pliny mentions the same custom practiced by the seamen of Ceylon (Pliny 1877). If such a method of navigation had been used in the second millennium B.C., it would have assisted mariners who sailed beyond sight of the coast.

Mast and Sail

Engravings on seals 264 and 351 have a centrally-placed mast with sail, and seals 263, 265, and 343 show only the masts. Although the mast on seal 343 does not have a sail, it appears to have one or two yards. All of the masts are centrally placed in the vessels. The mast location differs from the position of mast sockets in boat models from Mesopotamia and Lothal. These models, if interpreted correctly, exhibit a mast stepped closer to the bow. This difference in the placement of the mast may be attributed to the evolution of a more efficient sailing vessel. Egyptian tomb reliefs reveal that the Egyptian mast gradually moved aft, until it was in the center of the vessel by 1500 B.C. (Casson 1971:19). An alternative explanation is that the mast location reflects different sailing techniques of river versus seagoing craft. The mast location on the Dilmun vessels more closely resembles that of seagoing Egyptian vessels.

The mast on seal 351 has rigging attached to the lower third of the mast. A double set of lines runs from the mast to the hull, suggesting two sets of stays. The position of this rig suggests a function to brace the mast and distribute the force from the mast and sail over the hull. This placement of stays could be stylized due to the spatial constraints of the seal. For example, the rigging on some stylized Minoan seals is also placed at the foot of the mast (Casson 1971:figs. 35, 37, 41, & 48). Another possibility is that these lines are analogous to the rope apparatus depicted on certain Egyptian vessels. The ships of Queen Hatshepsut's expedition to Punt, for example, exhibit ropes attached to the lower mast (Bass 1972:32-33).

One vessel has a half-ellipsoid sail, and another has a tall, narrow sail. Both are decorated, possibly to indicate either a woven rush-mat sail or sewn sections of a cloth sail. Strabo related that Mesopotamian sails were made of reed; and according to Herodotus, Egyptian sails were made of papyrus (De Graeve 1981:179). Sails of Arabian vessels continued to be made of rush mat into this century.

Methods of Steering

Contemporary portrayals of vessels from Egypt, the Indus Valley, and Mesopotamia, show boats with steering oars. However, none of the vessels engraved on the Dilmun seals reveal how they were steered. Some lashed boats from the Persian Gulf region have underwater rudders that are not easily discerned and would thus not be depicted in the seal representations.

The lack of a rudder may be due to the small size of the boats. Small craft can be steered with a paddle and even when sailed could be brought about with the occasional use of a paddle. Also, ballast can be shifted in order to counter the effects of lateral resistance and thus to some extent direct the boat. Nineteenth-century travelers to the Arabian coast of Yemen reported crude methods of steering by employing leverage alone or in combination with altering the set of the square sail (Bowen 1952:215-216). One such traveler described a rudderless craft at Mocha which the native Arabs sailed by using the weight of the crew as movable ballast (Bowen 1952:215-219; Paris 1841). Shifting the position of their weight changed the draft and thus directed the boat.

Conclusion

The watercraft depictions on the Dilmun seals testify to the achievements in nautical technology during the second millennium B.C. The innovations in mast, sail, and hull design are the attributes of seagoing vessels. The appearance of a centrally-placed mast in the Persian Gulf region during the second millennium B.C. is a development that parallels similar innovations in Egyptian seagoing vessels. Dilmun-type craft portrayed on the seals from Failaka are the foremost examples of seagoing vessels that traded on the eastern Arabian coast and traded with Mesopotamia and the Indus Valley.

These depictions contrast with vessel representations from Mesopotamia and the Indus Valley. The centrally placed mast, horned Figurehead, lack of a discernable rudder, and angular hull shape reveal a distinctive class of vessel. One cuneiform text, dating to the second millennium B.C., alludes to the votive offering of a Dilmun-type boat. Therefore a Dilmun-type boat may have differed perceptibly in ornament and construction from other vessels built by the peoples of the Persian Gulf region. The horned Figurehead has some parallels in both Mesopotamia and Egypt, but their recurring presence on seal depictions is a consistent characteristic of the Dilmun-type boats. The employment of such Figureheads and their symbolic and ritual significance has continued in these waters until the present.

In the Persian Gulf region primitive reed rafts, dugouts, and simple plank boats continued to be used in this century. Some of these boats bear a resemblance to the vessels depicted on the seals. Dugouts, extended dugouts, and simple plank-built boats, rather than appearing as distinct types, seem to blend their constructions. Hence, a boat that begins as a dugout may end its days as a plank-built boat. Similar transitions from dugout to extended dugout and then to plank-built boat may have occurred in Persian Gulf vessels by the second millennium B.C. The Dilmun seal representations of wooden boats may reflect this blend.

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A Survey of Classical Harbors in Cilicia

This report represents a preliminary study of harbor sites on the south coast of Turkey or the territory of ancient Cilicia between the modern cities of Alanya and Mersin. The objectives were to identify harbor installations, to inspect them both on land and in the water, and to recommend priorities for future studies in the region. The survey treats some sites with more detailed observations than others, not necessarily corresponding to the importance of the city or its harbor. In many cases work was restricted to more convenient sites that could be reached by overland vehicle, leaving others to be investigated by boat in future years.

For the purpose of this study, the south coast is divided into three zones: Western Zone from Alanya to Anamur, a distance of 125 km; Central Zone from Anamur to Silifke, a distance of 139 km; and Eastern Zone from Silifke to Mersin, a distance of 89 km. The sequence of investigation will be from west to east following the path of two of the most important sources, the late 1st century BC geography by Strabo and the early 19th-century Admiralty survey by Captain Francis Beaufort (1817). Strabo (14.5.1) describes ancient Cilicia as the land crowded between the Mediterranean Sea and the ridges of the Taurus Mountains between Coraceseum in the west and Issus in the east. Our ancient geographer mentions another border near Soloi-Pompeiopolis (Viransehir) and Tarsus near the center of this coastline that divided the territories of Cilicia Tracheia and Cilicia Pedias. These two areas, Rough Cilicia and Smooth Cilicia, correspond to the mountainous terrain west of Soloi-Pompeiopolis and the broad alluvial plains to the east (Jones 1971:191-214; Mitford 1980).

The Taurus Mountains dominate Cilician topography. Rough Tracheia is a rugged and sparsely populated territory where steep mountains often plunge directly into the sea along a coastline relieved by very few plains. In the Western Zone, the mountain ranges from Alanya to Anamur run parallel to the shoreline. This region, characterized by steep, high bluffs and long stretches of shoreline, is without the indentations necessary for adequate sized harbors. There are a few small coastal plains at the effluences of short seasonal streams such as the Görcal Çay at Gazipsaşa and the Yakacik at Charadrus (Kalediran). The towns on or near this coast include Coraceseum, Syedra, Iotape, Selinus, Cestrus, Antiocheia ad Cragum, and Charadrus (Rosenbaum et al. 1967).

Iotape is a good example of the small harbors found along this portion of the coast. The site stands on a small promontory and around a tiny cove with a wider, open bay to the east (Bean and Mitford 1965:24-29, 1970:149-153; Beaufort 1817:171-172; Rosenbaum et al. 1967:35-47, 58-65). The promontory, connected to the mainland by a low saddle on one side, is steep on the other three sides with cliffs more than 40 m high along the western edge. Early 19th-century surveyors found fortification walls and house remains on the hill and additional houses in a low valley extending inland to the north. More recently, Rosenbaum, Huber, and Onurkan (1967) published descriptions and plans of its major buildings, its necropolis, and a schematic site plan. The cove is about 60 m^2. It has been suggested that there are additional protected anchorages beyond the point of land south of Building eight. If so, the small port might consist of inner and outer portions that still appear too small to require, or even allow, a breakwater between the two. I found no evidence of a breakwater. Broader bays with broad beaches flank the city to the northwest and southeast, and during calm weather ships might have been brought close to shore and off-loaded outside the small harbor. These activities would have been cut short if there were high seas from the southwest, which would strike the shore along this stretch in perpendicular wave patterns. Although the site has not been excavated, the terraces on the promontory west of the inner harbor are clear and house remains clearly visible. Unfortunately, no wall lines could be identified along the water's edge.

At Gazipsaşa—ancient Selinus—the situation is different. The city stands on the banks of the Dörcal Çay, 45 km southeast of Alanya (Bean and Mitford 1962:206-207, 1970:153-155; Beaufort 1817:173-185; Rosenbaum et al. 1967:29-35, 53-58). The city's remains cover the flat plain between the river and the lee of a high rocky hill whose south and west sides fall in steep cliffs, almost 200 m into the sea. The coastal plain extends to the north and east of the city; likewise to the north is a beach of petrified sand deposits and several other small hillocks. Selinus was perhaps most famous as the city where Trajan died, after which it briefly took the name of Trajanopolis. Where was the harbor of Selinus used by Trajan in 117? The anchorage must be sought in the lee of the acropolis near the river mouth. The stream now takes a sharp bend to the southwest avoiding a sand bar and enters the sea at the acropolis base. It is possible that the westernmost peristyle structure with vaulted chambers was a warehouse or *horrea*; if so, its position near the mouth of the river would have been most convenient for a nearby harbor. Finally, Beaufort (1817:183) reported that river banks, then covered with oleander, were raised to prevent overflowing and that internal angles of its meandering path had been faced with stonework. Was this stonework part of a river-based harbor at Selinus?

A final example from the Western Zone is the tiny anchorage at Antiocheia ad Cragum (Bean and Mitford 1965:34-42, 1970:184-186; Beaufort 1817:185; Rosenbaum et al. 1967:18-29, 49-53). The site is large, extending over a kilometer and a half along the coast with its city-center, set on cliffs 300 m above the sea. A small natural cove, 40 x 40 m, between the fortified citadel and necropolis is the most likely location for the harbor. Rosenbaum's very schematic plan suggests that there might have been another small harbor immediately to the east in an area now apparently landlocked. Field investigations at Antiocheia focused on these two inlets. The western inlet is small and approached by a narrow channel flanked by very steep cliffs, while that on the east must be entered by a natural cavern through the hill, which brings you into an even smaller protected body of water. The size of each inlet as well as the very steep terrain to the city some 300 m above would suggest an impractical harbor. If fact, the anchorages are easiest to reach by sea rather than land. The entrances must have been very difficult to recognize from the water for those who did not know the terrain, but a small boat reaching the safety of these anchorages was then protected by its rugged terrain that offered defenders a tremendous advantage over any approaching craft. In short, the coves at Antiocheia ad Cragum seem ideal for pirates but not as successful as commercial harbors.

The Central Zone between Anamur and Silifke features a coastline crossing the grain of the mountain range at an angle, thus creating numerous indented bays separated by projecting rocky headlands. Likewise, there are numerous offshore islands along this stretch including some that represent the peaks of submerged mountains. The best natural harbor along this portion of the coast is the little-known site of Aphrodisias in Cilicia on the Zephyrium promontory (Bean and Mitford 1970:193-195; Beaufort 1817:204-206). This projecting headland, with cliffs over 200 m tall, is almost exactly 2.5 km across from east to west and north to south, roughly circular in shape, with the exception of an inlet to the southwest and a promontory to the northeast. Massive fortification walls are the most conspicuous architectural feature on the island. Budde (1987) has recently suggested a late Bronze Age date. The site is a classic example of the city with two anchorages on either side of an isthmus. The western harbor, somewhat exposed to high seas from the southwest, might still be used in calm weather, and just outside the seawalls along this portion of the peninsula is a stone platform that appears to be the remains of a quay built perpendicular, to the shore. The better harbor, and perhaps one of the finest in all of Cilicia, was the eastern anchorage at Aphrodisias. In the early 19th century there were two shallow ponds connected to the sea by channels. Beaufort suggested that they were for a "military inundation," presumably to isolate the peninsula from attack over the isthmus. It is also possible that this passage might be part of earlier channels between two harbors on either side of the isthmus, a familiar pattern among ancient cities such as Alexandria, Tyre, Knidos, and perhaps Halikarnassos. A rapid survey included both sides of the isthmus as well as adjacent shores of the peninsula and mainland for evidence of ancient harborworks.

The transition between the Central and Eastern Zones of Tracheia is the Bay of Incekum whose western shore, formed by the last portion of the western Taurus, is steep and irregular. The eastern shore of the bay is the low, sandy delta of the ancient Calycadnus river (Göksu) terminated by Point Sarpedon or Zephyrium (Incekum Burun). The delta is flat and marshy with sand hills lining the coast. The Eastern Zone coastline from Silifke to Mersin is once again parallel to the range of mountains with no direct access across the rugged Bolkar range of the Taurus. The taller mountains are inland and the coast flanked by hills of a deceptively gentle slope through which small, seasonal streams create a rugged terrain of deep ravines. A wider coastal plain emerges at Evanli, gradually increasing in width toward Mersin and Tarsus.

Among the important harbor sites in this zone are Seleucia on the Calycadnus, Silifke, Corasium, Corycus, Elaeusa-Sebaste, and Soloi-Pompeiopolis. The port of Seleucia was in the delta of the Calycadnus river. A careful search for this site was not among the top priorities of the survey, but the assignment of Byzantine naval units to this city as late as the early 7th century would suggest its continued importance. The next site is Corycus or Kiz Kalesi, named for the twin fortresses of Byzantine and Armenian date that stand on land and on an adjacent island (Beaufort 1817:32-38). A small concrete breakwater stands at the southern corner of the Land Castle but does not provide a safe anchorage unless the story of a now absent breakwater connecting the island with the mainland is, in fact, true. If that were the case, there would have been an enormous harbor at Corycus. The monumental Roman arch, now built into the Land Castle, must have been the gate leading to this anchorage. But the first port of the city was probably east of the later harbor or perhaps inland behind a promontory where the city stood. This rather schematic plan of burial placements suggests that an inner, low-lying valley might have once been a well protected harbor.

Elaeusa-Sebaste lies 5 km east of Corycus (Beaufort 1817:241-244). The remains stand on the lower slopes of hills around what was in antiquity a shallow bay that has subsequently silted in, creating a headland out of the island that was once the site of Archelaus' palace. There is very little evidence remaining of the harbor, perhaps the remains of a few warehouses on the mainland and harbor walls on the island. At a later period, when the siltation was in an advanced stage, an aqueduct was built over to the island.

The final example of this rapid survey is Soloi-Pompeiopolis (Beaufort 1817:249-256; Boyce 1958:67-78). The most impressive ruins in the city are the standing columns of the major street extending from the north city gate to the harbor entrance. Other remains are very poorly preserved at the site, but Beaufort's description included references to fragments of buildings along the colonnaded street. The most important feature of the site for the present study is the vast artificial harbor, which still stands practically intact. A commemorative coin of the city, dated to AD 143-144, the 209th year of the city's era since its dedication as Pompeiopolis, illustrates the facility. Its rounded end is visible to the left and a two-story structure, with jar-like objects above, surrounded the interior basin where a reclining figure identified as a harbor god fills the central field. A male figure stands on the base at the upper (eastern) breakwater terminus; a higher tower on the opposite (western) side might have been the lighthouse. Although badly silted and now filled with beach rock that has formed since antiquity, the basic lines of the harbor are recognizable. The basin is enclosed by two parallel breakwaters more than 200 m apart that define a rectangular anchorage almost 300 m long. The harbor is expanded by two large semicircular ends, that to the northwest partially excavated into the land and the other to the southeast, open on its central axis to serve as the entrance. Its overall length is almost 500 m and the strong central urban axis of the colonnaded street continued through the harbor and out to sea. The breakwaters at Pompeiopolis are built of solid concrete faced with large blocks of heavily clamped ashlar blocks. Detailed measurements of the west breakwater reveal the width to be in excess of 20 m, but the scarcity of facing materials made exact measurements difficult. The width tapered somewhat toward the southwest curve, narrowing to 15 m; despite the badly eroded nature of the breakwater, it appears that the width continued to taper toward its terminus. The huge platforms were built up as layers of concrete poured into a casemate system behind the ashlar (*opus quadratum*) facing best preserved on the inside (eastern) face of the western breakwater. Two crosswalls could be carefully observed and measured.

The focus of this survey is Cilicia Tracheia that had, with exceptions, few cities of consequence in the classical period. They were, for the most part, small towns compared to the larger cities in the plains of Pamphylia to the west and Cilicia Pedias to the east. In contrast to the flat lands, this rugged terrain of Tracheia remained sparsely populated. Some obvious port cities were not included. For example, both Seleucia on the Calycadnus and Tarsus were on navigable rivers and were ports in their own right. Others such as Anemurium and Celenderis are already included on the excavation permits of other teams. Still other sites were attractive possibilities but have only been mentioned briefly because of limitations of time, but one would hope that the survey might be enlarged over additional seasons.

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Fifteenth- and Sixteenth-Century Ships and Maritime Trade

JONATHAN W. BREAM

Bermuda's Role in Sixteenth-Century Navigation

The first New World chronicler, Fernández de Oviedo, wrote the Bermuda Islands were named for Juan Bermúdez. He also stated they were called La Garza because that was the name of the ship that Bermúdez was sailing at the time. In January 1505, Bermúdez sailed with provision for Hispaniola on a *nao*, *Santa María de la Antigua*. This ship was also known as *La Garza* (Archivo General de Indias [AGI], Contratación 4674) and carried a cargo of 17 slaves—one of the first to carry slaves to the Indies. Bermúdez arrived back at Sevilla between September 20 and October 15, 1505; thus under this tight schedule it is almost impossible that Juan Bermúdez became shipwrecked on Bermuda or went ashore. It is more probable that he saw the islands from a distance. He, or someone who knew about this happening, had to relay this information to Fernádez de Oviedo. The news of the discovery and location of these islands also reached Peter Martyr before 1511 when he published *Décadas* (Martyr 1530). This anonymous map is a wood engraving believed to date from 1510.

A Portuguese pilot, Esteban Gomez, signed on to sail with the Magellan fleet to circumnavigate the globe, but, dissatisfied with these arrangements, he (Gomez) petitioned similar support to find a northwesterly route. King Charles granted this on March 27, 1523, with the condition that he survey the northern part of Ultramar or North America. He returned to Spain on June 5, 1525, without finding a northwest passage and with a cargo of native North Americans for His Majesty. This Portuguese pilot, however, did provide a detailed description of Bermuda, found in Alonso de Santa Cruz's *Islario general de todas las islas de mundo*. This is probably the earliest description that exists of these islands. Bermuda was not inhabited and had little to offer. Those sailing to Spain navigated the channel called Bahamas (Florida Straits) and continued for Bermuda even though they avoided it because of the many shoals surrounding it. Almost the entire island was surrounded by reefs. There were many flying fish and birds. The island was located in the 33° north latitude in a gentle climate (Santa Cruz 1920).

Fernan Camelo, a Portuguese noble from the Azores Island of San Miguel, petitioned King Charles to colonize Bermuda. It is possible that Fernan Camelo knew of Esteban Gomez. Another possibility is the Fernan Camelo saw the 1527 Ribiero map. Despite these uncertainties, this Portuguese noble heard about Bermuda. After receiving the license to colonize the island, it is not known what happened. No archival evidence demonstrates such a colonizing attempt occurred, nor have archaeologists unearthed 16th-century settlements on Bermuda. A little more than three years later, the Queen Regent of Spain wanted information about Camelo and the Colony. She knew that Camelo was in charge but was not aware whether he had started (AGI, Indiferente General 1961). The queen apparently received no reply from the officials of the House of Trade.

Gaspar de Avila and Andres de Tonda, on two of the *naos* of the 1536 Santo Domingo fleet, spotted fire and smoke emanating from Bermuda. Curious about this, they launched one of the ships' boats in an attempt to get ashore and find the cause. Due to strong currents and the coming of night, the ships' boat returned to the *nao* (AGI, Indiferente General 1092). Back in Sevilla, they informed the officials at the House of Trade and His Majesty, both of whom desired more information about this phenomena. In May 1538, Captain Bartolomé Carreño, who later became the captain-general of the outbound 1554 flota wrecked at Padre Island, sailed from

San Juan for Bermuda. He found two ports for anchoring ships as good as the Guadalquivir River. Each could fit 200 ships. According to Carreño, the two he found were the Great Sound, the one to the northwest, and Castle Harbor, the one to the southeast. He was there 29 days, searching the land for the cause of the fires. He found no people, although he did find ship remains on the beaches. He found areas of scorched palms and cedars on every island, and, upon examining the burned areas, he determined that because of the dense underbrush, lightening could have sparked the fires. Upon reaching Santo Domingo, he gave his report to the royal officials (AGI, Santo Domingo 49).

In the 16th century, Bermuda played a key role in navigation between the New World and Spain. While the island's shores were not thought desirable for colonization, the knowledge of its location in the Atlantic Ocean was vital to the fleet. This importance can be seen in the treatises written on navigation, in the documentary records at the Archives of the Indies, and in the shipwrecks that lie beneath Bermuda's waters and on the reefs. Shortly after the discovery of the West Indies and the New World, books were written concerning the geography of the islands and continents and navigation and navigational routes.

Between 1518 and 1538, Alonso de Chaves, who was a pilot, cosmographer, and master, wrote *Espejo de navegantes*. He provided a description of Bermuda and used Bermuda in his sailing routes between the Indies and Spain. When sailing from Havana for Spain, he noted the preferred route through the Bahamas Channel. Once the Bahamas Channel was behind them, three options were provided to sail to or near Bermuda. To sail north of Bermuda the ships were to "sail east of northeast 220 leagues, then to the east 100 leagues." To sail to Bermuda, the directions were to sail "east northeast 230 leagues, then 100 leagues to the east." This latter option was considered dangerous because it would put the ship directly onto the shoals and reefs west of Bermuda.

Alonso de Chaves also wrote about the Gulf Stream in relation to Bermuda. He noted that while sailing in the Bahamas Channel little sail was needed because the currents were strong. It was better to hug the Florida coast and not the shoals to the east that were dangerous. Estimating distances was difficult in the Bahamas Channel and around Bermuda. A ship could travel about 50 percent farther per day than normal, depending on the wind and the cargo. A *nao* that usually traveled 30 leagues daily in some other area could travel 45 leagues over night because of the strong currents that flow to the northeast of east-northeast. He noted that these currents diminished in strength in mid-ocean and by the time the Azores Islands are reached, they are barely felt. He stressed that these currents, their effects on navigation, and the dangerous reefs and shoals of Bermuda should be taken into consideration.

In 1564, the ships destined for the New World left Sevilla at two times during the year. The New Spain Fleet, that also served the Antilles, sailed in April and the *Tierra firme* galleons in August. This change by the House of Trade also required that all ships rendezvous at the Cuban port of Havana and then return to Spain. Dispatch vessels from Santo Domingo were exempted from sailing to Havana before returning to Spain. One such navigational instruction stated that to return to Spain the dispatch vessel was to sail east, around the island of Saona on Hispaniola's southeast coast, and follow the normal route until some 200 leagues east of Bermuda. The pilot was to sail 40 or 50 leagues south of the island of Fayal. This route suggested that the dispatch vessels sail away from the Bermuda Islands so they not fall prey to its dangerous reefs and shoals.

Juan de Escalante de Mendoza, a master and captain of numerous ships and captain-general of the New Spain fleet, finished *Itinerario de navegación de los mares y tierras occidentales* in 1575 but never published it. It is perhaps the most complete work on navigation, cosmography, cartography, piloting, meteorology, naval construction, artillery, etc. In the route between Havana and Spain, he measured 1,510 leagues. The fleet could sail this distance, without repairs and delays, in about 60 days. Once out of the

Bahamas Channel, the ship should sail east-northeast to the 35° latitude. From there, the ship should sail east-northeast to the 39° latitude and then directly east to the Azores Islands. This route would place the fleets north of Bermuda in the return voyage (Escalante de Mendoza 1985).

Escalante noted that some ancient mariners still preferred to sail south of Bermuda. Early sailors fabricated a lore striking fear in the hearts of those who sailed north of Bermuda. They said that devils roamed that area, causing large storms. Just the opposite was discovered; sailing to the north of the island was safer and more secure in both summer and winter. Adverse conditions, such as sudden changes of winds, winds from the southeast and east-southeast, hurricanes, dead calms, and rainstorms, were prevalent south of the island. He added that if two *naos* disembarked the Bahamas Channel (same day, hour, and winds) to sail to Spain, one sailing north of Bermuda and the other sailing south, the one sailing to the north arrived 15 days earlier at the Azores islands with fewer storms than the one that sailed south. Juan de Escalante also stated that ships tended to sail more quickly than usual through the 365 leagues from Cape Cañaveral to the island of Bermuda due to the ocean currents (Escalante de Mendoza 1985).

Baltasar de Vellerino de Villalobos wrote *Luz de navegantes* in 1592. He placed the Bermuda Islands in the middle of the ocean, not close to anything. He stressed taking heed when sailing to 360 leagues between Cape Cañaveral and these islands because of the currents (Gulf Stream), especially when turning eastward. Early in the 16th century ships usually sailed south of the islands for fear of the demons to the north. Most later 16th-century mariners thought it was better to sail well north of the island and steer clear of it. Many *naos* had been lost near Bermuda, and its reefs could cause considerable damage.

Toward the end of the 16th century, two important nuclei began to develop in the Caribbean. Santo Domingo became the jurisdictional and governmental seat for the Audiencia of Santo Domingo, which encompassed the Caribbean islands and Florida. Havana, at the western edge of the Audiencia, became the commercial center for the region, especially after 1564 when all ships had to rendezvous there before returning to Spain. Communication between these two centers was extremely important. Despite the corsairs and pirates infesting northern Hispaniola, ships could reach Havana from Santo Domingo with little or no problem. To sail from Havana to Santo Domingo was quite different. Ships had to sail through the Bahamas Channel, go north to the latitude of Bermuda, then sail south to the latitude of Puerto Rico. Ships could sail from Santo Domingo to Havana in a fortnight, but the return took almost two months (AGI, Santo Domingo 52).

The Bermuda Islands became a navigational turning point in the Western Atlantic Ocean. Ships heading back to Spain would turn east. Ships needing to return to Santo Domingo would turn south. For those ships ravaged by storms, Bermuda became a decision point: whether to turn back to Santo Domingo, San Juan, or Puerto de la Plata, or to continue their voyage in hopes of making it to the Azores Islands. For a few ships, Bermuda became the final port of call. For the past three years, the Bermuda Maritime Museum has been studying one of these ships. It is thought to be *Santa Lucia*, also known as IMHA3, the 1577 Shipwreck, and the Western Ledge Wreck. It was a dispatch vessel that fell prey to the reefs on January 11, 1584. The survivors constructed another vessel and sailed back to Puerta de la Plata on the northern coast of Santo Domingo. The cause of the wreck was pinned on the pilot who was negligent in his duties.

The focus of the 1990 underwater field season was to excavate and record the major section of the shipwreck. The first objective required meticulous excavation to locate and plot every ceramic shard, seed, nut, and any other artifact. Construction details, such as fasteners and tools marks, were measured and carefully plotted on the drawings. Once mapping of the wreck was complete, it was photographed to construct a photomosaic. Toward the end of the 1990 season, additional detailed examinations, such as profiles of the hull, were made. After the entire wreck structure was recorded using a small underwater video system, the wreck was re-buried with sand for protection.

Over the winter of 1990-1991, various methods of recovery were discussed. The objectives for the 1991 season were the disassembly and recovery of the timbers and their removal to the Corange Laboratory for Artifact Conservation. Because 400-year-old water-logged wood is extremely fragile, even in the best conditions, special pallets were constructed to lift and support the timbers during transport. The timbers, on their pallets, were lifted using air bags and were transported on a barge back to the conservation laboratory.

Initial recording of features began shortly after the timbers arrived at the laboratory. Almost every timber contained organic debris from the ship, sand, and ocean bottom dirt. Careful cleaning revealed cultural remains including olive pits, wood shavings, caulk, and pitch. These were saved for future studies which will hopefully contribute to the interpretation of this ship and ship construction in the 16th century. Each timber was then reproduced at a scale of 1:1 on which tool marks, construction marks, fasteners, and wrecking details were carefully and accurately recorded. Manuel Izaguirre, who worked with the Red Bay project, supervised the drawing so the shipwreck would be recorded similarly to *San Juan*. This process was completed later by a field school program from East Carolina University. This wreck yielded more than 130 individual timbers, some of which had been broken into smaller fragments over 400 years. In addition, all timbers were photographed in black-and-white and color. This process ensured that no details of the rare hull remains will be lost and provides the data from which the hull will be analyzed.

Brad Lowen of Parks Canada, who has analyzed the timber remains from the Red Bay galleon, traveled to Bermuda to study the hull remains. The preliminary analysis indicated that the tonnage of this vessel was between 117.8 and 190.8 *toneladas*. This ship's stern appears to have been highly raked. Analysis of the timbers from *Santa Lucia* demonstrated poor quality of timber supply. The lower ends of some futtocks were actually the gnarled roots of oak trees 35 to 45 years old. This ship revealed the increasing difficulty in Europe of timber for ship construction. The oak tree furnishing the keel was about 45 years old.

This ship's timbers are in fresh water to remove salt and marine organisms to proceed with the next step in conservation. The material from the field seasons is now being analyzed. Although little of intrinsic value was recovered from the site, the shipwreck is one of the few 16th-century vessels to be discovered in the Western Hemisphere. The amount of surviving hull structure makes this more than merely a source of historical data; the well-preserved timbers provide Bermuda and the Bermuda Maritime Museum with the opportunity to develop a unique exhibit of the hull remains. The task ahead is the study of this shipwreck and the conservation of its timbers for posterity and exhibition to promote cultural tourism.

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Remains of a Fifteenth-Century Spanish Ship Found in Sardinia

The Cavoli Project was begun in 1990 in Italian waters off the island of Sardinia by a team from the Universidad de Zaragoza in collaboration with the Sopprintendenza Archeologica de Cagliari of the Fifth Centenary Society. The project is part of the naval archaeology program of Spain's Sociedad Estatal Quinto Centenario. Its aims are to provide archaeological information about Mediterranean naval technology and navigation in the late Middle and Early Modern Ages and to determine to what extent that technology contributed to the development of European oceanic navigation at the time of the Discovery.

Through written documents, much is known about Mediterranean navigation of the time, especially the main axes of trade as shaped by political and commercial forces. However, that information has not been sufficiently correlated to significant material elements from watercraft. These remains are still very scarce, although in a few years more information on the subject will be available when the latest findings of 14th- through 17th-century vessel remains from the Spanish, French, and Italian coasts are studied and published. These data will complement the valuable information already recovered from *Mary Rose*, *Vasa*, and the Bremen cog.

The beginning of the Cavoli Project dates to 1988 when an Italian team of divers accidentally discovered a series of ceramic remains and pieces of iron artillery. Some of the cannons were later recovered under the archaeological control of the Sopprintendenza Archeologica de Cagliari and identified as belonging to two possibly Spanish wrecks from the Modern Era. It was later learned that in 1972 a series of totally indiscriminate recoveries of material were carried out by a team of British divers belonging to the Royal Air Force (RAF) stationed in Germany. The material was then illegally exported from Italy, and its present whereabouts are unknown. A note was published in the *International Journal of Nautical Archaeology* (Fennel 1974:331-332) identifying the wreck as that of a 16th- or 17th-century Spanish ship. The news of the later find was given briefly in the Ital-

FIGURE 1. Island of Cavoli, Sardinia in the background.

ian bibliography of 1988 (D'Agostino), and Italian historians contacted Spanish scholars in case it should be of interest given the upcoming Columbus celebrations.

The remains were found off Cape Carbonara on the southern side of the small island of Cavoli, a small uninhabited island occupied only by a coastal lighthouse (Figure 1). Cavoli is situated in turn at the southern end of Sardinia. The place constitutes a point of extraordinary importance in Mediterranean sea trade of the time, especially the so-called Spice Route, and lay along the compulsory passageway between Spanish ports and the Aragonese possessions of Naples and Palermo. The Kingdoms of Sardinia and Naples together with Sicily had belonged to the Spanish Crown of Aragon since the 14th century (Figure 2).

It was later determined that there was only one shipwreck, dating from the 15th century, a period of immense importance in Mediterranean sea trade since it immediately preceded the Discovery. The opportunity to study elements of 15th-century naval construction, about which very little is known, was sufficient argument to begin a project whose scope was initially limited to 3 years to verify the findings and to extract the relevant information.

The wreck belongs to a very significant historical period in the Mediterranean: the transition from the Middle Ages to the Modern Era. At that time, the Crown of Aragon enjoyed a special role as the indisputable arbiter of politics and the kingdom with greatest political and economic weight despite the other Mediterranean powers: the Seigniories of Venice, Genoa, Pisa, and other Italian states, the Pontifical states, France, the Moslem states of North Africa, and the Turkish colossus which from Constantinople controlled much of the activity in the Eastern Mediterranean and beyond.

Since the 14th century, the Crown of Aragon had been immersed in a policy of Italian expansion, consolidating its possessions, and laying down guidelines for them through military and economic activity based on an active trade in competition with other commercial powers. The wars in Italy represented a great deal of trade for Catalan, Valencian, Mallorcan, and Aragonese ships and joined the ports of Barcelona, Valencia, Tortosa, Tarragona, Mallorca, Denia, and other less active ones with

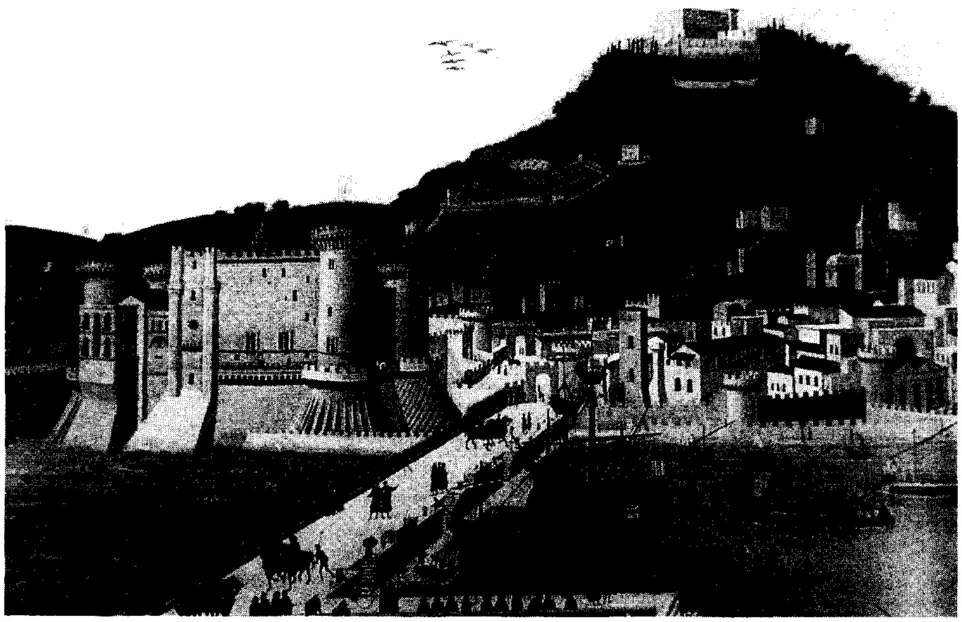

FIGURE 2. Port of Naples and the castle of Alfonso V in the 15th century.

the Italian ports of Alghero and Cagliari in Sardinia, Naples in southern Italy, and Palermo in Sicily as well as Genoa, Rome, Pisa, and La Valetta. Although much is known through written documents, this important traffic of people and goods has not been studied sufficiently through archaeological sources.

The regulation of sea transport of the time, above all commercial traffic, was assured by a great quantity of orders and norms issued by different authorities. Among the regulations, those pertaining to defense constitute an important chapter. There is evidence dating from as early as the middle of the 14th century regarding the use of onboard artillery to protect ships: in 1338 by the Genovese, in 1359 by the Spaniards, and in 1380 by the Venecians. The same shipping registers give an account of the presence of artillery pieces for the ships' own defense or even the export of these or other arms, among which were crossbows manufactured in Mallorca and destined to the other ports in the Mediterranean.

According to the 1392 statutes, the presence of artillery onboard ships was compulsory. Here it is recorded that 100-ton ships must be equipped with a bombard, 12 stone balls, and the corresponding gunpowder; from 130 to 220 tons, a ship would be armed with two bombards, 24 balls, and the corresponding gunpowder. In any case, onboard cannons had reduced efficiency, and their effect was more dissuasive than anything else since ships were not designed to use artillery. Galleys and galleasses, warships par excellence, mounted culverins in the stern to protect their flight and sometimes mounted one or two light pieces in the bow to pursue enemies in flight. In the 15th century, war was not waged at sea using artillery duels as a strategy. This fact produces enormous difficulties when studying ship types and determining if they were of military use or not as warships were not clearly differentiated until many years later.

The work carried out by the Italian team before our arrival, work is still not completely published, was reduced to superficial documentation of the remains spread out over the sea bottom. Among the remains were an important but disordered group of iron cannons of different sizes and calibers, fragments of crossbows, pistols, long arms, and personal arms, one of the most important being a 15th-century Spanish sword. Also found were ceramic sherds and some smaller objects.

These materials were recovered and stored in Cagliari awaiting their final treatment by the official Italian laboratories of Beni Culturali.

The Spanish team intervened in 1990 after previously collecting the existing documentation as well as beginning a search in the archives for data which could complement the archaeological research. Not much is known about 15th-century ships as the topic has not attracted researchers' attention as much.

The 1990 campaign was dedicated to completing a reconnaissance of the area where the findings were made, as well as documenting the area both geologically and sedimentologically for later reconstruction of the shipwreck. Following the reconnaissance, a wide survey of the area was made to determine the scope and extension of the wreck and to estimate the cost and length of the operation.

The work used modern survey and positioning systems, although the proximity of the site to land and the average depth of 12 to 15 m together with the extraordinary clearness of the waters permitted a very effective direct survey. However, the existence of a covering of seaweed (oceanic posidonia) with very powerful roots, which at times reached thicknesses of almost 2 m in successive sedimented layers of dead and living posidonia, complicated the task of visually locating the totally hidden remains. Check probes were constantly necessary. On the other hand, the metal remains were heavily encrusted and almost totally oxidized, providing very weak signals on the magnetic and magnetometric remote-sensing equipment.

The operation was mounted by transferring a great amount of material to the island of Cavoli by sea and helicopter, installing a base with air supply equipment, accommodations, campaign laboratories, repair and maintenance workshop, and medical equipment. Also, the

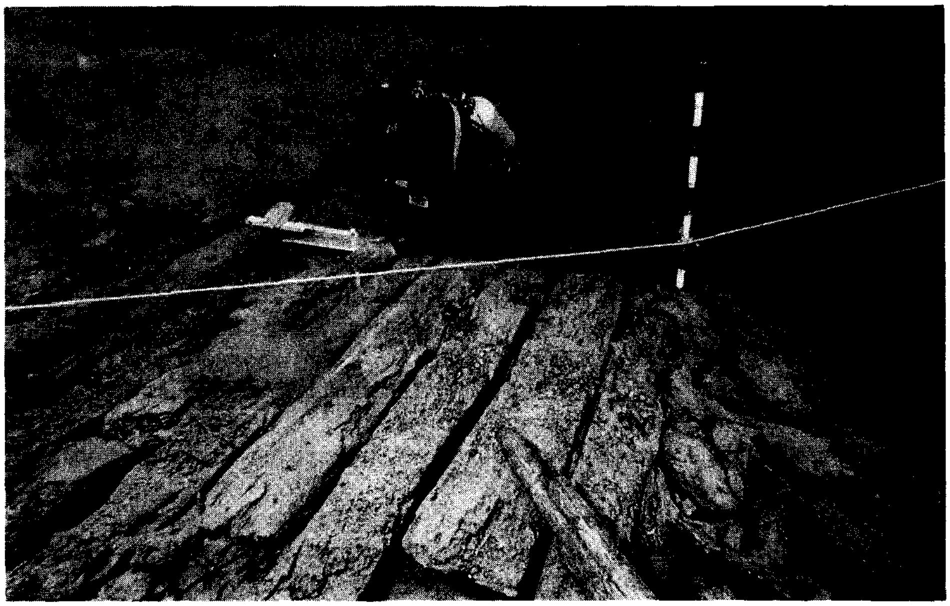

FIGURE 3. Hull remains.

land was conditioned for helicopter landing for possible evacuations if needed. In the village of Villasimius, 20 minutes away in a rapid craft, the main base was established with computer equipment, photographic laboratory, and drawing and mapping work area, as well as accommodations for personnel (25 in all) for more than two months' effective work between July and September of 1990.

The second campaign, a very short one only for checking and taking samples, was carried out in the month of October 1991, with 10 working days and a reduced team as there was a great deal of laboratory and filing work.

A third long campaign of more than two months is scheduled for summer 1992, when the excavation of the remains and the survey of the rest of the island of Cavoli will be completed.

The surveys and excavations have determined two areas containing remains corresponding to only one shipwreck, not two as the Italian researchers thought. The ship was split in two by the force of the storm and both parts were moved almost 100 m.

The survey/excavation units were situated by means of an extensive grid using light PVC which has proved to be much more effective than heavy metal. A previous grid with stakes every 10 m was subdivided into 4-m squares which were again subdivided as required. The site was documented using the traditional systems of drawings, stereoscopic photography, 8 mm video, and 16 mm film. The documentation was completed with surface photography and filming of the work carried out on land.

The remains uncovered on the bottom were divided into two units containing two types of finds. The main section, where the stern of the ship crashed and from which the anchor was recovered, contained some 20 cast-iron cannons, reinforced with rings, typical of the time. The large ones were pieces of up to 3 m in length and the smaller ones ranged between 0.8 to 1.0 m. Next to these guns lay stone ammunition, not much in proportion to the number of guns, as well as lead ammunition for personal arms. Pieces of ceramics completed the group.

In the second area, ceramic findings predominated, along with some armament. These remains had been looted in 1972 by the British RAF divers who fortunately had not detected the cannons of the first area.

In a space of 10 m^2 near the first area lay part of the wooden structure (Figures 3 and 4).

The remains consisted of planking and frames from the bottom of the ship although none of the keel survived. The hull was fastened by treenails and iron nails, the latter being protected against corrosion and sealed by molten lead. In addition, a series of other frames and planking spread out under the posidonia roots.

The dispersion of the findings in separate areas, as well as their distribution, leads to the conclusion that the ship sank violently after crashing against the rock cliffs during a storm. The violence of the destruction indicates, and the excavation confirms, that it would be difficult to find any important section of the ship's hull intact.

Two types of wood were used, oak and pine, the planking being very well preserved while the frames were largely destroyed by *Teredo navalis*. The teredos were extraordinarily large for Mediterranean waters.

The ceramic remains were scattered, more as a result of clandestine prospectors and successive looting than of the sinking. Apart from the ship's crockery, a load of tiles was being transported for a palace of the Becadelli family, an important family in the service of the King of Aragon in Sicily, judging by the heraldic emblem found on the tiles (Figure 5).

Together with the tiles, the cargo included table and kitchenware which was both typologically and quantitatively excessive to have belonged to the ship's crew.

The majority of the cannons were recovered by the Italian team in 1988, but four more remain on the seabed (where they have already been analyzed) awaiting recovery and treatment in 1992. Their distribution indicates that they were not part of the ship's armament, as had been assumed by the Italian team. First, there are too many for a ship of that time, and second, their arrangement revealed that they undoubtedly constituted the ship's main cargo.

The cannons were stored in the ship's hold, acting as a ballast along with the ceramics. As a result, they appear piled up in a relatively small space. In addition, the amount of ammunition found is very small and totally insufficient for the number of artillery pieces.

Also found were personal arms—swords, crossbows, pistols—as well as a lead seal with the Mallorcan coat-of-arms to secure a bundle of cloth, and an illegible coin.

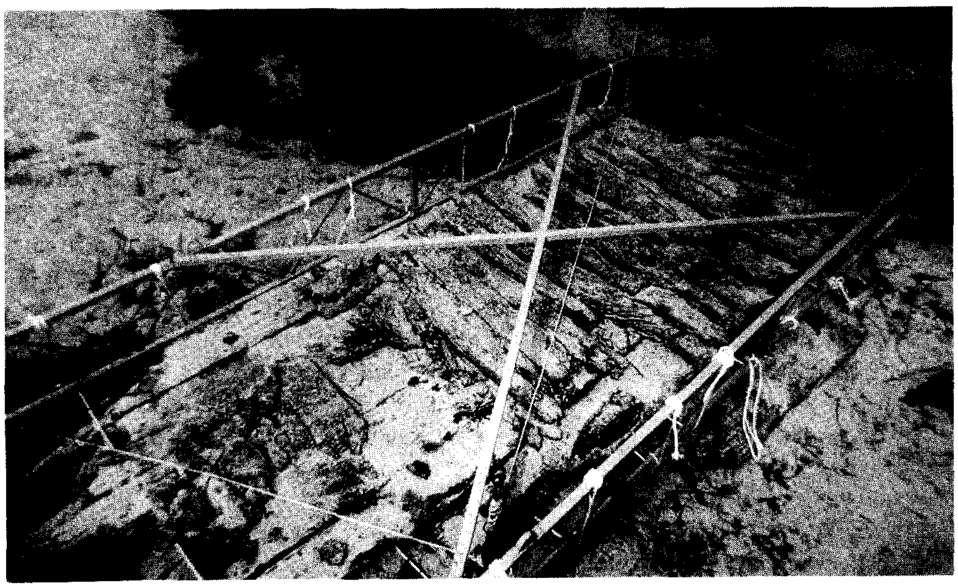

FIGURE 4. Hull remains prepared for transfer.

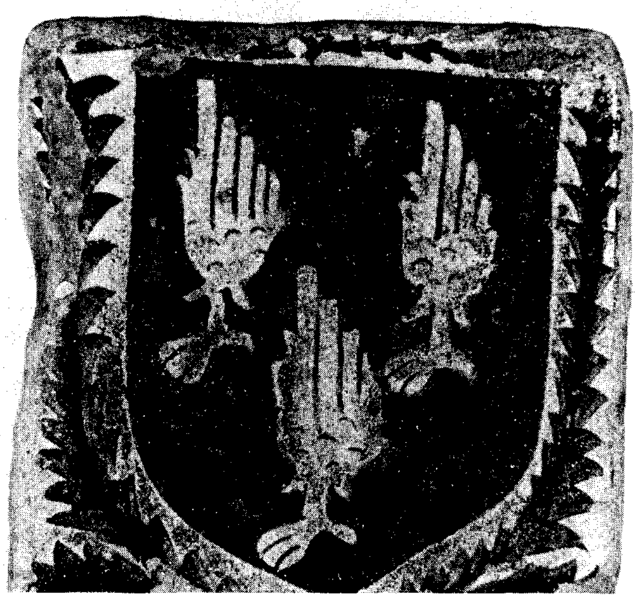

FIGURE 5. Decorative tile made in Manises with the coat-of-arms of the Becadelli family.

From the analysis of the remains and the archival research, it can be deduced that the ship, sailing for the Crown of Aragon, departed the Port of Valencia with a cargo of artillery and ceramics from Manises destined for Palermo in Sicily. It called at Mallorca, where apart from food and water, it loaded a cargo of cloth and small arms, perhaps the crossbows, then coasted along Aragonese Sardinia south towards Cagliari. From there it abandoned the Gulf of Cagliari and from Cape Carbonara and Cavoli, point of the shipwreck, was to continue to Palermo.

The storms of Cape Carbonara are well known as a hazard to navigation. As ships abandon the shelter of the coast for the open sea, very strong winds frequently cause such tragedies as befell the ship of the Cavoli Project.

The tiles decorated with the heraldic arms of the Becadelli family offer the best indication that the vessel was destined for Palermo. The family had a castle in Palermo, and the tiles were surely to be used to decorate it. In addition, written documentation testifying to the concession of different privileges to the Becadelli family for services to the King of Aragon support this conclusion.

The wreck dates to ca. 1440. This dating is based upon the type of Mallorcan seal, the ceramic typology, and archival documentation of the heraldic emblems.

In the middle of the 15th century, King Alfonso V (the Magnanimous) of Aragon was pursuing his expansionist and hegemonic policies in Italy. The wars needed supplies of men and arms which arrived constantly from the Spanish territories. Therefore, a cargo of artillery and small arms destined to the Aragonese territories in Italy to supply the troops would not be abnormal, and Spanish cannon, the so-called Catalan casting, was very famous. At that time, Mallorca exported large numbers of crossbows and fabrics for manufacturing clothing for the troops in Italy, as testified abundantly by the documentation of the period. Perhaps the presence of the lead seal bearing the heraldic arms of the city of Mallorca indicates a sort of quality assurance.

The completed project will include the studies in progress on the typology of the cannons, a study of the wooden remains to determine the type of ship, and conservation of woods, metals, and ceramics.

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SESSION

RICHARD J. ANUSKIEWICZ, MODERATOR

Technology, Theory, and Analysis

RICHARD J. ANUSKIEWICZ

Using Remote-Sensing as a Tool for Middle-Range Theory Building in Maritime and Nautical Archaeology

Introduction

This paper is presented to provide some guidance to the archaeologists working underwater contemplating using geophysical-prospecting data as a tool for middle-range theory building in maritime and nautical archaeology. The methodology and data presented herein are based on archaeological research conducted on and around St. Catherines Island, Georgia, and focus on the use of magnetometer remote-sensing. The research objectives were basically three-fold: first, to develop an historic maritime model for St. Catherines Island; second, to test this model by conducting comprehensive maritime and nautical archaeological studies of the waterways adjacent to and contiguous to the island; and third, to develop a correlation between remote-sensing signatures and the archaeological context for middle-range theory building. This presentation will specifically discuss the methodological approach used to develop a maritime model and how the model used nautical archaeology in middle-range theory building for St. Catherines Island.

Middle-Range Theory and How it Works

An example of how middle-range theory building works in historical archaeology can be drawn from a brief discussion of David Hurst Thomas' recent work (1987:67) at the Mission Santa Catalina de Guale on St. Catherines Island. Thomas was able to define linkages between the traditional archaeological concepts of walls, structures, and features and the way they are perceived remotely by sensors of geophysical prospecting, such as magnetometers (Anuskiewicz 1989:6).

Further, Thomas defines archaeological concepts as typically abstract categories employed by the archaeologist. In his research Thomas explored the archaeological context of 16th and 17th-century Spanish Florida, such as buildings, pits, graves, palisades, bastions, wells, etc., on St. Catherines Island. Therefore, effective middle-range theory relates these concepts to an unambiguously defined *class of empirically observed phenomena*; in remote-sensing these phenomena are the battery of signals and signatures that derive from nondestructive geophysical prospecting (Thomas 1987:66; Anuskiewicz 1989:7).

Constructing a correlation of remote-sensing signatures and the archaeological context *must* be viewed as middle-range theory building in archaeology. This is simply another way of assigning meaning to our empirical observations (Schiffer 1976; Garrison and Bray 1976; Binford 1977; Thomas et al. 1979; Hayden and Cannon 1984; Thomas 1986:238; Anuskiewicz 1989:7). Middle-range theory is how we *perceive* the past and is quite different from how we *explain* the past (Binford 1981:29; Thomas 1983a, 1983b).

Maritime Archaeology

The study of sunken watercraft on St. Catherines Island and their associated economic and cultural activities were subsumed under the general headings of historical and maritime archaeology. Muckelroy specifically defines *maritime archaeology* as:

The scientific study, through the surviving material evidence, of all aspects of seafaring: ships, boats, and their equipment; cargoes, or passengers carried on them, and the economic systems within which they were operating; their officers and crew, especially utensils and other possessions reflecting their specialized lifestyles

Chronological Periods - Spanish, British, Early American and Modern

Maritime Site Typology	Cultural Periods	Expected Site Factor Locational Indices	Expected Site Formation Processes	Expected Archaeological Indices	Expected Instrumental Indices
3.a.) SHIPWRECK Wooden hull, (continuous)	3.) Spanish, British, Early American	3.) "Loss traps", harbors, shoals, ocean-side beaches, shallows of navigable river and creeks.	3.) Poor navigation, natural-floundering, storms or hurricane, accidental-fire, economic-abandonment, warfare-scuttling or battle damage.	3.) Wooden debris and some metal fittings, nautical and personal implements, marine hardware, ship's cannons, sheathing and ballast stones.	**3.a.)** Bouyant hull pattern. A linear distribution of multiple anomaly peaks. A dipolar signature pattern oriented along the same heading as the long axis of the hull. Low to medium gamma intensity(10-80 gamma).
3.b. and c.) SHIPWRECK Wooden hull (discontinuous).					**3.b.)** Bouyant hull fracture pattern. Multiple dipolar anomalies radiating upslope and downcruuent from a more tightly clustered, high-intensity anomalies. Low gamma intensity(5-65 gamma).
					3.c.) Bouyant structure pattern. Non-clustered dipolar anomalies of varying intensities, scattered unevenly across the beach. Low gamma intensity(5-45 gamma).

TABLE 1. The St. Catherines Island Maritime Model

(Muckelroy 1978:6).

Maritime activity sites and sunken watercraft are a part of the archaeological resources. They were part of an active cultural landscape wherein maritime activities, processes, and the people who participated in them were part of a larger historical cultural context.

In my research, the use of nautical archaeology remote-sensing technology to evaluate the St. Catherines Island maritime landscape and waterways made it possible to discover and examine specific types of archaeological sites and materials of the historic period. By examining the physical characteristics and recent geological history of the island's landscape and waterways, this study was able to specify which waterways were navigable and to what size of vessel, and therefore predict the archaeological record for shipwrecks (Anuskiewicz 1989:11).

The St. Catherines Island Maritime Model

The maritime model for St. Catherines Island was developed to conceptualize archaeological expectations and to formulate and test a set of verifiable hypotheses. The model is represented by six major descriptive and analytical categories for data input, interpretation, and analysis (Table 1). The categories described in this model were developed from archaeological information initially derived by Thomas (1987, 1988) from the discovery and issuing studies of the Mission Santa Catalina de Guale.

Descriptive, Analytical Model Categories, and Expectations

Maritime Site Typology

This category identifies the types of specific maritime sites expected to occur on St. Catherines Island. These included a Spanish mission, a careening site associated with the mission complex, shipwrecks, and a ballast pile or marine dump site associated with the Spanish, British, early American, and modern periods of occupation.

Cultural Periods

This category is pretty much straight forward and represents individual cultural periods considered in this model. Each cultural period is matched with a maritime site type to provide specific site-type correlates for each period of the island's maritime history.

Site Factor Locational Indices

This category describes the expected geographic locations of maritime sites within the physiographic landscape of the island. These indices are specifically correlated with the ***Maritime Site*** and ***Cultural Periods*** categories to determine the most probable geographic location at which to search for a specific maritime site type.

The expected Site Locational Indices for shipwrecks on the island consist of the specific concept of "loss traps" as described by Schiffer (1976). These are specific areas where vessels are lost due to natural phenomena of storms, currents, and shoals. These loss traps are expected to be concentrated along open and unprotected areas of the eastern Atlantic coast and beaches of St. Catherines Island. Heavy shoaling areas located near the northeastern tip of the island and an inlet near the center of the island are also expected to be additional high probability areas for loss traps.

It is also expected that there is a direct correlation between the size of the vessel lost and the size of the loss trap or waterway in which it was lost. For example, the smaller, meandering creeks found on the island have historically been navigable only to smaller type vessels such as canoes, launches, sloops, skiffs, and smaller motor-powered recreational and sport fishing watercraft.

Site Formation Processes

This category describes how each type of maritime site was formed. For example, Thomas' recent work (1987) suggests the remains of the Mission Santa Catalina de Guale were formed as the result of the construction, destruction, and reconstruction sequence of the mission during the Spanish occupation of the island.

Site formations for shipwrecks are expected to be caused by poor navigation, natural foundering, accidental fire, economic abandonment, or mutiny, warfare, scuttling, or battle damage. The subsequent examination of the archaeological indices of individual wreck sites is expected to substantiate the site-specific shipwreck formation process. If a wreck is located in a "loss trap" and shows evidence of burning, one can assume that the vessel caught fire and ran aground.

Expected Archaeological Indices

This category represents specific archaeological features and material culture remains expected to be found in association with a particular maritime site type (Anuskiewicz 1982) identified in this model.

Wooden-hulled shipwreck sites associated with the Spanish, British, and early American period are expected to have the following archaeological indices: wooden debris, some metal fittings and fasteners, ballast rock, cannons, nautical implements, marine hardware, and personal items of the crew.

Wrecks of the later American and modern periods are assumed to contain more metal components associated with later construction techniques and the presence of the debris from these motor-powered vessels. Modern wrecks are expected to be constructed of materials such as steel, aluminum, and fiberglass and to be powered by diesel or gasoline engines (Garrison 1989).

Expected Instrumental Indices

This category is expected to produce correlative remote-sensing signatures for specific maritime features located during this study. These signatures and their verified archaeological correlates will form the foundation of middle-range theory building for maritime sites associated with the island.

The Expected Instrumental Indices for a shipwreck associated with the island should vary with the particular historic period. For example, sailing vessels of the 16th, 17th, and 18th centuries were constructed mainly of wood and had relatively few associated ferrous metal fasteners and fittings. Some of these vessels are expected to have associated cannon, and all vessels should have associated anchor, ground tackle, and the crew's personal items as part of the ship's archaeological context. It is expected that historic period shipwrecks reflect specific wreck patterning and correlative magnetic signatures. In general, the magnetometer signature should reflect the lack of large quantities of ferrous components and produce low to medium amplitude dipolar anomalies.

Nineteenth- and 20th-century ships were, and modern ships are, constructed of more ferrous and steel components. These wrecks, and their specific wreck patterning, are expected to produce multi-point source, dipolar anomalies that are larger, sharper, and broader at a medium to high amplitude. These signatures would reflect the amount of iron or steel in the vessel's construction and the associated metal in the steam, diesel, or gasoline power train components.

It must be noted that the Expected Instrumental Indices represent only a general range of magnetometer readings for the periods identified in the St. Catherines Island maritime model. There are multiple variations of these instrumental indices for shipwrecks, variations caused by the wreck distribution pattern and the amount of ferrous material associated with the wreck.

The Archaeological and Material Cultural Expectations of Shipwreck Sites

Muckelroy wrote extensively on the expectations for shipwreck distributions and the preservation of specific elements of these sites (1978:157-225). His fundamental taxonomy divided shipwrecks into *continuous* and *discontinuous* types.

The continuous sites represent shipwrecks that, while undergoing varying levels of wrecking processes, are still relatively localized in their remains of the hull and any cargo or ship's fittings. The artifact distributions associated with these wreck have not been interrupted by sterile areas which do not have to be taken into account during the interpretation (Muckelroy 1978:182).

Discontinuous sites are those with elements of the ship widely scattered, with no single specific locus of the wreck site. These sites have been disturbed by the wrecking process. There is a total absence of any defining framework, making the reconstruction of such sites extremely difficult (Muckelroy 1978:196).

Clausen (1966) and Clausen and Arnold (1975) further discuss the discontinuous shipwreck patterns for shallow coastal wrecks:

> In the majority of cases, vessels of wooden construction lost on active, exposed coasts tend to break up and disintegrate under the influence of storm-generated waves and currents. Later, they may also be destroyed by intense attacks of various marine organisms and the effects of succeeding storms, scattering their components, ballast, and cargo over an area much larger than the dimensions of the original ship (Clausen and Arnold 1975:80).

Recent research in maritime and nautical archaeology has classified shipwreck patterning and developed Expected Instrumental Indices for specific wreck patterns, indices based on studies of the wreck's physical remains. Delgado et al. (1984) and Gearhart (1988a, 1988b) have further refined shipwreck patterning by developing distinctive site patterns using correlative magnetic signatures. They have designated these specific site patterns as buoyant hull, buoyant hull fracture, and buoyant structure. These wreck-type patterns and their correlative magnetic signatures were used as a basis to predict and develop shipwreck instrumental indices in this maritime model.

Development of Shipwreck Instrumental Indices Expectations

The *Buoyant Hull Site* is defined as a continuous wreck site in which the vessel comes ashore and settles in the sand relatively intact. Gearhart (1988b:40-43) reports that buoyant hull wrecks may differ from one wreck to the next because of materials used in their construction (e.g., wooden versus steel hulls). His expectations for this site type are characterized by two important magnetic patterns. First is a linear distribution of multiple anomaly peaks within the overall pattern produced by the remains of the intact hull. For a wooden-hulled vessel, one expects the anomaly patterns to exhibit a complex, elongated anomaly containing areas of high and low magnetic intensity within its boundaries. Further, the expectation is that the long axis of the anomaly pattern will be oriented along the same heading as the long axis of the hull. Finally, Gearhart suggests that the long axis of the anomaly pattern should be oriented parallel to the surf line because of the tendency of a drifting hull to turn broadside to the waves.

Buoyant Hull Fracture Sites are discontinuous wreck sites that occur when the hull of the ship comes ashore intact but breaks up on the beach and is dispersed by the surf. Therefore, the expected anomaly pattern for this wreck type would consist of multiple anomalies (i.e., wreck scatter) radiating upslope and downcurrent from an area of more tightly clustered, high-intensity anomalies (i.e., the area of hull breakup). This magnetic signature is produced as a result of the distribution of wreck parts (e.g., iron fittings or magnetic ballast material) that become scattered away from the main body of the wreck due to storms and wave action.

Buoyant Structure Sites are also discontinuous wrecks, formed when a vessel breaks apart offshore and washes onto the beach in pieces (Gearhart 1988b:40). This wreck type could leave a trail of wreckage scattered for miles along the beach. The magnetic signature would depend upon the size and quantity of associated ferrous debris that remained with the floatable materials that came ashore and the areal extent of their dispersal onto the beach.

This is a very complex wreck type because of the many variables to consider (e.g., distributional length of the wreck site, construction materials of the ship) when deriving expectations as to the magnetic signature pattern. Gearhart (1988b:43) expects such sites to consist of non-clustered anomalies of varying intensities, scattered unevenly across the beach.

Development of Specific Hypotheses

The specific information presented above has provided the necessary archival data and theoretical concepts to formulate working hypotheses to test the maritime, and nautical model for St. Catherines Island. From the maritime model, six working hypotheses were generated with respect to locating maritime sites and shipwrecks associated with the island. The hypotheses concerning shipwreck instrumental indices were easily evaluated using the St. Catherines Island data. The wrecks encountered, and their magnetic signatures, provided exhaustive data on the variety of expected site types discussed above. Certainly the data allow us to broadly classify sites based on the instrumental data. Evaluation of these hypotheses has led to the recognition of ancillary hypotheses. For example, the high correlation of wrecks with the "loss traps" of shoals and bars leads one to pose hypotheses concerning vessel type and size for other areas and to project probabilities for losses in those areas (Ervan G. Garrison 1992, pers. comm.). Even though several of these hypotheses are germane to this discussion, only one is presented below.

Results of Testing the Specific Hypotheses

What must be noted here is that state-of-the-art proton magnetometer instrumentation and underwater and terrestrial search techniques were used to test the specific hypothesis.

Hypothesis: Shipwreck sites will be concentrated at "loss traps"

This statement is true. The six shipwrecks inventoried during this research support the maritime model categories of the Expected Site Factor Locational Indices, Expected Site Formation Processes, Expected Archaeological Indices, and Expected Instrumental Indices developed for St. Catherines Island.

The Expected Site Factor Locational Indices category for shipwrecks in the model projected that wreck sites would be located in loss traps (Schiffer 1976). This study envisioned St. Catherines Island's loss traps at shoals and ocean side beaches. All of the shipwreck sites inventoried during this study were located in these areas. The wrecks exhibited various types of vessel damage prior to, or as a result of, the wrecking process. From the vessel damage, one could postulate the wrecking process and compare it with the Expected Site Formation Processes identified in the model. The debris observed at the wreck sites supported the Expected Archaeological Indices for modern-period shipwrecks. The magnetic signatures recorded for these wrecks also supported the Expected Instrumental Indices for modern wrecks as described in the model.

Middle-Range Theory Building for St. Catherines Island Using the Maritime Model

Maritime model building for St. Catherines Island through the use of archival research has developed sets of perceived archaeological indices for anticipated maritime sites and assigned correlative magnetic signatures to these expected sites. The testing of the maritime model through remote-sensing field work has developed sets of remote-sensing signatures that can be used as baseline reference information. These signatures have produced a framework for middle-range theory building for maritime sites associated with St. Catherines Island.

The shipwrecks studied and analyzed during the maritime study of St. Catherines Island are certainly specific to the island. The model building and testing by scientific inquiry for this study have provided sets of verifiable magnetic signatures. Therefore, this part of the research has provided the foundation for baseline geophysical signatures and the foundation for middle-range theory building for modern shipwreck sites associated with St. Catherines Island and similar physiographic sites throughout the southeastern United States.

Conclusion

The intent of this paper was to provide some guidance to archaeologists working underwater contemplating using geophysical-prospecting data, in particular from the use of the proton magnetometer, as a tool for middle-range theory building in nautical archaeology. This has been accomplished by presenting the methodological approach to building a maritime model. Further, this paper has shown that the systematic application of the scientific method and state-of-the-art instrumentation, along with a theoretical model, a sound methodological approach, and systematic field techniques, has provided the desired results in locating modern shipwreck sites associated with the island.

Using instrumental survey techniques in the service of well-defined theoretical expectations has eliminated many of the areas where many shipwreck sites could not occur. At a basic level of archaeological inquiry, this study has increased the discovery probability of locating these particular nautical sites with a continued application of this methodology.

This statement is particularly true if the specific theoretical expectations are manifest in discrete, archaeological indices. The archaeological indices are either the features and assemblages themselves or the observable instrumental correlates of these indices established by the application of middle-range theory building (Anuskiewicz 1989:228).

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Computer Video Image Digitization On The USS *Monitor*: A Research Tool For Underwater Archaeology

Introduction

Since the 1973 discovery of the remains of the USS *Monitor* in 235 ft. of water off Cape Hatteras, North Carolina, and its establishment in 1975 as the nation's first National Marine Sanctuary, the site has been managed by the National Oceanic and Atmospheric Administration (NOAA). Under a federal management plan, which has as one of its overall goals the promotion and coordination of scientific research to expand our knowledge of this historically important cultural resource, the ironclad has been the subject of several research expeditions involving deep ocean technology (NOAA 1983; Arnold et al. 1991). Remotely operated cameras, side-scan sonar, deep sea submersibles, submersibles utilizing lock-out divers, remotely operated vehicles, and other equipment have descended to the ocean bottom to make a record of the site (Arnold et al. 1991). These operations, although providing valuable information about the site, had limited access to the shipwreck (mostly its north side) because of prevailing currents and other weather conditions. In 1977 and 1979, during expeditions supported by the Harbor Branch Foundation, several scientists visited the site as lock-out divers tethered to a deep sea submersible (NOAA 1983; Watts 1979). With the discontinuation of lock-out dives following the 1979 expedition (NOAA 1983), researchers have been allowed to work on the site only remotely — by submersible, ROV, or data collection devices placed on the site. Researchers have not been able to do "hands-on" research on the site in over a decade. NOAA did not permit researchers to dive to the site using scuba equipment because of the extreme depth and for safety considerations. However, by the late 1980's, advances in scuba equipment, dive computers, underwater lighting, and camera technology made diving and filming at depths equivalent to that of *Monitor* commonplace among technical scuba divers. In 1990, after several years of consideration, NOAA allowed scuba divers to do limited research on the *Monitor* site for the first time.

In June 1990, the Farb Monitor Expedition became the first group to dive and document the shipwreck using scuba equipment. Following the historic first dive, 17 divers made 105 dives to the shipwreck during 4 cruises throughout the summer, photographing and recording areas of the site that had heretofore been inaccessible to all but free swimming divers. Computer digitization of video analog images has been in general use since the mid-1980s (Scheingold 1986; Tompkins and Webster 1988). Computer video image digitization (CVID) was used for the first time on an underwater archaeological site to increase our knowledge about the shipwreck and to document its condition.

Computer Video Image Digitization

Technological advances in microcomputers, video cameras, video image digitization, and data analysis software make it possible to acquire accurate measurements using high performance personal computers and video camcorders (Molinari and Preston 1989). The first application of CVID to shipwreck archaeology was utilized to document the deep ocean shipwreck, USS *Monitor*, during the first survey of the site by scuba divers. More recently, a similar approach was used to document the schooner *Alva Bradley* in Lake Michigan's waters (Stoltman 1991:11-12).

The reduced work time on the site because of its excessive depth (235 ft.), good visibility because of the presence of clear Gulf Stream water, and its low cost make video imaging the preferred means of acquiring data. Film images from 16 mm film cameras, though having at least four times the resolution of video images, are more expensive to produce; film images may be dubbed to video for CVID.

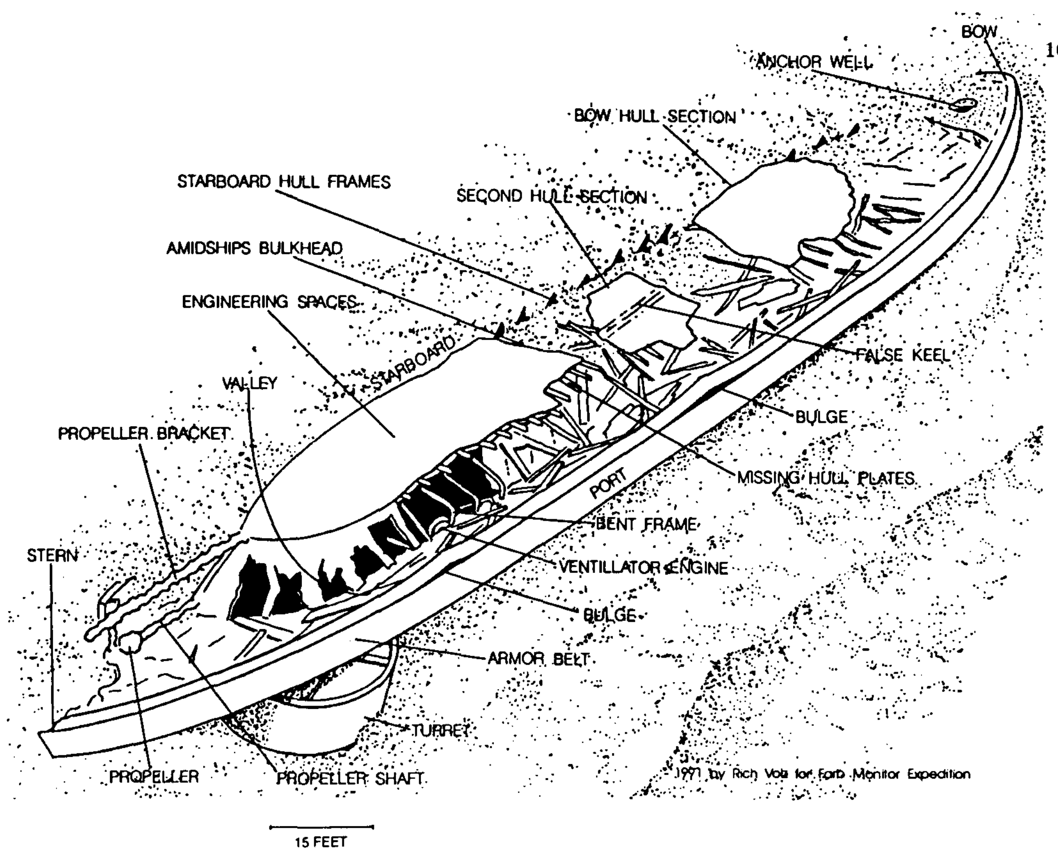

FIGURE 1. Artist's conception of the USS *Monitor* site. By Rich Volz for the Farb Monitor Expedition.

The recording rate of video camcorders is 30 images per second; film cameras record at 24 frames per second. The potential for data acquisition per unit time is enormous with either of these two media compared to still photography. Producing images, although necessary for CVID, is not sufficient for useful analysis unless it is coupled with a computer equipped with high resolution digitization hardware and powerful software designed to enhance and quantify elements within each digitized image frame.

Before a computer can manipulate and quantify an image, it must acquire image data from a video source via a digitization board or frame grabber that converts the analog video image to a digital computer format. The frame grabber's analog-to-digital converter has both spatial and gray scale resolution characteristics. The picture on a video or computer screen is made up of tiny elements called pixels. The resolution of an image is expressed in terms of the number of pixels that fill the image in a horizontal and vertical direction. Furthermore, each pixel within an image can possess a range of intensities, or gray levels, which is a measure of the reflectance of light coming from the part of the subject being represented by the pixel. Thus, the greater the number of pixels comprising a video or computer image and the greater the gray scale range of each pixel, the greater the resolution of the image and the more "true" the image will represent the subject. High resolution frame grabbers possess at least 512 x 512 x 8 spatial and gray scale resolution, a 512 x 512 pixel display that has a 256 gray-level (so-called 8-bit) resolution for each pixel.

In order to optimize digitization, the manner in which original images are recorded (the spatial relationship of the camera to the subject, the use of lighting to provide proper image contrast, and the presence of stadia within each image for calibration purposes) is critical for good image analysis. Successful CVID depends upon the resolution of the original image, the resolution of the computer digitization board used to capture the image, and the sophistication of software being used for quantification of elements within the image. Once the video image has been digitized by the computer's frame grabber, computer software designed for the purpose can modify the image. Contrast and brightness may be enhanced, and elements within the image, length, area, or angle may be determined.

The Research

During the 1990 USS *Monitor* research, free swimming scuba divers made two 20-minute dives per day breathing air, using a three-hour surface interval between dives. A total of 105 dives were made during a complete CVID survey of the site. Dive times and decompression schedules were determined by a U.S. Divers Monitor 2 dive computer worn by each diver. Decompression was done using air up to a depth of 20 ft.; pure oxygen was used from 20 ft. to the surface. Decompression times ranged from 90 to 120 minutes.

Sony 8 mm High Band video cameras (450 lines of horizontal resolution) and Airiflex 16 mm film cameras (1,200 lines of resolution) were used with 600 watts of light to record images for CVID. During each of the dives to the shipwreck, 36,000 images for CVID analysis were generated by free-swimming divers using 16 mm film. Film images were dubbed to one-inch videotape. Video images were digitized using a Data Translation 2953 digitization board (512 x 512 x 8 resolution) installed in an IBM Model 80 80386 20 Mhz computer. Still images were recorded using Nikon cameras and Ikelite strobes. Still film images were digitized using a Hewlett Packard Scan Jet Plus flat-bed scanner. Measurements from digitized images were made using BioScan's Optimas data analysis software. The digitized images were output to a 300 dpi laser printer for halftone images and to an Agfa Matrix film recorder for 4000 lpi 35 mm slides. Compressed images were stored on disk.

Results

There have been a number of changes in the structure of the site since 1979 (Watts 1979; Arnold et al. 1991). The entire port side of the stern displacement hull, and all but one of its frame members, have collapsed, creating a "valley" between the engineering spaces and the port armor belt.

The lower hull on the port side of the fire room has settled significantly as indicated by three severely bent frame members. The lower hull surrounding the boilers and galley is leaning approximately 15° to starboard. One consequence of the shift is the displacement of three or four bottom hull plates from the port side of the galley (forward corner of the engineering space). The shift probably caused the fragile rivets holding the plates in place to shear, leaving the hull plates free to move in the presence of strong currents. One displaced hull plate is lying on top of the adjacent starboard plate.

The starboard armor belt, which was exposed at the bow and stern in 1979 (Watts 1979:14, 103) is covered with sand and is not visible. The port armor belt has undergone changes since 1979 (Watts 1979:16, 103). The large gap on the inboard side of the belt at the stern end, present in 1979 (Watts 1979:16), is no longer visible; the armor belt appears solid across its width for the last 20 ft. to the stern end. A large vertical crack in the armor belt begins at the top of the belt (edge closest to the sand) a few feet from its stern end and runs vertically for a distance of approximately 18 in. The port armor belt does not touch the sand anywhere along its length except at the bow where there is an area of scour caused by currents sweeping sand away from the belt.

There are at least three bulges (separations) on the bottom of the armor belt that may be some of the predicted armor belt hinge points referred to in Bruce Muga's (1982:57) engineering report. One bulge is located above and slightly forward of the turret; a minor bulge is located across from the midpoint of the engineering spaces; and the largest bulge, quite prominent when viewed from the south side of the armor belt, is located across the valley from and slightly forward of the amidships bulkhead. The bulge above the turret and the larger bulge were present in 1977 (NOAA video tapes provided to author). Bulging may result from the deterioration of the wood portion of the armor belt under the iron plate allowing the belt to settle downward, producing buckling of the iron plate covering the bottom of the belt. The extent of buckling may indicate the extent of deterioration of the armor belt's wood substructure.

The inboard side of the bottom of the armor belt has a large crack running longitudinally for much of its length. This crack may represent an earlier separation of the lower displacement hull from the bottom of the armor belt.

The large opening inboard of the port armor belt and near the port forward corner of the galley described by Gordon Watts (1979:100) is still present. The opening provides access to the wreck beneath the armor belt and aft to the turret. Deck plates are still attached from the opening aft to the turret inboard of the armor belt. On the deck, four feet west of the turret, there is a large opening that exposes some pipes of the engine room. Adjacent to the southwest side of the turret, deck plates are separating and hanging, the result of the deck settling where it rests on the turret.

The stern end of the engineering space where the propeller, propeller shaft, and propeller bracket are located appear to be unchanged from 1979 (Watts 1979:103, 115) except for more calcareous growth on the structures. The starboard armor belt is covered with sand and is no longer visible. There is a large opening under and starboard of the propeller bracket where a flange and some pipes from the engine room are exposed. There is also a piece of dark leather or rubber fabric in the wreckage near the base of the opening.

The boilers, engine, galley area, and machinery of the engineering spaces appear relatively unchanged since 1979 (Watts 1979:103). The increased calcareous growth on all of the structures has made many of the features of these areas unrecognizable compared to 1979 (Watts 1979). The fire room has the least support inside the engineering spaces (Peterkin 1985). The hull surrounding it would be expected to collapse before other areas of the engineering spaces if lack of internal support contributed to the collapse of the areas forward of the amidships bulkhead.

Frame members along the starboard side of the engineering spaces remain undistorted. There are a few frame members missing, creating gaps in their regular progression along the starboard side. The anchor well on the bow has lost much of its symmetry but has not become filled with sand.

Conclusions

Qualified, properly equipped and supervised scuba divers should be permitted to evaluate the USS *Monitor* site annually for changes in its structure using CVID. Free-swimming divers have access to every nook and cranny of the *Monitor* site, unlike submersibles which are limited to the down current (north or turret) side of the site due to presence of strong currents and other environmental factors. Submersibles operating up current of the site run the risk of being swept into the site, and even the smallest of them are too large to enter any standing structure on the site. Although new video and film technology makes it possible to acquire images with two- to eight-fold resolution compared to a decade ago, historical video and film images may be digitized and compared to contemporary images for some types of useful analyses. One such use was the evaluation of the bulges in the area of the armor belt, previously discussed.

A year-to-year comparison of digitized images acquired by free swimming divers can provide a rapid, accurate, low-cost and reliable means of obtaining valuable information about structural changes in all areas of the *Monitor* site.

Special attention should be given to acquiring information about "indicator areas" on the site, fragile portions of the wreck that we believe will undergo changes in structure more rapidly than other areas. Indicator areas may provide information about site deterioration processes and may give advance warning of major structural changes in the site. The following are recommended as indicator areas: a) the bulges in the bottom of the armor belt; b) the deck and openings next to the turret on west side; c) the frame members along the port side of the engineering spaces, especially the three severely distorted ones at the fire room; d) the single frame member that straddles the valley between the port armor belt and the amidships bulkhead; e) inside the engineering spaces, especially the fire room; f) propeller bracket and the stern of the engineering spaces; and g) the amidships bulkhead.

Information gathered about indicator areas by CVID will be important in making future management decisions about the shipwreck and its artifacts. NOAA has permitted the Farb Expedition to continue CVID research work on the USS *Monitor* site in 1991 and 1992. This work demonstrates the utility of CVID as a research tool in archaeology.

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The Investigation of the Factors Which Affect the Preservation of Underwater Archaeological Sites

Introduction

In recent years site environmental assessments have been recognized as a fundamental part of effective cultural resource management. However the inclusion of an assessment of the natural and burial environment in underwater archaeological investigation has not been adopted universally. This paper reviews the various benefits of environmental assessments and suggests strategies, using the principles of environmental impact assessments and geographic information systems (GIS), to develop methodologies to enable such evaluations to be carried out routinely on underwater archaeological sites in the future.

The Burial Environment

The nature of the burial environment of a site plays a fundamental role in determining what evidence survives, in what form, and in what position. Certain specific conditions will promote the survival of particular material types. Studying the nature and impact of the environment of a site is vital to understanding the quality of the evidence that is eventually recovered. The environment of a site also dictates the techniques and methods that will be most effective throughout the archaeological investigation, from the initial survey stage to the post-excavation analysis. Objective data collected at the pre-disturbance survey stage will therefore indicate the most effective techniques that should be used on the site.

Site Formation and Site Classification Models

Site formation and site classification models are becoming an increasingly common feature of shipwreck studies as tools to help workers understand the formation of sites and the effect the formation processes have had on the archaeological evidence contained in the site. The concept of extractive filters has been used to attempt to distinguish between the effects of natural processes and cultural ones. The formation of a site can be extremely complicated as, for example, where a shipwreck lies on top of prehistoric remains (Murphy 1990).

Classification models have been based on perceived levels of preservation (Cederlund 1980) or the zonation of the seabed into areas of specific environmental conditions thought to have affected the preservation of particular artifact types (a strategy used to analyze finds distributions in Orange Bay, St. Eustatius, as described by Nagelkerken 1985).

Muckelroy concluded that there are several types of "intermediate" sites on which the remains are neither "perfectly preserved nor smashed to pieces" and he demonstrated the importance for the survival characteristics of a site of the variety of forces acting on it. This was reflected in the relatively high correlation between the survival of material and factors relating to the site's position, for example, the extent of the sea horizon open to the site (Muckelroy 1977).

It is clear that site assessment studies provide a fundamental role in improving the viability of any site classification system or site formation study (Gibbins 1990).

Conservation Science and Finds Handling

Conservation science will obviously benefit from an increased knowledge of the burial environment of objects and materials and more effective conservation treatments will be developed if the properties of the environment that surrounded an object (and which contributed to its deterioration) have been considered (Pearson 1987). The analysis of concretions and associated corrosion products from non-ferrous artifacts from Australian wrecks, together with a characterization of the marine environment for each site, contributed towards establishing the previous history of the artifacts for the period between the wreck and the excavation of the vessel (MacLeod 1991).

In finds' handling, it is important to minimize the damage caused by moving the object from one environment to another, completely different one, during the recovery process. This can be attempted by reproducing the characteristics of the objects' burial environment or by applying holding treatments to help the object survive until it can be safely transported to a conservation laboratory. In order to construct and maintain correct storage environments, the conservator must have objective information about the conditions of burial (Carpenter 1987).

Cultural Resource Management (CRM)

Site environmental assessments should form a fundamental part of any CRM scheme as such evaluations provide the basis for achieving a better understanding of the site and its formation and indicate ways in which it can be better managed and preserved for the benefit of future generations. Strategies such as the taking of baseline information followed by periodic monitoring form a fundamental part of the management plans for underwater heritage parks in many parts of the world.

The investigation of the USS *Arizona* represents a major landmark in site assessment studies as no one had previously confronted the problem of developing a long-term preservation program for a whole ship in situ. The program included collecting a baseline inventory of biological communities on the structure of the 600-ft. battleship that would help determine the biochemical processes impacting the vessel fabric. Stations were established to enable quantified measurements of the state of deterioration of structural elements to be collected at periodic intervals (Lenihan 1989).

An example of the complicated nature of resource management in archaeology underwater is the study conducted at Yorktown. Its purpose was to assess the environmental impact of measures taken in order to carry out the archaeological investigations, particularly the effect of the introduction of the large ferrous metal structure of the cofferdam and the use of visibility enhancing chemicals (Rodgers 1989).

In the Legare Anchorage Shipwreck Project, the bottom topography and vegetation patterns were mapped as part of the initial survey to determine placement of the excavation units. Site stabilization strategies to encourage the deposition of protective sediment through the use of artificial and natural seagrasses were also investigated (Fischer et al. 1984).

Preservation In Situ and/or Site Stabilization

It is well known that artifact deterioration on site can be lessened by action based on an understanding of the chemical and physical processes of the marine environment (McCarthy 1982). The further development of the quantified monitoring of underwater sites will help conserve archaeological material in situ using techniques such as sacrificial anode systems that continually "treat" metal objects, for example, cannon on sites in the John Pennekamp State Park (Bump and Muncher 1987).

Significant work has been carried out in Australia on the measurement of the factors on which the corrosion of iron objects is dependent. On-site measurement of corrosion potentials together with the use of sacrificial anodes have demonstrated the link between environmental assessments and the benefits of in situ conservation methods in cultural resource management and the development of new conservation treatments: on SS *Xantho* the pre-disturbance biological, chemical, and electrochemical survey followed by the recovery of the engine, the treatment of the anchor from HMS *Sirius*, and the cryogenic deconcreting of the *Trial* cannon (McCarthy 1982; MacLeod 1987; McCarthy 1988).

An important technique for the recovery of information from archaeological sites without incurring the substantial costs of conservation and storage is the reburial of archaeological material after suitable recording has been carried out. It is likely that variations on this method of resource management will become increasingly popular in the future, but its effectiveness depends ultimately on how well the reburial environment mimics the original burial conditions. This, in turn, depends upon how precisely the preservation conditions of the site are known.

In addition, the development of quantified measurement and monitoring techniques is crucial to the success of any predictive survey aimed at identifying areas that might have a high potential for containing archaeological sites. Various physical, chemical, and biological parameters have been determined to be important for wreck site location as well as for predicting expected states of preservation (Smith et al. 1981).

An important initiative in furthering site stabilization studies is the National Clearing House for Archaeological Site Stabilization (see below for contact address), which maintains a bibliography intended to support the conceptualization, design, and development of site stabilization and preservation projects. The bibliography is divided into four sections: Philosophy, Technical Support, Management Recommendations, and Practical Applications. It is salutary to note that virtually no references are available for underwater archaeology at this time.

Principles of Environmental Assessment

The perceived reluctance by archaeologists to carry out site environmental assessments may be due to factors such as a lack of an accepted methodology (for example, what physical, chemical, or biological factors should be measured and how often?) and an in-built wariness when relating data and terminologies that are derived from the natural sciences (such as pH or the measurement of obscure chemical species) to archaeological problems. There have been few objective data published that might be useful for comparing one site against another, with regard to factors such as the differential preservation of the materials present; therefore the opportunity of building up a useful corpus of evidence on the nature of archaeological sites underwater as a whole has been lost (Wildesen 1982).

With a view to suggesting an achievable methodology for site environmental assessments, it is instructive to examine the environmental assessment process that has emerged from the recent implementation of environmental impact regulations in many parts of the world. Those organizations that have been forced to carry out environmental assessments because of statutory obligations have had cause to examine the fundamental basis of assessment methodology (National Research Council 1990).

Environmental assessments are the collection of data and information on the basis of which decisions are made. *Good* data and information help to make good decisions. Environmental systems are recognized to be made up of: individual environmental parameters (any single characteristic of the total environment that can be measured by an objective methodology, e.g., pH or temperature) and interactions between parameters or components (e.g., degradation processes).

Environmental criteria are selected parameters based on a current understanding of importance, such as those factors thought to be important for preservation that might include the criteria that describe sedimentary environments (Robinson 1981). Terminology must be used carefully as there is a danger that the decision-maker who has to use the information will be faced with an overload of highly-specialized information, none of which they know how to relate effectively to their problem.

Modelling an environmental resource means essentially constructing a map of how various components are interrelated, how a change in one component can instigate a change in another, the conditions that must be met for the change to occur, and the rate at which it occurs (Erickson 1979).

Identifying Processes

Once the nature of the environment has been assessed, then any potential alterations must be considered. These provide the key to understanding the development of the environment and can be categorized into five basic ways: introduction, transformation, translocation, sequestration, and dissipation. All site formation processes, whether cultural or natural, can be categorized in terms of these alteration types.

Inter-disciplinary Cooperation

No one individual has sufficient knowledge to identify precisely all the interconnections represented in the complex archaeological site environments so specialists from other disciplines must be enlisted. Initiatives taken to involve other disciplines in archaeology underwater are to be applauded as, although there is a recognized need, it is not always easily achieved effectively (Smith et al. 1981; Wildesen 1982).

UKDMAP

A recent development in the application of information technology in archaeology is the availability of geographic information systems (GIS) (Allen et al. 1990). The United Kingdom Digital Marine Atlas Project (UKDMAP) has been developed by the British Oceanographic Data Centre with funding provided by various UK government organizations. UKDMAP is intended to be a reference work on the marine environment of the UK that will be of use to the scientific, educational, government, and commercial sectors, and it enables widely differing environmental parameters to be directly compared. In this case it is possible to compare these parameters with at least one category of underwater archaeological site as the locations of the UK Protected Wreck Sites have been included in the database.

In addition to the presentation of spatially referenced information in the form of maps, that may be zoomed and/or overlaid upon each other, and individual points queried to obtain detail information, the Atlas presents accompanying textual information that enables the user to contact the source of data and technical expertise in the relevant subject. This feature has proved useful in bringing the underwater cultural heritage to the attention of other major sea and sea-bed operators in the United Kingdom (e.g. commercial fishing, aggregate extraction, and dredging operations).

Conclusions

Site environments are complex systems, and although the benefits of environmental assessments have been recognized widely in contributing towards understanding these complexities, they have not been universally adopted in archaeology underwater. A full characterization of the physical, chemical, and biological environment of a site, as it was when it was occupied or active as well as through the later stages that brought it to the condition in which it was found, should be considered an integral part of any investigation. What is required is a broader discussion of what is required to be measured and how the data is to be collected, on all sites, but in ways in which the data can be directly comparable. Such assessments could then be routinely carried out as part of preliminary site surveys. It is hoped that established environmental assessment impact methodologies and the availability of geographic information systems will enable some of these problems to be addressed.

Information about the National Clearing House for Archaeological Site Stabilization and the Archaeological Site Stabilization Bibliography can be obtained from: Robert M. Thorne, Center for Archaeological Research, University of Mississippi, University, MS 38677.

Further information about UKDMAP can be obtained from: UKDMAP Project Manager, British Oceanographic Data Centre, Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside, UK L43 7RA.

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Texas Shipwrecks: A Statistical Characterization

The State of Texas has a Gulf of Mexico shoreline that extends 367 mi. from the Sabine River to the Rio Grande (Figure 1). For 20 years the Texas Antiquities Committee (TAC) has been compiling information on the shipwrecks in state waters. The information is recorded in the agency's shipwreck reference file. For ease of distributional analysis, wreck locations are plotted on a set of charts from the General Land Office that show the mineral

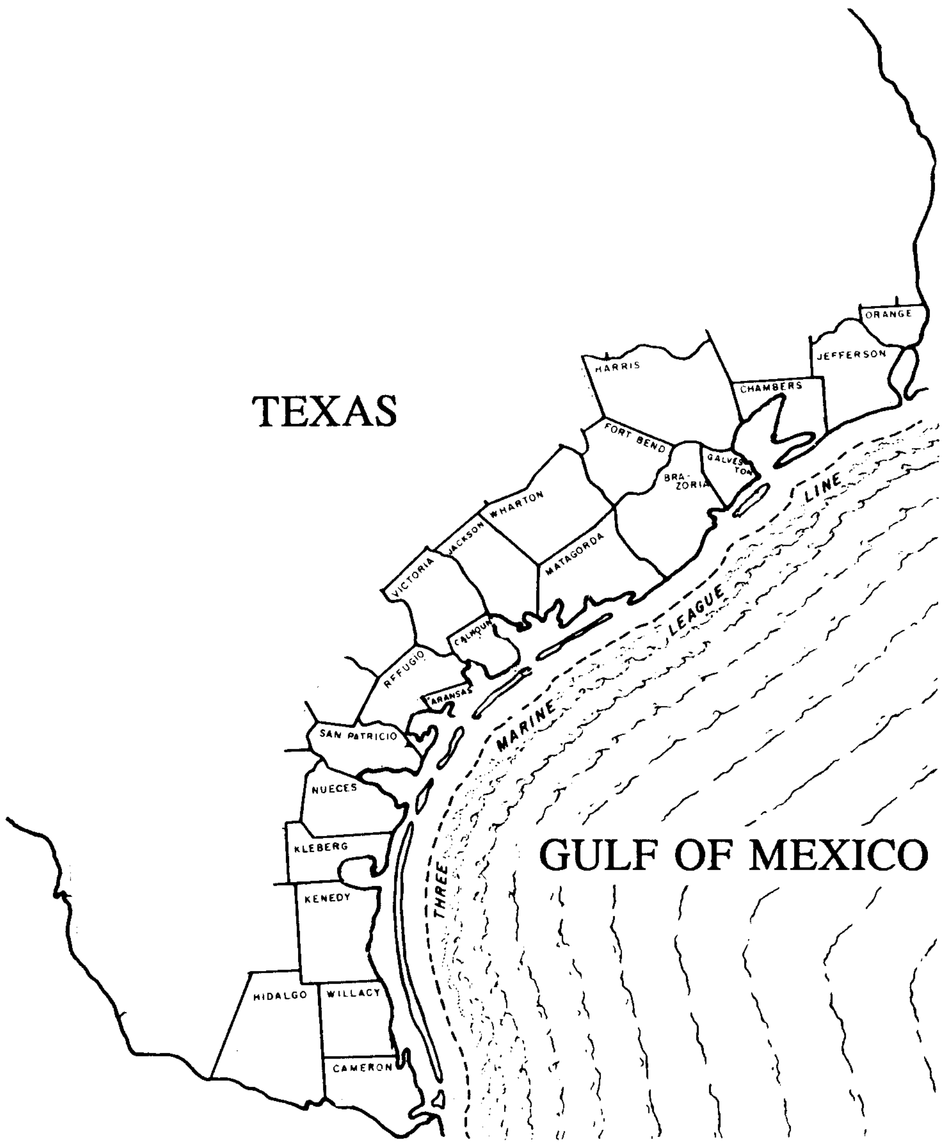

FIGURE 1. The Texas coast of the Gulf of Mexico.

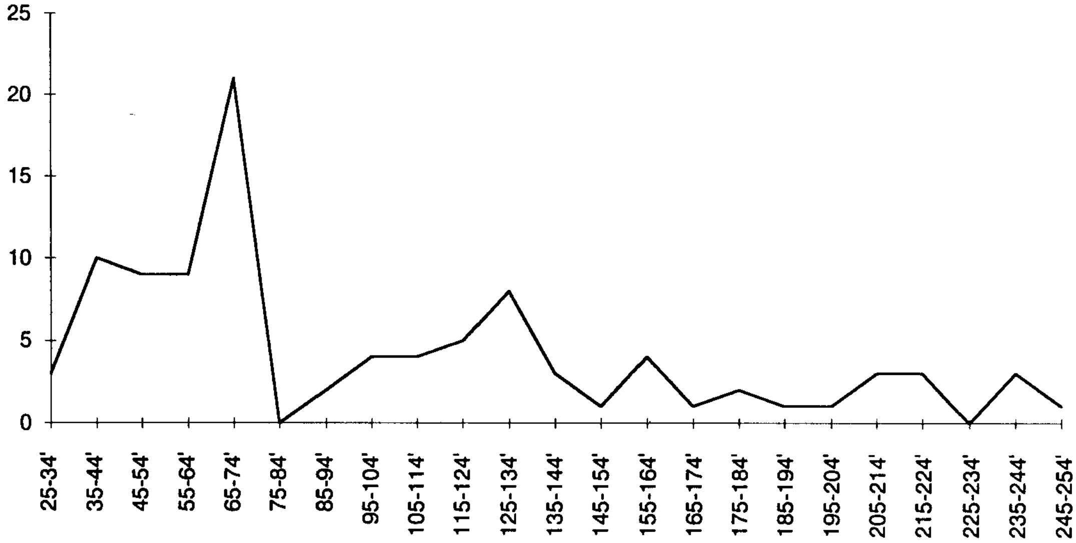

FIGURE 2. Length grouped by 10-ft. intervals.

lease blocks. Also, the shipwreck reference file has been computerized, originally on a mainframe computer (Mallouf et al. 1981; Arnold 1982). In recent years personal computers (PC's) have reached levels of significant capabilities, and the wreck file was migrated from the mainframe to an IBM-type clone PC where it was recorded in Dbase III+. The wreck file is a vital part of the state's shipwreck management and research program (Arnold 1989). Each state possessing shipwrecks is obligated to have such a program, and an active one, by the terms of the federal Abandoned Shipwreck Act of 1987 (P.L. 100-298) and the accompanying National Park Service guidelines. Title to historic shipwrecks was passed to the states from the federal government by the terms of this law.

Having a substantial body of data on the shipwrecks in Texas, it is possible to characterize the wreck population whose main characteristics are summarized in the following lines. First, the frequencies of shipwreck characteristics are calculated. Also presented when appropriate are basic descriptive statistics accompanied by frequency graphs for the variables dealing with vessel dimensions.

There were 1,935 wrecks recorded in the TAC's wreck file as of December 1991. Of these, 1,540 had sufficient data to make them useful in this review. Those wrecks formed the body of data manipulated using SPSS/PC+ V3.0 software (Norusis 1988). SPSS/PC+ was able to read the Dbase III+ file where the wreck data resided, greatly facilitating the project. Eighteen characteristics (called variables in SPSS terms) for each wreck (case) were tabulated and cross tabulated with the SPSS/PC+ software and the resulting tables are presented.

The variables fall into two basic categories: first, measurements or other data about the ship, and second, information useful in cultural resource management (CRM). Of the total 35 variables coded in the Dbase III+ wreck file, most are of the CRM kind and do not lend themselves well to statistical manipulation. The sources of the data in the file are from two sources: maps and written records. Maps and charts yield good location information on wrecks but usually nothing else, not even the name of the vessel. Primary and secondary historical sources often produce important facts about the vessel, such as measurements. In the frequency tables presented here, this leads to large numbers of "MISSING" or omitted cases or wreck entries in the file for which information on a particular variable is lacking. Fortu-

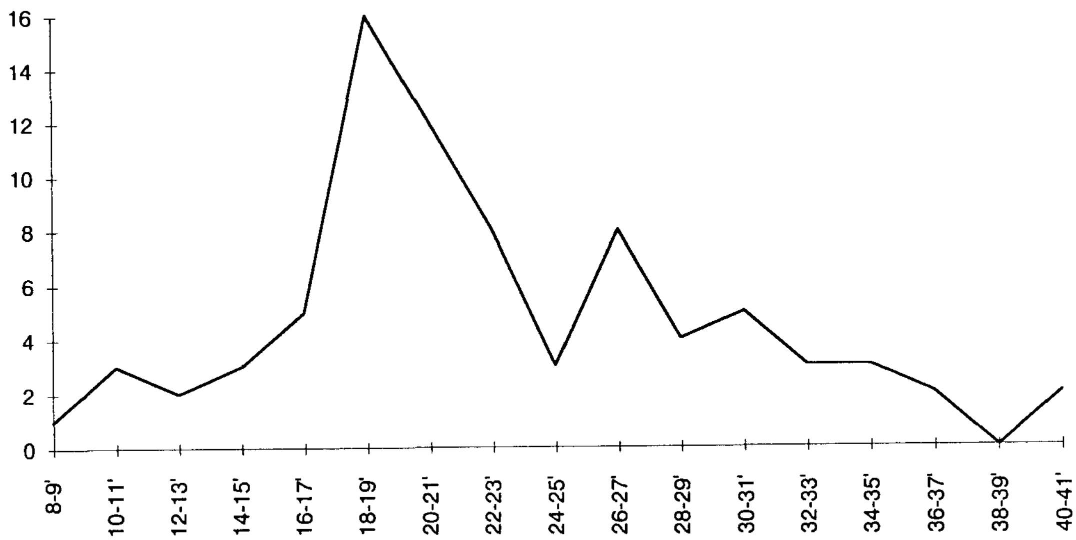

FIGURE 3. Beam grouped by 2-ft. intervals.

nately the SPSS/PC+ software can handle this and ignore the cases with "MISSING" data in making calculations. This is the reason that the "N's" or number of valid cases vary on each of the tables below.

Vessel Dimensions

Length, beam, depth of hold, and tonnage tables are presented. Vessel lengths range from 29 to 442 ft., but most fall between 29 and 250

FIGURE 4. Depth of hold.

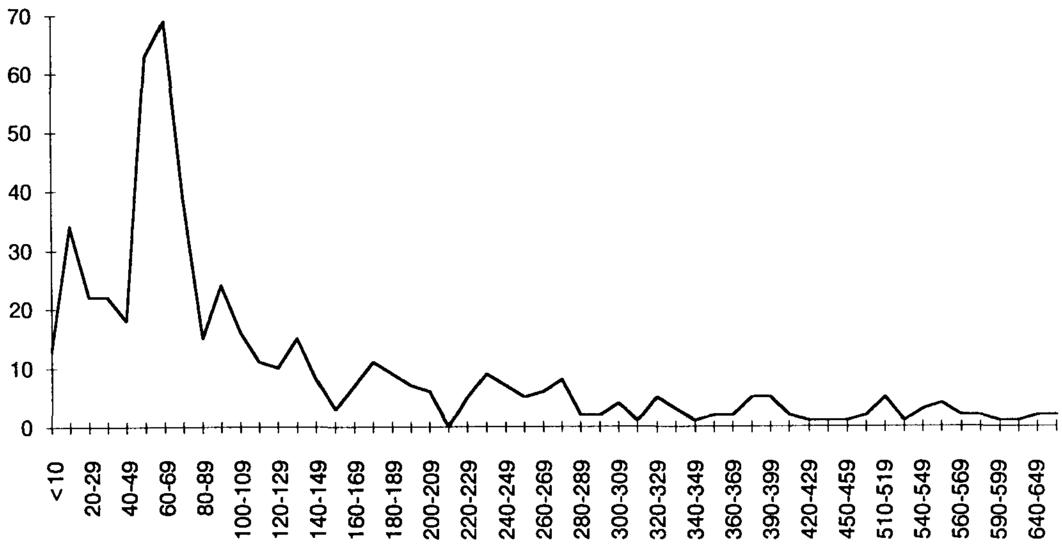

FIGURE 5. Tonnage grouped by 10-ton intervals.

ft. (Table 1). The length data are presented in 10-ft. intervals or groupings and reveal quite interesting patterns (Table 2 and Figure 2). It should be added, however, that 13 very large, recent wrecks were dropped from the data files shown in Table 2, as well as subsequent tables. Twelve of these were Liberty Ships scuttled as artificial reefs in the 1970s. Exclusion of these very large ships eliminated an unnecessary distortion in the frequency distributions for the several variables. Table 2 is remarkably skewed to the right (skewness measure = .927), and an interesting peak in the length array appears at around 70 ft., with a smaller clustering near 130 ft. The first group is modern shrimp boats, and the second is mostly 19th-century wrecks. Given the seeming multimodality and extreme skewness of the frequency array, descriptive statistics for central tendency and dispersion are not presented.

Continuing, beam (Table 3) and depth of hold (Table 5 and Figure 4) are functionally related to length and show fairly similar distributions. Beam measurements have been plotted according to 2-ft. intervals (Table 4 and Figure 3). This array somewhat mirrors that for length but is less skewed and has a more poorly developed secondary mode. Tonnage measurements are very broadly distributed, and for them two tables are shown: one grouped by 10-ton intervals (Table 6 and Figure 5) and the other by 100-ton intervals (Table 7). The few vessels over 2,000 tons are again deleted to avoid distortion that would be caused by Liberty Ships and a few other very large vessels. The frequency distribution is extremely right skewed, and little hint of multimodality can be seen in it. In the array plotted by 10-ton intervals, there is a single peak in the 60-ton range (again the modern shrimpers), while the distribution according to 100-ton intervals shows that most wrecks are under 100 tons.

Speaking generally, the dimensional measurements show the predominance of small vessels in the shipwreck data base. Interesting questions of correlation of vessel type and dimension, as well as changes through time, have yet to be dealt with in detail, although a few relevant conclusions can be drawn. A preview of the potential is seen in Figure 8 showing vessel lengths for wrecks after 1880 plotted against the whole sample.

Time Factors

The patterns of vessel losses through time and by season are of considerable interest, and in this plotting the wrecks have been grouped by decade (Table 8 and Figure 6). Furthermore, a look at seasonal distribution was achieved by grouping the raw dates by month (Table 9 and Figure 7). Two interesting peaks can be observed in the decadal array. The first falls between 1830 and 1860, centering on the Mexican War, while the second, in the 1860s, centers on the U.S. Civil War. The peak in the 1950s-1970s decades may be an artifact of the emphasis on mapping wrecks during that period of time and of our assignment of dates to the wrecks. Wrecks recorded from such charts were assigned the publication dates of the charts themselves, when in fact some wrecks may predate the charts considerably. The data on month lost, though not extremely variable, show an interesting peak in September and another in February. The fall equinox is a stormy time in the western Gulf of Mexico, and the winter peak in February is also predictable because of winter storms. Interestingly, the least dangerous months are those immediately following the above two.

The potential for further study can be seen in Tables 19 and 20. Length and tonnage by 10-ton intervals are cross tabulated with decade of loss. Very interesting clusterings are revealed. Also, it appears that in the 1880s there were important developments in navigation safety resulting in a dramatic decrease in the number of ships lost.

Other Vessel Characteristics

The types of vessels are shown in Table 10. The biggest group by far is merchant sailing ships at 45 percent, followed by river steam boats and merchant sail-steam vessels. Sailing vessels are, of course, more vulnerable to the vicissitudes of weather than are ships with engines. Also, in the heyday of the sailing vessel the Texas coast was much more dangerous to mariners who had to do without jetties and dredged entrance channels, sophisticated aids to navigation, and electronic instrumentation. The most common causes of vessel loss are foundering, fire, and stranding in that order (Table 11).

FIGURE 6. Losses by decade.

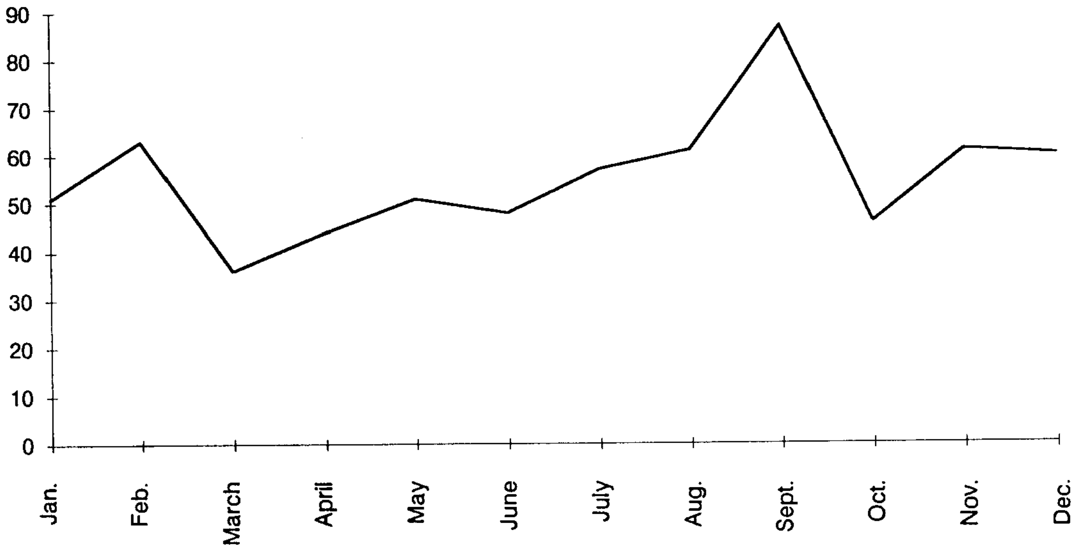

FIGURE 7. Month lost.

In the sail rig category, schooners comprise nearly 77 percent, a noteworthy predominance (Table 12). The next most frequent are sloops at 11 percent. The shallow sand bars of Texas are known to have restricted the size of ships entering port in the historic period, and this fact surely helps explain the numerical dominance of schooners and sloops in the sailing rig sample. Therefore, the dominance of smaller type vessel rigs is to be expected. Continuing the general size distribution, brigs are twice as common as barks (3.3%), which in turn out-number ships (.8%). In the steam propulsion category, side wheelers (44%) outnumber stern wheelers (12%) (Table 13). This relates to the very shallow nature of most Texas rivers, since side wheelers were considered better at forcing their way over sandbars. Also, ocean going steamers were, at first, side wheeled. Referring to vessel types, river steamboats are a relatively small part of the wreck population compared to the other types. In other areas of the country, where rivers were more amenable to navigation, one might expect a higher proportion of river steamboats. The flag or nation of origin (Table 14) is greatly dominated by U.S. vessels at 87 percent with less than 3 percent from any single foreign nation. Since a higher proportion of foreign vessels is to be expected because of a brisk international trade after the 1830s, this figure may be biased by the incomplete nature of the data.

CRM Variables

The following categories of data are interesting for purposes of cultural resource management. The body of water where each wreck occurred was recorded (Table 15). The biggest category is the Gulf of Mexico (away from an individual bay or river mouth) at 35 percent. Galveston Bay, always the most active area for shipping, is next at 17 percent. Brazos Santiago follows at 8 percent, revealing the high level of shipping at that port and the dangerous nature of the bars there. Brazos Santiago was very important during the Mexican War and the Civil War. During the 19th century, Indianola on Matagorda Bay was an important port, with the result that Matagorda Bay has almost 6 percent of the wrecks. The rivers, on the other hand, have relatively small percentages of wrecks, illustrating that the nature of the rivers and the difficulty of navigating them restricted traffic to levels lower than might be expected in other parts of the country.

Looking at the distribution of wrecks by county (Table 16) is an interesting exercise because the area of wreck occurrence is grouped in a different way from that coded by body of water. Galveston County (25%, the largest percentage) focuses attention on the Port of Galveston (Figure 1). In contrast to the previous coding by body of water, Galveston County includes parts of Galveston Bay, the bay entrance, and parts of the Gulf of Mexico. Upper Galveston Bay and areas closer to Houston (Harris County), as well as the mouth of the Trinity River (Chambers County), are excluded. At 17 percent, Cameron County comes second and includes the lower Laguna Madre, Brazos Santiago, the lower Rio Grande and its mouth, and the neighboring part of the Gulf of Mexico. The towns of Brownsville and Matamoros and their hinterlands are the focus of the shipping lost in Cameron County. A distant third place, at less than 7 percent, is Brazoria County with the mouth of the Brazos, the lower Brazos River, and neighboring parts of the Gulf of Mexico. Calhoun (5.8%) and Matagorda counties (6.8%) divide between them Pass Cavallo, Matagorda Bay, Indianola, parts of the Gulf of Mexico, and the lower Colorado River. Taken together, at 12.6 percent, they surpass Brazoria County. Nueces and Aransas counties divide between them Aransas Pass, Corpus Christi Bay, Aransas Bay, and Copano Bay.

The register table refers to those wrecks officially designated as State Archeological Landmarks (SALs) or National Register sites (Table 17). SALs are protected by the Texas Antiquities Code and include all wrecks dating before the 20th century. SALs are not available for commercial exploitation in Texas, although privately sponsored, bonafide archaeology is encouraged. Such projects are carried out under antiquities permits and all recovered artifacts remain in the public domain. Note that over 56 percent of the wrecks in Texas remain available for completely unrestricted access by the private sector.

The quality of the location data for each wreck is recorded in Table 18. The accuracy of the location is expressed as "exact" for those with actual coordinates or map references (leaving aside the issue of how accurate those may be); "located within a 1 sq. mi. area" for those with a reasonably accurate locational descrip-

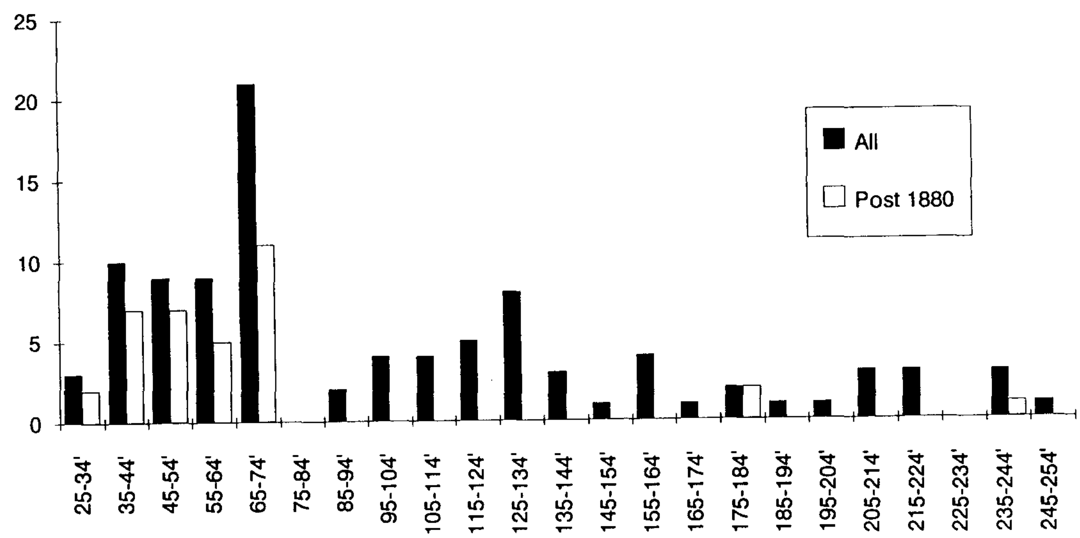

FIGURE 8. Length grouped by 10-ft. intervals.

tion; "located within a few square miles" for those assignable to a general area or a high-probability area such as that around the entrance to a bay; "not mappable" for locations that are too generally described for mapping. Using the system of mineral lease blocks is a handy compromise for the requirement to give public notice of wreck locations. By saying a given wreck is located only in a particular lease block, a balance is achieved in protecting the precise location information that, if published, might very well lead to the site's destruction. The Texas Antiquities Code exempts locational information on archaeological sites from the disclosure requirements of public records.

Conclusions

In this paper some of the interesting information yielded by the frequency counts on data in the Texas shipwreck file are summarized. When similar data from other states and regions are available, it will be possible to compare shipwreck samples. Further, more complex statistical analysis of the Texas data is also possible, and variables will be correlated. Another fruitful way to study this information is to employ computerized geographical information systems (GIS), which the larger state agencies are beginning to acquire. The Texas Antiquities Committee may be able to piggyback on one of those systems in the future. For the present, some quite interesting data trends are already revealed.

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TABLE 1
LENGTH

Length in Feet	Frequency	Percent	Valid Percent	Cum Percent
29	1	0.1	1.0	1.0
30	1	0.1	1.0	2.0
34	1	0.1	1.0	3.1
36	2	0.1	2.0	5.1
37	1	0.1	1.0	6.1
38	1	0.1	1.0	7.1
39	2	0.1	2.0	9.2
40	2	0.1	2.0	11.2
41	1	0.1	1.0	12.2
43	1	0.1	1.0	13.3
46	1	0.1	1.0	14.3
48	1	0.1	1.0	15.3
50	2	0.1	2.0	17.3
51	2	0.1	2.0	19.4
52	1	0.1	1.0	20.4
54	2	0.1	2.0	22.4
55	2	0.1	2.0	24.5
57	1	0.1	1.0	25.5
58	1	0.1	1.0	26.5
59	1	0.1	1.0	27.6
62	3	0.2	3.1	30.6
64	1	0.1	1.0	31.6
65	4	0.3	4.1	35.7
66	5	0.3	5.1	40.8
67	4	0.3	4.1	44.9
68	1	0.1	1.0	45.9
69	3	0.2	3.1	49.0
70	1	0.1	1.0	50.0
71	1	0.1	1.0	51.0
72	1	0.1	1.0	52.0
74	1	0.1	1.0	53.1
86	1	0.1	1.0	54.1
94	1	0.1	1.0	55.1
96	1	0.1	1.0	56.1
100	1	0.1	1.0	57.1
103	2	0.1	2.0	59.2
107	1	0.1	1.0	60.2
109	2	0.1	2.0	62.2
114	1	0.1	1.0	63.3
115	1	0.1	1.0	64.3
120	2	0.1	2.0	66.3
121	1	0.1	1.0	67.3
122	1	0.1	1.0	68.4
125	1	0.1	1.0	69.4
127	2	0.1	2.0	71.4
130	3	0.2	3.1	74.5
131	1	0.1	1.0	75.5
132	1	0.1	1.0	76.5
135	2	0.1	2.0	78.6
138	1	0.1	1.0	79.6
151	1	0.0	1.0	80.6
155	2	0.1	2.0	82.7
160	1	0.1	1.0	83.7
164	1	0.1	1.0	84.7
172	1	0.1	1.0	85.7
177	1	0.1	1.0	86.7
181	1	1.0	1.0	87.8
188	1	0.1	1.0	88.8
201	1	0.1	1.0	89.8
210	2	0.1	2.0	91.8
212	1	0.1	1.0	92.9
215	1	0.1	1.0	93.9
220	1	0.1	1.0	94.9
223	1	0.1	1.0	95.9
235	1	0.1	1.0	96.9
238	1	0.1	1.0	98.0
241	1	0.1	1.0	99.0
250	1	0.1	1.0	100.0
Unknown	1442	93.6	MISSING	
TOTAL	1540	100.0	100.0	

Valid Cases 98 Missing Cases 1442

TABLE 2
LENGTH GROUPED BY 10 FOOT INTERVALS

Length (10s)	Frequency	Percent	Valid Percent	Cum Percent
25 to 34 feet	3	0.2	3.1	3.1
35 to 44 feet	10	0.6	10.2	13.3
45 to 54 feet	9	0.6	9.2	22.4
55 to 64 feet	9	0.6	9.2	31.6
65 to 74 feet	21	1.4	21.4	53.1
85 to 94 feet	2	0.1	2.0	55.1
95 to 104 feet	4	0.3	4.1	59.2
105 to 114 feet	4	0.3	4.1	63.3
115 to 124 feet	5	0.3	5.1	68.4
125 to 134 feet	8	0.5	8.2	76.5
135 to 144 feet	3	0.2	3.1	79.6
145 to 154 feet	1	0.1	1.0	80.6
155 to 164 feet	4	0.3	4.1	84.7
165 to 174 feet	1	0.1	1.0	85.7
175 to 184 feet	2	0.1	2.0	87.8
185 to 194 feet	1	0.1	1.0	88.8
195 to 204 feet	1	0.1	1.0	89.8
205 to 214 feet	3	0.2	3.1	92.9
215 to 224 feet	3	0.2	3.1	95.9
235 to 244 feet	3	0.2	3.1	99.0
245 to 254 feet	1	0.1	1.0	100.0
Unknown	1442	93.6	MISSING	
TOTAL	1540	100.0	100.0	

Valid Cases 98 Missing Cases 1442

TABLE 3
BEAM

Beam in Feet	Frequency	Percent	Valid Percent	Cum Percent
9	1	0.1	1.3	1.3
10	1	0.1	1.3	2.5
11	2	0.1	2.5	5.0
12	1	0.1	1.3	6.3
13	1	0.1	1.3	7.5
14	2	0.1	2.5	10.0
15	1	0.1	1.3	11.3
16	1	0.1	1.3	12.5
17	4	0.3	5.0	17.5
18	9	0.6	11.3	28.8
19	7	0.5	8.8	37.5
20	5	0.3	6.3	43.8
21	7	0.5	8.8	52.5
22	4	0.3	5.0	57.5
23	4	0.3	5.0	62.5
24	2	0.1	2.5	65.0
25	1	0.1	1.3	66.3
26	7	0.5	8.8	75.0
27	1	0.1	1.3	76.3
28	2	0.1	2.5	78.8
29	2	0.1	2.5	81.3
30	3	0.2	3.8	85.0
31	2	0.1	2.5	87.5
32	2	0.1	2.5	90.0
33	1	0.1	1.3	91.3
34	1	0.1	1.3	92.5
35	2	0.1	2.5	95.0
36	2	0.1	2.5	97.5
40	2	0.1	2.5	100.0
Unknown	1460	94.8	MISSING	
TOTAL	1540	100.0	100.0	

Valid Cases 80 Missing Cases 1460

TABLE 4
BEAM GROUPED BY 2 FOOT INTERVALS

Beam (2s)	Frequency	Percent	Valid Percent	Cum Percent
8 to 9 feet	1	0.1	1.3	1.3
10 to 11 feet	3	0.2	3.8	5.0
12 to 13 feet	2	0.1	2.5	7.5
14 to 15 feet	3	0.2	3.8	11.3
16 to 17 feet	5	0.3	6.3	17.5
18 to 19 feet	16	1.0	20.0	37.5
20 to 21 feet	12	0.8	15.0	52.5
22 to 23 feet	8	0.5	10.0	62.5
24 to 25 feet	3	0.2	3.8	66.3
26 to 27 feet	8	0.5	10.0	76.3
28 to 29 feet	4	0.3	5.0	81.3
30 to 31 feet	5	0.3	6.3	87.5
32 to 33 feet	3	0.2	3.8	91.3
34 to 35 feet	3	0.2	3.8	95.0
36 to 37 feet	2	0.1	2.5	97.5
40 to 41 feet	2	0.1	2.5	100.0
Unknown	1460	94.8	MISSING	
TOTAL	1540	100.0	100.0	

Valid Cases 80 Missing Cases 1460

TABLE 5
DEPTH OF HOLD

Value in Feet	Frequency	Percent	Valid Percent	Cum Percent
2	1	0.1	1.4	1.4
3	5	0.3	7.1	8.6
4	8	0.5	11.4	20.0
5	9	0.6	12.9	32.9
6	11	0.7	15.7	48.6
7	6	0.4	8.6	57.1
8	10	0.6	14.3	71.4
9	6	0.4	8.6	80.0
10	7	0.5	10.0	90.0
11	1	0.1	1.4	91.4
12	1	0.1	1.4	92.9
13	1	0.1	1.4	94.3
16	1	0.1	1.4	95.7
17	1	0.1	1.4	97.1
18	1	0.1	1.4	98.6
19	1	0.1	1.4	100.0
Unknown	1470	95.4	MISSING	
TOTAL	1540	100.0	100.0	

Valid Cases 70 Missing Cases 1470

TABLE 6
TONNAGE GROUPED BY 10 TON INTERVALS

Tonnage (10s)	Frequency	Percent	Valid Percent	Cum Percent
<10	13	0.8	2.3	2.3
10	34	2.2	6.1	8.4
20	22	1.4	3.9	12.4
30	22	1.4	3.9	16.3
40	18	1.2	3.2	19.6
50	63	4.1	11.3	30.9
60	69	4.5	12.4	43.3
70	39	2.5	7.0	50.3
80	15	1.0	2.7	53.0
90	24	1.6	4.3	57.3
100	16	1.0	2.9	60.1
110	11	0.7	2.0	62.1
120	10	0.6	1.8	63.9
130	15	1.0	2.7	66.6
140	8	0.5	1.4	68.0
150	3	0.2	0.5	68.6
160	7	0.5	1.3	69.8
170	11	0.7	2.0	71.8
180	9	0.6	1.6	73.4
190	7	0.5	1.3	74.7
200	6	0.4	1.1	75.8
220	5	0.3	0.9	76.7
230	9	0.6	1.6	78.3
240	7	0.5	1.3	79.5
250	5	0.3	0.9	80.4
260	6	0.4	1.1	81.5
270	8	0.5	1.4	82.9
280	2	0.1	0.4	83.3
290	2	0.1	0.4	83.7
300	4	0.3	0.7	84.4
310	1	0.1	0.2	84.6
320	5	0.3	0.9	85.5
330	3	0.2	0.5	86.0
340	1	0.1	0.2	86.2
350	2	0.1	0.4	86.5
360	2	0.1	0.4	86.9
380	5	0.3	0.9	87.8
390	5	0.3	0.9	88.7
400	2	0.1	0.4	89.0
420	1	0.1	0.2	89.2
440	1	0.1	0.2	89.4
450	1	0.1	0.2	89.6
480	2	0.1	0.4	89.9
510	5	0.3	0.9	90.8
530	1	0.1	0.2	91.0
540	3	0.2	0.5	91.6
550	4	0.3	0.7	92.3
560	2	0.1	0.4	92.6
580	2	0.1	0.4	93.0
590	1	0.1	0.2	93.2
610	1	0.1	0.2	93.4
640	2	0.1	0.4	93.7
670	2	0.1	0.4	94.1
700	1	0.1	0.2	94.3
730	1	0.1	0.2	94.4
740	1	0.1	0.2	94.6
800	1	0.1	0.2	94.8
820	2	0.1	0.4	95.2
830	1	0.1	0.2	95.3
880	1	0.1	0.2	95.5
890	3	0.2	0.5	96.1
930	1	0.1	0.2	96.2
940	2	0.1	0.4	96.6
960	2	0.1	0.4	96.9
1070	1	0.1	0.2	97.1
1100	1	0.1	0.2	97.3
1120	1	0.1	0.2	97.5
1150	3	0.2	0.5	98.0
1220	1	0.1	0.2	98.2
1250	2	0.1	0.4	98.6
1280	1	0.1	0.2	98.7
1370	1	0.1	0.2	98.9
1480	1	0.1	0.2	99.1
1510	1	0.1	0.2	99.3
1560	2	0.1	0.4	99.6
1740	1	0.1	0.2	99.8
1900	1	0.1	0.2	100.0
Unknown	983	63.8	61.9	MISSING
TOTAL	1540	100.0	100.0	

Valid Cases 557 Missing Cases 983

TABLE 7
TONNAGE GROUPED BY 100 TON INTERVALS

Tonnage (100s)	Frequency	Percent	Valid Percent	Cum Percent
< 100 tons	319	20.7	57.3	57.3
100 to 199 tons	97	6.3	17.4	74.7
200 to 299 tons	50	3.2	9.0	83.7
300 to 399 tons	28	1.8	5.0	88.7
400 to 499 tons	7	0.5	1.3	89.9
500 to 599 tons	18	1.2	3.2	93.2
600 to 699 tons	5	0.3	0.9	94.1
700 to 799 tons	3	0.2	0.5	94.6
800 to 899 tons	8	0.5	1.4	96.1
900 to 999 tons	5	0.3	0.9	96.9
1000 to 1099 ton	1	0.1	0.2	97.1
1100 to 1199 ton	5	0.3	0.9	98.0
1200 to 1299 ton	4	0.3	0.7	98.7
1300 to 1399 ton	1	0.1	0.2	98.9
1400 to 1499 ton	1	0.1	0.2	99.1
1500 to 1599 ton	3	0.2	0.5	99.6
1700 to 1799 ton	1	0.1	0.2	99.8
1900 to 1999 ton	1	0.1	0.2	100.0
Unknown	983	63.8	MISSING	
TOTAL	1540	100.0	100.0	

Valid Cases 557 Missing Cases 983

TABLE 8
LOSSES GROUPED BY DECADE

Decade	Frequency	Percent	Valid Percent	Cum Percent
1520s	1	0.1	0.1	0.1
1550s	5	0.3	0.4	0.5
1560s	1	0.1	0.1	0.5
1630s	1	0.1	0.1	0.6
1680s	2	0.1	0.2	0.8
1740s	1	0.1	0.1	0.8
1750s	1	0.1	0.1	0.9
1760s	9	0.6	0.7	1.6
1770s	7	0.5	0.5	2.1
1780s	1	0.1	0.1	2.2
1800s	1	0.1	0.1	2.3
1810s	19	1.2	1.4	3.7
1820s	7	0.5	0.5	4.3
1830s	66	4.3	5.0	9.3
1840s	74	4.8	5.6	14.9
1850s	67	4.4	5.1	20.0
1860s	150	9.7	11.4	31.4
1870s	113	7.3	8.6	40.0
1880s	76	4.9	5.8	45.8
1890s	45	2.9	3.4	49.2
1900s	27	1.8	2.1	51.3
1910s	62	4.0	4.7	56.0
1920s	38	2.5	2.9	58.9
1930s	21	1.4	1.6	60.5
1940s	28	1.8	2.1	62.6
1950s	90	5.8	6.8	69.5
1960s	125	8.1	9.5	79.0
1970s	274	17.8	20.9	99.8
1980s	2	0.1	0.2	100.0
Unknown	226	14.7	MISSING	
TOTAL	1540	100.0	100.0	

Valid Cases 1314 Missing Cases 226

TABLE 9
LOSSES GROUPED BY MONTH

Month	Frequency	Percent	Valid Percent	Cum Percent
January	51	3.3	7.7	7.7
February	63	4.1	9.5	17.1
March	36	2.3	5.4	22.6
April	44	2.9	6.6	29.2
May	51	3.3	7.7	36.8
June	48	3.1	7.2	44.1
July	57	3.7	8.6	52.6
August	61	4.0	9.2	61.8
September	87	5.6	13.1	74.9
October	46	3.0	6.9	81.8
November	61	4.0	9.2	91.0
December	60	3.9	9.0	100.0
Unknown	875	56.8	MISSING	
TOTAL	1540	100.0	100.0	

Valid Cases 665 Missing Cases 875

TABLE 10
TYPE OF VESSEL

Type	Frequency	Percent	Valid Percent	Cum Percent
barge	33	2.1	4.8	4.8
tug	5	0.3	0.7	5.5
dredge	5	0.3	0.7	6.2
freighter	8	0.5	1.2	7.4
tanker	4	0.3	0.6	7.9
ferry	1	0.1	0.1	8.1
yacht	10	0.6	1.4	9.5
trawler	29	1.9	4.2	13.7
river steamboat	113	7.3	16.3	30.1
naval vessel	24	1.6	3.5	33.5
merchant sail	312	20.3	45.1	78.6
merchant sail-st	105	6.8	15.2	93.8
flatboat	2	0.1	0.3	94.1
nao	3	0.2	0.4	94.5
galleon	2	0.1	0.3	94.8
packet	1	0.1	0.1	94.9
passerger	1	0.1	0.1	95.1
freight-passenge	21	1.4	3.0	98.1
pilot boat	1	0.1	0.1	98.3
lighter	12	0.8	1.7	100.0
unknown	848	55.1	MISSING	
TOTAL	1540	100.0	100.0	

Valid Cases 692 Missing Cases 848

TABLE 11
CAUSE OF LOSS

Cause	Frequency	Percent	Valid Percent	Cum Percent
storm	83	5.4	14.2	14.2
stranding	103	6.7	17.6	31.7
battle	46	3.0	7.8	39.6
collision	26	1.7	4.4	44.0
fire	129	8.4	22.0	66.0
explosion	13	0.8	2.2	68.3
scuttled	12	0.8	2.0	70.3
other accident	19	1.2	3.2	73.5
foundered	132	8.6	22.5	96.1
snagged	23	1.5	3.9	100.0
unknown	954	61.9	MISSING	
TOTAL	1540	100.0	100.0	

Valid Cases 586 Missing Cases 954

TABLE 12
SAIL RIG

Sail Rig	Frequency	Percent	Valid Percent	Cum Percent
bark	12	0.8	3.3	3.3
brig	28	1.8	7.6	10.9
barkentine	1	0.1	0.3	11.2
ship	3	0.2	0.8	12.0
schooner	282	18.3	76.8	88.8
sloop	41	2.7	11.2	100.0
unknown	1173	76.2	MISSING	
TOTAL	1540	100.0	100.0	

Valid Cases 367 Missing Cases 1173

TABLE 13
STEAM RIG

Steam Rig	Frequency	Percent	Valid Percent	Cum Percent
steam type unkn	56	3.6	23.5	23.5
steamer, screw	48	3.1	20.2	43.7
steamer, side wh	105	6.8	44.1	87.8
steamer, stern w	29	1.9	12.2	100.0
unknown	1302	84.5	MISSING	
TOTAL	1540	100.0	100.0	

Valid Cases 238 Missing Cases 1302

TABLE 14
FLAG

Flag	Frequency	Percent	Valid Percent	Cum Percent
U.S.A.	624	40.5	86.7	86.7
Spain	18	1.2	2.5	89.2
France	15	1.0	2.1	91.3
Great Britain	12	0.8	1.7	92.9
Republic of Tex	16	1.0	2.2	95.1
Mexico	5	0.3	0.7	95.8
C.S.A.	26	1.7	3.6	99.4
Norway	4	0.3	0.6	100.0
Unknown	820	53.2	MISSING	
TOTAL	1540	100.0	100.0	

Valid Cases 720 Missing Cases 820

TABLE 15
BODY OF WATER

Body of Water	Frequency	Percent	Valid Percent	Cum Percent
Gulf of Mexico	548	35.6	36.1	36.1
Sabine Lake	12	0.8	0.8	36.9
Galveston Bay	258	16.8	17.0	53.9
West Bay	14	0.9	0.9	54.8
Oyster Bay	9	0.6	0.6	55.4
Espiritu Santo B	2	0.1	0.1	55.5
Matagorda Bay	90	5.8	5.9	61.5
San Antonio Ba	12	0.8	0.8	62.3
Copano Bay	3	0.2	0.2	62.5
Aransas Bay	24	1.6	1.6	64.0
Nueces Bay	1	0.1	0.1	64.1
Corpus Chrisi B	20	1.3	1.3	65.4
Laguna Madre	13	0.8	0.9	66.3
Sabine Pass	17	1.1	1.1	67.4
Galveston Bay E	20	1.3	1.3	68.7
San Luis Pass	16	1.0	1.1	69.8
Mouth of Brazo	21	1.4	1.4	71.1
Pass Cavallo	38	2.5	2.5	73.6
Aransas Pass	34	2.2	2.2	75.9
Mansfield Cut	4	0.3	0.3	76.2
Brazos Santiago	125	8.1	8.2	84.4
Mouth of Rio G	52	3.4	3.4	87.8
Red River	1	0.1	0.1	87.9
Brazos River	14	0.9	0.9	88.8
Colorado River	2	0.1	0.1	88.9
Rio Grande	40	2.6	2.6	91.6
Nueces River	2	0.1	0.1	91.7
Guadalupe Rive	1	0.1	0.1	91.8
Lavaca River	1	0.1	0.1	91.8
San Jacinto Rive	3	0.2	0.2	92.0
Trinity River	41	2.7	2.7	94.7
Sabine River	34	2.2	2.2	97.0
Cypress Bayou	1	0.1	0.1	97.0
Buffalo Bayou	11	0.7	0.7	97.8
Trinity Bay	3	0.2	0.2	98.0
Chocolate Bay	2	0.1	0.1	98.1
San Bernard Riv	5	0.3	0.3	98.4
Lavaca Bay	4	0.3	0.3	98.7
Houston Ship Ch	16	1.0	1.1	99.7
Intracoastal Wat	4	0.3	0.3	100.0
Unknown	22	1.4	MISSING	
TOTAL	1540	100.0	100.0	

Valid Cases 1518 Missing Cases 22

TABLE 16
COUNTY

County	Frequency	Percent	Valid Percent	Cum Percent
Anderson	1	0.1	0.1	0.1
Aransas	60	3.9	3.9	4.0
Austin	3	0.2	0.2	4.2
Brazoria	103	6.7	6.7	10.9
Cameron	264	17.1	17.2	28.1
Chambers	69	4.5	4.5	32.6
Calhoun	89	5.8	5.8	38.4
Ellis	1	0.1	0.1	38.4
Fayette	1	0.1	0.1	38.5
Offshore, genera	171	11.1	11.1	49.6
Galveston	389	25.3	25.3	75.0
Hidalgo	3	0.2	0.2	75.2
Harris	43	2.8	2.8	78.0
Jefferson	75	4.9	4.9	82.9
Jackson	1	0.1	0.1	82.9
Kleberg	5	0.3	0.3	83.3
Kenedy	18	1.2	1.2	84.4
Liberty	6	0.4	0.4	84.8
Matagorda	104	6.8	6.8	91.6
Marion	1	0.1	0.1	91.7
Nueces	74	4.8	4.8	96.5
Newton	1	0.1	0.1	96.5
Orange	24	1.6	1.6	98.1
Red River	1	0.1	0.1	98.2
Starr	2	0.1	0.1	98.3
Travis	1	0.1	0.1	98.4
Walker	2	0.1	0.1	98.5
Willacy	23	1.5	1.5	100.0
Unknown	5	0.3	MISSING	
TOTAL	1540	100.0	100.0	

Valid Cases 1535 Missing Cases 5

TABLE 17
SITE REGISTRATION

Registration	Frequency	Percent	Valid Percent	Cum Percent
None	870	56.5	56.5	56.5
St Arch Lndmrk	666	43.2	43.2	99.7
Ntl Register & S	4	0.3	0.3	100.0
TOTAL	1540	100.0	100.0	

Valid Cases 1540 Missing Cases 0

TABLE 18
QUALITY OF LOCATION DATA

Location	Frequency	Percent	Valid Percent	Cum Percent
Not mappable	418	27.1	27.1	27.5
Exact location	660	42.9	42.9	70.3
Within 1 sq mi	148	9.6	9.6	79.9
Within > 1 sq m	309	20.1	20.1	100.0
TOTAL	1540	100.0	100.0	

Valid Cases 1540 Missing Cases 0

TABLE 19

CROSSTABULATION OF VESSEL LENGTH GROUPED BY
10 FOOT INTERVALS BY LOSSES GROUPED BY DECADE

DECADE -> LENGTH	1520s	1680s	1830s	1840s	1850s	1860s	1870s	1880s	1890s	1910s	1950s	1960s	1970s	Row Total	
25 to 34 feet								2						2	2.2
35 to 44 feet	1							1				3	3	8	9.0
45 to 54 feet		1				1		1	1		1	3	1	9	10.1
55 to 64 feet						2			1			4		7	7.9
65 to 74 feet			1			5			2			4	5	17	19.1
85 to 94 feet						2								2	2.2
95 to 104 feet				1		1	2							4	4.5
105 to 114 feet					1	1	2							4	4.5
115 to 124 feet			2	1		2								5	5.6
125 to 134 feet					1	4	3							8	9.0
135 to 144 feet				1		1	1							3	3.4
145 to 154 feet						1								1	1.1
155 to 164 feet					1	2	1							4	4.5
165 to 174 feet						1								1	1.1
175 to 184 feet										2				2	2.2
185 to 194 feet					1									1	1.1
195 to 204 feet				1										1	1.1
205 to 214 feet						3								3	3.4
215 to 224 feet					1	2								3	3.4
235 to 244 feet						1	1	1						3	3.4
245 to 254 feet						1								1	1.1
Column	1	1	3	4	5	30	10	5	4	2	1	14	9	89	
Total	1.1	1.1	3.4	4.5	5.6	33.7	11.2	5.6	4.5	2.2	1.1	15.7	10.1	100.0	

Number of Missing Observations = 1451

TABLE 20

CROSSTABULATION OF VESSEL TONNAGE GROUPED BY

10 TON INTERVALS BY LOSSES GROUPED BY DECADE

DECADE -> TONNAGE (10S)	1680s	1830s	1840s	1850s	1860s	1870s	1880s	1890s	1900s	1910s	1920s	1930s	1940s	1950s	1960s	1970s	Row Total	
Less than 10 tons					2	5	4		1								12	2.2
10 to 19 tons					2	10	6	7	3	2					3	1	34	6.1
20 to 29 tons					5	5	2	8	2								22	4.0
30 to 39 tons		1				7	7	3	2	1					1		22	4.0
40 to 49 tons				1	3	5	3	3						1	1	1	18	3.2
50 to 59 tons				1	2	4	1		4	6	1	2	3	22	17		63	11.4
60 to 69 tons			1		3		2			2			3	24	33		68	12.3
70 to 79 tons			1	2	4		2			3	1	1		10	13	2	39	7.0
80 to 89 tons		3	2	2			2	1		1				1	3		15	2.7
90 to 99 tons			4	3	5	3				2	1	1	1		1	2	23	4.2
100 to 109 tons			5	1	1		2			1				3	3		16	2.9
110 to 119 tons			3	2		2	1			2				1			11	2.0
120 to 129 tons		1	2		5	1							1				10	1.8
130 to 139 tons		1	4	3	2	1								3	1		15	2.7
140 to 149 tons		1	1		2					1				1	2		8	1.4
150 to 159 tons				1	1									1			3	0.5
160 to 169 tons				3	1	1	1		1								7	1.3
170 to 179 tons		1	2	1	3	2							1		1		11	2.0
180 to 189 tons		1		2	2	2				1				1			9	1.6
190 to 199 tons			1		2	1				1			1		1		7	1.3
200 to 209 tons					2	1	1						1		1		6	1.1
220 to 229 tons			1		1	1								2			5	0.9
230 to 239 tons			1		2					4		2					9	1.6
240 to 249 tons				3	1	1		1	1								7	1.3

250 to 259 tons				1		1	1			2						5	0.9
260 to 269 tons		1		1		2			1	1						6	1.1
270 to 279 tons				1	2	1				2			2			8	1.4
280 to 289 tons							1			1						2	0.4
290 to 299 tons			1							1						2	0.4
300 to 309 tons	1		1		1					1						4	0.7
310 to 319 tons				1												1	0.2
320 to 329 tons			1		3					1						5	0.9
330 to 339 tons			1				1			1						3	0.5
340 to 349 tons					1											1	0.2
350 to 359 tons									1				1			2	0.4
360 to 369 tons			1		1											2	0.4
380 to 389 tons						1	1		1	2						5	0.9
390 to 399 tons					2	2				1						5	0.9
400 to 409 tons							1						1			2	0.4
420 to 429 tons											1					1	0.2
440 to 449 tons							1									1	0.2
450 to 459 tons					1											1	0.2
480 to 489 tons				1									1			2	0.4
510 to 519 tons					3				1	1						5	0.9
530 to 539 tons				1												1	0.2
540 to 549 tons				1						1	1					3	0.5
550 to 559 tons							1		1	1	1					4	0.7
560 to 569 tons		1	1													2	0.4
580 to 589 tons										1					1	2	0.4
590 to 599 tons					1											1	0.2
610 to 619 tons					1											1	0.2
640 to 649 tons											2					2	0.4
670 to 679 tons					1		1									2	0.4
700 to 709 tons													1			1	0.2
730 to 739 tons					1											1	0.2
740 to 749 tons			1													1	0.2

800 to 809 tons					1												1	0.2
820 to 829 tons				1		1											2	0.4
830 to 839 tons										1							1	0.2
880 to 889 tons										1							1	0.2
890 to 899 tons				1	2												3	0.5
930 to 939 tons					1												1	0.2
940 to 949 tons				1					1								2	0.4
960 to 969 tons						1		1									2	0.4
1070 to 1079 tons									1								1	0.2
1100 to 1109 tons											1						1	0.2
1120 to 1129 tons					1												1	0.2
1150 to 1159 tons							1				2						3	0.5
1220 to 1229 tons										1							1	0.2
1250 to 1259 tons				1	1												2	0.4
1280 to 1289 tons							1										1	0.2
1370 to 1379 tons				1													1	0.2
1480 to 1489 tons						1											1	0.2
1510 to 1519 tons										1							1	0.2
1560 to 1569 tons											2						2	0.4
1740 to 1749 tons										1							1	0.2
1900 to 1909 tons											1						1	0.2
Column	1	11	35	37	75	62	44	24	21	49	14	6	17	71	81.0	6	554	
Total	0.2	2	6.3	6.7	13.5	11.2	7.9	4.3	3.8	8.8	2.5	1.1	12.8	12.8	14.6	1.1	100.0	

Number of Missing Observatoins = 986

HERBERT D. BUMP
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Artifacts Lost, Artifacts Conserved

There are many hundreds of shipwrecks recorded off the Florida coast, and each wreck may contain several thousand artifacts. These artifacts range from very small simple items, such as a nail, to very large complex artifacts incorporating thousands of component parts, such as a battle ship. If a conservation laboratory could process one artifact every hour (it takes longer of course), it would take centuries to treat them all. If terrestrial artifacts are added, both historical and archaeological, it becomes obvious that only the most archaeologically or politically important materials can be accepted for treatment.

To illustrate this problem even further, Colin Pearson has estimated that one month's intensive excavation will produce one year's conservation work. Those experienced in artifact conservation agree that this statement is accurate, yet archaeologists rarely consider how many artifacts the laboratory can treat (Figure 1).

The corrosion of metals has been studied for decades throughout the world. Much has been learned about metals in their relation to one another and to the environment in which they are located. The complex kinetic energy within a metal and the rate that energy is released is the mechanism that drives corrosion. The complexities of corrosion underwater or in wet archaeological settings adds further difficulty to any explanation of corrosion in artifacts.

There are various kinds of corrosion. The

FIGURE 1.

type depends on the materials involved, their physical properties, and the surrounding media. There are two major types that need some discussion in order to understand the importance of what is taking place. The first type of corrosion is best illustrated by the basic corrosion cell. A corrosion cell is created by an electrochemical process in which there is a flow of current between two different metallic areas, the anode and the cathode. The anode is consumed, while the cathode remains unchanged. The second type of corrosion is intergranular corrosion which will crack the metal and cause exfoliation and eventually cause large segments to fall off. Intergranular corrosion is defined as preferential corrosion at or adjacent to the grain boundaries of a metal or alloy. It can be extensive in archaeological metals and lead to structural weakness.

When any non-noble metal is left exposed to the elements, the laws of thermodynamics state that it will have a tendency to return to its original low energy state. In other words the metal will return to the oxides, e.g. iron oxide (rust), from which the material was derived. This return to a low energy state (oxidation) is typically what happens when no conservation treatments are provided for artifacts recovered from wet environments.

Corrosion and the resulting related problems it causes in historic structures and artifacts are often not recognized before serious damage has already occurred. This condition prevails not always because of neglect but because the people charged with maintenance are not trained to recognize these problems. They have a high degree of interest in the materials with which they are entrusted, but the information is often not available to advise them of the problems and inform them of whom they can contact to solve the of-

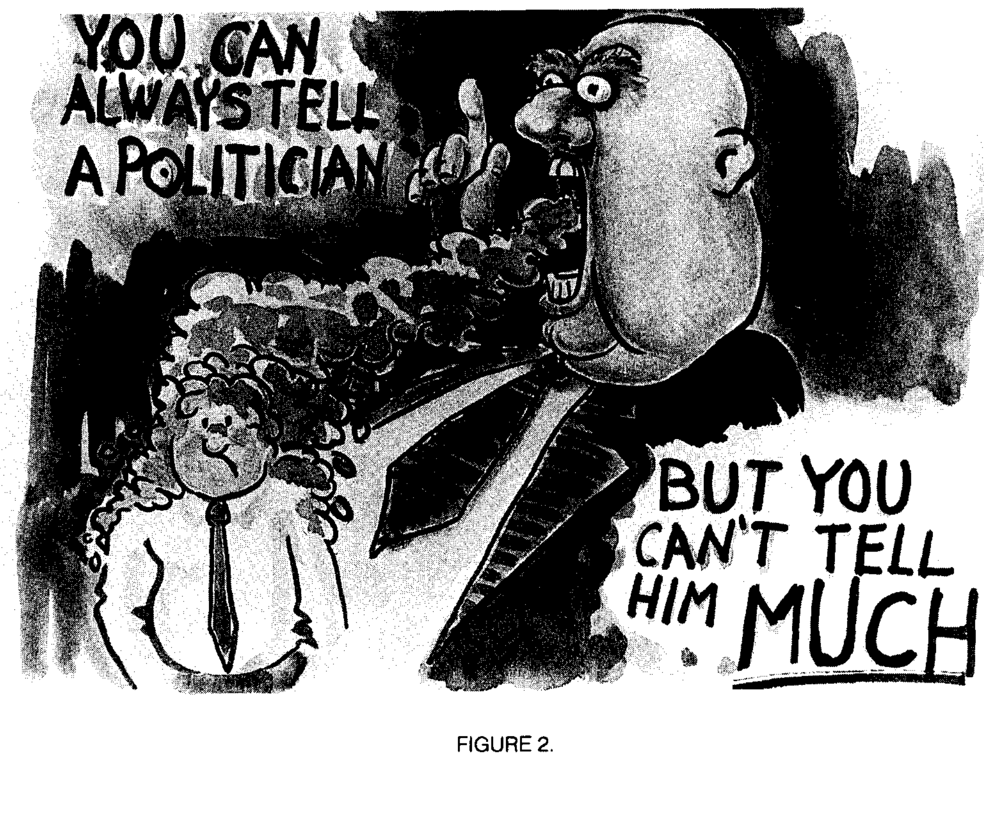

FIGURE 2.

ten complex conservation requirements. Yet the sooner these individuals can identify problems, the easier and less costly they are to correct.

State and federal agencies possess many, if not the majority, of the valuable artifacts recovered in the United States, yet the people that actually care for and maintain these materials are for the most part trained in fields not related to the science of conservation. It would be nice if all artifacts were well cared for, but this is rarely the case.

Most government systems have a very long chain of command and this chain, plus the logistics involved with most administrative procedures, is not conducive to quick response (Figure 2). Often, minor problems remain unknown to the heads of government agencies. These minor problems then become major ones before anyone of authority is aware of them.

One needs to look at why these conditions prevail in order to correct them. Corrosion and other related problems occur over a long period of time and often go unnoticed or untreated. For example, the average park superintendent changes location approximately every five years. Problems often go unreported because during any given period of time there may be no perceptible change in the condition of the artifact. In addition, many of the management's plans and budgets are set up biannually. This fact

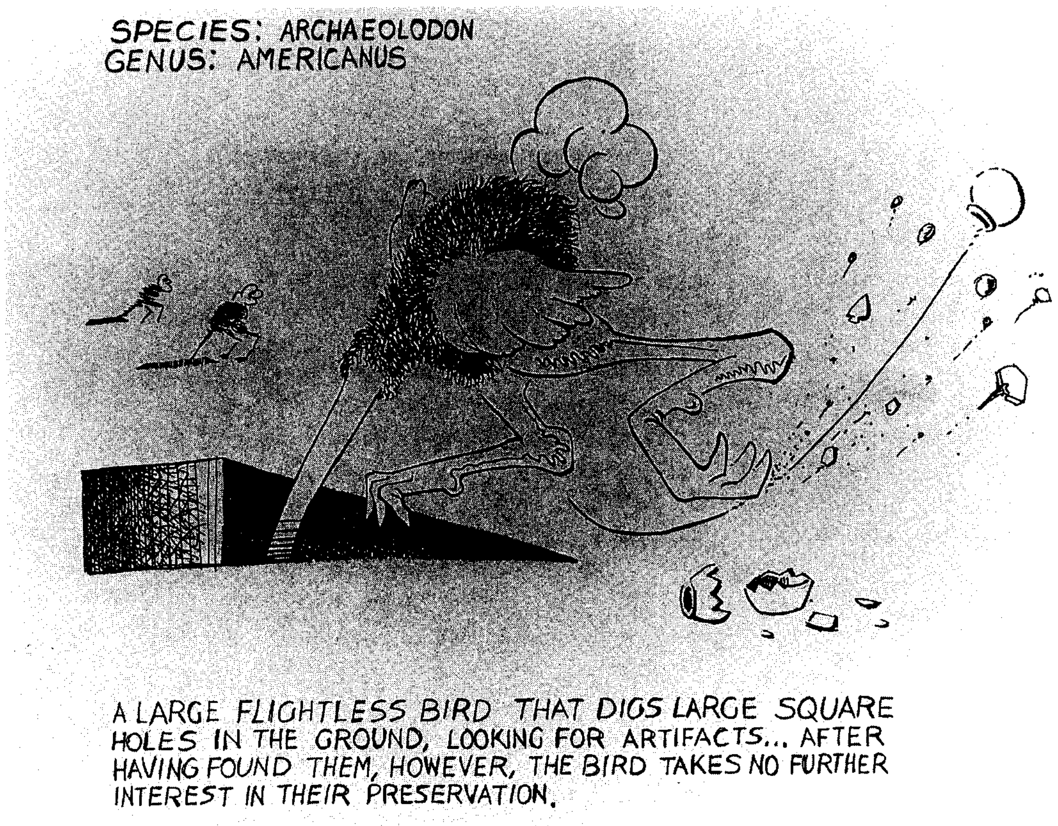

FIGURE 3.

poses a serious problem in that immediate needs cannot be addressed and often must be budgeted for treatment one to two years in the future. By that time, the artifact's condition has deteriorated, sometimes beyond repair or restoration.

Problems built into timely budget procedures and high manpower turnover tend to prevent any continuous program of preservation. Even after severe corrosion has been identified, it receives very low priority in many cases. Additionally, there is a lack of technical understanding of the conservation problems by those in administrative and planning positions. Those in charge of maintaining artifacts and historic structures often lack the technical ability to recognize signs of deterioration. The conservation laboratory is often called upon to perform its special magic only after the artifact has been allowed to reach a severe state of decomposition. Artifacts selected for conservation may be extremely fragile, thus limiting the laboratory's ability to effectively deal with all the various types of corrosion products. Most modern materials would simply be thrown away if allowed to reach the advanced state of decay typical of such artifacts. Often when conservation needs are compared to the conservation facilities available, the shortcomings become apparent.

Conclusion

It would seem that far too little importance is placed on the artifacts that derive from historical and archaeological sites. It is doubtful that one person out of a million reads even one archaeological report in a lifetime. On the other hand, most everyone sees artifacts in museums many times in his or her life. With this comparison in mind, it seems that our priorities are somewhat confused. It seems logical that we should be putting as much effort into conservation of artifacts as we are into archaeological recovery and documentation (Figure 3).

The National Association of Corrosion Engineers (Houston, Texas) has a subcommittee composed of experts who can assist in solving corrosion problems on artifacts and historic works of art. The American Institute of Conservation (Washington, D.C.) and the International Institute for Conservation of Historic and Artistic Works (London, England) also have a reference network to assist in disseminating conservation and restoration technology.

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Surveys and Site Reports

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Brodie's Wharf: Maritime Archaeological Investigations of an Early Eighteenth-Century Sunken Caisson at the Pensacola Naval Air Station, Florida

In November 1990, dredging operations at the Naval Air Station in Pensacola, Florida, were being conducted adjacent to the newly refurbished "Old Lexington" carrier pier. During dredging, a wooden structure of unknown identity was encountered. Work was halted and the Mobile District of the U.S. Army Corps of Engineers was notified of the find. The Corps subsequently contacted Panamerican Consultants of Tuscaloosa, Alabama, to perform an archaeological assessment of the structure. Inwater and archival research succeeded in identifying the wooden structure as the remains of a caisson sunk at the Navy Yard during its early history (Mistovich, Agranat, and James 1991). The discovery of this caisson was to cause numerous delays and cost overruns in the completion of the carrier pier, but this was in keeping with the history of the caisson, a structure that would vex four commandants and likely contribute to the untimely death of one of them.

The Pensacola Navy Yard was established in 1825 when the United States Navy abandoned the Naval Depot at what is today known as Key West. The station at Pensacola became the new base for the West India Squadron, charged with the protection of commerce and the suppression of piracy in the West Indies and Gulf of Mexico.

Early on, the Navy recognized Pensacola's suitability as a base for the repair and supply of vessels. The bay was accessible at low water to the largest of the Navy's sloops-of-war, and it offered locations suitable for the construction, repair, and launching of vessels, as well as for docks and dockyards (U.S. Congress, Senate, 1836:808).

Embracing the gradual improvement of the U.S. Navy, Congress passed the Act of March 3, 1827, which included provisions to assess the practicality of constructing a marine railway and ship repair facility at Pensacola. Upon completion of the assessment, recommendations were made for the locations of the railway and a wharf (U.S. Congress, House [USCH] 1830:580-581).

During a visit to the nation's capital toward the close of 1831, Captain Alexander Dallas, Commandant of the Navy Yard, received authorization from the Navy Commissioners to begin construction on the wharf, the completion of which had been estimated to cost $27,000. Upon his return, Captain Dallas was presented with a modified wharf plan developed by Charles Brodie, naval constructor at the Pensacola Yard. Brodie envisioned

> "a stone wharf 150 ft. long--33 ft. wide at the base and 37 ft. deep...seated on the bed of the Bay in thirty-seven feet of water...and having for its foundations a bed of logs 150 feet long and 35 feet wide, which will prevent in a great degree any settlement, and may of course be considered permanent" (U.S. Congress, Report of the Secretary of the Navy [USCRSN] 1832).

Although Brodie would have preferred a wider structure, he was limited by the maximum 35-ft. length of foundation logs already procured. Brodie planned to build a structure that would serve not only to heave vessels down for inspection and repair but also to buffer them from heavy winds and seas.

With construction authorized in February 1832, Captain Dallas requested over 5000 sheets

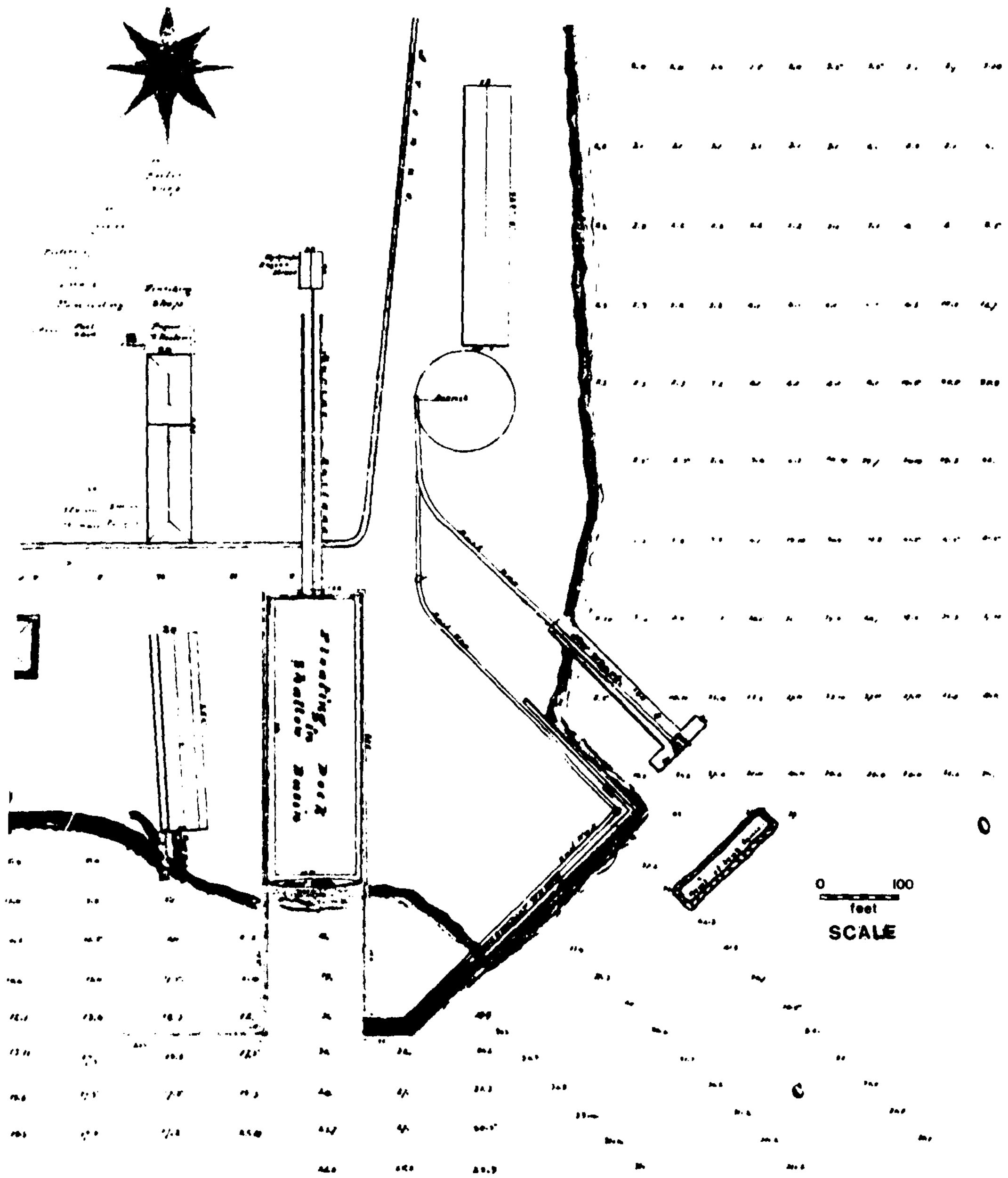

FIGURE 1. Map of the Navy Yard, Pensacola, 1853, showing the location of the "Sunk Caisson."

of 14 oz. copper. Because 14 oz. copper was not a standard weight, it had to be manufactured especially for the wharf construction. This difficulty in obtaining copper was the first of many supply and labor related problems to plague Brodie's wharf. In November of 1832, Dallas reported that the cofferdam had seven tiers of logs laid down and was ready for coppering before launching. After its launching it would be built up tier by tier, coppering as they went, with stone and hydraulic cement being placed into its interior to help sink it, as well as to form the wharf itself. Slaves and paid workers steadily built the caisson, but labor and material shortages hampered its construction. By October of 1833, 29 ft. of the 37-ft.-high caisson walls were on and bolted, 27 ft. were caulked, and 23 were coppered. Despite the fact that the wharf was now $50,000 over its original budget of $27,000, the Navy no doubt concluded that it had too much money invested in the project to give it up and requested an additional appropriation of $12,000 towards its completion for 1834.

In July of 1834 a new commandant, Captain Wolcott Chauncey, vigorously determined to finish the wharf. But labor and material shortages increased. By November 1834, with more than 80 men assigned to the wharf, Chauncey became disheartened. The Army Engineers had hired away his best laborers, and the cofferdam was subject to flooding and starting to sink. During the first two weeks in December of 1834, 96 men were employed on the wharf, and yet Chauncey reported: "I have found great difficulty, even by pumping night and day, to keep the water inside below the mason work" (USCRSN 1834). The water level inside the dam was only 13 ft. below that of the bay. With the structure already down in the mud 18 in. on the southwestern end and resting on the bottom at the northeastern end, Chauncey feared that the water might overflow the work, causing it to settle so unequally that the walls would break.

By the summer of 1835, Chauncey began to suspect that Brodie's original wharf design was inherently flawed. During July, Chauncey announced plans to make one more attempt at pumping out the caisson. After six days of round-the-clock pumping, work stopped with the water level inside the caisson 12 ft. above the stone work. Chauncey postponed any further attempts to pump out the dam, and no doubt weakened by the constant and prolonged strain of the wharf fiasco, he was taken ill with fever and succumbed to "dropsy of the brain."

In 1836, Captain Bolton was appointed to command the yard. He immediately described the wharf as "a deformity and encumbrance" and refused to allow anyone near it. He wrote to the Navy Commissioners that he would consider it a "lucky event" if a hurricane would sweep it away. On November 9, Bolton got his wish when a hurricane struck Pensacola and caved in the caisson's seaward side. An inspection committee recommended salvaging as much of the copper and ironwork as possible from the now ruined caisson. Thereafter, the above water sections of the dam would be removed to prevent them from fouling the wharves used for landing in the event of a strong gale. The remaining structure would be marked with hazard buoys to prevent injury to vessels in the vicinity (USCRSN 1836).

Marking the location of the sunken caisson was only a temporary solution. During 1855 and 1856, the Navy engaged in its removal as a navigational hazard. An 1853 map reveals the caisson's original location, labeled as "Ruins of Sunk Caisson" (Figure 1). The Annual Report of the Navy for 1856 reported that the removal of the "old sunken caisson" had been satisfactorily completed. The caisson was forgotten until dredging discovered it during construction of the recently built carrier pier. Panamerican Consultants was contacted in December of 1990 to perform an assessment of the remains, as well as to conduct preliminary archival research. The initial assessment identified the remains as those of a caisson. The structure was 150 ft. long and 35 ft. wide and was situated in 40 ft. of water. Only 9 ft. of the caisson's base remained. However, having been encased or sunk into a dense compact clay, it was extremely well preserved, with the wood as sound as the day it was cut and its copper sheathing gleaming like new.

Subsequent to the structure's identification as the caisson, an intensive program of excavation, mapping, and artifact retrieval, as well as archival research, was implemented to retrieve as much information as possible. Little time was left before the Navy destroyed the structure in their effort to make room for a new, deeper-draft pilot training carrier.

It was found that the caisson's 35-ft.-long end oriented to the southwest was the most intact. Therefore, excavation and mapping concentrated in this area. The exterior of this end was uncovered, exposing a 9-ft.-high wooden side, sheathed in copper sheets 14 in. x 4 ft. in size. Several of these were removed in an attempt to locate gauge and manufacturer stamps. While none were present, archival research revealed that these were of 14-oz. gauge and were custom ordered from suppliers in New York and New Orleans (Mistovich, Agranat, and James 1991).

The offshore corner of the southwest end of the caisson proved to be more intact than its inshore counterpart. Therefore, mapping of the construction techniques was extensive in this area (Figure 2). It was found that the outer walls of the caisson were reminiscent of log house and wharf construction. Seven horizontal timbers comprised the southwest end, six 13-in.-wide yellow pine timbers resting on a sill or basal timber twice the size of those above it. The ends of these timbers interlocked at the corners with the side timbers in what is known in log building construction as "half-notched false corner timbering" (Jordan 1978:49-71). The notches were pinned together using iron drift

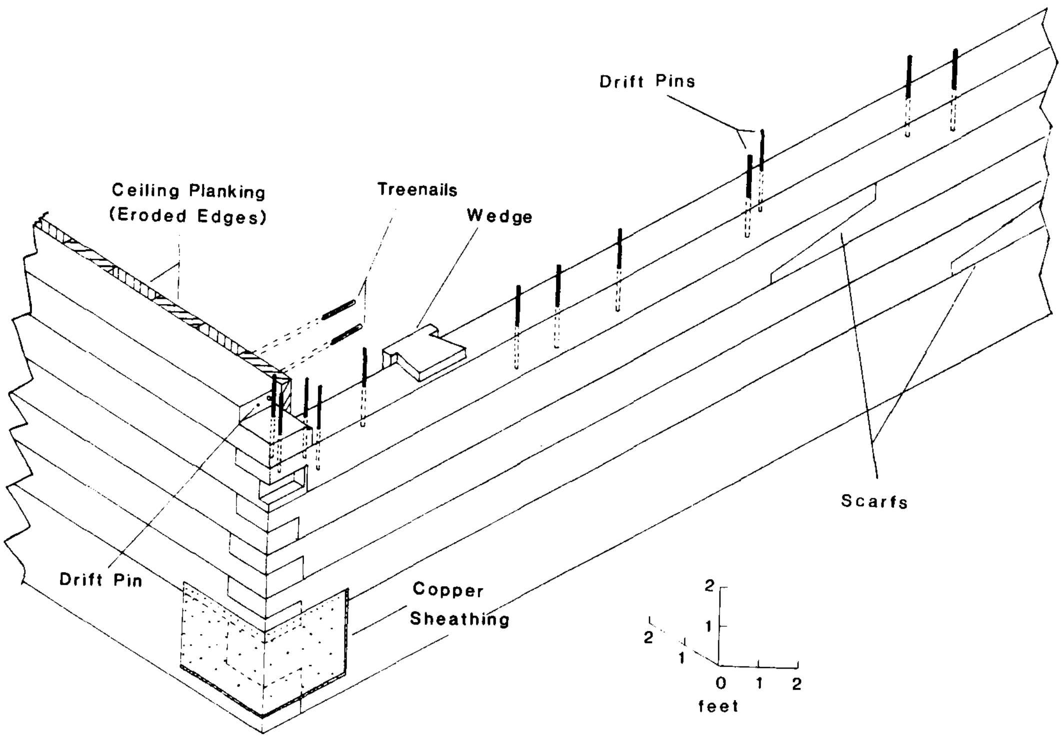

FIGURE 2. Composite drawing of Brodie's Wharf Caisson. cross-section based on results of in-water evaluation.

bolts. Several other construction attributes noted during the excavation and mapping of the offshore corner included "Z" scarfed lap joints and "T" headed dove-tailed wedges, which fit into dovetail joints on the interior of the caisson's walls to prohibit shifting of the timbers.

The interior of the caisson was filled with an impenetrable concrete matrix resembling a fired white kaolin-type clay. Archival research found that a shell lime mortar was employed to fill the caisson. Owing to the presence of this matrix, the only construction attributes recorded for the interior of the caisson, apart from the matrix itself, were the vertical ceiling planks attached to the interior of the side timbers.

Following completion of the diving phase, removal of the upper portions of the caisson was scheduled by the Navy in order to attain the required channel depth for the new, deeper draft training carrier. During this removal process, an archaeologist was stationed on the dredge. Numerous timbers and artifacts were brought to the surface, enabling the recording of additional significant construction details, such as the use and placement of the "T" headed dove-tailed wedges. Among the artifacts recovered were portions of common circular pump shafts and gear assemblies that relate to the intensive pumping activities detailed in the archival literature.

Upon completion of this study, a scale model of the caisson was produced, along with accompanying pamphlets and an archaeological report. The model helps to illustrate that the uniqueness of Brodie's wharf caisson lies not in its construction or application, but rather in its size. At its design size of 150 ft. x 35 ft. x 37 ft., Brodie's caisson had an interior volume of over 190,000 cu. ft. However, the technology was simply not available to keep that large an expanse dry when surrounded on all sides by water. As the caisson sank deeper into the bottom, the pressure acting on its walls increased. Brodie's design was inherently flawed. It just was not possible to keep a 190,000-cu.-ft. box, sunk in 37 ft. of water, dry using hand and mule driven pumps.

The story of Brodie's wharf is significant beyond the engineering principles, however. It offers a rare perspective into the administrative actions and policies of the United States Navy during a time for which very little research has been conducted. Given the difficulties in procuring materials and labor, and the harsh environment characterized by hurricanes and teredo worms, Brodie's wharf was an imbroglio of the first order. Nevertheless, the Navy approved the design and Congress appropriated more than $125,000 toward its construction, over four and a half times the original estimate. In addition, the wharf vexed four commandants, and likely contributed to the untimely death of one of them, during the five years in which it was being built.

The base of the caisson now lies buried beneath the sediments of Pensacola Bay. And although time will let us forget its presence, its past history of vexation almost assures us that the Navy has not seen the last of Brodie's Wharf.

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The Lake George Radeau: An Intact Vessel of 1758

Lake George, in what is now New York State, and its sister Lake Champlain, provided colonial water routes between French Canada and the English colonies. During the French and Indian War these waterways became the scene of major maritime and military campaigns that ultimately determined British supremacy on the North American continent (Morison 1965:164).

In 1755, 1756, and 1757, the British unsuccessfully tried to remove the French from their Lake Champlain forts. These efforts culminated in July 1758, when a much smaller French force resoundingly defeated the British at Ticonderoga. The British then returned to their Lake George base and began a major shipbuilding program (Bellico 1990).

Barely a week after the disaster at Ticonderoga, Maine shipwright Samuel Cobb began work on a sloop named *Halifax* (Cobb 1981:20), launched in August. On September 18, 1758, Cobb began work on a radeau. Named *Land Tortoise*, it was a flat-bottomed, raft-like vessel with seven cannon ports. The radeau form may have developed in response to the long, narrow waters in which it was used to provided military and naval support for the British and colonial troops during the French and Indian and Revolutionary Wars.

Colonel Henry Champion, a Connecticut officer, drew a seven-sided outline of *Land Tortoise* in his journal on October 7, 1758, describing it as "... 51 feet in length, about 16 or 18 wide, straight flat bottom, flaring waist about 5

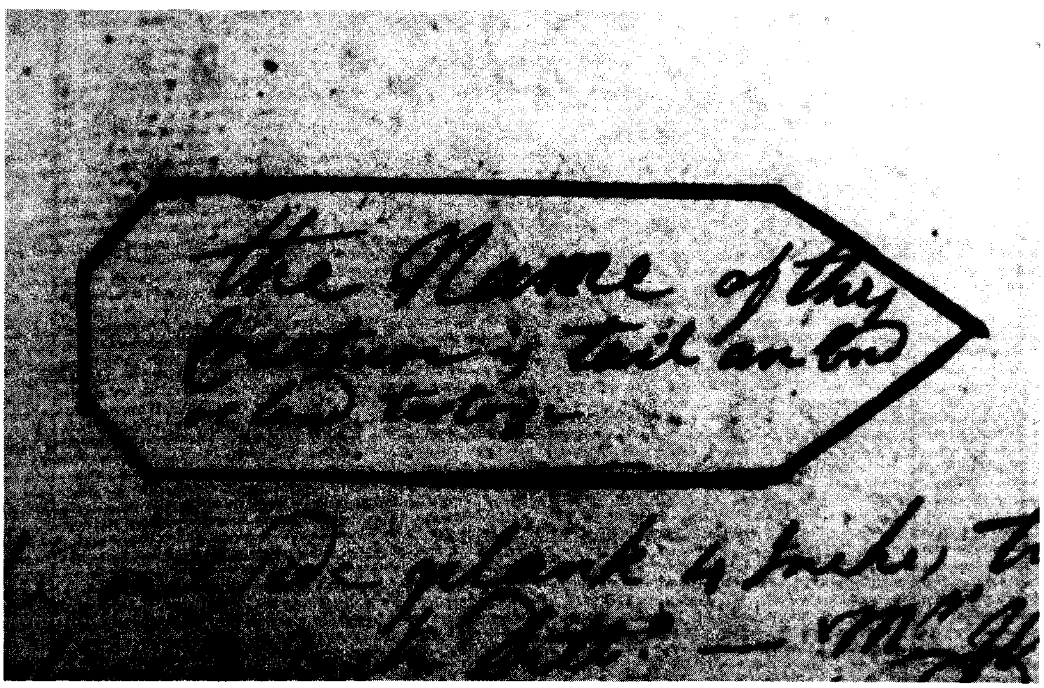

FIGURE 1. 1758 Champion journal drawing of *Land Tortoise*.

feet high, then turns with an elbow..." (Champion in Trowbridge 1891:431) (Figure 1). On October 19, Cobb noted that they launched two radeaux, the larger of which was 50 ft. long x 19 ft. wide x 6 ft. deep. The next day he stated that the radeau had rowed well with 26 oars (Cobb 1891:30).

On October 22, Cobb's notation reads: "Working on the Raddows Sinking them in the lake" (Cobb 1891:30). At the same time the British sank the sloop *Halifax*, 260 bateaux, and other vessels in shallow water, with the intention of raising them the following spring. This effective method of boat storage also protected them from French raids because the British kept no winter garrison on Lake George.

When the British returned in 1759 to raise the fleet, the sloop came up with difficulty (Webster 1931:125). On July 16, the British launched *Invincible*, a large radeau with eight cannon ports. In the July 1759 British attack on Ticonderoga, the only large vessels in the fleet were the sloop *Halifax* and the radeau *Invincible* (Wilson 1857:89). There is no mention of *Land Tortoise*; its fate remained a mystery until 1990.

In June 1990, a group of amateur underwater archaeologists used a Klein 590 Digital Side Scan Sonar to survey the lake bottom, searching for colonial bateaux to nominate them to the National Register of Historic Places. The Lake George Bateaux Research Team also discovered a radeau in the middle of the lake, in the South Basin, at a depth of 107 ft. (Figure 2).

With the knowledge of the New York State Office of State Archaeologist, the first dives to the radeau determined that the vessel was seven-sided, approximately 52 ft. long, with an 18 ft. beam, and 7 cannon ports. There is little doubt that this vessel is the lost *Land Tortoise*. The depth to which the ship plunged is probably why the British did not retrieve it in 1758; it

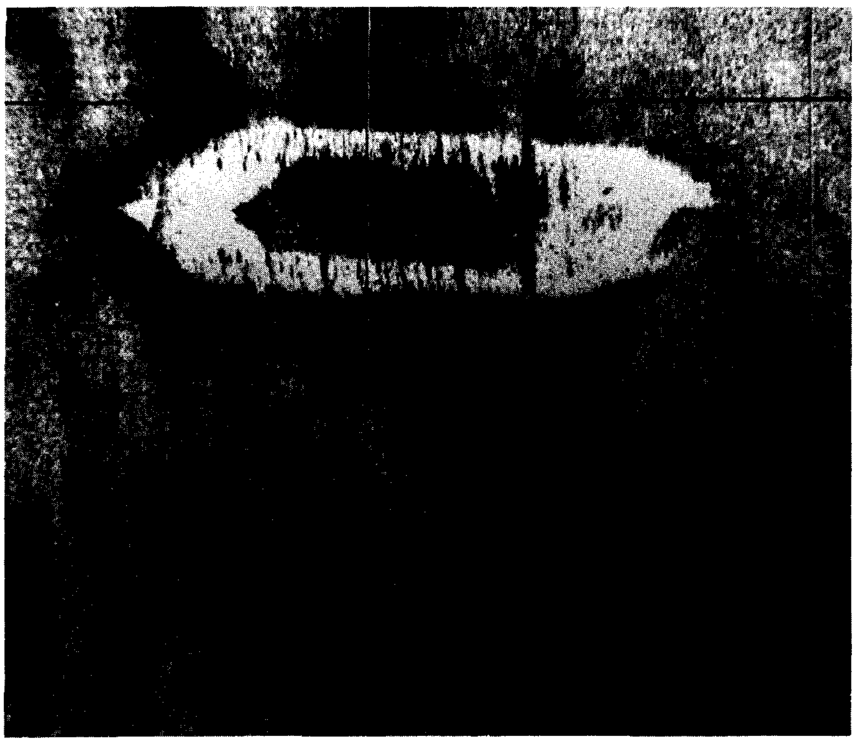

FIGURE 2. June 1990 side-scan sonar image discovery of *Land Tortoise*.

also is why it has survived the hazards of the environment, wayward fishing gear, and marauding artifact hunters.

In 1991 the principals of the discovery team formed the non-profit organization, Bateaux Below, Inc., and with the inclusion of professional archaeologists, they began a study of the radeau. All participants in the research have been unpaid volunteers, contributing time, expertise, equipment, and overhead costs. Many businesses and non-profit agencies have donated space, materials, equipment, and overhead. These include Rensselaer Polytechnic Institute, Lake George Historical Association, Marine Search and Survey, Princeton Aqua Sports, and the Marine Study Program. This project is a good example of the ability of volunteers to retrieve data from a sensitive cultural resource.

The preliminary results of the 1991 field season show that *Land Tortoise* is sitting intact on the soft silt bottom, lying slightly down by the bow, listing to port, and filled with the rock ballast used to sink it (Figure 3). There are approximately 1,000 ft^3. of fine silt covering the interior. Except for minor down-rigger damage and some wastage of planks and iron fastenings, the ship is in its original condition after 233 years on the bottom.

The ship is unfinished and lacks rigging and fittings and, because it was intentionally sunk unfinished, there are no artifacts aboard or nearby. There are no cannon, no shot, and no loose equipment or paraphernalia usually associated with underwater sites. This is not really a shipwreck. Because the vessel is intact, the 1991 field work married the methodology of archaeology and marine survey to retrieve construction data (see also National Park Service 1988).

The main limitation to this research has been the depth and temperature of the water in which the vessel lies. Visibility on the bottom

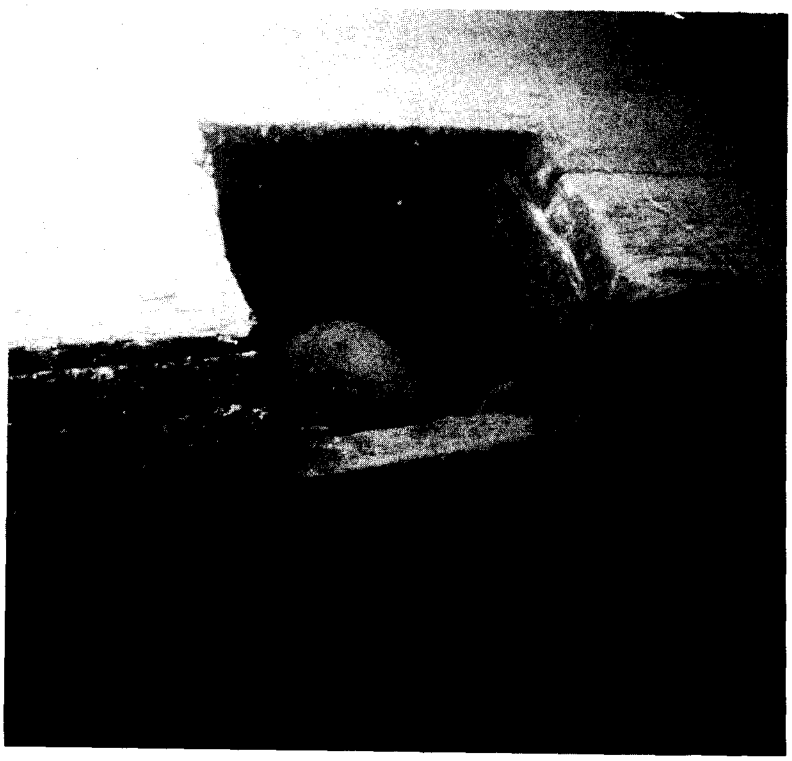

FIGURE 3. Forward port side cannon port showing interior silt and ballast rock.

varied between zero and 30 ft., depending on the season of the year and diver disturbance of the silt. Retrieving data from more than 100 ft. with bottom water temperatures as cold as 38° F demands a high level of diving skill, the use of wet or dry suits, and an auxiliary air supply.

The depth of the vessel limited the safe bottom time allowed per dive. Our team of volunteers agreed to use a conservative limit of 15 minutes bottom time for the first dive of the day (with proper decompression stops), at least 3 hours of surface interval, and 12 minutes bottom time for the second dive. This protocol provided an estimated 22 minutes per diver per day for useful work. To date, the members of the team have logged more than 70 hours of dive time collecting data on the radeau.

The 1991 state permit, issued by the New York State Education Department, did not allow the removal of the interior silt. Therefore, our study to date has been limited to the retrieval of data from the exposed sections of the vessel. These exposed portions are the most vulnerable to the ravages of diving souvenir hunters, and therefore it was important to retrieve the data most likely to be lost first. Plans for the 1992 season include the removal of the interior silt and ballast stones to reveal currently silt-covered construction details.

Our first season determined that *Land Tortoise* is an undecked, heavily constructed raft- or ferry-type vessel, crudely and casually built of flat panels. A protective single-planked canopy or bulwarks is superimposed on the hull, except at the transom, and exhibits exaggerated tumble-home. These bulwarks presumably functioned as protection from enemy shore fire, a serious consideration on a body of water that rarely exceeds one mile in width.

Despite the unusual seven-sided shape, the ship's construction details conform to typical boat-building practices of the period (Goldenberg 1976). Except for the layer of silt and ballast stones covering the interior, the structure is open to inspection. Construction data collected to date include the location, measurement, and recording of all frames, stanchions, bulwark planks, fittings and some fastenings; location and measurement of cannon ports and plugs, sweepholes, view holes, and other cutouts of undetermined function; distribution of ballast stones; and damage to the vessel.

Sixteen frames, each port and starboard, support the single-planked hull panels, and floors support a sole above the flat bottom. For every hull frame there is an adjacent grown hanging knee that acts as a stanchion to support the bulwarks. The spacing of the frames and stanchions is arranged to support the cannon port openings and to accommodate the sweep holes cut in the gunwale.

The frames and stanchions appear to be hardwood, probably oak, and the planking appears to be soft wood, probably pine. The hull is caulked and tarred. *Land Tortoise* is fastened with treenails and what appear to be hand-wrought metal nails or drifts. All of these materials will be sampled and identified in 1992.

These data show that the hull and bulwark construction of *Land Tortoise* followed normal boat-building practices under the direction of shipwright Cobb, but the execution is crude. The uneven planking width and thickness, the unmatched joints, the lack of backing blocks for mooring rings, and the flat panels of the structure may be a function of the urgent need to produce vessels quickly during the autumn of 1758. The crude construction may also indicate that carpenters other than boat builders performed most of the actual construction. This hypothesis fits with what we know of the personnel involved in the 1758-1759 campaign (Goldenberg 1976:114-115).

Radeaux were propelled by sails and oars. Contemporary drawings of other radeaux show a simple brig or schooner rigging. The Lake George vessel has two possible mast steps and the support structures for related rigging. There are a total of 26 sweep holes spaced along the gunwale, 13 port and 13 starboard. The ship's efficiency has yet to be determined, but it is obvious it was meant to be mobile.

There are seven cannon ports cut along the gunwales, two of which are missing their plugs. The locations of these cannon ports provide a unique opportunity to infer military use, naval sophistication, and technological limitations. *Land Tortoise*'s cannon ports are spaced three along the starboard side and two along the port. The asymmetrical location of the other two cannon ports, one on the port bow gunwale and the other on the port quarter gunwale, may indicate a limited ability to fire while under sail.

What is not entirely clear in earlier published materials, and what the 1990-1991 work suggests, is that the vessel was probably used as a stable platform for cannon to protect the shore or lake front and was rowed or sailed only as necessary to move it. Rather than a ship of the line, *Land Tortoise* would have been used as a floating battery. This hypothesis suggests that the radeau was a specific adaptation to the needs of the narrow waters of eastern New York, Vermont, and Quebec, and would not have been as useful on large waterways. As a test for this hypothesis, direction for the 1992 season will be to determine the radeau's bottom construction, the existence or absence of a keel, structures to support cannon, and other currently silt covered details.

The radeau *Land Tortoise* is the only one of its kind ever found and therefore provides an unique opportunity to study radeau construction details and to measure the success of this unusual type of vessel. In addition, it is believed that this ship is the earliest extant intact North American warship found to date.

Although *Land Tortoise* was sunk on purpose and the site includes no artifacts, souvenir hunters have slightly vandalized the site since its 1990 discovery. Therefore, New York State officials are preparing a more aggressive approach for site protection while preparations are underway for the final field season. In addition, a group of interested agencies, organizations, and individuals are evaluating the options for protection, conservation, and possible public display. In these economic times, the public future of the Lake George radeau is uncertain.

Retrieval of *Land Tortoise*'s unique construction data before they are lost is vital to illuminate a currently darkened corner of North American history.

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SESSION

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Jamaica Archaeology Underwater

DONALD G. GEDDES III

Archival Research: The Search for the Columbus Caravels at St. Ann's Bay, Jamaica

In a final act of desperation, Admiral of the Ocean Seas Christopher Columbus ordered his two sinking caravels run aground at Santa Gloria, Jamaica, on June 25, 1503. It was the termination of his fourth and final voyage of discovery. For one year and three days, he and 115 men and boys were to remain stranded on Jamaica until rescued on June 28, 1504. Left behind and abandoned to history were Columbus' two worm eaten vessels, mired in the sediments of the bay known today as St. Ann's. These ships are Columbus' flagship *Capitana* and *Santiago de Palos* (Morrison 1942:639).

Historic Documentation

Three first person accounts of the actual grounding of the ships are known to exist. The first in the narration of Columbus in his letter to the King and Queen of Spain, dated July 7, 1503:

> At the end of eight days, I resumed my voyage and at the end of June reached Jamaica, having always contrary winds and the ship is a worse state. With three pumps, pots and kettles, and with all hands working, they could not keep down the water which came into the ship, and there was no other remedy for the havoc which the worm had wrought. I steered a course which should bring me as near as possible to the coast of Espanola, from which we were twenty-eight leagues distant, and I wished that I had not begun to do so. The other ship, half under water, was obliged to run for port. I struggled to keep the sea against the storm. My ship was sinking under me, when our Lord miraculously brought me to land... (Navarette 1922[I]:329-341).

The second chronicle is by Ferdinand Columbus, the Admiral's son, who accompanied his father on the fourth voyage:

> However, making the best of this on the day after St. John's day [June 24], we set out for another harbour to the eastward called Santa Gloria, which is protected by reefs. Having got in, and no longer able to keep the ships afloat, we ran them ashore as far in as we could, grounding them close together, board and board and shoring them up on both sides, so they could not budge. In this position, the tide rose almost to the decks. Upon these, and the fore and stern castles, cabins were built where the people might lodge, intending to make them so strong that the Indians might do us no harm, for the island at that time was not inhabited by or subject to Christians (Columbus [Keen] 1958:264-265)

Ferdinand then went on to give an account of their distance from shore, as follows: "While we were thus entrenched in our ships about a crossbow shot from land..." (Columbus 1958:265).

The third recitation of events is taken from the will of shipmate Diego Mendez:

> It pleased our Lord God that we should be able to reach the island of Jamaica, where we ran the two ships aground, and made of them two houses roofed with straw in which we remained, not without great danger from the people of that island, who were not

subdued or conquered, and who might set fire to our dwellings in the night, which they would have been easily able to do despite our greatest watchfulness (Navarette 1922[I]:314).

There occurs in these three historical annals certain statements that provide useful clues to analyzing the possible location of the caravels in St. Ann's Bay.

In all three accounts, the ships were in danger of sinking; therefore, they were drawing more water than normal. According to Eugene Lyon's research, the Nina, one of Columbus' caravels of the first voyage, had a draft just under 7 ft. (Fuson 1987:40). Jose Maria Martinez Hidalgo, former director of the Barcelona Maritime Museum, estimated the Nina's draft at just under 6 ft. (Fuson 1987:40). A reasonable compromise therefore should be about 6.5 ft. of draft for a seaworthy, normally ballasted caravel. Ferdinand Columbus stated that when the ships were grounded "the tide rose almost to the decks" (Columbus 1958:264-265). If we assume 3 ft. of freeboard and a high tide of 1 ft., the caravels were likely grounded in no less than 8.5 ft. of water.

Interpretation

From the narratives of Ferdinand Columbus and Diego Mendez, it is obvious that both narratives shared a common apprehension about the possibility of attack by Jamaica's Taino (Arawak) Indians. Their fear of hostility was well founded. In April, a bloody battle with natives occurred near the Rio Belén in what is now Panama (Morrison 1942:629). Ferdinand Columbus' reference to "a crossbow shot from land" (Columbus 1958:265) becomes relevant not only as a distance to the shore but by inference to a distance from which Columbus and his men could protect themselves in the event of conflict with the Tainos.

According to James Lavin, Professor of Spanish Culture and authority on 16th-century Spanish weapons, there are watch towers along the seacoast of Spain from Malaga to Gibraltar. These towers are approximately 400 yds. from each other and are said to be a crossbow shot apart. Sir Ralph Payne-Galloway, in his authoritative book entitled *The Crossbow* published in London in 1903, states: "The ordinary military crossbow of the 15th century with a thick steel bow was able, if elevated to forty five degrees, to propel its bolt from 370 yards to 380 yards" (Payne-Galloway 1958:20). This distance we can therefore conclude refers to "the maximum range."

As to "the killing range," most experts agree with Nicholas McCullough, Southeby's London authority on arms and armor, that it is between 50 and 100 yds., depending on the strength of the bow. This estimate is further supported by Payne-Galloway as follows: "If one of these strong military crossbows was aimed horizontally at the forehead of a man standing at a distance of fifty yards, the bolt would not strike lower than his chin" (Payne-Galloway 1958:20-21). He further states that "The so called point-blank range of a weapon of this description (i.e., ordinary military crossbow) was from 65 to 70 yards" (Payne-Galloway 1958:21).

Based on the foregoing information, it is our opinion that the Columbus caravels were run aground in no less than 8.5 ft. of water and not closer to mean tide mark than approximately 100 yds., more near to the "killing range" of a crossbow than the "maximum range." An important objective therefore has been to find the relic beach of 1503 in order to define the best potential search area for the caravels.

Geoarchaeology

During the summer of 1991, a team of geoarchaeologists working in conjunction with the Columbus Caravels Archaeological Project (CCAP), an Institute of Nautical Archaeology endeavor, succeeded in identifying the relic shoreline of 1500. A series of parallel test pit excavations and core samples were able to provide significant subsurface information. Radio carbon dating of wood and charcoal, artifacts of known age, and exposed historic structures all contributed to the conclusions that considerable shoreline advance had taken place in St. Ann's Bay, particularly in the area known as Reader's Point. According to the geoarchaeologists, sediment deposition began before the year 1000 AD through the native use of a slash and burn technique causing soil erosion accelerated by rain runoff into the bay. By the year 1300, the lagoon area was filled in, and by 1500 the shoreline was smooth and unbroken with southwest directed waves and a long shore current running east to west along the beach. The eastern bay was subjected to wave action while the western side was relatively calm. While occasional hurricanes contributed to sand accumulation, the long reef across the bay kept shoreline damage to a minimum (Michael Waters, John Gairdino, Derek Ryter 1991, pers. comm.). This was the tranquil Santa Gloria that Christopher Columbus first found May 5, 1494, on his second voyage of discovery and where he became marooned nine years later (Morrison 1942:451).

A few years after the British occupation of Jamaica in 1655, the shoreline of St. Ann's Bay underwent a further transformation. Plantation land clearing and the building of canals for irrigation accelerated silting of the bay (Padron 1952). Additionally a long wharf was erected jutting into the bay, which interrupted the long shore current, creating the area known as Reader's Point. This 500-year accumulation of marine sediments leaves little doubt that the remains of Columbus's caravels are totally buried.

Survey

CCAP Project Director, James Parrent, elected to employ a combination of remote sensing devices in order to locate buried shipwreck sites in St. Ann's Bay. The primary technique involved the use of the most advanced sonar subbottom profiler developed jointly by Steven Schock, assistant professor of ocean engineering at Florida Atlantic University and Lester LeBlanc, professor of ocean engineering at Rhode Island University. This towable equipment has the ability to find and graphically display objects beneath the sea floor down to a depth of 36 ft. A marine and a land magnetometer were employed as secondary techniques to confirm the possibility of shipwreck-associated metal objects. Two sonar surveys conducted in October and November of 1990 and from June through August 1991 produced 27 possible shipwreck sites. Each site was subjected to testing with steel rods or probes to determine the nature and depth of buried objects. In a number of instances, pockets of organic gasses, which can appear as solid objects to the sonar, were eliminated. Other sites were cored with a raft mounted vibracore with the result that 11 locations were selected for test excavation.

Excavations

MS3 was located in 1990. In 1991 a test trench was dug through 10 ft. of mud and water revealing the hull shape of an early vessel with a maststep of complex and unique construction. The ship appeared to contain 4 ft. logs with axe marks, some of lignam vitae, stowed amidst the ballast. Radio carbon dating of the hull and a single Taino Indian bead suggest an early dating. Other artifacts, however, suggest a later period.

Site 21/22 first appeared from remote sensing to be two wrecks side by side. Excavation proved otherwise and revealed a single badly damaged large vessel lying parallel to the shore. It appears to be a deep-drafted, ocean-going ship with a heavy keel and deadwood assembly with V-shaped floor timbers resting on the deadwood. Artifacts point to a late 17th- century or 18th-century dating.

Site 16 is a well-preserved hull again lying parallel to shore. A 13-ft. section of the starboard bow was excavated revealing a radial cant frame construction. Associated artifacts indicate a late 18th-century dating.

Site 14, upon examination, revealed ballast and numerous artifacts but no hull remains. We believe it to be a ballast dump.

Although the caravels have not yet been located, there are seven more sites to be test excavated. One thing is clear, we are finding all of these sites within our parameters of our interpretation of a "crossbow shot from shore."

Acknowledgements

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The Search for Columbus's Last Ships: The 1991 Field Season

The second field season of the Columbus Caravels Archaeological Project (CCAP) was conducted at St. Ann's Bay, Jamaica, between June 15 and September 1, 1991. During these 11 weeks, archaeologists from the Institute of Nautical Archaeology (INA) and Jamaica National Heritage Trust (JNHT) as well as Texas A & M University (TAMU) field school students surveyed the area of St. Ann's Bay in search of the remains of Columbus's last command, the caravels *Capitana* and *Santiago de Palos* (Parrent 1989:16; Parrent et. al. 1990:4-7). Earlier attempts to discover the sites of the carvel remains can be found in Smith (1988:41-44). The fatigue and unseaworthiness of these ships forced Columbus to conclude his fourth and final voyage by grounding them on the shore of St. Ann's Bay in 1503. Columbus and his men lived on the decks of the beached ships for over a year before being rescued (Jane 1988).

The 1991 Survey

The 1991 field season consisted of two phases: a remote sensing survey of the area to the west of Reader's Point followed by test excavations of several significant anomalies. We conducted the remote sensing survey with a "chirp" sub-bottom profile unit developed and operated by Steven Schock of Florida Atlantic University. Named after the distinctive sound it makes during operation, the "chirp" unit uses advanced sonar technology to produce an image of subsurface sediments and any objects buried within the sediments.

This season, 21 potential shipwreck sites were located. Adding these sites to those found in the 1990 field season, we have discovered a total of 27 anomalies, or potential archaeological sites, beneath the sediments. Each new site discovered was probed with steel rods in order to verify the type of material and depth of detected objects. The most promising sites were tested again with a vibracore. This machine is designed to take 3-in. diameter core samples. The vibracore served a dual purpose allowing us to identify the sonar anomaly and also providing us with a sediment profile. This sediment profile will be used to reconstruct the geological history of the bay.

Probing and coring allowed differentiation between different materials detected by the sonar system, materials as diverse as gravel, ballast stone, wood, and pockets of organic gas. For example, the nature of the reflective properties of submerged organic gas are such that the anomaly might appear as a solid object buried beneath the seabed. Elimination of such targets by both probing and coring prevented much unnecessary excavation.

The success in identifying potential wreck sites is a mixed blessing. Our surveying methods allowed us to quickly cover a large section of the bay, but we located far too many sites to excavate during a single field season. Of the 21 new sites located in 1991, probing and coring indicated that 14 of them were associated with wood. Coring with the vibracore confirmed four of these sites as shipwrecks. Cores from these sites contained fragments of ship's wood such as frames, ceiling planking, and hull planking. A number of targets were eliminated from consideration when probing showed them to be pockets of organic gas.

In the final analysis, we identified 11 sites that fit within the broad criteria established for identifying the resting places of the caravels (Figure 1). These are located in protected areas of the bay that would have been shallow enough in the 16th century for Columbus to have beached his ships. Some sites also appear to represent two contiguous wrecks. This configuration agrees with historical accounts of Columbus beaching his ships next to each other

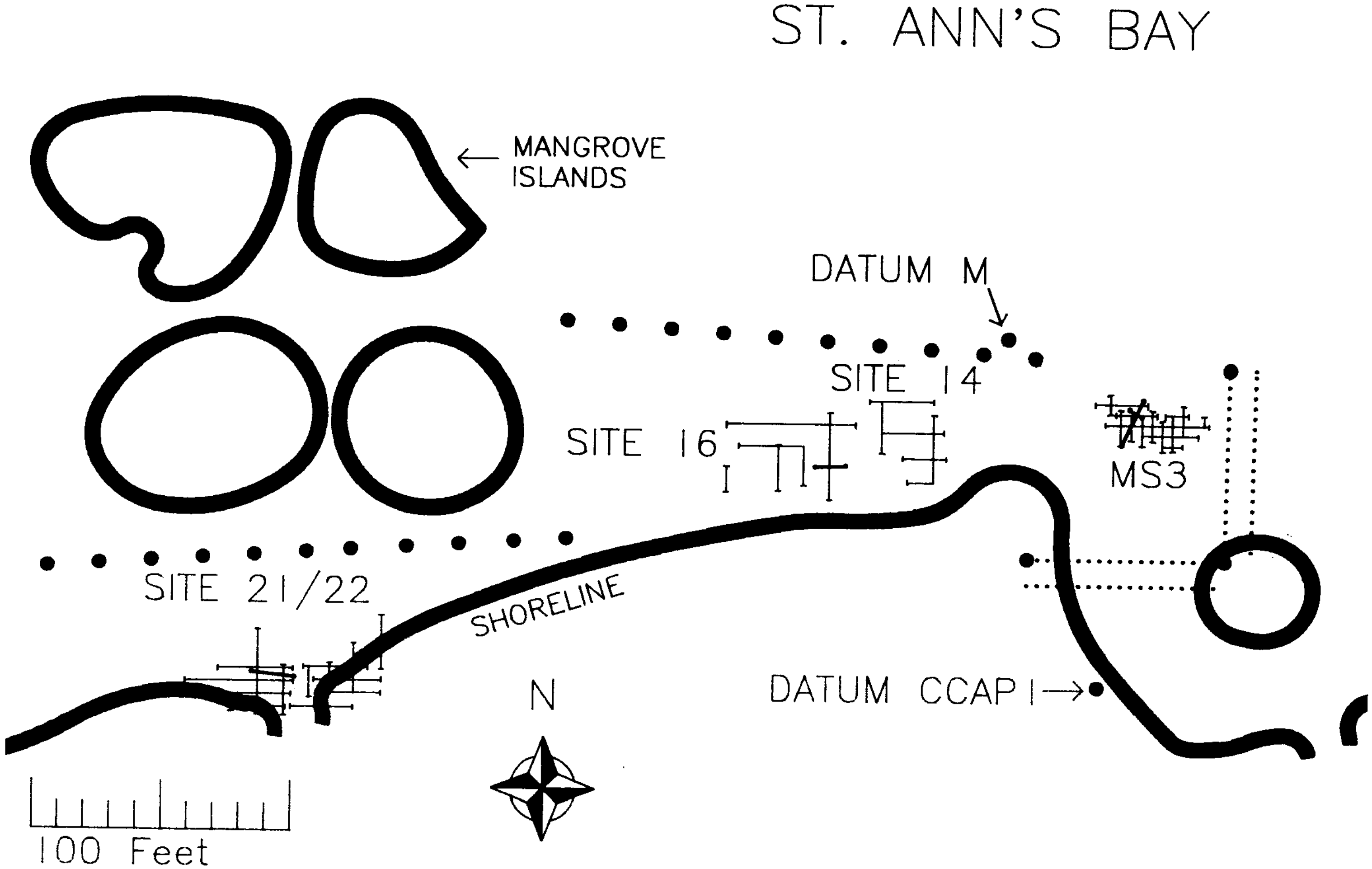

FIGURE 1. Map of the area surveyed during the CCAP 1991 field season. MS3, Site 16, and Site 21/22 are the shipwrecks discovered with the Chirp sub-bottom profile and are denoted by the crossed lines. The test trenches excavated at these sites are shown with heavier lines. Both the large and small dots represent range poles and datum points. (Drawing by John Neville)

and permanently fixing their position by shoring underneath the hulls. These sites were given the highest priority for test excavation.

1991 Excavations

Test excavations were conducted on four sites this summer. Shipwrecks were found to be buried beneath as much as 10 ft. of sediment. This sediment was deposited as a result of agricultural activity beginning with the Taino Indian occupation around 1100 B.P. and dramatically increasing with the colonization and development of the St. Ann's Bay area after the English conquest of Jamaica in 1655.

Site MS3

The first site chosen for testing is referred to as "Mangrove Site 3" (MS3). Originally located in November 1990, MS3 was quickly examined during the final days of the 1990 season. Work in 1991 began with a thorough sub-bottom profile survey of the site which we refined by probing and coring. The sub-bottom profile showed an anomaly having a maximum length of 42 ft., width of 16 ft., and depth below sediment of 9 to 10 ft. After consideration of these data, a test trench was excavated through the approximate center of the wreck. The test trench revealed a section across the breadth of the hull remains near the mast step (Figure 2). This indicated that the ends of the vessel were oriented in an east-west direction. From the preliminary analysis, however, it is difficult to identify which ends are the bow and the stern.

The hull remains were covered with 2 to 3 ft. of ballast except over the mast step where there was virtually no ballast. The absence of ballast in the mast step area indicates that this part of the hold had been protected by a bulkhead or mast trunk.

The hull remains have a preserved breadth of 11.6 ft. and are of either European or American white oak. They are preserved only to the second strake on the north side of the keel. The south side is better preserved and extends about six strakes to the turn of the bilge. The outer hull planking, exposed frame ends, and the mast step to the west of the mortise had been damaged by teredo worms, indicating that the wreck had been exposed long enough to incur damage. Also, the keel and mast step show extensive wear; thus, the vessel had seen much use prior to its sinking.

Approximately 5 ft. of the mast step were exposed during the excavation (Figure 3). The mast step has a complex and unique construction, being composed of six oak timbers fastened to the keelson with iron bolts. Two L-shaped timbers cap the port and starboard faces

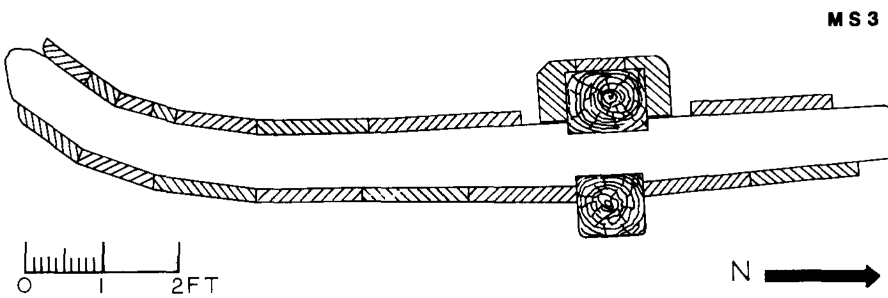

FIGURE 2. Cross-section of the MS3 hull remains showing the keel, floor timber, keelson, and eastern end of the mast step. (Drawing by Robert Neyland).

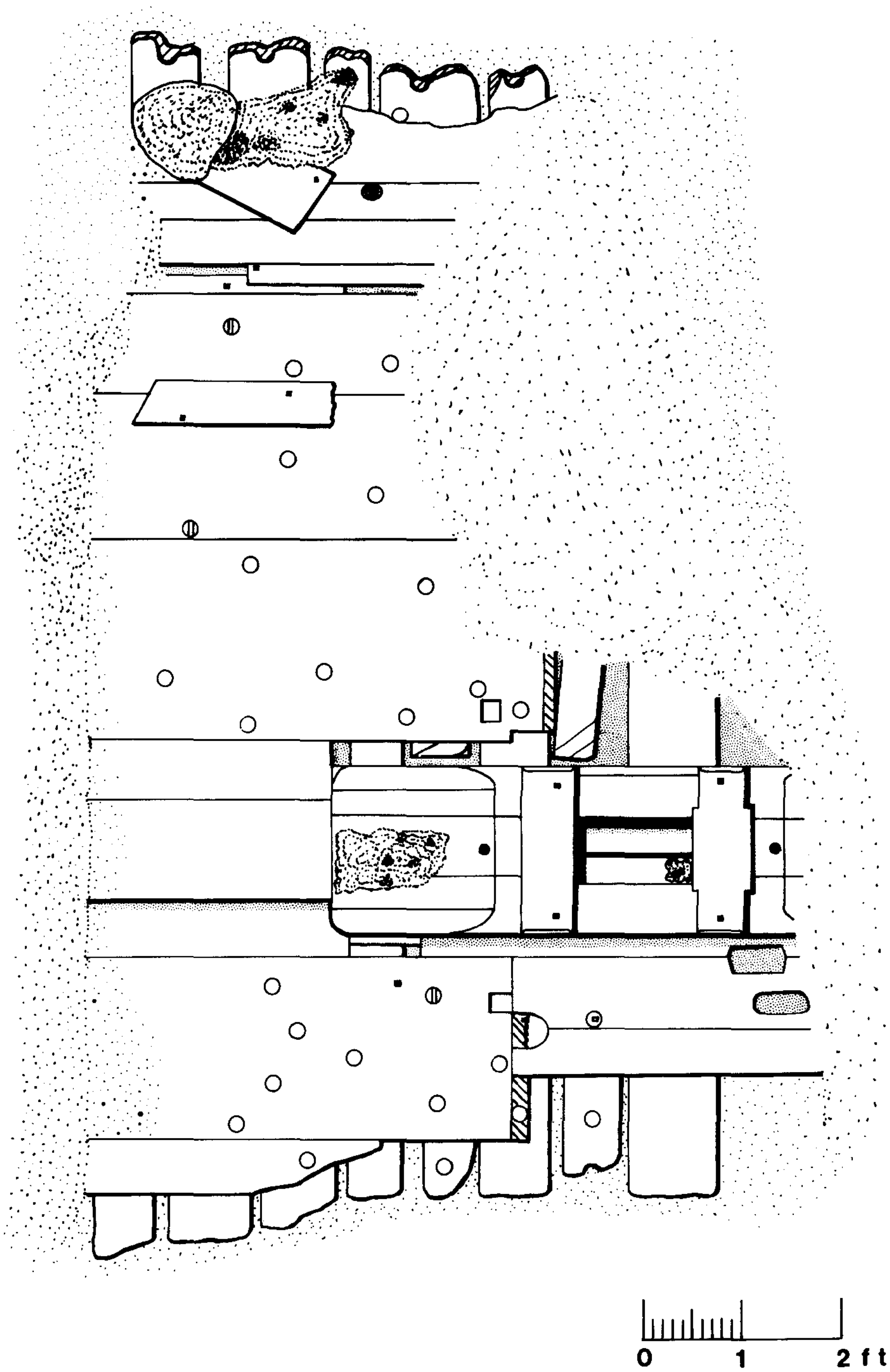

FIGURE 3. View from above of the MS3 hull remains. (Drawing by Robert Neyland).

of the keelson and run the length of the mast step. Two filler pieces fit between the L-shaped timbers. These fillers are atop the keelson to the east and west of the mortise chocks. All of the composite parts are fastened to the keelson with iron bolts which originally were countersunk.

Two chocks form the forward and after faces of the mast step mortise although they do not extend to the full depth of the mortise. Both chocks are T-shaped but are not identical in their overall form. The chock east of the mortise was the better preserved of the two and is distinctly T-shaped, the upper arms of the "T" riding atop the upper face of the mast step. The chock to the west has cross-shaped arms, as seen from above, and the mast step also was notched to this shape. Both chocks appear to be permanently fastened to the keelson by two iron spikes each.

Large notches cut into the keelson constitute most of the mast step mortise. The keelson was also notched on the east and west sides of the mast step mortise for the two chocks of the mast step. The mast step mortise is 1.2 ft. long x 0.7 ft. wide x 0.825 ft. deep. In one end of the mortise was a large glob of brown aromatic tar, and in the other end was an iron encrustation which could not be dislodged without damaging the mast step. A slit in the keelson runs the length of the mortise and, as it penetrates through to the bottom of the keelson, once served to drain water from the mortise.

The only evidence of a cargo in the MS3 wreck was a number of logs stowed amidst the ship's ballast. The logs appear to be of different tropical species, one of which has been tentatively identified as lignum vitae (*Guaiacum officinale*). All of the logs recovered had been cut into approximately 4-ft lengths, or billets. Lignum vitae was found to have a wide variety of uses. Its hardness and durability made it a favored material for the construction of sheaves for blocks and a drink prepared by boiling shavings of the wood was used as a remedy for syphilis (Crosby 1973:155). These small logs may have been intended for shipment to Europe as trade goods or perhaps for research purposes.

The artifacts recovered from the site include ceramic sherds, kaolin pipe fragments, the lower portion of a case bottle, part of a brass buckle, and numerous iron encrustations. The ceramic sherds and kaolin pipe fragments indicate a probable 18th-century date for this site. It is hoped that further analysis of this material will yield a more precise date.

The MS3 hull remains show a shallow draft vessel built solidly of oak. The worn condition of the keel, outer hull planks, and mast step indicate a vessel that had seen a great deal of service. It is unknown how much of the teredo damage to the outer hull planking occurred after the vessel sank but because no hull sheathing was found some of the damage must have occurred prior to its sinking. A great deal of charcoal was found throughout the wreck. Pieces of charcoal were present in the ballast, bilge area between the frames, under the mast step, and in the mast step mortise. The presence of abundant amounts of charcoal throughout this wreck may be an indication that the ship was burned.

Because the vessel was worn and damaged, one explanation for the existence of the wreck is that the vessel was a derelict. Plentiful amounts of charcoal present the alternative hypothesis that the vessel burned and its presence is explained as the result of a catastrophe.

Site 21/22

The second test excavation was carried out at the site designated 21/22. When this site initially was chosen it appeared to be two targets situated side by side. A trench was excavated between the two sites so that sections of both wrecks could be easily examined. The excavation revealed 13 ft. of a solitary wreck lying parallel to the shore on an east/west axis with the bow probably facing west.

The section of the hull uncovered was badly damaged, but it appears to be aft of midships and near the stern, as evidenced by what appears to be the beginning of the stern knee. Below the stern knee was another length of deadwood which rode atop the keel. Heavy V-shaped floor timbers set atop the deadwood. Atop the floor timbers was a keelson which ended just forward of where the stern knee began.

The keel/deadwood construction formed a relatively deep-drafted bottom to the vessel. The overall length of the wreck area is 70-80 ft., with a maximum width of 20-30 ft. This is a much larger site than either MS3 or the third shipwreck site and perhaps indicates a much larger seagoing vessel.

Due to its proximity to a stream mouth, this area of the hull was largely swept clear of artifacts. The few ceramic artifacts recovered were found below the ceiling planking and include three porcelain sherds and a single piece of tin-glazed earthenware, possibly of Dutch origin, suggesting a late 17th- or 18th-century date for the wreck site.

Site 16

The third site tested this season is designated Site 16. This vessel, like the other two wrecks, was oriented in an east/west direction with the bow pointed east. Thirteen feet of the starboard bow were uncovered. The bow is characterized by a radial cant-frame construction. Preliminary analysis of the hull remains indicates a sharp bow, perhaps having some hollow. The stem was missing but portions of the stemson, keel, and keelson survived. Both the keel and keelson were notched to receive the floor timbers but the cant frames were fastened only to the planking. Artifacts such as salt-glazed stoneware sherds, case bottle, and kaolin tobacco pipe date the wreck to the late 18th century.

Site 14

Site 14 was examined during the last two days of the field season. Sub-bottom profile, probe, and core data suggested that this site contained ballast stone but did not show any evidence of hull remains. Test excavation revealed a lens of thick gravel containing some ballast stones and a few artifacts including a leather shoe sole, encrusted iron nails, an iron cargo hook, sherds from a creamware pitcher, and fragments of worked wood. These artifacts do not represent a shipwreck site and are more likely the result of ships dumping their ballast in the bay.

Although not the prime directive of the Columbus Caravels Project, the three shipwrecks partially excavated this summer represent significant discoveries. All are in an excellent state of preservation and exhibit interesting hull construction features. Although possibly salvaged at the time they were lost, these wrecks have not been disturbed by modern looters. Thus, their pristine archaeological condition and their location in shallow water give them a high potential for future research.

The discovery, exploration, commerce, and development of early Jamaica are all represented in the archaeological sites of the St. Ann's Bay area. The high concentration of shipwrecks in the primary search area indicates it was an attractive, protected anchorage that was in use for several centuries.

Summary

The primary goal of the Columbus Caravels Archaeological Project continues to be the discovery and study of the remains of the caravels *Capitana* and *Santiago*. Although they were not identified this summer, seven high-priority sites still remain to be excavated. Therefore the caravels' search area is being narrowed and plans are underway for another field season in 1992 including additional remote sensing of the St. Ann's Bay area.

The 1991 field season laid a solid foundation for further research in St. Ann's Bay. Potential shipwreck sites were located, prioritized, and evaluated with speed and accuracy. We feel confident that given the time and resources, the remains of Columbus's caravels will be found.

Acknowledgements

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PANEL DISCUSSION

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State Responses to the Abandoned Shipwreck Act of 1987

The Abandoned Shipwreck Act of 1987 (P.L. 100-298) gives each state title to historic shipwrecks in its waters. Along with this privilege comes the responsibility, explicitly stated, for each state to have an active shipwreck management and research program. The National Park Service published guidelines to aid the states in designing such programs. The purpose of the discussion session reported here was to provide an opportunity for the state participants to exchange information on how they are responding to the new responsibilities of the Abandoned Shipwreck Act. To kick off the discussion, the following questions were sent to each participant in advance, and a summary of the responses is presented below:

(1) How is your state meeting its obligation to have an active historic shipwreck management and research program? and,

(2) How is your state handling the required "appropriate nondestructive private sector access" to historic shipwrecks?

California (Peter Pelkofer)

1. Subsequent to the passage of the Abandoned Shipwreck Act, the State Lands Commission, the California agency entrusted with the responsibility for the preservation, protection and management of the state's 3.5 million acres of submerged lands, sponsored legislation to provide additional protection for submerged cultural resources. The law, as it existed, was oriented to commercial salvage and did not consider the historic significance of many of California's shipwrecks. The new law, Chapter 732 of 1989, (Cal. Public Resources Code Sections, 6309, 6313 and 6314) was effective January 1, 1990. It created the California Shipwreck and Historic Maritime Resources Program.

The State Lands Commission was empowered to administer the California Shipwreck and Historic Maritime Resources Program and to make any necessary rules and regulations for its management. The new law added sections to the code to confirm the state's ownership of all abandoned shipwrecks and all underwater archaeological resources in state waters. Any shipwreck site that has existed for more than 50 years is presumed to have historic significance.

Penalties are provided for injury, destruction, or removal of underwater historic objects, and a peace officer may confiscate artifacts he has reason to believe have been taken without authorization.

To implement the law, the Commission's executive officer established the Submerged Cultural Resources Unit. Initial tasks were to develop a policy statement and formulate guidelines for applications for both commercial and scientific permits. The policy statement provides that the objectives of the Shipwreck and Historic Resources Program are to:

a. Identify shipwreck sites or marine areas with archaeological or historic significance;

b. Provide comprehensive and coordinated conservation and management of such marine sites and areas;

c. Support, promote, and coordinate scientific research on archaeologically or historically significant marine sites and areas; and

d. Facilitate, where compatible with resource protection, all public and private uses of marine archaeological and historic sites and their resources.

The permit application guidelines set the standards and the requirements necessary to obtain a permit. Projects with historically significant sites as their objective require more extensive research designs.

The Unit has also compiled an inventory of California shipwrecks. The inventory is maintained in R Base in a format compatible with that used by the National Maritime Initiative. It contains some 1,600 entries and is updated with information and new listings daily. Information from the inventory is available on public request, with some limitations. To add information on shipwrecks in the inventory, the Commission has contracted with the Institute for Western Maritime Archaeology at the University of California Berkeley, which provides historic research and develops both additional data and a basis, where appropriate, for nominations for the National Register of Historic Places.

The Unit has also written a pamphlet guide for sport divers, entitled "Historic Shipwrecks in California Waters." It outlines the goals of the shipwreck program, provides an overview of California shipwreck law, advises how to report an accidental discovery of a shipwreck, and encourages sport divers to locate and report shipwrecks.

2. All California shipwreck sites, historic and non-historic, are open to nondestructive and non-consumptive uses by the private sector. Although the Commission has authority to withhold site location information if it believes that will provide protection, the location of most historic sites are documented and well known to divers. Because the submerged lands under the Commission's jurisdiction are so extensive, it is impossible to police them. Diver education and cooperation must be relied upon to provide conservation and protection of historic sites.

As a part of the effort to educate sport divers to the need to protect and conserve archaeological and historic sites, the staff of the Submerged Cultural Resources Unit regularly talks to dive clubs, participates in diver education programs, and writes articles for and letters to dive publications. Deep cold water and capricious offshore weather combined with watchful cooperation from the state and federal agencies that patrol the waters to regulate commercial fishing have prevented unauthorized treasure hunter salvage efforts.

Florida (Roger C. Smith)

1. Since the passage of the National Preservation Act of 1966, the State of Florida has placed increasing importance on preserving its historical and archaeological resources. The Florida Historical Resources Act, enacted in 1967 as Chapter 267 of the Florida Statutes, established various programs and policies to encourage public and private entities to protect and preserve historic resources for the public welfare and for future generations.

The Division of Historical Resources was created within the Department of State to administer Florida's historic preservation policy. Major goals of the state's historic preservation program are to identify, register, protect, and preserve the significant historic resources of the state. These include prehistoric and historic archaeological sites, historic shipwrecks and related artifacts, historic buildings, and other structures and objects.

The Florida Historical Resources Act states that all treasure troves, artifacts, and such objects having historical or archaeological value that have been abandoned on state-owned submerged lands belong to the state. The title to such property is vested in the Division of Historical Resources of the Department of State for management and protection.

In the absence of law to the contrary, Florida, like most states, historically assumed jurisdiction of the management of shipwrecks submerged in the state's waters. Since the 1930s, the state has permitted shipwrecks to be salvaged or explored under contracts with the state. Since 1967, this program has been administered by the Department of State, Division of Historical Resources. Two rules in state law have direct bearing on historic shipwrecks and other archaeological sites.

Chapter 1A-31, Florida Administrative Code (FAC), establishes procedures for the exploration and salvage of historic shipwreck sites under contractual agreements with private parties under certain guidelines. The rule provides that no person may conduct operations to explore, excavate, or salvage archaeological materials from shipwrecks without an exploration or salvage agreement issued by the Division of Historical Resources. The rule also states that all archaeological materials salvaged are the property of the Division. The Division may pay for the salvage in accordance with the terms of the contract. Generally, the terms have permitted salvers to retain 75 to 80 percent of the artifacts salvaged. The division is also required to supervise the salvage through proper documentation of all salvaged artifacts.

Chapter 1A-32, FAC, provides procedures for archaeological research of state-owned or state-managed archaeological sites. Any archaeological research of such sites must be permitted by the division in accordance with the rule. The rule establishes criteria imposed by the division for institutions seeking research permits. Only institutions and archaeologists meeting the criteria may conduct archaeological research on state-managed sites, and all artifacts remain in the custody of the state.

Since the out-of-court settlement with Cobb Coin in 1982, salvage of the remnants of the 1715 Spanish fleet sites has continued under archaeological guidelines established by an independent committee. Arrests of these sites are grandfathered under the Abandoned Shipwreck Act. Before the act was passed, two newly discovered Spanish shipwreck sites were arrested in federal court and then contested by the state. In attempts to mitigate these threatened but grandfathered sites, the state has pursued agreements with stricter guidelines that require closer supervision by a professional archaeologist and division only of duplicate artifacts. It remains to be seen if these agreements can work in these two instances.

The Secretary of State's Reserve Area Task Force is continuing to address shipwreck issues and private sector recovery in particular. The focus of three meetings to date has been on establishing public-benefit criteria with which to determine the appropriateness of any proposal for work on shipwrecks, whether private sector or not.

2. Florida has established a program of creating Underwater Archaeological Preserves at sites of historic shipwrecks that are nominated by local citizens for such designation. Similar to parks on land, the underwater preserves are open to the public free of charge and are accompanied by interpretive literature that explains their historical context and archaeological features. By necessity, Florida's underwater archaeology staff has worked with local volunteers and amateurs during every research project. Whether on an individual basis or with organized groups, semi-skilled assistance is exchanged for training and participation opportunities. The establishment of shipwreck parks has depended on input and help of local communities.

The first preserve opened in September 1987 on the site of the *Urca de Lima*, one of the ships of a Spanish Plate Fleet that wrecked on the east coast of Florida in 1715. Located in 12 ft. of water north of the Ft. Pierce Inlet, the shipwreck park encourages snorkeling and diving visitors to view part of the sunken remains of one of Florida's most famous maritime disasters. Two additional sites have been dedicated since 1987 and several nominations are still pending.

Maryland (Paul Hundley)

1. Maryland's assertion of its rights over the ships and articles wrecked or abandoned on its shores predates the passage of the Abandoned Shipwreck Act by nearly 300 years. In 1692, Royal Governor Copley appointed Edward Greene of Somerset County to be

> "Chief and only Officer under me for the taking, seizing and cutting up, and trying blubber, and making such other use and benefit as you shall think fit or possibly can for the most advantage, of all such drift whales or other fish, and of all or any other drifts,

> wastes, or wrecks whatsoever as shall at any time hereafter happen to come or be cast on shore on the seaboard side within the limits and jurisdiction of this Province." This action was taken when the Royal Governor found that whalers, wreckers, and other marine poachers would appropriate whales, wreckage, and other flotsam or jetsam along the Maryland sea coast that was the exclusive right and possession of the state.

With the passage of the Submerged Archaeological Historic Property Act (SAHPA), Maryland has updated the old Royal Order and taken an active role in the preservation of historic shipwrecks and other submerged cultural resources within its state waters. This legislation enacted during the 1988 session of the General Assembly authorized the Maryland Historical Trust to establish a program to protect historic shipwrecks and administer activities related to submerged archaeological historic property. The passage of this Act was a response to the Abandoned Shipwreck Act even though it was state law prior to the actual signing of the federal act. According to the Act, a submerged archaeological historic property is,

> "any site, structure, object, or remains which yields or is likely to yield information of significance to the scientific study of human prehistory, history or culture and is embedded in submerged lands and has remained unclaimed for 100 years or longer; or is included in or has been determined eligible for inclusion in the National Register of Historic Places."

The SAHPA sets out certain responsibilities that the Maryland Maritime Archaeology Program (MMAP) must fulfill in carrying out the intention of the legislation. Among these responsibilities are:

a. Systematic survey of Maryland waters to locate, identify, and register property, shipwrecks as well as other historic and prehistoric sites;

b. Protection of submerged archaeological historic property;

c. Education and certification of the general and diving public on maritime archaeology; and

d. Issuance and administration of permits for the excavation of sites.

Regulations that protect cultural resources have been drafted and are awaiting codification. Development of an active program of site location, investigation, interpretation, and protection, directed by the State Underwater Archaeologist within the Maryland Historical Trust, has provided Maryland the basic management tools to apply in preservation of its submerged resources. The state currently funds MMAP to maintain a staff of three maritime archaeologists and the equipment necessary to conduct survey and inventory activities for submerged cultural resources. A 25-ft. fiberglass survey vessel was fitted out with a magnetometer, side-scan sonar, and microwave positioning system with onboard plotter. This equipment enables the Trust to undertake independent research and survey as well as conduct field check and monitor review and compliance projects under Section 106. A 16-ft. inflatable boat provides a secondary work platform from which to conduct diving operations and shallow-water surveys.

2. The task of the Maryland Historical Trust in drafting regulations and guidelines was to clarify the requirements of the legislation. The process has been a long and controversial one. It was a legislative requirement of the Maryland Historical Trust to work with all sectors of the population that have an interest in state waters and the submerged property beneath them in the development of regulations that would both protect the submerged resources and allow access to all those interested in the state's submerged past.

The sport diver is potentially the program's greatest asset or greatest liability. The Maryland law is very specific regarding the individuals rights of access to sites. The law states, "A person may inspect, study, explore, photograph, measure, record, conduct a reconnaissance survey, or otherwise use and enjoy a submerged archaeological historic property without being required to obtain a permit if the activity does not involve excavation, destruction, or substantive injury of the historic property or its immediate environment; endanger other persons or property; or violate other regulations or provisions of federal, state, or local law." The law and regulations further stipulate that subject to provisions of the regulations, a person without a permit may collect from any one site not more than five individual artifacts exposed or resting on the bottom sediments of submerged lands but not embedded; do not require excavation to recover; and weigh cumulatively not more than 25 lbs. Artifacts may not be recovered from a site unless they can be obtained by hand or through the use of screwdrivers, wrenches, or pliers, which may be not larger than 12 in. in length and have a width across the jaws of not more than 2 in.

Certain restrictions are placed on this right to collect artifacts from sites. If the activities or collection of artifacts by a person without a permit results in damage to the site, the state has the right to restrict access to the site, to require that any artifacts recovered be turned over to the Trust, and to begin disciplinary proceedings or to require that the person apply for a permit. The state further maintains that a person may not collect artifacts from a site listed on or determined eligible for inclusion in the National Register; or designated or determined eligible for designation as a National Historic Landmark; or is entered on the Trust's list of sites for which permits will not be issued. This list consists of sites that were located by state survey activities. The state maintains a record of the artifacts that have been removed from sites through the requirement that all persons who have collected objects in accordance with the regulations furnish the Trust with a list of the objects and a description of the places from which the objects were recovered as soon as possible but not later than 30 days from the date of collection. The Trust will review each list of objects and may require reasonable access to any artifact for documentation, analysis, or conservation.

The Maritime Archaeology Program is now in the position of protecting archaeological resources from legally sanctioned looting. Therefore, the emphasis of the MMAP over the next few years must be on public eduction. The Maryland Historical Trust is setting up a program that will allow full public involvement, for both divers and non-divers, in the state's maritime preservation efforts. If a system based on cooperation and mutual trust is set up, the sport diver can provide the MMAP with a wealth of information on site location, artifact distribution, and site interference. If, on the other hand, the diving community is alienated, it can become the greatest threat to submerged archaeological sites since it can legally strip a site of artifactual material. The draft Minimal Standards for Education in Maritime Archaeology, which has been prepared for the ACUA, provides a solid foundation for cooperative private sector and state training programs.

South Carolina (Christopher F. Amer)

1. Since 1976, South Carolina has had a program for managing and researching all submerged archaeological historic properties, including historic shipwrecks, found beneath the state's navigable waterways and under its Territorial Seas. The custodian of submerged archaeological historic properties owned by the state is the South Carolina Institute of Archaeology and Anthropology (SCIAA) at the University of South Carolina. The day to day responsibilities of carrying out the research and management of these resources falls to SCIAA's Underwater Archaeology Division.

The Abandoned Shipwreck Act of 1987 and the National Park Service guidelines have served to focus the Division's management and research activities while providing a framework for revising the state's underwater antiquities legislation. Since the passage of the federal act, the Division has concentrated on developing a cultural resource management program that embodies a holistic approach to the management of the state's historic shipwrecks and other submerged cultural sites. With a staff of seven, which includes four archaeologists, SCIAA's Underwater Archaeology Division is one of the country's largest programs of its type.

The Division has adopted a regional survey approach to researching the state's submerged cultural heritage that is geared specifically toward inventorying and identifying historic shipwrecks and cultural sites and recording each to a level sufficient for inclusion in the State Site Files. Each site is further evaluated using National Register criteria, and, if determined eligible, is protected. This approach involves an increased interaction between state and federal agencies whose areas of responsibility overlap that of SCIAA, including the State Historic Preservation Office, South Carolina Coastal Council, and South Carolina Wildlife and Marine Resources.

In addition to receiving an annual state appropriation, the Division has explored a variety of funding sources to further the research and management of the state's submerged historic properties. State Historic Preservation funds were received for research and preservation of a threatened shipwreck site near Charleston, for example. Funding is being sought to survey Charleston Harbor and approaches through the federally funded Charleston Harbor Project. This area contains a great quantity of known historic shipwrecks as well as vernacular craft and other submerged cultural sites associated with the state's history.

2. Building on an existing state program, the Division's Sport Diver Archaeology Management Program is providing the education and information to the sport diving community and the public to foster an awareness of the historical and archaeological importance and the non-renewable nature of the state's shipwrecks. The program further encourages recreational access to shipwreck sites. Archaeology training is provided to divers and dive instructors who subscribe to the Division's program through annual field schools. The Division utilizes volunteers on state projects and encourages graduates of its training courses to conduct non-intrusive research projects of their own on shipwreck sites and also to conduct joint projects with the Division. A newsletter published quarterly by the Division announces upcoming state projects, publishes articles by staff and hobby divers, and is a busy avenue of communication between the state and the dive community.

During 1990, following a jurisdictional dispute over an historic shipwreck in state waters, the state's existing Underwater Antiquities Act was completely revised using the Abandoned Shipwreck Act of 1987 and National Park Service guidelines as a guide. The intent of the South Carolina Underwater Antiquities Act of 1991 (Article 5, Chapter 7, Title 54, Code of Laws of South Carolina, 1976), which was signed into law in June 1991, is to "preserve and encourage the scientific and recreational values inherent in submerged archaeological historic properties and paleontological properties" in the state. The Act encourages recreational, nondestructive usage of submerged sites, including non-intrusive surveys. It allows for licensed surface collection of artifacts but restricts the collection of artifacts associated with shipwreck sites to a limited number. The law also prohibits the unlicensed removal of a ship's structure. Exclusive licenses are required for intensive surveys and data collection that require excavation of submerged cultural sites or removal of a ship's structure. All such activities must meet professional archaeological standards.

Taken as a whole, South Carolina has met the spirit and intent of the Abandoned Shipwreck Act of 1987 through implementation of an active submerged cultural resource and historic shipwreck management program, using research, education, and volunteers coupled with strong legislation that recognizes the need for both scientific and recreational use of the state's submerged cultural heritage.

Texas (J. Barto Arnold III)

1. Texas has had an active management and research program for historic shipwrecks since

1972. At first, the program concentrated on field work for the 1554 flota wrecks on Padre Island. In the early 1980s, the emphasis shifted to cultural resource management. In response to the new federal law, Texas is moving toward a more balanced program of management and field and archival research although state funding available for these activities was cut during recent legislative sessions. The resulting lack of funding remains a big problem.

2. The Texas Antiquities Committee (TAC) is committed to providing appropriate non-destructive access to historic shipwrecks. Antiquities' permits are issued to private sector groups for bona fide archaeological projects on historic wrecks. All artifacts remain public property. Wrecks dating prior to the 20th century (43%) are protected. Wrecks of the 20th century (57%) are available for unrestricted use. Sport divers can visit historic wrecks but not collect from such sites.

Public access to historic shipwrecks should be seen in a much larger framework than just the sport diving community. Most people do not dive. Therefore, the TAC has made major efforts to provide publications on its underwater archaeological work. The agency also distributes a nationally televised documentary film and slide shows. Museum exhibits on the 1,554 flota wrecks toured the state and a new permanent exhibit opened in 1990 at the Corpus Christi Museum. The Austin Children's Museum also created an impressive exhibit that continues to tour cities outside the state. The non-diving public must not be forgotten in considering the access question.

Virginia (M. Catherine Slusser)

The Virginia Underwater Historic Properties Act, which predates the federal Abandoned Shipwreck Act of 1987, gives management responsibility for all underwater historic properties jointly to the Virginia Marine Resources Commission (VMRC), the Virginia Department of Historic Resources (DHR), and the Virginia Institute of Marine Sciences (VIMS), a branch of the College of William and Mary. In 1988 the Office of the Attorney General informally reviewed both laws and indicated that the Virginia law was consistent with the new federal legislation.

1. In a time of continuing and severe budget deficits, none of the three primary agencies named in the Virginia law is in any realistic position to conduct surveys, research and interpretation in-house, or to manage shipwrecks as interpretive parks as the National Park Service guidelines suggest and encourage. Nor is the state's Division of Parks able to add new parks to the existing system. This is entirely a budgetary and pragmatic situation rather than an issue of policy.

Efforts to build an in-house underwater survey and planning program were caught in the first wave of major budget reductions last year. Archaeologists and preservationists are well aware of the limitations this reduction imposes. Within those limitations, however, the agencies involved still take shipwrecks and other underwater historic resources quite seriously.

The law and procedures used by VMRC and DHR do provide for survey, identification, and documentation to be conducted by other individuals and organizations through a two-tiered permit process as suggested in the National Park Service guidelines. DHR uses its review of Corps of Engineers' permit applications and state environmental reviews conducted through the Virginia Council on the Environment as a mechanism to encourage identification and protection of a wide range of underwater historic properties.

The Department now has representation on the state's Coastal Zone Management (CZM) committee and has included shipwrecks as sensitive resources in virtually all the priority statements for a new category of federally funded CZM grants. These grants may provide a mechanism to encourage survey. The Department is actively pursuing non-state funding sources to develop a state-wide comprehensive plan for underwater historic resources.

Finally, VMRC and DHR worked together this fall to obtain the first conviction for a violation of the state Underwater Historic Properties Act. This case is not being publicized until it is known whether or not it will be appealed. Virginia has also joined Florida and other states in an amicus curiae brief supporting the constitutionality of the Abandoned Shipwreck Act now being challenged in an Illinois case.

2. The Virginia law allows for complete access to any underwater historic property unless otherwise designated by VMRC. Currently no site has been set off-limits. While allowing free access, the Virginia law does not allow the removal of artifacts or other forms of damage to shipwrecks once they have been determined historic. However, budgetary constraints limit this aspect of management to allowing access rather than encouraging it through interpretative parks and programs.

Puerto Rico (Marisol J. Melendez Maiz)

The Council of Underwater Archaeology is the operating arm of the Council for the Conservation and Study of Underwater Archaeological Sites and Resources, ascribed to the Institute of Puerto Rican Culture. The Council was created by Public Law #10 of the Commonwealth of Puerto Rico, approved August 7, 1987. The Office was established in January of 1990 and with the Council is responsible for identification, protection, and conservation of sites and artifacts; setting standards for declaring a site to be of public interest according to its cultural, scientific, and educational value; searching for, identifying, and assuming custody of the sites; promoting the scientific investigation, protection, and conservation of sites; and establishing and maintaining a site register.

Since its establishment, the Council has developed a management plan for the protection and preservation of underwater sites. The management plan is four-fold including a list of known shipwrecks from published literature and previous research in Puerto Rico, a document program for archival research related to historic shipwrecks, a public relations' campaign among various groups to explain the law and discourage treasure hunting, and the establishment of a conservation laboratory for underwater artifacts, the first of its kind on the island. Also, the Council has received and approved three proposals, granting the applicants permits for exploration or excavation. The Council recently approved a proposal establishing an underwater archaeological reserve, which will be the first one in Puerto Rico.

Illinois (Thomas E. Emerson)

1. Illinois has implemented shipwreck management and research programs only within the broader context of the state's historic resources program. The approach has been consistent with a philosophy of a uniform policy for all historic resources. State statutes simply list shipwrecks as one of many types of historic resources that need protection and management. The Illinois Archaeological and Paleontological Resources Protection Act (Ill. Rev. Stat. 1989, ch. 127, par. 133c01, *et seq.*) sets up a permitting system to control archaeological investigations and research. The law also makes disturbance of the resources punishable by criminal and civil penalties.

Over the last three years volunteers from the dive community have worked on several recordation projects aimed at producing National Register Forms. To date they have mapped *David Dows*, a badly vandalized five-masted schooner, and *Wells Burt*, a largely intact schooner, and collected relevant historic documentation.

Illinois has not been able to add any personnel to the historic resources' staff with expertise in underwater archaeology nor provide any funding beyond one $3,000 Historic Preservation Fund grant to the Chicago Maritime Society for expenses while working on the *David Dows* project.

2. No shipwrecks in Illinois are off-limits to the public. This is in keeping with a general policy of not restricting public access to any of the archaeological or historical sites owned and managed by the state. In the *Wells Burt* project, volunteers recorded and tagged all of the artifacts, including loose artifacts on deck, and removable portions of the shipwreck. Signs were attached to the ship informing people of the ship's history and state law. The site was then made available to the public. In three years there has been only one case of vandalism. In that instance, about a dozen artifacts and ship parts were stolen and the signs vandalized. While the loose artifacts have now been removed, the rest of the ship is still open to the public. The state police are investigating the case and there is a $2,000 reward for information leading to the arrest of the vandals.

Michigan (John Halsey)

1. In 1980, the Michigan Legislature passed Public Law 184 providing the legislative underpinnings for regulation of salvage, shipwreck protection, and the establishment of bottom land preserves. The law confirmed the direction that officials in the Department of Natural Resources and Department of State had taken in trying to manage shipwrecks in the absence of existing regulatory legislation. The 1980 legislation was revised and strengthened in 1988 with the passage of Public Act 452.

However, the legislation, as progressive as it was, contained no provisions for additional staff or any dedicated funding. On the positive side, a bureaucratic structure long predisposed to protect shipwrecks now viewed them as an inherent responsibility. After the passage of the 1980 law, several violations were aggressively prosecuted and the state demonstrated its intentions to enforce the law to a somewhat skeptical sport diving community. The 1988 law created a broader membership in the Underwater Salvage and Preserve Committee and encouraged broader attendance by representatives of the dive community at this committee's meetings.

A preserve support group developed for each bottom land preserve, and these groups have provided the main source of actual public involvement with the resources. It was quickly apparent to these groups that preservation of shipwrecks made excellent financial sense, and a series of surveys over the years have confirmed the importance of sport diving in the local economy. Each preserve has published a brochure describing its shipwrecks and other attractions. It is not surprising that charter boat operators have been the prime movers in most preserves. Individual preserve support groups have secured grants, created museums, or established working relationships with existing museums, undertaken recording projects, and developed training courses in basic archaeological recording techniques, all in cooperation with the state. An umbrella group representing all the preserves has also come into existence.

The Michigan Sea Grant College program at Michigan State University has had an active interest in shipwreck preservation and the financial repercussions of shipwreck preservation. Sea Grant's staff expertise and professional contacts throughout the country have been invaluable in developing projects conducive to positive shipwreck management practices.

Michigan's Costal Zone Management program in the Department of Natural Resources has been very responsive to the needs of shipwreck preservation and interpretation, and its grant program was particularly important in the completion of the Michigan Maritime Museum's excavations and preliminary publication of the results of work on the scow schooner ***Rockaway*** and the development of a new video mosaic system tested on the schooner ***Alva Bradley***. Other branches of the Department of Natural Resources continue to take aggressive action in cases of theft from shipwrecks and in the processing of requests for new bottom land preserves. This agency also has received no additional staff or funding for the additional responsibilities incurred under the new laws.

The Bureau of History of the Michigan Department of State has progressively increased its involvement in shipwreck management and interpretation. Since 1989 the Bureau has mounted a major exhibition on underwater archaeology in the Great Lakes seen by more than 250,000 people and published a popularly oriented book, ***Beneath the Inland Seas: Michigan's Underwater Archaeological Heritage.*** It has nominated two shipwrecks to the National Register of Historic Places and seen three staff members certified as open water divers, two with training in basic underwater recording techniques.

2. The problem of appropriate nondestructive private sector access to historic shipwrecks has never been a problem in Michigan. State law guarantees access to wrecks and there is little, realistically, that the state could do to restrict access, even if it wanted to. With an area of more than 38,000 square miles, enforcement of an access prohibition would be impossible. Recently published books such as Steve Harrington's *Divers Guide to Michigan* stress diver responsibility in preserving the resource. Michigan's bottom line is that unrestricted public access does have its dangers, but a willingness to be open with the public, especially sport divers, and the problems presented by the lack of funding of a state program has created a common sense of stewardship unmatched anywhere in the Great Lakes.

Minnesota (Scott Anfinson)

1. In response to the Abandoned Shipwreck Act of 1987 (PL 100-298), the Minnesota Historical Society (MHS) requested funding from the Legislative Commission on Minnesota Resources (LCMR) to develop a shipwreck management strategy for the Minnesota waters of Lake Superior. The MHS was granted significant funding for the 1989-1990 state biennium to begin this task and received a second grant for the 1991-1992 biennium. A third Lake Superior shipwreck proposal has been submitted to the LCMR for the 1993-1994 biennium. The State Historic Preservation Office (SHPO) of the MHS has been managing the Minnesota shipwrecks' project. All the work completed to date has been accomplished through contracting with recognized underwater archaeologists and maritime historians.

The first phase of the project has been finished and consisted of the following elements:

a. completion of a Multiple Property Definition Form (MPDF), which provides the historical context for Lake Superior shipping as well as defining property types and registration requirements,

b. establishment of a comprehensive inventory of shipwrecks that are known or suspected to have occurred in Minnesota waters,

c. survey of and National Register nominations for *Thomas Wilson* and *Madeira*, and

d. survey of and National Register nominations for *Onoko* and *A.C. Adams*.

Phase Two of the Minnesota shipwrecks projects is underway and consists of the following elements:

a. shoreline and near shore survey of the Split Rock State Park vicinity,

b. survey of and National Register nominations for *Essex*, *Amboy*, and *Hesper*,

c. survey of and National Register nominations for two or three shipwrecks yet to be determined, and

d. development of a master management plan and public education (brochure, poster, video, book). Contracts have been implemented for the first two projects of this phase.

Should it be funded, Phase Three will consist of:

a. completion of an expanded MPDF for Lake Superior shipping to include non-vessel elements such as docks, navigation aids, and fishing villages,

b. surveys of shoreline and harbor features, especially Duluth Harbor, and

c. sponsorship of a major conference on Lake Superior shipping.

2. While the SHPO is responsible for undertaking the historical and archaeological study of Lake Superior shipwrecks, promoting non-destructive private sector access is a responsibility shared with the Minnesota Department of

Natural Resources (DNR). The DNR was granted LCMR funds to study the feasibility of developing a diver facility at Split Rock State Park. Split Rock was chosen because a well-known, accessible wreck, *Madeira*, is nearby and a major historic site, Split Rock Lighthouse, is already within the park. The SHPO-sponsored survey of a 15 mi. stretch of shoreline near Split Rock, to take place in the summer of 1992, will hopefully find additional cultural resources in the vicinity to allow for a multifaceted diving experience.

Of all the states affected by the Abandoned Shipwreck Act, Minnesota has perhaps the most manageable supervision responsibilities. There are only 50 to 60 shipwrecks in Minnesota waters of Lake Superior, of which about half have known locations. Many wrecks are in deep water, beyond the effective reach of sport divers and economical salvage. The variety of these shipwrecks is considerable, however, and they offer a rich resource worth protecting, studying, and interpreting.

Ohio (Jay C. Martin)

1. In December 1991, the governor of the State of Ohio signed House Bill 264, legislation aimed at establishing a method of managing underwater cultural resources in the Ohio waters of Lake Erie. Previous attempts over the previous five years to obtain similar legislation had met with defeat, largely due to the inability of preservationists to draft legislation that would effectively protect historic and archaeological resources while allowing free recreational access and controlled commercial salvage.

The deadlock was broken when commercial salvors filed for permit to recover items from the Great Lakes steamer *Anthony Wayne* (1837-1850). A permit application was submitted to the Department of Natural Resources and subsequently referred to the State Attorney General who decided in December 1990 that the state could not issue a permit because current statutes provided no specific mechanism for granting permission to salvage. The decision triggered a cooperative effort among the various interest groups to draft legislation that would adapt the recommendations contained in the National Park Service guidelines to the specific needs of Ohio. The result was Ohio House Bill 264, a bill that passed both the House and Senate unanimously, and will go into effect in March 1992.

House Bill 264 recognizes state responsibility for abandoned shipwreck and aircraft sites in the Ohio waters of Lake Erie. The Ohio Department of Natural Resources is the agency charged with implementing the provisions of the bill, but the Ohio Historical Society is responsible for evaluation of historical and archaeological submerged resources.

Part of the management program will consist of establishing Submerged Land Preserves in which the recovery of objects will be prohibited except for archaeological research. There may be any number of preserves, but each can be no larger than 300 $miles^2$ and their combined area is not to exceed ten percent of Ohio's total underwater land area. Criteria for establishing preserves will include the recreational, historical, and archaeological value of area resources.

Recovery of artifacts may occur outside the preserves without prior permission if the artifacts are not associated with a shipwreck or other archaeological site, are valued at less than $100, and require no mechanical devices for recovery. Removal of artifacts that exceed these limitations require prior written application to the Department of Natural Resources for review within 60 days by both the DNR and the Historical Society. One year permits for commercial salvage of sites determined to be of minimal archaeological, historical, or recreational value are allowed, but possession of all artifacts determined by the state to be of historical or archaeological value will be retained. The state will receive payment from the salvor for 10 percent of all artifacts not of historical value, and 20 to 40 percent of any gold or specie found during salvage.

The bill encourages public participation in the decision-making process by creating a seven member Submerged Lands Advisory Committee made up of representatives of the DNR, Historical Society, recreational diving groups, commercial salvors, historians, archaeologists, and other interested parties. The Advisory Committee may recommend action in determining the boundaries of preserve areas, the issuing of salvage permits, and the creation of policies and rules needed to implement the provisions of the bill.

Penalties related to the illegal removal of objects range from a third degree misdemeanor for a first offense to a fourth degree felony for the third or any subsequent convictions. On a third or subsequent offense, the conviction requires the seizure and sale of all dive gear, boats, or any other tools or equipment used in the illegal removal of artifacts.

Funds received from the sale of non-historic artifacts or equipment confiscated from illegal recovery operations will be credited to the Lake Erie Submerged Lands Preserves Fund. These funds will be used to enhance the effectiveness of the management program and to assist in the establishment and maintenance of preserves. Emphasis will be on educational programs, better recreational access to dive sites, the development of archaeological and historical research projects, and the support of volunteer efforts to document Ohio shipwrecks. The responsibility for locating, identifying, and evaluating cultural resources in Lake Erie lies with the Ohio Historical Society. The Society is authorized to recruit, train, and supervise volunteers to assist in this effort. The bill also allows the DNR to hire or contract with an underwater archaeologist and/or maritime historian, but does not provide funding to support these activities.

2. The current division of responsibility between the Department of Natural Resources and the Historical Society is intended to balance the recreational uses of these sites against their archaeological and historical value. The Ohio program follows the Michigan example by encouraging the participation of recreational divers in the location and non-destructive documentation of historic shipwrecks and in the establishment and management of underwater preserves. Through cooperative regional educational efforts, such as the Association for Great Lakes Maritime History's "Diver Manual," divers can be taught to take a non-destructive approach to historic shipwrecks. Such efforts will help Ohio manage its resources while directing the energies of recreational divers to assist in this process.

Wisconsin (Bob Birmingham)

1. In January 1988, the Wisconsin state legislature provided initial funding for the State Historical Society to conduct a pilot study of state underwater archaeological resources, with an eye to improving the management of historic shipwrecks and the development of marine preserve areas for resource protection and recreation. This pilot program was dovetailed with new state and federal efforts to protect and manage submerged cultural resources in Wisconsin by the 1988 State Omnibus Historic Preservation Act and the federal Abandoned Shipwreck Act of 1987.

The pilot study began with a statewide historical inventory aimed at identifying types and locations of reported or potential submerged cultural resources. This initial inventory of 700 sites was used to assess the potential for submerged cultural resources in given areas of state bottom lands to aid in planning archaeological field surveys.

Since 1988, the State Historical Society of Wisconsin has conducted reconnaissance surveys, mapping, and other documentation on nearly 40 different underwater archaeological sites. These sites have ranged from inundated 18th-century fur trading posts, to 19th-century Great Lakes' schooners and steamers, to 20th-century fishing and logging vessels. This work has resulted in a series of technical publications, six individual nominations to the National Register of Historic Places (NRHP), as well as a multiple property NRHP nomination for Great Lakes' shipwrecks.

While much of this work has been conducted using volunteers and university field schools employing simple sketching, mapping, and photographic methods, joint projects with other institutions and governmental agencies have allowed the state underwater archaeology program access to research vessels, sophisticated remote-sensing equipment, and infrared and microwave survey equipment. Funding, staffing, and in-kind assistance for projects has come from University of Wisconsin Sea Grant, East Carolina University, Wisconsin Coastal Management Program, University of Wisconsin Marine Studies Center, the U.S. Army Corps of Engineers, and the Apostle Islands National Lakeshore. The state underwater archaeology program was nominated by the State of Wisconsin to the Kennedy School of Government's Innovations in Government award for its creative approach to operational funding.

The state underwater archaeology program has also been very active in the public education sphere, providing more than 30 public presentations and workshops on shipwreck preservation in the past year alone. Program staff have worked to cultivate good relations with the dive community, helped form the Wisconsin Underwater Archeological Association (a volunteer diver archaeology and preservation group), contributed to the 1991 *Diver's Guide to Wisconsin*, authored a chapter in a manual in shipwreck preservation for the Association for Great Lakes Maritime History, and generally have sought to use education, outreach, and the fostering of a stewardship ethic to gain diver support for shipwreck preservation and management.

The systematic documentation and evaluation of Wisconsin's shipwreck resources has been important in integrating these sites into state and federal resource management and preservation programs, including the National Register program, and Section 106 project reviews. The submerged cultural resource inventory is also helping to define several areas for consideration both as state marine preserves, based on the Michigan model, or as National Marine Sanctuaries. Legislation for a system of state preserves is pending, as well as an evaluation of a National Marine Sanctuary candidate. Future program efforts are to include greater involvement in public education (especially sport-diver education), expanded resource surveys, development and analysis of a shipwreck database, development of predictive models of spacial and temporal distribution of Wisconsin shipwrecks, and development of a statewide submerged cultural resources' management plan.

2. Appropriate nondestructive private sector access to historic shipwrecks is taken quite literally in Wisconsin. There are no restrictions to this type of access in state waters, but artifact collecting and other destructive activities are simply not allowed on wrecks more than fifty years of age on state bottom lands, and the law is backed by penalties of up to $5,000. The sole exception to unrestricted access is in National Lakeshore waters, where dive permits are issued free of charge by the National Park Service. One wreck site within the park is currently not open to diving due to its archaeological sensitivity. This restriction has the support of many divers, including the local dive charter, and has not been actively challenged.

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