

EIGHTEENTH-CENTURY COLONIAL AMERICAN MERCHANT  
SHIP CONSTRUCTION

A Thesis

by

KELLIE MICHELLE VANHORN

Submitted to the Office of Graduate Studies of  
Texas A&M University  
in partial fulfillment of the requirements for the degree of

MASTER OF ARTS

December 2004

Major Subject: Anthropology

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Approved as to style and content by:

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Kevin Crisman  
(Chair of Committee)

---

Donny Hamilton  
(Member)

---

James Rosenheim  
(Member)

---

David Carlson  
(Head of Department)

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## ABSTRACT

Eighteenth-Century Colonial American Merchant

Ship Construction. (December 2004)

Kellie Michelle VanHorn, B.S., Indiana University

Chair of Advisory Committee: Dr. Kevin Crisman

Past research on eighteenth-century ships has primarily taken one of two avenues, either focusing on naval warship construction or examining the merchant shipping industry as a whole in terms of trends and economics. While these areas are important to pursue, comparatively little is known about actual construction techniques used on the ordinary merchant vessels of the period. Most modern sources emphasize hull design and lines drawings; contemporary sources take a similar direction, explaining the theory of ship design but often leaving out how to put the ship together. In recent years, however, new information has come to light through archaeological excavations regarding Anglo-American merchant ship construction. In this study, several of these shipwrecks were examined in light of economic factors and the literary evidence from the period in an attempt to gain a better understanding of colonial American merchant ship construction in the eighteenth century. While the data set was not large enough to make conclusive statements, this type of comparative analysis should begin to establish a framework for the interpretation of future shipwreck excavations.

For my parents,  
who taught me to pursue excellence,  
and for Jason,  
who never stopped believing in me.

## ACKNOWLEDGMENTS

This thesis and my graduate work would not have been possible without the help of many people. My grateful thanks go to my advisor, Dr. Kevin Crisman, for his direction, patience, and many suggestions during the completion of this work, and also to my other committee members, Dr. Donny Hamilton and Dr. Jim Rosenheim, for generously giving their time to help me. Thanks also to Chris Sabick, who graciously allowed me to look at his thesis before it was publicly available. I also want to acknowledge my fellow classmates; I could never have learned so much without their help and the patient instruction from the faculty in the Nautical Archaeology Program.

My thanks go to my parents, Gary and Denise, and my brother Matt, for their help in editing and their love, support, and faith. I also want to thank my parents-in-law, Marsha and Lee, for their encouragement. To my wonderful husband Jason, I give my deepest thanks. His patient help in editing, scanning images, and staying up with me on late nights was invaluable, but most of all I appreciate his love, strength, and gentle kindness. He probably knows more about ships than any other geographer. My thanks go also to my other writing companion, our little cat Madison, who faithfully kept me company by sleeping on my desk while I worked and only occasionally knocked all of my papers off onto the floor. Finally, if I have accomplished anything of merit, it is only because of the grace and strength of my Savior and King, Jesus Christ, who allowed me to do what looked like the impossible: “I can do all things through Christ who strengthens me.” Philippians 4:13.

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## CHAPTER I

### INTRODUCTION

The eighteenth century was an important period in the age of the wooden sailing ship. Shipwrights were expanding on design innovations from the seventeenth century and building vessels of increasingly larger size. As steam engines would not be introduced until the nineteenth century, ships were still powered completely by sail, or occasionally with sweeps. In the pursuit of various qualities such as speed or economy, shipbuilders experimented with new types of rigs. England's Royal Navy was the dominant force on the seas, although multiple wars during the eighteenth century periodically threatened its power. This period also saw England's dominance in the New World and the expansion of its colonies, until that authority collapsed during the American Revolution. Shipbuilding and the shipping industry were critical elements of the economy, wars, and colonization efforts of England and the other major world powers.

Despite the importance of shipbuilding during the eighteenth century, the subject has not been extensively studied. Although a fair amount is known about British and American eighteenth-century warships, much less has been written about merchantmen from the period. R. Davis observed this problem in 1962, writing, "No expert on ship design has ever examined in any detail the ordinary merchant ship of the seventeenth

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This thesis follows the style and format of *American Journal of Archaeology*.

and eighteenth centuries...”<sup>1</sup> Modern scholars have tended to focus on British warships because of the abundance of sources available, including naval treatises, archaeological remains, iconography, and Royal Navy plans and lines drawings. Works such as P. Goodwin’s *The Construction and Fitting of the English Man of War, 1650-1850* and B. Lavery’s *The Arming and Fitting of English Ships of War, 1600-1815* are two excellent examples of the type of resources available.<sup>2</sup> These books provide detailed information on the construction and outfitting of English warships.

Scholars wanting to research merchant ship construction from the period face a paucity of contemporary written information in comparison to what is available on warships. Because merchant ships were considered commonplace, they were rarely discussed in detail by contemporary authors. Most of the naval treatises from the seventeenth and eighteenth centuries focus on warship construction, perhaps including a draft or two of a merchant ship. One exception is Fredrik af Chapman’s *Architectura Navalis Mercatoria* of 1768, which consists of several plates showing lines drawings of both typical and more unusual merchant vessels of various nationalities.<sup>3</sup> Helpful as the work is in looking at and determining vessel shapes, it provides little information on actual construction practices. Although treatises are useful to some degree, knowledge about eighteenth-century colonial American merchant ship construction has advanced primarily through archaeological excavations.

Unfortunately, most modern sources on eighteenth-century British and American merchant ships do not incorporate much archaeological data. For the most part, the authors focus on lines drawings and shipping records, discussing vessel forms, rigging,

and trade in general. Examples include D. MacGregor's *Merchant Sailing Ships, 1775-1815: Sovereignty of Sail*, R. Gardiner's *The Heyday of Sail: The Merchant Sailing Ship, 1650-1830*, and H. Chapelle's *History of American Sailing Ships*.<sup>4</sup> Although these works contain useful information, they rarely provide details on actual ship construction techniques. Within the last two decades, after many of these books were written, several British and colonial American merchant ships have been located and documented. Other than an article by J. Morris et al. on a theory of framing evolution, little synthesis of the various remains has been done.<sup>5</sup> The goal of this thesis is to help rectify this problem by providing a comparative analysis of Anglo-American merchant ship construction based on archaeological data from both British and American shipwreck sites. In addition, literary evidence from the period, in the form of treatises and reports, is incorporated into the study to compare the archaeological remains with the instructions of contemporary shipwrights.

### **Research Questions**

The main focus of this research has been to examine eighteenth-century Anglo-American construction techniques in merchant vessels based on archaeological and literary evidence. The data was analyzed in the context of contemporary economic and political factors in an attempt to gain a better understanding of colonial American shipbuilding. This century represents a critical period in both English and American history, with the growth of the American colonies and the ensuing War of Independence in the 1770s. Alongside these changes came the development of the shipbuilding

industry in the colonies, first as an outgrowth of the British industry and then as its own entity.

With these considerations in mind, three main questions were addressed in this study. First, the archaeological evidence was examined for any major trends visible in the actual construction. In addition, this data was evaluated in light of the literary sources to determine whether the archaeological examples reflect what was written in contemporary treatises. Second, the relationship between hull design and a vessel's intended trade or use was considered; comparison with examples of warships and small river craft provided additional insight. Third and finally, American and British vessels were compared to look for differences in construction. Possible reasons for any divergence in techniques between the two industries were considered, especially in light of economic and political factors during the period.

### **Sources of Data**

Primary sources used in this study included archaeological reports and literary documents in the form of dictionaries and treatises from the seventeenth and eighteenth centuries. Rather than being an exhaustive survey of all material available on merchant ships from the period, this work focuses on the main construction techniques used by eighteenth-century colonial shipwrights as evidenced by archaeological data, with the emphasis on merchant vessels capable of coastal or trans-oceanic voyaging. As many published excavations of Anglo-American New World shipwrecks as possible have been incorporated to provide the most data for analysis. Colonial-built, sea-going merchant

ships included: the Phips wreck, anse aux Bouleaux, Quebec (pre-1690); the Ronson ship, Manhattan, New York (1700s-1740s); the Rose Hill wreck, Northeast Cape Fear River, North Carolina (1725-1750?); the Terence Bay vessel, Halifax, Nova Scotia (pre-1750s); the Reader's Point sloop, Jamaica (pre-1765); the Otter Creek wreck, Oriental, North Carolina (1770s); the privateer *Defence*, Penobscot Bay, Maine (1779); and the Clydesdale Plantation vessel, Back River, Georgia (1790s?).<sup>6</sup> The three main British merchant ships evaluated were the Bermuda collier, Chubbs Head Cut, Bermuda (pre-1770s); the *Betsy*, Yorktown, Virginia (1772); and the *Nancy*, Ontario, Canada (1789). Also included for comparison with these merchant vessels were five warships, mainly British: the Port Royal wreck, Port Royal, Jamaica (pre-1692); the *Boscawen*, Lake Champlain, Vermont (1759); the Deadman's Island wreck, Pensacola, Florida (1776-1781); the Cornwallis Cave wreck, Yorktown, Virginia (pre-1781); and the *Charon*, Yorktown, Virginia (1778). Finally, two small riverine craft were also considered: the Brown's Ferry vessel, Black River, South Carolina (pre-1740s) and the Town Point vessel, Pensacola, Florida (1763-1781). Figure 1 shows a map of these vessel locations.

Detailed information about the important features of each of these vessels is discussed in Chapter V. A table presenting the main scantlings may be found in Appendix A. Before the archaeological data can be interpreted, the historical background of the period must be considered to establish a framework for analysis. An overview of hull types and rigs is also provided, as well as a synopsis of the important points from

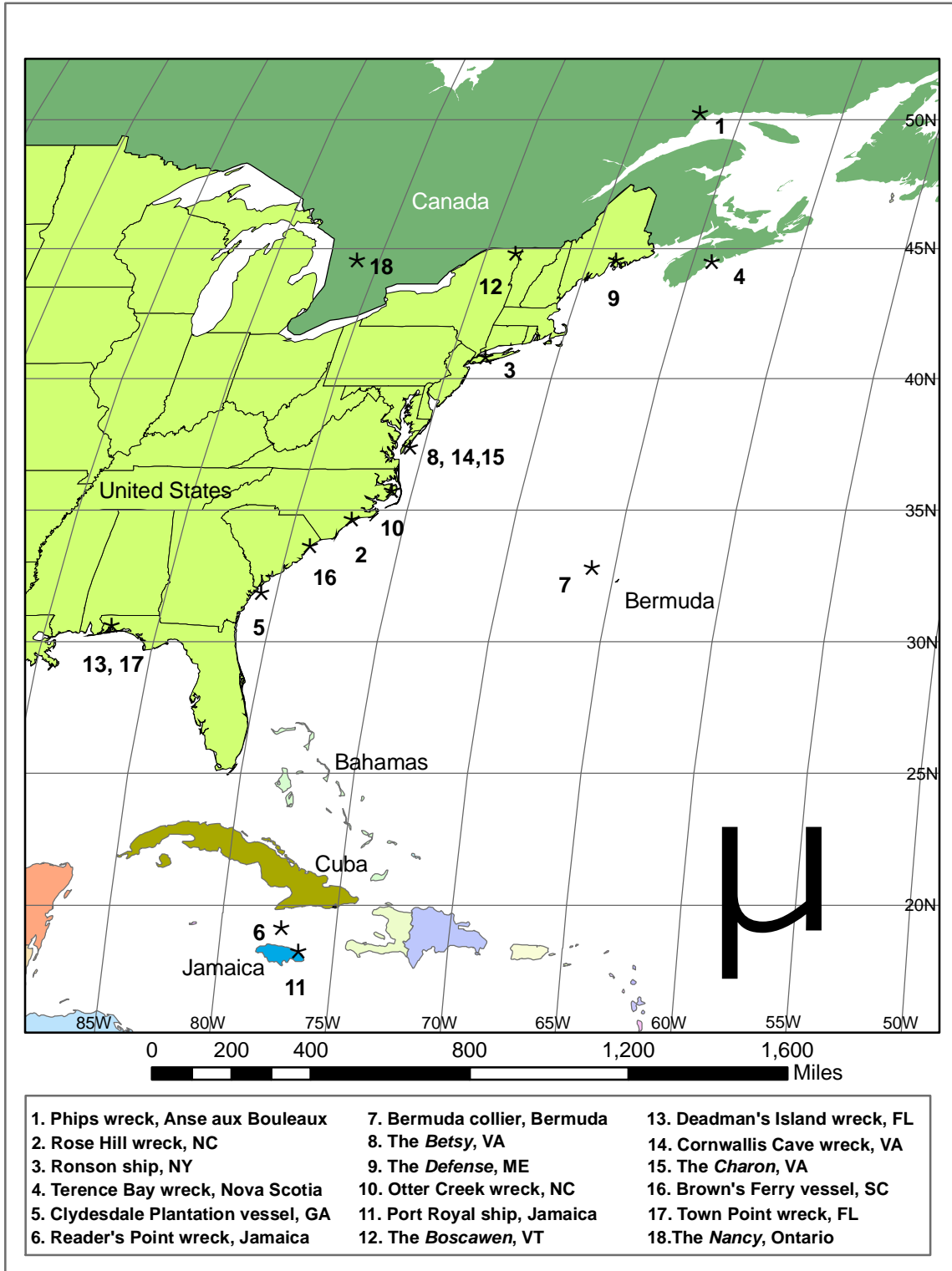


Figure 1. Shipwreck locations. (Courtesy of Jason VanHorn).

the major contemporary literary sources. With this information, the archaeological data can be analyzed in an effort to better understand colonial shipbuilding techniques.

### **Endnotes**

<sup>1</sup> Davis 1962, 71.

<sup>2</sup> Goodwin 2001; Lavery 1987.

<sup>3</sup> Chapman 1971.

<sup>4</sup> MacGregor 1988; Gardiner 1995; Chapelle 1935.

<sup>5</sup> Morris et al. 1995.

<sup>6</sup> Dates in this list refer to the approximate date of construction.



## CHAPTER II

### HISTORICAL BACKGROUND: SHIPBUILDING IN GREAT BRITAIN AND THE AMERICAN COLONIES

By the seventeenth century when the first American colonies were founded, England had developed into a major maritime power and its shipbuilding industry played a crucial role in the British economy. Merchant shipbuilding activities centered on yards in London, Newcastle, Liverpool, Whitby, Bristol, Yarmouth, Ipswich, and several other locations during the seventeenth and eighteenth centuries.<sup>1</sup> Major areas of trade included: bulk goods from northern and eastern Europe, such as timber, grain, fish, tar, and metals; valuable luxury items from southern Europe and the East Indies; coal from northern England to London and the continent; and, with the founding of the colonies, sugar and rum from the West Indies and tobacco, rice, indigo, timber, and fish from North America.

At the beginning of the seventeenth century, the English predilection for defendable ships was clearly seen in the design of their merchant vessels, favoring speed at the expense of cargo capacity and closely resembling naval ships in their sharp lines and armament. The similarities were so close that larger merchantmen were used in the line of battle through the middle of the century. After this period, only the warship-like East Indiamen continued to be useful in actual combat, but other merchant vessels were still employed for less hazardous military purposes, such as transporting men and supplies.<sup>2</sup> The impetus for change in the general design of British merchant ships came

as a result of the three Dutch Wars (1652-1654, 1664-1667, and 1672-1674) during the mid-seventeenth century. The English merchants, already in competition with the Dutch in most spheres of trade, could not operate their vessels nearly as efficiently as the Dutch in the bulk cargo trades. The Dutch flyboat, or flute, was a slow, capacious vessel that was cheap to build, sailed unarmed, and carried a simple rig, allowing the use of a small crew in proportion to its size. Flyboats traveled in convoys to provide safety in the absence of armament or speed.<sup>3</sup> The Dutch Wars provided English merchants with the chance to use flyboats for themselves, in the form of prizes of war. After a few years of using the flyboat, English merchants were no longer content to return to their style of ships and began to demand a change from the shipwrights.<sup>4</sup> The shipbuilders, however, were resistant to change and preferred their traditional plans, especially in London, East Anglia, and the other major shipbuilding regions, even though they had captured flyboats as models for new design. Consequently, when the northern ports such as Newcastle began to supply a type of large bulk carrier for the coal and timber trades, the center for British shipbuilding shifted to the north and away from the old yards.<sup>5</sup>

A major economic factor for England during the seventeenth century was the founding of colonies in North America. Following their early exploration of North America in the fifteenth century, Europe's maritime powers began a protracted competition to colonize the continent. While Spain claimed lands in the Caribbean, Central America, and Florida, most of North America was left to the English, French, and Dutch. English efforts at colonization were sporadic at first, with an initial unsuccessful attempt at Roanoke Island in North Carolina in 1585. The first permanent

settlement was founded in Jamestown, Virginia in 1607, followed by Plymouth, Massachusetts in 1620. Other successes included Connecticut in 1633, Maryland in 1634, and several other colonies with Georgia being the last of the original thirteen in 1733. The colony of New York was captured from the Dutch when the city of New Amsterdam was conquered in 1664. By the time the last settlement was founded, the British colonies dominated the eastern seaboard from Georgia to Maine and the population had grown from 5000 in 1630 to over a quarter million; by the American Revolution in 1775, it would reach two and a half million.<sup>6</sup>

The success of the colonies depended both on their ability to utilize natural resources and on the arrival of ships from England, bringing new colonists and much-needed supplies. While some materials were readily available to the colonists in North America, including food and building supplies, they depended heavily on England for manufactured goods and luxury items.<sup>7</sup> In exchange for these goods, the colonists, who had little access to currency, made purchases using credit from English merchants or traded bulk items. The southern and middle colonies quickly focused on the production of raw materials and foodstuffs sought after by the British; large plantations farmed sugar, tobacco, rice, indigo, and cotton for export. Because of the abundance of these bulk goods, trade with the southern colonies developed into one of the largest sectors of England's shipping industry. With so many merchants eager for trade, the southern colonies were slow to develop their own manufacturing and shipbuilding industries, instead remaining dependent on England throughout much of the eighteenth century.<sup>8</sup>

Almost the opposite conditions occurred in the northern colonies. Without the cash crops of the south, the northern colonies had a difficult time attracting British merchants and often could not get credit for purchasing, with merchants demanding payment in cash instead. Even the formation of strong fishing and lumber industries did not alleviate the problem, as these commodities were not as valuable to British merchants as goods from the southern colonies. With little ability to attract English ships for trade, it quickly became apparent that New England merchants would need to establish their own trade routes and shipbuilding industry to earn cash and credit for commerce with England.<sup>9</sup> As a result, New England became the center of the burgeoning colonial shipbuilding industry during the mid-seventeenth century.<sup>10</sup> New England merchants focused on inter-colonial trade and the West Indies trade. Ships carried timber and fish to the West Indies, brought sugar and molasses from the West Indies to England, and returned to the colonies with English manufactured goods.<sup>11</sup>

International trade increased with the founding and growth of the colonies as well. Competition was most fierce with the Dutch during the seventeenth century; in an attempt to protect its trade interests with the colonies and the West Indies, England passed a series of legislative acts called the Navigation Acts. The First Navigation Act of 1651 required that most products imported into England be carried only on British or colonial-built ships with crews at least three-quarters British. Foreign merchants could only bring the produce of their own countries to England. Poor enforcement of the law resulted in continued illegal trade by other nations, particularly the Dutch, with the West Indian and American colonies. The Second Navigation Act of 1660 went further in

attempting to stifle this trade, mandating that European cargoes intended for the colonies be shipped through British ports first. In addition, a list of enumerated goods was created, naming specific commodities from the colonies, including tobacco and sugar, that had to be shipped through British ports before being sent elsewhere in Europe. In 1674, the law was further extended to place duties on cargoes shipped between colonies.<sup>12</sup> These laws initially strengthened the established British merchant marine and provided important protection for the growing colonial shipping industry. As trade and shipbuilding increased, however, the colonists began to feel constricted by the strict legislation and smuggling became rampant.<sup>13</sup>

With the stringent shipping requirements, shipbuilding became increasingly important in the colonies to provide sea-going vessels. Additionally, the lack of paved roads in the seventeenth century meant that transporting goods or people between colonies was faster by water than by land.<sup>14</sup> Fortunately for most of the colonies, quality timber for ship construction and iron for fasteners were readily available. Sailcloth, cordage, and manufactured fittings initially had to be imported from England.<sup>15</sup> Building and outfitting a ship required a large investment and success was not guaranteed. To put up the necessary capital, several merchants often split the cost into shares, which had the added benefit of minimizing potential losses. As English merchants began to invest in the growing New England fishing industry, colonial merchants had more capital to expand shipbuilding and trade.<sup>16</sup>

The eighteenth century saw continued growth in the colonial shipbuilding industry. Major yards developed at Boston, Newport, New London, New York,

Philadelphia, Norfolk, and Charleston. The most marked expansion occurred during the beginning of the century, spurred on by the loss of English merchant ships during King William's War (1689-97) and Queen Anne's War (1702-13).<sup>17</sup> Enemy attacks, especially by privateers, meant the loss of many English-built merchant ships, a decline in commerce, and an increase in shipbuilding costs. In addition, the Royal Navy often hired British merchant vessels to serve as transports during war, meaning the loss of more shipping.<sup>18</sup> By contrast, the colonial industry had an extensive supply of cheap timber and iron and American vessels were constructed more quickly than English ships.<sup>19</sup> When not enough tonnage could be recovered through prizes of war, English merchants could purchase colonial-built vessels. Despite the lower cost of colonial shipping, most English merchants held a strong prejudice against American-built vessels, claiming that they were inferior to English ships. This bias appeared to be national, as even the Navy Board expected American ships to last no more than four or five years and tried to avoid the building of warships in the colonies, even though timber was cheaper and far more available than in England. It appears that American shipwrights earned this reputation for their vessels by using wood that had not been properly seasoned, causing it to rot much quicker than thoroughly dry timber.<sup>20</sup> Many British merchants must have overlooked these potential problems in favor of the lower costs, however, because some estimates suggest that as much as one third of British-owned ships were colonial-built by the time of the Revolution.<sup>21</sup>

As noted above, the colonial shipwright's major advantage was an abundance of raw materials for ship construction, especially timber. White oak, the most common

shipbuilding timber in England, was available in abundance in the colonies during the eighteenth century, as was red oak. The southern colonies also had large forests of live oak, a wood that far surpassed white oak in durability and strength but was heavy and difficult to work. Other, less frequently used types of shipbuilding timber, such as pine, maple, beech, birch, hickory, ash, and cypress, were also plentiful.<sup>22</sup> While the extent of England's timber shortage has possibly been overestimated in the past,<sup>23</sup> the increasing sizes of warships and need for merchant vessels produced a demand on forests that was greater than tree stand growth rates. Clearing of land for cultivation and building would have further reduced the amount of available trees in England.<sup>24</sup> The first types of timber to run out would have been large, straight trees for masts and naturally curved pieces, or compass timber, for frames and knees. As England's native forests were depleted, the timber trade with the Baltic and the American colonies took on increasing importance.<sup>25</sup> As a result, England established the broad arrow policy in the colonies in the late seventeenth century to preserve mast-quality trees for Royal Navy warships; pines with a diameter of 24 in (61 cm) or more were marked with a broad arrow to reserve them. In addition, ship and mast timber was added to the list of enumerated goods in 1729, further preserving the government's interests by requiring timber to be shipped through English ports.<sup>26</sup> Even though it is clear that a shortage of timber never prevented England from building ships, colonial shipwrights had ready access to an ample supply and this difference was probably reflected in how vessels were constructed.

When English merchants did purchase American ships, they tended to buy larger vessels than the colonists, mainly because they had more capital to invest and their trade

routes operated more efficiently with larger cargoes. Additionally, while colonial-owned vessels were found primarily in inter-colonial and small-scale West Indies trade, British-owned ships dominated transatlantic routes between England and the colonies.<sup>27</sup> Larger ships were needed to carry bulk cargoes of sugar and tobacco back to England. Colonial merchants, on the other hand, generally purchased small ships or sloops and schooners for coastal trade.<sup>28</sup> In addition to ordering their own vessels, the American merchants often acted as middlemen between British purchasers and colonial shipwrights to coordinate the construction of a vessel. Sometimes the British merchant would send the future master of the ship to the colonies to oversee the building process. They also might send the necessary cordage, sailcloth, and fittings to the shipwright specifically for their vessel. Some colonial merchants used their British contacts as agents to assist in the speculative sale of ships; this type of chancy venture involved having a vessel built, sending it with cargo to England, and then looking for a willing purchaser. Other merchants would tell the captain of their vessel to sell the ship with the cargo if offered a good price while on a trading run.<sup>29</sup>

To purchase a vessel, a colonial merchant would choose a shipwright and after agreeing on the size and type of the ship, a written contract would be signed.<sup>30</sup> Payment was usually made in installments; the merchant would pay part of the cost up front as cash, which was used by the shipwright to purchase timber for the hull.<sup>31</sup> The rest was paid as parts of the vessel were completed, with the final payment being made after the vessel was launched. Sometimes a portion of the payment might be made in goods instead of cash. Additionally, the merchant would often supply the iron and fittings for



the ship, as well as occasionally hiring the other tradesmen needed to complete the vessel.<sup>32</sup>

The typical shipyard in colonial America consisted of a small plot of flat land located near the water. Most yards were located in areas close to cities where the additional craftsmen needed to work on a vessel could be hired. The yard was quite simple, perhaps with only a toolshed or a wharf as permanent structures; a shipwright needed only his tools and timber to begin construction.<sup>33</sup> Depending on the size of the vessel, from one to six shipwrights might be working on it at any given time, with the hired shipwrights paid by the day or for a certain part of the work, such as planking the hull. The builder or master shipwright was usually the owner of the yard and took care of the hiring, purchased the supplies, and supervised the construction. While the yard could build a large merchant ship in as little as four months, merchants generally assumed a year would be necessary for the whole process, including finding cargo.<sup>34</sup>

The first colonial shipwrights would have had their training in England, either at a Royal yard specializing in warships or a private yard working on merchant vessels. In England, shipwrights were trained through a seven year apprenticeship, after which time they became journeymen and sought employment, as well as seeking to join a guild. In the colonies, guilds were not established until much later; with no enforced regulations from guilds and high demand for skilled workers, the colonial training system was much less rigid. Colonial apprentices generally served from four to seven years or until they turned 21. Once the training was completed, as in England, the apprentice became a journeyman; unlike in England, however, the new shipwright had far more opportunities

for work and a better chance of purchasing his own yard at a younger age. Until that time, shipwrights took temporary jobs at different yards as they became available.<sup>35</sup>

Once the master shipwright received an order from a merchant, most often he would first plan the design on a draft, basing it on dimensions agreed upon in the contract with the merchant and considerations based on the vessel's intended trade.<sup>36</sup> The shape of the midship frame was usually designed using sweeps, or a series of arcs from circles of different radii. In the whole molding method, a set of patterns or molds was made from this midship frame shape and used to determine the rest of the frames as long as the molds fit the necessary curves. Often, not all of the ship's frames were shown on the draft, but only the mold or master frames, which would determine the shape of the hull. Based on the draft, the frames could be enlarged on a mold loft floor and full-scale molds or deal patterns constructed; these molds were then used to find appropriately shaped timbers for the actual frames. If whole molding was used, the full-scale frames could be designed using the same method as on the draft. As an alternative to whole molding, each master frame could be designed separately using sweeps.<sup>37</sup> Once the master frames were installed on the ship's keel, ribbands or battens were attached to them, allowing the intermediate or filler frames to be fitted and placed.

Another variation of these methods was to design every frame on the draft, either geometrically with sweeps or by using molds of the curves from the midship frame. The lines of the vessel could be faired on the draft and each frame shape determined prior to construction. The shapes could then be chalked on a mold loft and every frame pre-assembled on the loft. Alternatively, if construction was taking place away from the loft,

lighter full-scale deal (plank) patterns could be made for each frame and after moving them to the building site, used to shape the frames to fit the patterns. Once the frames were built, they would be erected on the keel and ribbands would be less important, as the lines were essentially already faired.<sup>38</sup> Judging by the techniques discussed in eighteenth-century treatises, whole molding, either on a draft or on the mold loft, appears to have been the most popular method for frame design.

In some cases, perhaps more common for builders working on small, local craft, the shipwright might choose to construct the vessel “by eye” rather than by starting with a draft. Master frames were constructed from memory, based on the shipwright’s previous experience of how to generate a vessel of the desired shape and size. Ribbands would then be used to fair the lines and construct the intermediate frames. This practice was usually only done if the shipwright routinely produced the same type and size of vessel.<sup>39</sup> Even with the use of drafts for design, the shipwright might choose to alter some of the standard methods to achieve the desired result. Since much of the specifics of any vessel’s design was left up to the shipwright, there was a large amount of variation between ships, even those intended for the same trade. Ship design was also influenced by local traditions and tended to vary by region.

Looking at the English merchant fleet in general, a few trends in ship design are apparent over the course of the eighteenth century. The most obvious change was a sharp decrease in crew size relative to tonnage, suggesting advancements in design and rig to reduce the number of required sailors. As might be expected, the increase in efficiency was more apparent on larger vessels, since some minimum of sailors was required no

matter how small the ship. In addition, vessels in dangerous trades requiring armament had to keep a larger crew to man the guns. An increase in average vessel size for the merchant fleet accompanied the change in crew size; both of these improvements could be partially accounted for by the English transition to the economic Dutch flute-style ships, abandoning their traditional sharp-lined vessels in favor of a boxier hull that could carry more cargo for the same overall dimensions.<sup>40</sup>

Changes in rig provided another means for improving the efficiency of vessels. Sails were broken up into smaller units, increasing the number of sails but allowing easier handling and better sailing close to the wind.<sup>41</sup> In addition, fore-and-aft sails were used more extensively and on larger vessels; these types of rigs required fewer sailors to work them than square sails, but there was an upper limit to the size of sail.<sup>42</sup> Other alterations in rig included the replacement of the spritsail topsail with the jib, the use of studding sails, and the increased use of two-masted rigs on larger vessels, especially the brig and snow rigs.<sup>43</sup>

Another trend that became apparent in American-built ships, especially towards the end of the century, was an attempt to build faster vessels.<sup>44</sup> The increase of smuggling as a result of British legislation was one reason to seek speed; the construction of sharp-lined schooners and sloops provided vessels for quick, illegal runs to the Spanish colonies of the West Indies. Speed was essential for the legal West Indies trade also, because of the dangers of piracy along many of the routes.<sup>45</sup> War favored fast vessels as well; privateering provided a potentially large source of income if large prizes could be caught. A fast vessel was essential for the normal merchant to avoid becoming

a prize. Even though American schooners, and later clippers, developed a reputation for good speed and extreme designs, most colonial ships retained the more typical hull shape that maximized cargo capacity. Almost invariably, a ship design reflected intended use or trade.

This brief overview of the historical and economic circumstances that shaped the American shipbuilding industry in the eighteenth century provides a context for analyzing the archaeological remains of English and colonial shipwrecks. The general trends observed from analysis of written documents and other data may be compared to the archaeological record to see if they were reflected in actual vessels. Archaeological data may also shed light on other factors that played a role in ship construction, including the availability of timber, common building techniques, regional variation in design, and selection of specific hull shapes or rig types depending on use. The next chapter addresses the various options for hull and rig styles and the classification of vessels during the eighteenth century.

### **Endnotes**

<sup>1</sup> Davis 1962, 35.

<sup>2</sup> Davis 1962, 45; French 1995, 16. Hope (1990, 190) writes that merchant ships were no longer hired for the line of battle after the First Dutch War in the early 1650s.

<sup>3</sup> Barbour 1930, 281-2.

<sup>4</sup> Davis 1962, 52.

<sup>5</sup> Davis 1962, 56-7, 61-2; French 1995, 19; Goldenberg 1976, 54.

<sup>6</sup> Steffy 1996, 107, 128; Egnal 1975, 193-4.

<sup>7</sup> Some of the first major manufactured items in the colonies were textiles and shoes; large factories to produce these items first appeared in the 1760s in Boston, New York, and Philadelphia (Egnal 1975, 219).

<sup>8</sup> Davis 1962, 267-9; Labaree et al. 1998, 74; Gibson and Donovan 2000, 13. Clowse (1984) gives a similar explanation for the slow growth of shipbuilding in South Carolina.

<sup>9</sup> Davis 1962, 267-9; Goldenberg 1976, 30.

<sup>10</sup> Gibson and Donovan 2000, 13.

<sup>11</sup> Steffy 1996, 116; Davis 1962, 291.

<sup>12</sup> Davis 1962, 306-10; Steffy 1996, 116; Hutchins 1941, 127; French 1995, 12.

<sup>13</sup> Egnal 1975, 221; Bauer 1988, 46-7.

<sup>14</sup> Goldenberg 1976, 3.

<sup>15</sup> According to Davis (1962, 42, 290) and Chapelle (1967, 13-4), ironwork was also imported, at least initially. During the eighteenth century, the colonies began working their own iron and producing sailcloth and cordage in addition to importing it. See also Clowse 1984, 223, Gwyn 1988, 22, and Goldenberg 1976, 17.

<sup>16</sup> Goldenberg 1976, 18, 30.

<sup>17</sup> In Europe, these wars were called the War of the League of Augsburg and the War of the Spanish Succession, respectively. Other major wars during the period prior to the Revolutionary War included King George's War (War of the Austrian Succession in Europe) fought from 1739-1748 and the French and Indian War (the Seven Years War in Europe) from 1756-63. See Davis 1962, 316-7 and Crisman 1996, 138-42, 148. These wars had a similar effect in helping the American shipbuilding industry.

<sup>18</sup> Syrett (1987) provides a detailed explanation of naval use of transports during the American Revolution.

<sup>19</sup> French 1995, 26; Goldenberg 1976, 31, 33, 95. The largest English private shipyards built on average one ship a year, whereas under the right conditions a colonial shipyard could launch two. Some colonial shipwrights would have two or more on the stocks at a time. See Goldenberg 1976, 57, 71.

<sup>20</sup> Gwyn 1988, 22, 23; Knight 1986, 229; Bauer 1988, 33.

<sup>21</sup> Davis 1962, 68; Hutchins 1948, 23.

<sup>22</sup> Hutchins 1948, 17; Mitchell 1994, 143.

<sup>23</sup> Albion (1926) and others have emphasized the Royal Navy's timber problem and its impact on warship construction from the seventeenth century on; however, Knight (1986, 224, 229) argues that the true problem in England was lack of skilled labor up until about 1800, when a major timber shortage did begin to occur. While Knight (1986, 222) may have been correct in saying that "the supply of timber to the navy was successful," this supply certainly did not come from native forests alone and required trade with the Baltic or the colonies to meet the navy's needs. With the best wood reserved for the navy, merchant shipbuilders no doubt felt any timber shortage more quickly.

<sup>24</sup> Hutchins 1941, 132-3.

<sup>25</sup> Hutchins 1948, 22; Mitchell 1994, 28.

<sup>26</sup> Hutchins 1941, 141, 143; 1948, 22.

<sup>27</sup> Shepherd and Walton 1972, 51.

<sup>28</sup> Goldenberg (1976, 41-2) points to the Massachusetts shipping register of 1674-1714 as an example. Of 181 ships registered at 100 tons or more, 129 were English-owned or at least had English investors. Merchants from Massachusetts, the West Indies, and Scotland owned the rest. See also Chapelle 1967, 10, 1935, 11, and Goldenberg 1976, 80-1.

<sup>29</sup> Goldenberg 1976, 99-106, 123. In general, most colonial merchants preferred to wait for an order for a ship from an English correspondent rather than taking the risks of speculative selling. See also Chapelle 1967, 13.

<sup>30</sup> See Sutherland (1717, 75-96) for a sample contract between a merchant and shipbuilder.

<sup>31</sup> Because of the high cost of converting logs into timber, most colonial shipwrights could not afford to keep a supply on hand. The result was that many ships had to be built with green or unseasoned timber, leading to the reputation that American ships tended to decay more quickly than European craft. See Chapelle 1935, 9.

<sup>32</sup> Goldenberg 1976, 82-5. Other craftsmen involved in ship construction included joiners, caulkers, painters, plumbers, carvers, sawyers, and additional shipwrights. See Goldenberg 1976, 55-6.

<sup>33</sup> Laing (1974, 14) describes the colonial shipyard as “a bare acre of riverbank.”

<sup>34</sup> Goldenberg 1976, 68-71.

<sup>35</sup> Goldenberg 1976, 54-61.

<sup>36</sup> Scale models were used in addition to drafts on some occasions. See Chapelle 1935, 18.

<sup>37</sup> Goldenberg 1976, 86-7.

<sup>38</sup> Riess 1987a, 68, 70.

<sup>39</sup> Riess 1987a, 68; Goldenberg 1976, 86.

<sup>40</sup> Davis 1962, 71-4.

<sup>41</sup> French 1995, 28-9; Davis 1962, 76.

<sup>42</sup> McGowan 1980, 31.

<sup>43</sup> Davis 1962, 75-7.

<sup>44</sup> Chapelle (1935, 4) wrote that he saw the “untiring search for speed” as the “single important factor in the evolution of the American sailing ship.”

<sup>45</sup> Chapelle 1935, 31, 297.

CHAPTER III  
CLASSIFICATION OF EIGHTEENTH-CENTURY SHIPS:  
HULL AND RIG TYPES

Just as today we identify automobiles by specific features such as shape, size, and function, so the eighteenth-century sailor could name all of the vessels in a harbor based on certain characteristics. Unfortunately for modern scholars, many of these names were not specifically defined until the nineteenth century, presenting an array of difficulties in interpreting historical accounts. Up until the eighteenth century, vessels were often named based on their hull design or function, but this tendency gradually shifted towards defining types by rig.<sup>1</sup> The result was that some names that originally referred to a hull design became associated with the rig typically used by that type of vessel; however, both meanings could remain in use at the same time, leaving one to ponder exactly what a vessel such as a bilander-rigged “brigantine sloop” looked like.<sup>2</sup> Another common problem was that although some types, especially larger ships and naval vessels, were fairly standard, others were called whatever the owner or builder chose to name them; two sailors in the eighteenth century might each call the same vessel by a different name.

In light of the potential confusion over different vessel types, it is important to sort through the various possible meanings before analyzing eighteenth-century merchant craft more closely. As noted above, vessels were classified by hull form, function, and rig during the eighteenth century. Vessels characterized by function often



had names that reflected their use, such as “slaver” for a ship in the slave trade or “collier” for a coal carrier in England. Many of these vessel names became associated with specific hull characteristics, such as the heavy construction and shallow draft of colliers, and often a rig type became standard as well, so that a vessel might be “collier-built” even if it was not used for shipping coal. The major types of hull forms, as illustrated in Chapman’s 1768 *Architectura Navalis Mercatoria*, included frigates, barks, flutes, pinks, cats, and hagboats, each of which could have a variety of different rigs. Vessel names based on rig included ships, snows, brigs, bilanders, ketches, schooners, sloops, and cutters. Some of these terms, such as “ship” or “sloop,” and others such as “shallop” and “hoy” could refer to a rig or were used as a general term for a type of craft based on overall appearance or use. The vessel types commonly used by England and her colonies are discussed below; popular Mediterranean types during this period, including the xebec, polacre, and tartane, have been omitted.

### **Chapman’s Hull Types**

#### *Frigate*

Frigates came into use as naval vessels noted for their speed and light construction. In the Royal Navy, they were the largest vessels not used in the line of battle, rated as fifth and sixth rates.<sup>3</sup> Vessels classified as “frigate-built” were used as merchant ships as well, as evidenced by the plans of frigates included in Chapman’s work. Chapman’s plans show a long, narrow vessel with a fine entrance and run, a full head with figurehead, and a square stern where the wales run into the transom. Varying

amounts of deadrise are present in Chapman's frigates, but the bilges are slack and the sides rounded.<sup>4</sup> All of the frigates have gunports for cannon. Most of the plans call for a ship rig, but there is one example each of a snow, schooner, and sloop rig.<sup>5</sup>

English square-sterned vessels could have either of two styles of tucks – a square tuck or a round tuck (fig. 2). In the square tuck, the transoms extended horizontally straight from the sternpost to the fashion piece, essentially the last frame. In the round tuck, the transoms were curved forward and the bottom of the fashion piece no longer was secured to the sternpost, but attached to some of the frame timbers farther forward. This change allowed the planking to run more smoothly up to the wing transom in the counter. Both styles were different than a true round stern, in which the wales and planking ran directly into the sternpost and were supported by vertical cant frames.<sup>6</sup>

### *Pink*

Pinks were identified mainly by the shape of their stern, so that later vessels were often called “pink-sterned” even if they were classified as a different type. Chapman's pinks have a round stern with a long, overhanging counter through which the head of the rudder pivoted and a narrow deck above. These hulls were designed with speed in mind, as evidenced by their large deadrise with hollow garboards, round sides, and fine entrance and run. A full head is present with a figurehead. Chapman's rigs used on the pinks include ship, snow, brig, ketch, and sloop rigs.<sup>7</sup>

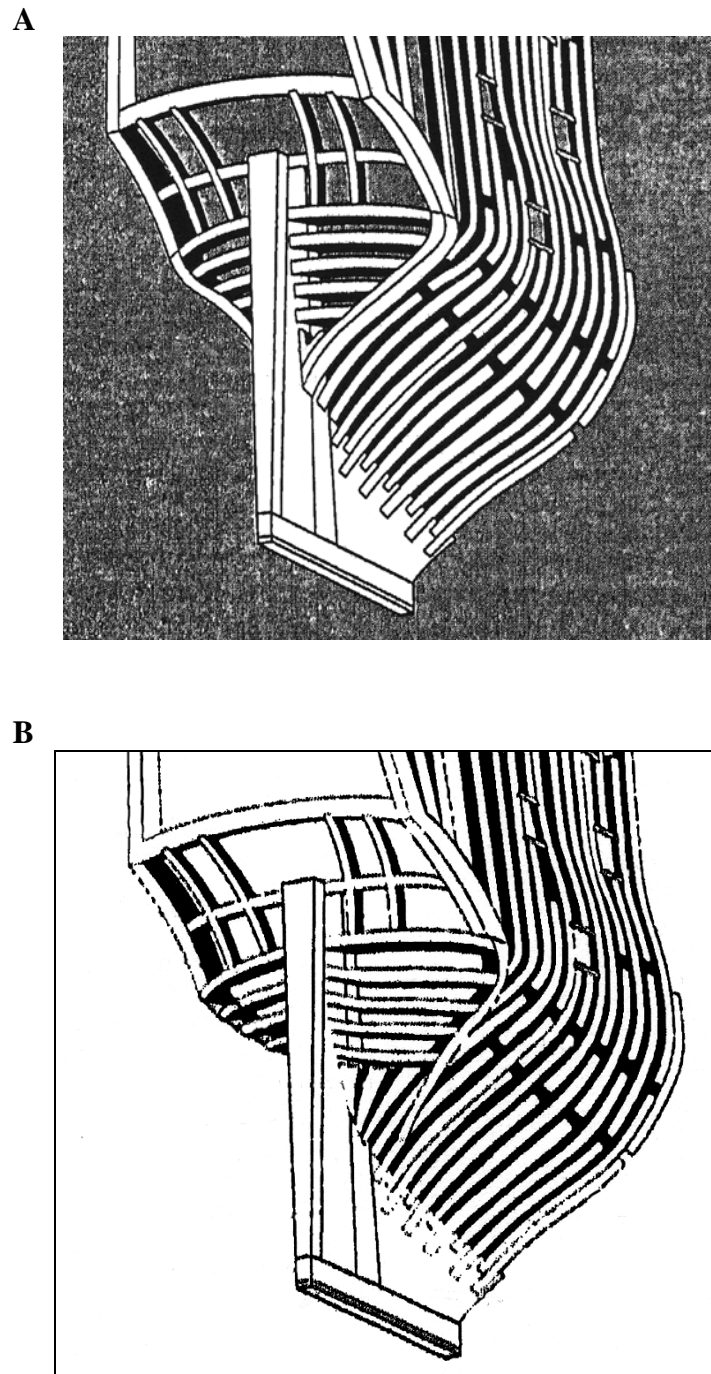


Figure 2. Two styles of English tucks used on square-sterned vessels. **A**, Square tuck; **B**, English round tuck. (After Kenchington 1993, 7-8).

### *Bark*

During the first part of the eighteenth century, the word “bark” referred to a hull form, but it came to represent a rig by the middle of the period. Chapman’s barks have a square stern like a frigate, but a plain bow with no cheeks. Regardless of size, all of the barks are very boxy in shape, with nearly flat floors, a hard bilge, and a full entrance and run; this hull form was optimized for carrying cargo. They could be armed and carried a variety of rigs, including ship, snow, brig, and sloop.<sup>8</sup> The mid-eighteenth-century bark rig was like a ship rig, except there was no topsail on the mizzen, like the barque of the nineteenth century.<sup>9</sup> Possibly this rig came to be called bark-rigged because of its use on vessels with the bark hull form. Colliers were often associated with barks because of their boxy shape with maximum space for bulk cargoes.

### *Flute*

The Dutch flute or flyboat was instrumental in changing the way English merchant ships were built. For most of the seventeenth century, English merchantmen were built similarly to naval vessels, well prepared for defense but not very economical in terms of cargo. The Dutch wars resulted in the capture of hundreds of Dutch merchantmen, many of which were sold into the English market as prizes of war.<sup>10</sup> Flutes were designed to maximize cargo capacity and require a small crew, thereby increasing efficiency. English merchants found these vessels to be far superior carriers than their typical merchant ships; after the initial captured flutes were worn out or lost, demand was placed on home shipyards to produce similar vessels. The northern British

shipyards responded with similar-shaped hulls, known as barks and cats, designed for bulk cargo trades.<sup>11</sup>

Chapman includes only two plans of a flute in his work and both are ship-rigged. Unlike the bark and frigate, the Chapman's flute is round-sterned so that the wales run into the sternpost, but a high square transom is present above the wales. The head of the rudder is outside of the hull with the tiller running through the counter. As in the bark, the bow is plain and the entrance and run are full with parallel sides for most of the vessel's length. There is little deadrise, but the bilges are slack and the sides are more rounded than in the bark. The plans show more sheer to the hull, more tumblehome, and a shallower draft than seen in the frigate or bark.<sup>12</sup> Like the bark, the overall shape emphasizes carrying capacity and economy of construction.

### *Cat*

Cats were developed in northern England around 1700 in response to Dutch flutes; they generally measured 250-300 tons and were used in bulk cargo trades such as coal and timber.<sup>13</sup> Chapman's plans show the cat to have a broad, round stern with a narrow square transom above. The bow is bluff with a plain stem and full entrance, but the run is finer. With little deadrise and hard bilges, the hull shape is boxy and the sides are vertical, even on the smaller vessels. Chapman uses ship, snow, brig, and sloop rigs on his cats and they all could carry guns for defense.<sup>14</sup>

### *Hagboat*

The hagboat was another version of a frigate optimized to carry cargo. Like the frigate, Chapman's hagboat has a full head with a figurehead, a fine entrance and run, and a rudder passing through a projecting counter; however, the stern is round and the sides are vertical with little deadrise. All are shown with a ship rig and gunports.<sup>15</sup>

### **Types of Rig**

#### *Ship*

While the term "ship" has come to be used as a generic name like the word "vessel," it did refer to a specific type of rig in the eighteenth century. A ship rig was the largest rig using square sails and was found on nearly all vessels of a few hundred tons or more and often on smaller vessels. At the beginning of the eighteenth century, a ship had three masts, with a course, topsail, and topgallant sail on the fore and mainmasts and a lateen sail and square topsail on the mizzen. Early on, the fixed bowsprit carried a square spritsail underneath and a small upright mast with a spritsail topsail at its forward end. The jib, an extension of the bowsprit, was introduced at the end of the seventeenth century and brought with it the use of triangular headsails and the demise of the spritsail topmast during the first decade of the eighteenth century. After about 1730, the lateen yard was still used but sail cloth only hung on the part of the yard behind the mast; by about 1745 the lateen yard was replaced by a gaff yard and loose-footed gaff sail on smaller vessels, but the full yard remained on larger East Indiamen and naval ships until the late 1700s.<sup>16</sup> Eventually the gaff sail was made larger and fitted with a boom; this

new sail was called a spanker.<sup>17</sup> Also later in this period ships began to carry royals – an extra mast and small square sail set above the topgallants on the fore and main masts – and studding sails, which were extensions on the sides of the square sails. Figure 3 shows a typical ship rig from the middle of the eighteenth century.

### *Brigantine*

The brigantine is a vessel type wreathed in confusion, possibly referring to a hull form or a rig type and maybe the precursor to the later brig and snow. A vessel called a “brigantin” was common in the Mediterranean; it had two masts with a lateen rig and was capable of being rowed. During the late 1600s, the Royal Navy introduced the “brigantine,” named for its hull features of light framing and ability to be rowed; it would appear that the name of the new hull form came from association with the Mediterranean brigantin.<sup>18</sup> The rig, according to Blanckley, consisted of square sails on fore and main masts; in 1750 he wrote that these vessels were no longer used but he does associate them with rowing.<sup>19</sup> By 1780, Falconer identifies the brigantine as the same vessel as a brig, with two square-rigged masts and a large fore and aft mainsail hung with a gaff yard and boom.<sup>20</sup> The brig may have developed from the square-sailed brigantine by the addition of the spanker, or the term “brigantine” may have been revived through the popularity of the brig in the mid-eighteenth century by the similarity of the two names.<sup>21</sup> In either case, neither vessel had a rig similar to the original Mediterranean lateen-rigged brigantin.

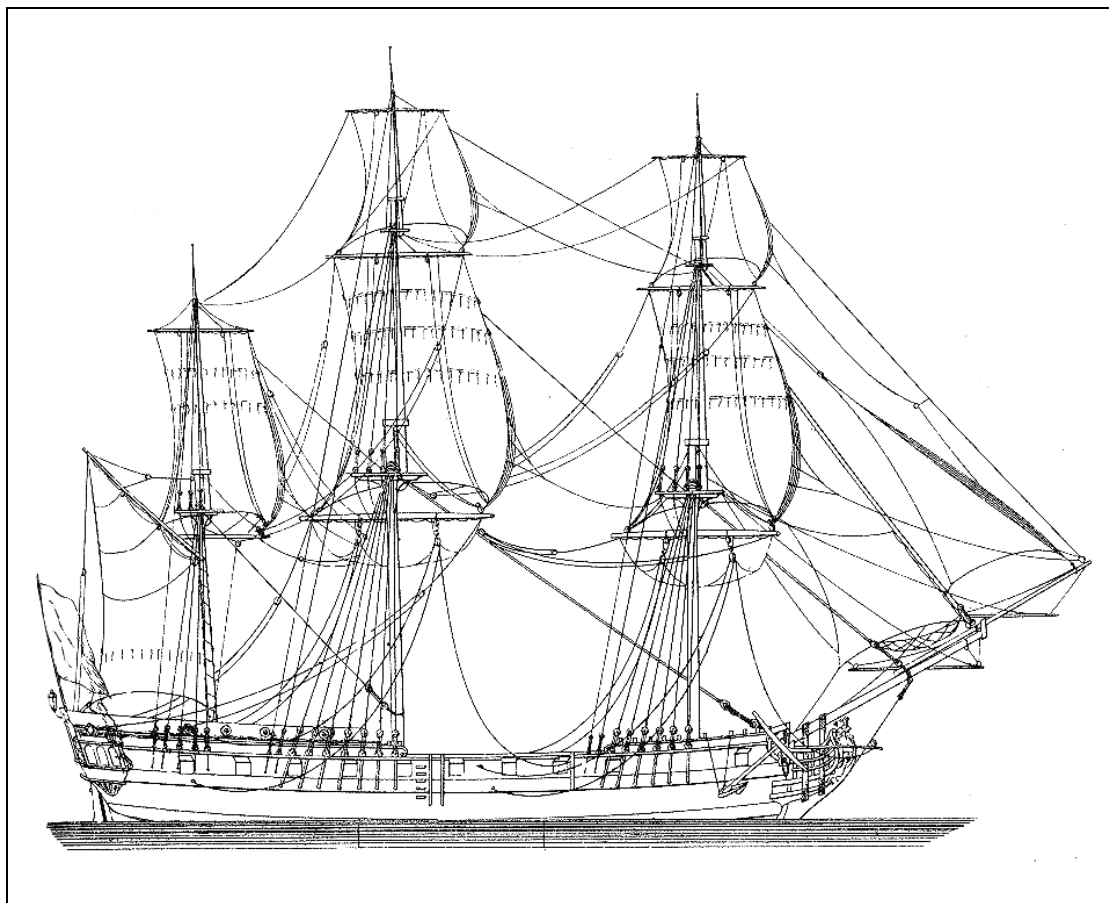


Figure 3. Ship rig c. 1760. (From Chapman 1971, plate LXII).



### *Brig*

The brig rig consisted of a foremast with square sails and a mainmast with square topsails and topgallants, but a spanker fore-and-aft mainsail instead of a square course (fig. 4). A special yard called a crossjack was used to secure the foot of the main topsail. The forward part of the spanker sail was secured to the mainmast by a series of hoops. A main staysail could be used on the brig because there was no square course to interfere with it.<sup>22</sup> Towards the early nineteenth century, the crossjack yard was replaced by a regular main square yard, leading to a sort of snow and brig hybrid that was called a brig.<sup>23</sup>

### *Snow*

The snow, the most common two-masted merchant ship in eighteenth-century Europe, looked very similar to the brig (fig. 5).<sup>24</sup> Rather than a spanker mainsail, however, the snow had a standard main square course with the addition of a loose-footed gaff sail; this sail was normally set on a trysail mast stepped abaft the mainmast to prevent the hoops of the gaff sail from interfering with raising and lowering of the main course. A boom was added to the gaff in the 1720s, essentially creating a spanker on the trysail mast. As not all snows had this trysail mast, the main distinguishing characteristic from the brig was the presence of the main course.<sup>25</sup> The word “snow,” related to the Scandinavian terms “snau” or “snaw,” suggests a possible origin for the rig in these small northern coasters.<sup>26</sup>

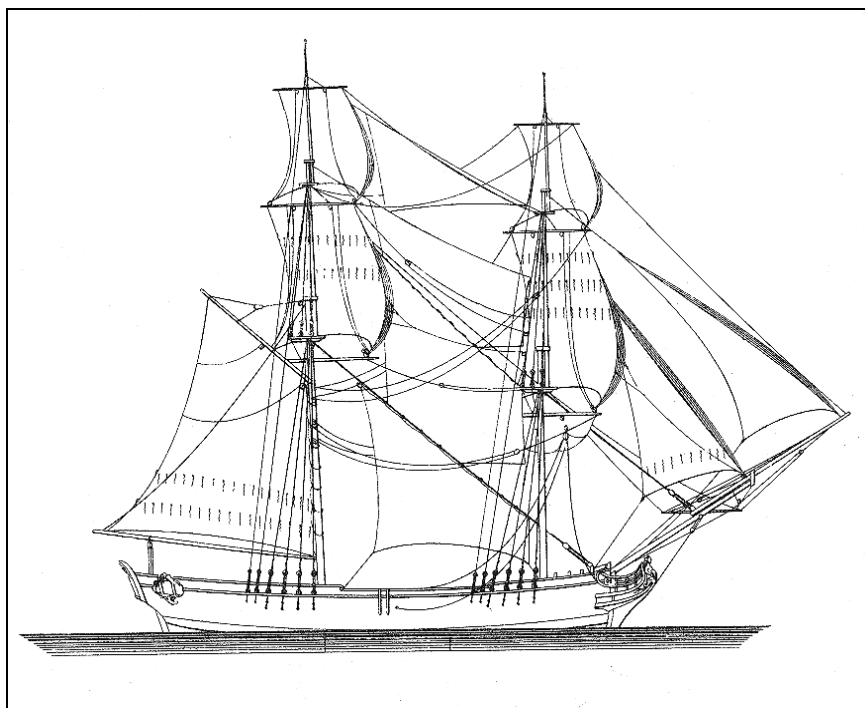


Figure 4. Brig rig c. 1760. (From Chapman 1971, plate LXII).

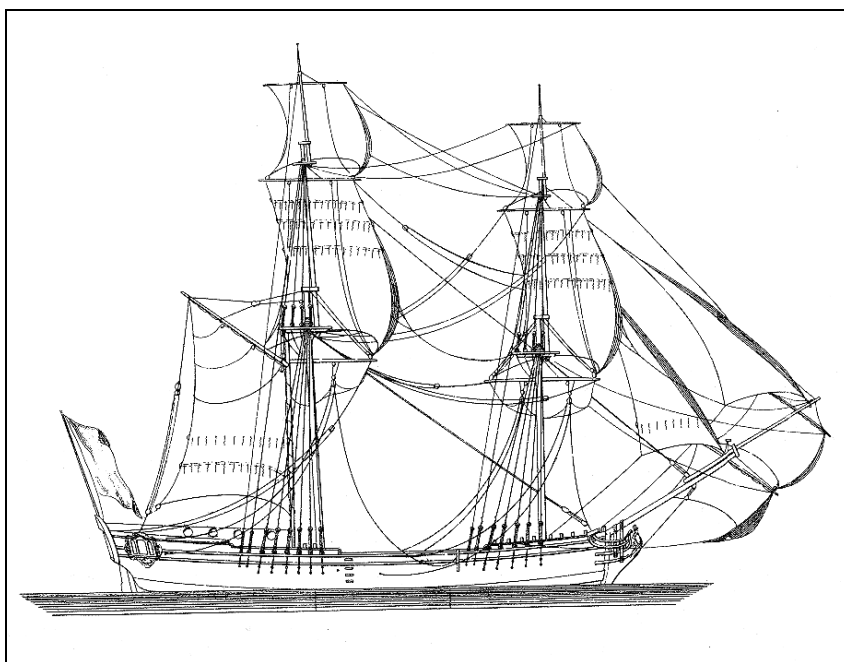


Figure 5. Snow rig c. 1760. (From Chapman 1971, plate LXII).

### *Bilander*

The bilander was very similar in appearance to the brig, except that its mainsail was a settee sail rather than a spanker (fig. 6). The settee sail had a yard like a lateen sail, but rather than being triangular it was quadrilateral in shape. This rig may represent the first application of fore-and-aft sails to a square-rigged two-masted vessel, potentially serving as a precursor to the brig and snow.<sup>27</sup> The bilander was Dutch in origin and probably initially had a typical Dutch hull with a bluff bow and flat floors.<sup>28</sup>

### *Ketch*

The ketch rig was another two-masted rig, but was used on smaller vessels than the other types (fig. 7). It essentially looked like a ship rig without the foremast, having a main and a mizzenmast only. The main carried square sails and the mizzen had a lateen sail with a square topsail. Large triangular fore staysails and jibsails stretched from the mainmast to the bowsprit. During the eighteenth century, the lateen became a gaff sail and eventually a spanker.<sup>29</sup> According to Falconer, this rig type was popular on naval bomb vessels.<sup>30</sup>

### *Schooner*

Schooners were the first high seas craft to rely mainly on a fore-and-aft rig; while offering a reduction in crew size, during the eighteenth century the schooner rig was only manageable on small vessels, usually of 100 tons or less. Two variations of the schooner rig were used during this period—the fore-and-aft schooner and the topsail

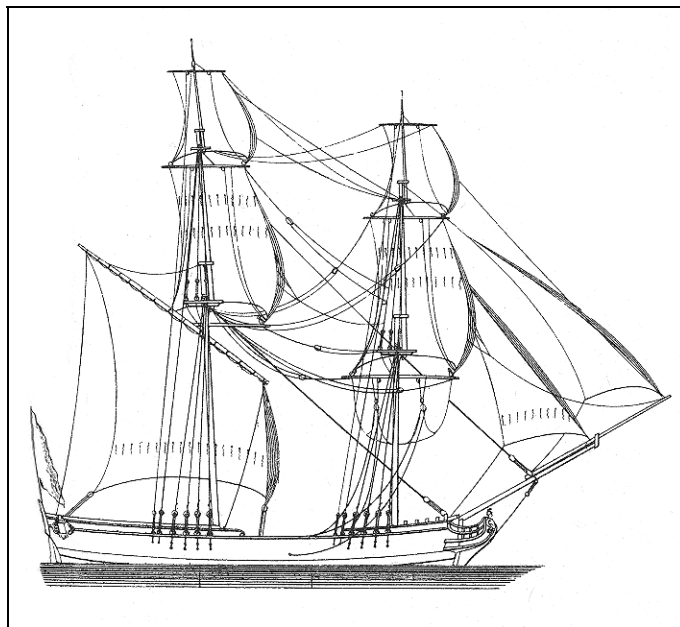


Figure 6. Bilander rig c. 1760. (From Chapman 1971, plate LXII).

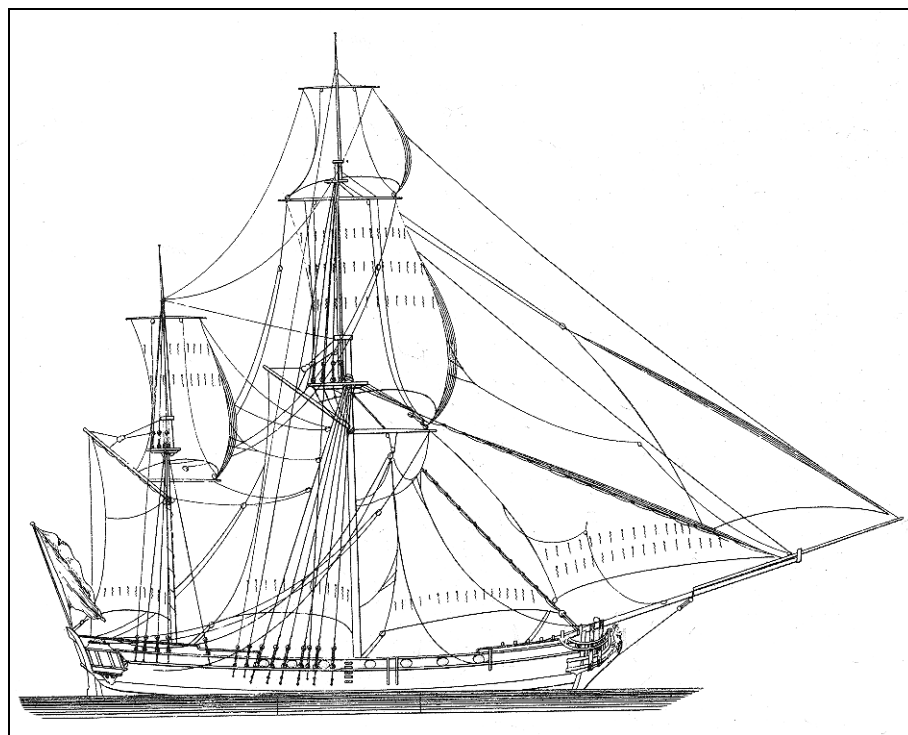


Figure 7. Ketch rig c. 1760. (From Chapman 1971, plate LXII).

schooner (fig. 8). The fore-and-aft schooner had, as the name implies, only fore-and-aft sails on its two masts. While not invented in America, this rig type was popularized in the North American colonies during the eighteenth century; first mention of the word “schooner” comes from an American document of 1717.<sup>31</sup> It appears to have developed from the addition of a triangular headsail to Dutch two-masted, gaff-rigged vessels. Americans developed sharp-lined schooners, such as Chesapeake and Marblehead varieties, during the Revolution and afterwards, when poor protection for merchant shipping created an increased need for speed. The topsail schooner seems to have originated in Europe from a square-rigged vessel type such as the brigantine, as evidenced by the presence of a main staysail as depicted in early paintings of schooners; this sail was not seen later, no doubt because it was not very useful with a gaff foresail.<sup>32</sup> Falconer’s 1780 definition for a schooner does not mention the presence of topsails and his detailed explanation of the rig arrangement suggests schooners were not as frequently seen in England as other ship types.<sup>33</sup>

### *Sloop*

The term “sloop” is often another matter of some confusion, as it can denote a rig type or be used as a general term. Blanckley’s 1750 definition illustrates this problem existed even when sloops were in use, saying sloops “are sailed and masted as Mens Fancies lead them, sometimes with one Mast, with two, and with three...”<sup>34</sup> Falconer provides a clearer definition, indicating that sloops were small, single-masted vessels that had a gaff and boom fore-and-aft mainsail. He also mentions the common naval

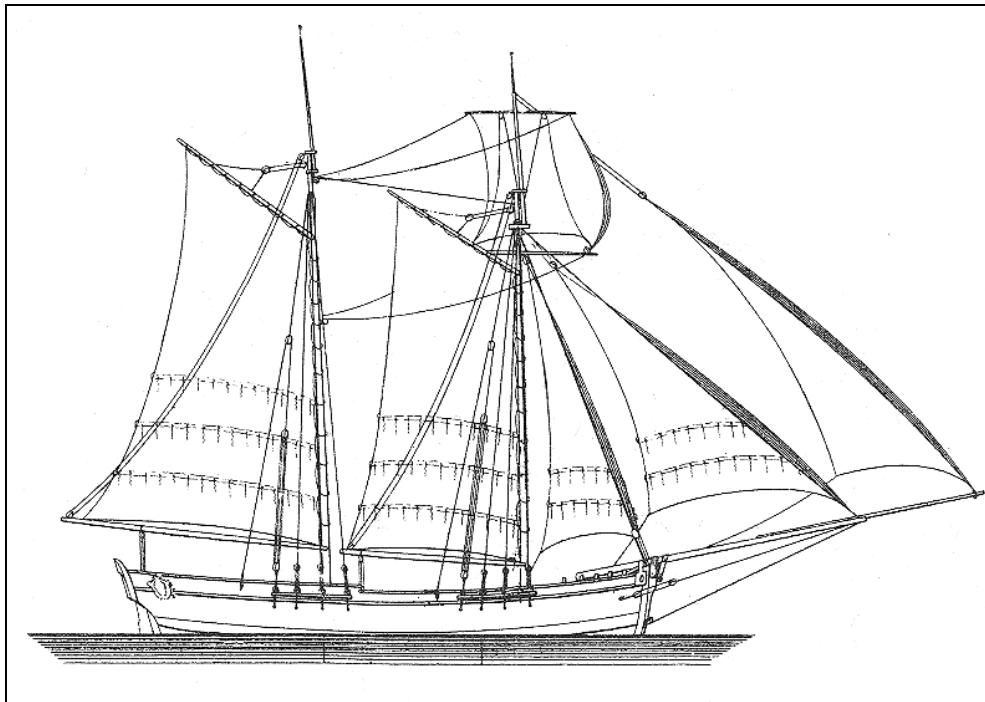


Figure 8. Topsail schooner rig c. 1760. (From Chapman 1971, plate LXII).

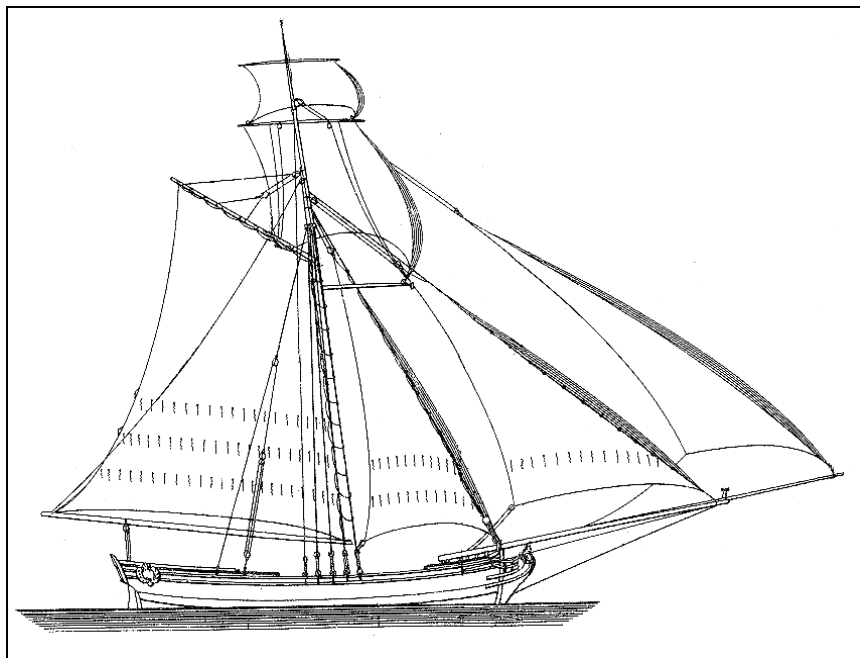


Figure 9. Sloop rig c. 1760. (From Chapman 1971, plate LXII).

definition, saying that the “sloop of war” was the smallest vessel of war and was rigged either as a ship or snow.<sup>35</sup> The sloop rig also included a jibsail and a forestaysail secured to the bowsprit and sometimes a square topsail above the main spanker (fig. 9).<sup>36</sup>

### *Cutter*

The cutter was an English development and initially signified a hull form, but came to denote a rig similar to the sloop rig (fig. 10). The original vessel type was lightly clinker-built, with a plain stem, a deep section with much deadrise, and fine lines even though the hull was broad. The design was intended for speed, so that the vessel could carry plenty of sail. The typical cutter rig used on this type of hull consisted of a single mast with an integrated topmast but separate topgallant. Unlike the permanent bowsprit of the sloop, the cutter’s bowsprit was moveable and placed nearly horizontally. Sails included a large fore-and-aft mainsail, square sails, and triangular headsails. The single piece mast/ topmast resulted in the stay being carried much higher on the mast; consequently, the square topsail had a deep cutaway to fit over the stay. The gap beneath the stay was filled in with a lower square course.<sup>37</sup>

### *Shallop*

The shallop was a small two-masted vessel that had a foremast and a mainmast. Blanckley indicates that shallops carried lugsails for occasional use, but his drawing of a shallop shows two loose-footed gaffsails without a bowsprit or headsails.<sup>38</sup> Falconer

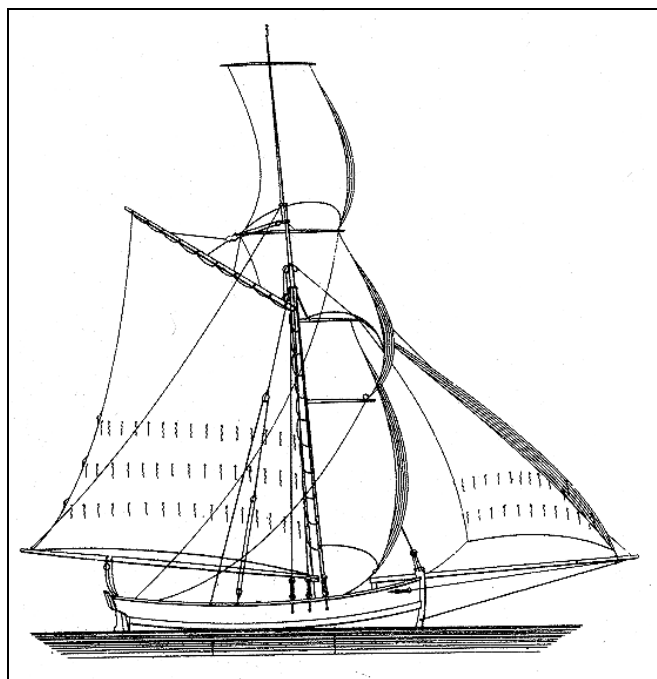


Figure 10. English cutter rig c. 1760. (From Chapman 1971, plate LXII).

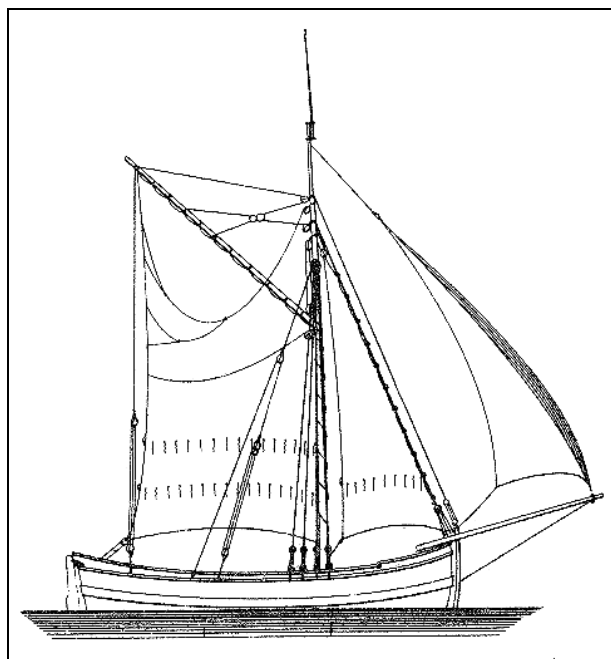


Figure 11. English hoy rig c. 1760. (From Chapman 1971, plate LXII).



writes that shallops were large boats that typically carried a schooner rig.<sup>39</sup> Sloops may have descended from the shallop.<sup>40</sup>

### *Hoy*

Like sloops, cutters, and shallops, hoys were small vessels that could be used for a myriad of purposes, such as carrying passengers and loading and unloading larger ships. These vessels had a single mast that generally carried a loose-footed gaff mainsail, a forestaysail, and sometimes a square topsail, although as with most small craft, the definition of the rig varied from person to person (fig. 11).<sup>41</sup>

As can be seen from the many types of vessels in use, the eighteenth-century merchant and shipowner had a large selection of hulls and rigs from which to choose. Selection of a ship design and rig for the merchant depended on several factors, including the type of goods to be carried, the intended trade route, and the desired sailing qualities of the vessel. Bulk cargoes required a boxy hull like a cat or bark, whereas a valuable or perishable cargo would demand a faster sailer like a frigate. When economy was paramount a fore-and-aft rig was better because smaller crews could be employed, but such a rig type might be less useful for long-distance trans-oceanic voyages than local, coastal routes. Additionally, a large crew was needed on dangerous routes to man the guns on armed vessels, better facilitating the use of square sails. All of these various and often contradicting factors went into the decision of what type of hull and rig to build.

## Endnotes

- <sup>1</sup> Marquardt 1992b, 125.
- <sup>2</sup> McGowan (1980, 37) shows a painting of a vessel called a brigantine sloop and interprets the rig as that of a bilander.
- <sup>3</sup> Gardiner 1992, 27-8.
- <sup>4</sup> MacGregor 1988, 29, 31.
- <sup>5</sup> Chapman 1971, plates I-VII.
- <sup>6</sup> MacGregor (1988, 30-1) differentiates between the square and round tucks in English square-sterned ships. See also Kenchington 1993, 6-8.
- <sup>7</sup> Chapman 1971, plates XII-XIV, XXX; MacGregor 1988, 29, 34-5.
- <sup>8</sup> Chapman 1971, plates XXI-XXIX; MacGregor 1988, 29, 31-2.
- <sup>9</sup> McGowan 1980, 30.
- <sup>10</sup> Hope (1990, 191-2) estimates the number of Dutch vessels captured during the three wars as high as 2700, suggesting that for the next 20 years at least one-third of the English merchant fleet was foreign-built.
- <sup>11</sup> McGowan 1980, 25-6.
- <sup>12</sup> Chapman 1971, plates XXVII, LIII; MacGregor 1988, 29, 32-4.
- <sup>13</sup> McGowan 1980, 26.
- <sup>14</sup> Chapman 1971, plates XV-XX; MacGregor 1988, 29, 36-40.
- <sup>15</sup> Chapman 1971, plates VIII-XI; MacGregor 1988, 29, 41-2.
- <sup>16</sup> McGowan 1980, 15-6; Marquardt 1992b, 126-7.
- <sup>17</sup> Marquardt (1992b, 127) points out that often confused with the term “spanker” is the driver, initially a fair weather square sail on the mizzen and later used in merchant vessels as an extension to the fore and aft mizzen sail. In the Royal Navy, a driver referred to a temporary fore and aft sail with a boom used occasionally in place of the standard loose-footed gaff sail prior to use of the spanker.
- <sup>18</sup> Gardiner 1992, 49; Marquardt 1992a, 63-4; Dingley 1920, 293-4.
- <sup>19</sup> Blanckley 1988, 148.
- <sup>20</sup> Falconer 1970, 50.
- <sup>21</sup> Dingley (1920, 294-6) provides other evidence for the presence of a fore-and-aft sail on brigantines, with a source from 1696 pointing to the transfer of the name to a different type of vessel called a brig. McGowan (1980, 36) suggests the brigantine was already fore-and-aft rigged on the mainmast and

evolved into the brig by the addition of square sails. Brindley and Moore (1921, 195) also point to early brigantines as having a square-rigged foremast with a fore-and-aft only mainmast.

<sup>22</sup> McGowan 1980, 35.

<sup>23</sup> Marquardt 1992b, 129; Brindley and Moore 1921, 205.

<sup>24</sup> Marquardt 1992b, 129.

<sup>25</sup> Marquardt 1992b, 129; Brindley and Moore 1921, 205.

<sup>26</sup> Marquardt 1992b, 129; Moore 1912, 39, 41.

<sup>27</sup> Marquardt 1992b, 129.

<sup>28</sup> McGowan 1980, 55.

<sup>29</sup> McGowan 1980, 51.

<sup>30</sup> Falconer 1970, 166.

<sup>31</sup> Marquardt 1992a, 76-7.

<sup>32</sup> McGowan 1980, 36-9; Marquardt 1992a, 76-7.

<sup>33</sup> Falconer 1970, 257.

<sup>34</sup> Blanckley 1988, 149.

<sup>35</sup> Falconer 1970, 270.

<sup>36</sup> Marquardt 1992a, 71; McGowan 1980, 42.

<sup>37</sup> Marquardt 1992a, 73.

<sup>38</sup> Blanckley 1988, 149.

<sup>39</sup> Falconer 1970, 260.

<sup>40</sup> Gardiner 1992, 46; Marquardt 1992b, 128.

<sup>41</sup> McGowan 1980, 44; Falconer 1970, 158.

## CHAPTER IV

### HULL DESIGN: THE LITERARY EVIDENCE

Despite the prominence of British shipping and the Royal Navy in the eighteenth century, England's shipwrights produced only a few major treatises on shipbuilding during the period. This situation was, in part, due to the fact that many of the craftsmen could not read. In addition, ship designs and specific techniques were passed down from master shipwright to apprentices and learned through practice; many shipwrights were hesitant about exchanging their proven designs for something untested. Finally, these yard-specific designs were often kept secret and revealed only to select apprentices; Henry Bushnell complained about these experienced shipwrights in the introduction to his 1664 treatise, saying, "...their knowledge they desire to keep to themselves, or at least among so small a number as they can..."<sup>1</sup> It was his intention in writing the treatise to help remedy this problem.

Fortunately for modern scholars, a few shipwrights during the eighteenth century found value in recording their methods of ship design. These treatises emphasize the geometric design of ships on paper and they often include a section on arithmetic, such as how to calculate square roots, and tables of dimensions for vessels of various sizes. They tend to be highly theoretical, occasionally incorrect, and often unhelpful, especially regarding the actual construction of a vessel; however, these works do provide valuable insight into how the shipwright thought about his ship and what design methods the leading authors recommended. For the colonial shipwright who had access to them,

these treatises would have been the major source for contemporary shipbuilding methods.

One of the most influential treatises of the late seventeenth century was Sir Anthony Deane's *Doctrine of Naval Architecture*, published in 1670.<sup>2</sup> Although already 30 years old by the beginning of the eighteenth century, Deane's theories would still have been prevalent and certainly influenced later design. As a member of the Navy Board and a Master Shipwright, Deane worked with the Surveyor of the Navy and gained extensive experience in the design and construction of naval vessels.<sup>3</sup> His treatise described the use of sweeps or arcs to determine the shape of a warship's midship frame. He also explained how to build the draft of a vessel up from the keel by drawing various lines and how to use these lines to determine the rest of its shape. Focusing only on naval vessels, he included a table of dimensions for 1st through 6th rate ships and a section on rigging for the various rates. His book concludes with a table of costs for vessels based on the location of construction. Deane's work was one of the first clearly explained, well-illustrated works on naval architecture and in some areas represented advances in the field. In addition, because he commissioned his own ships to be built, his design methods can be compared to actual vessels.

The first major treatise on ship design during the eighteenth century was William Sutherland's *The Ship-builders Assistant: or, some Essays Towards Completing the Art of Marine Architecture* first appearing in 1711. Sutherland worked as a Master Carpenter on Royal Navy ships and spent several years at the Portsmouth and Deptford yards as an inspector and overseer of shipwrights.<sup>4</sup> Even though his experience was with naval

vessels, Sutherland explained in his preface that his treatise was intended not only for shipbuilders and prospective seamen, but also for merchants and ship owners. His work was divided into five main essays, covering physics and Newton's principle of least resistance, prices of timber, aspects of marine architecture, calculating tonnage, and rigging proportions.

Sutherland's third essay, on marine architecture, contains the information most directly related to methods of ship design and construction. In the section on "solidity," or building a ship on the stocks, Sutherland gave a brief overview of the order of construction. The keel was laid and then the stem and apron lifted and tenoned or scarfed into place, along with the sternpost, transoms, and fashion-pieces. To frame the ship, the floors of the mold or articulated frames, usually located at every third or fourth station, were placed first.<sup>5</sup> After installing a ribband at the floor sirms and fairing the floors, the intermediate floors were installed and bolted to the keel.<sup>6</sup> This method of installing the framing, timber by timber with the floors first, is depicted in William Burgis' c. 1717 engraving of New York City shipyards (figs. 12 and 13).

After installing the floors, the half-timbers were to be placed next – these frames were probably located in the extreme ends of the vessel and rotated to make their outer faces match the run of the planking.<sup>7</sup> Next, the keelson was notched to fit over the floors and bolted through every other floor to the keel. After placing the keelson, the remaining futtocks and top timbers of the master frames were installed, being careful to follow the designed molds. It is not clear whether these timbers were to be laterally fastened, but with all of the floors placed prior to the first futtocks, there would not have been space to



Figure 12. Detail from William Burgis' 1717 engraving of New York City. (From Labaree et al. 1998, 75.)

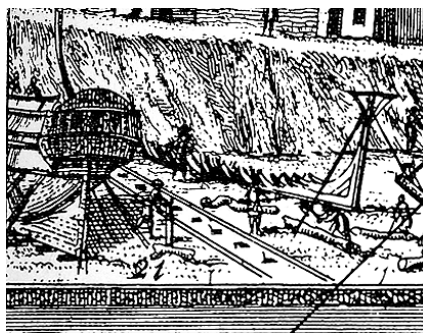


Figure 13. Detail from Burgis' 1717 engraving. Close-up from the upper right corner of the scene in fig. 11, depicting a ship on the stocks with floor timbers in place on the keel. (After Laing 1974, 15.)

attach their heels to the heads of the floors unless the bolts were driven in diagonally from above. The breadth ribband was placed next, according to sirmarks on the mold frames, followed by a wale.<sup>8</sup> Here Sutherland ended his section on building the ship, but the next logical steps would be to fill in the rest of the futtocks and plank the hull, with either futtocks or planking placed first. It is uncertain whether the heels of futtocks touched the heads of the timbers below; some of Sutherland's text suggests a gap may have been present between the timbers.<sup>9</sup>

A description of whole molding explains how the frames were typically designed. Sutherland wrote that first a ship was planned on a draft to scale and then the curves of the hull are drawn out with chalk to full size on a large platform called a mold loft. Once the midship timber had been laid out, two sets of molds for the floors and futtocks –one for the forebody and one for the after body–were made out of thin planks. The molds in each set were fastened together and then lifted and narrowed according to the rising and breadth lines to form the other frames, so that essentially each frame would start from the same general shape.<sup>10</sup> While the frames could be marked out on the mold loft directly from the scale draft, it appears that Sutherland preferred to mold his frames in full scale; he wrote that if all the transverse lines of the ship could be drawn out, “it will be moulded much truer from Lines drawn at large, than from a Draught.”<sup>11</sup>

Sutherland included more suggestions about shipbuilding throughout the rest of the essay. Regarding framing, he wrote that all of the timbers should have equal room and space so that each part of the vessel had equal amounts of timber. He indicated that the old method of placing floors and lower futtocks next to each other had been shown to



cause rot in the timbers, so he recommended leaving some space between them. In addition, the previous method led to “over-scantling the ships.”<sup>12</sup> In his section on planking, Sutherland wrote the planking should lie on a direct plane and that some strakes could be stopped short of the stern. He noted that the planking in the bow must be converted from compass timber because it could not be bent to fit the necessary curves.<sup>13</sup>

Sutherland also included a section on economy in shipbuilding in his essay. He observed that if ships were standardized, every necessary timber and component could be exactly calculated and pre-fabricated for use, requiring much less timber than was commonly needed. Additionally, only the timber that would actually be used in building a ship would need to be delivered to the yard, saving costs on transport.<sup>14</sup> He concluded the essay with information on measuring timbers and a table of scantlings for a ship of 500 tons. Even though specific construction techniques are not discussed, Sutherland’s treatise provides valuable information regarding shipbuilding in the early eighteenth century and fills in the gap between Deane and the treatises from the middle to end of the period.

Although later in date, the material covered in the 1739 treatise *Marine Architecture: Directions for Carrying on a Ship* essentially predates the work of Deane. Whereas the date of the book would suggest it might be an important source for eighteenth-century shipbuilding, the anonymous work was almost entirely copied from three treatises written nearly 80 years earlier: Edmund Bushnell’s 1664 *Compleat Shipwright*, Henry Bond’s 1642 *The Boat Swaine’s Art or the Compleat Boatswaine*, and

Thomas Miller's 1664 *The Compleat Modellist*.<sup>15</sup> Most of the contents would have been completely outdated by the time the 1739 version was published, but copies must have still sold. The first part of the text discusses geometry and designing the draft of a ship; the midship frame was very simple, being formed by two sweeps and two straight lines, as compared to Deane's midship formed by multiple sweeps. Interestingly, like Sutherland, the author indicated that the molds for the frames should be made full size in a mold loft rather than to scale first; these molds were to be labeled with sirmarks to help with their assembly.<sup>16</sup> Other than this information on making the frames, there are no details given on actual construction methods. A good part of the text is dedicated to an explanation of square roots and a method for determining the tonnage of vessels. The last part of the work covers masts, spars, and rigging and includes tables of dimensions for the rigging. Despite the promising date of this treatise, in a part of the century when little else on the subject was being written, it provides very little relevant information.

Several years passed before the next major work was published – Mungo Murray's *A Treatise on Ship-Building and Navigation* from 1765. The treatise consists of three major sections on mathematics and geometry, ship design, and navigation. In addition, Murray incorporated several tables of dimensions for various sized merchant ships and ships of war. He also included partial translations of two contemporary French treatises, authored by M. Bouguer and M. Duhamel.

Murray included a description of whole molding and how to draw the shape of a vessel using sweeps. Although the basic dimensions of a merchant vessel, including the length of keel, extreme breadth, depth in hold, and height between decks, were agreed on

by contract, much of the design was decided on by the shipbuilder based on the type of trade for which the vessel would be used. After designing the midship timber, a deal mold was made and along with a hollow mold used to form the rest of the frames.<sup>17</sup> The frames in the bow and stern were to be canted to intersect perpendicularly with the ribbands and reduce the use of compass timber.<sup>18</sup> Unlike Sutherland, it appears that Murray intended for the frames to be formed first on paper using a mold to scale, as later he referred to using the same method in the mold loft but with the molds made to their actual size in feet and inches. After forming the frames on paper, ribbands were added to the draft and used to fair the frames.<sup>19</sup> Once the full size molds were formed, they could be used as guides to cut the actual frame timbers. Sirmarks were to be cut into the floors to allow the first futtocks to be aligned, as these timbers ended short of the keel, leaving a three to four inch gap. Murray indicated that the floors should be fastened to the keel first and leveled, after which the futtocks were to be nailed to the floors. His explanation of the frames makes it clear that by this time the heads of the lower floors and futtocks were joined to the heels of the upper timbers without gaps.<sup>20</sup>

Although by a Swedish author, Fredrik af Chapman's *Architectura Navalis Mercatoria* of 1768 deserves a brief mention for the quality of work. This large volume consists of several plates showing drafts of several kinds of merchant vessels of different nationalities, a few of which were discussed in the previous chapter on hull types. These drafts represent a valuable collection of representative vessels plying the seas in the mid-eighteenth century.

Chapman also published a small treatise entitled *Tractat om Skepps-Byggeriet* in 1775 as a companion to *Architectura Navalis*. In his preface, Chapman observed that the ships of all nations could be divided into two groups: the first, small vessels for short, coast or inland voyages, and the second, larger, sea-going ships. Although members of the first class differed considerably between regions, the ships of the second class tended to be similar in their construction and proportions. Chapman then listed five qualities to be desired in a sea-going ship, which often opposed each other in practice, and explained that his aim was to unite theory with practice in an attempt to maximize these characteristics.<sup>21</sup> In a later section on determining the best proportions for a vessel, he listed four desirable qualities specific to merchant ships: ability to carry a large cargo in proportion to size, sails well by the wind, requires a small crew in proportion to cargo, and sails with only a small amount of ballast. These characteristics were again at odds with one another, so that the shipbuilder had to attempt to include as much of each as possible but often gave preference to one based on the trade in which the vessel was to be used.<sup>22</sup> Such factors as cargo type, route to be traveled, necessity of speed, and the ports for anchorage were to be considered. While Chapman's work provides insight into the desired characteristics of merchant craft and the trouble in procuring them, it does not include further specifics on actual construction methods.

William Hutchinson's *A Treatise of Naval Architecture* was the next major British treatise, first published in 1777 and reprinted several times. Hutchinson included some comments on proportions for ships, but focused mainly on aspects of practical seamanship such as sailing, anchoring a ship, navigation, armament, and sailors' health.

In his suggestions for the best shape of ships' bodies, the author wrote that rather than building ships on an even keel, they should have a keel that curves upwards towards the ends.<sup>23</sup> He believed this form would best prevent hogging and would help ships move through the water better; he compared this shape to that of a flat rock skipping over the water. Hutchinson also wrote that according to his experience, square-sterned ships were preferable to those with pink sterns for all uses.<sup>24</sup> Later he recommended that a common practice for London East Indiamen be adopted on all ships – the use of what he called chocks placed lengthwise atop the keel between the frames; he believed these timbers would help prevent bilge water from dangerously washing between the two sides of the ship while at sea.<sup>25</sup> For merchant ships, Hutchinson noted that the length of the keel should be three times the beam. These suggestions, he wrote, proceeded from his experience and a desire to provide standard rules for the construction of merchant ships.<sup>26</sup>

Following Hutchinson's work was an anonymous text published in London in 1788, entitled *The Shipbuilder's Repository; or, a Treatise on Marine Architecture*. The book was printed only once, suggesting it was not very popular. Its lack of success was probably due in part to the fact that only one draft was included and because it contained little new information for the professional shipwright – much of the material was either directly copied from earlier sources or was covered in more detail elsewhere. This type of plagiarism was apparently fairly common, as David Steel later copied from the *Repository's* tables of dimensions in his *Elements and Practice of Naval Architecture*, published in 1805.<sup>27</sup>

Similar to the other treatises examined so far, the *Repository* begins with a discussion of Newton's solid of least resistance principle and some basic observations on desirable qualities in ships. The author wrote that a merchant ship should be able to carry a good cargo, steer well, go smoothly through the water, and carry a good sail. He observed, like Chapman, that to attain any particular one of these qualities results in losing another one, saying "all of them cannot possibly be possessed in one body to any degree of perfection; we therefore should adopt that which is the most useful to our design, and according to what our vessel is intended for."<sup>28</sup> He did suggest as a general rule that the midship frame should be kept well forward in order to allow the vessel to move with less resistance through the water by giving the underbody the shape of a fish; also, the extreme breadth should be higher towards the stern than at midships so that the ship draws more water aft.<sup>29</sup>

Rather than continuing with a section on arithmetic and geometry, the author moved on to a discussion of proportions for different sized merchant and warships. He included several tables of dimensions for specific vessels and probably originally meant to include drafts as well. He included a section on finding a ship's tonnage and several chapters on how to design a vessel. After designing the ship on a draft, the author wrote that molds of the midship timber should be made, both a dead flat mold of the floor and a hollow mold called a floor hollow. It appears that these molds were made to full size, as the author said they could be compared to the actual timber to make sure the piece would be large enough for the floor and to determine what size support chocks would be needed. Once made, the molds were to be applied to the body plan to find how many

floors could be molded by them, depending on the radius of the floor sweeps.<sup>30</sup> A separate mold was to be made for the frames forward and aft that could not be formed by the dead flat mold. After molding all the floors, the lower and upper futtocks and top timbers were to be molded.<sup>31</sup> This author also recommended the use of cant frames in the extremities of the vessel because of the strength they contributed and the conservation of timber through less beveling.<sup>32</sup> After this section on designing a vessel, the *Repository* concludes with a glossary and tables of dimensions of masts and spars. Despite the fact that the treatise would not have been very useful to the late eighteenth-century shipwright, it provides a valuable compilation of techniques for the modern scholar.

The last major British treatise on ship design of the eighteenth century was Marmaduke Stalkart's *Naval Architecture*, first published in 1781 and reprinted in 1787 and 1803. His book proved to be one of Steel's main sources for his *Elements and Practice of Naval Architecture*. Accompanying Stalkart's text is a volume of large plates illustrating his designs. The work is organized to lead the reader through designs of increasing complexity, beginning with a longboat and moving to a yacht, sloop, 44-gun ship, and 74-gun ship. Stalkart concluded with the introduction of a design for a cutter and a brief note about a frigate designed using his suggestions. All of these vessels, unfortunately, were designed on paper only, so they cannot be compared to actual ships; however, Stalkart's clear descriptions with matching illustrations make up for this lack of experimental testing in understanding ship design during the period.

In his preface, Stalkartt reiterated what previous authors observed – namely, that no rules had been fixed for ship design and so the builder was left to follow his own opinion. Stalkartt pointed out that a shipwright's practices could become such a matter of habit that he was resistant to any change, even if it would be beneficial.<sup>33</sup> In the main text, Stalkartt first discussed whole molding. As described in other treatises, the term essentially applied to the use of molds made from the midship frame to form the other frames as far forward and aft as suited the curve of the rising line in order to make the shape fair. Stalkartt's molds were drawn on paper rather than initially constructed in full size, although he used a board to determine the beveling of timbers.<sup>34</sup> He also used cant frames in the bow and stern and said they should be evenly spaced and as near the keel as possible at the heels to keep the beveling nearly square. He explained that cant frames added strength to the ship, conserved timber, and provided better security for the planks.<sup>35</sup> The beveling should be done in a mold loft.<sup>36</sup> For the square frames in vessels larger than the longboat, the heels of the lower futtocks were often butted against the keel or deadwood rather than leaving a gap.<sup>37</sup> Like Hutchinson, Stalkartt also suggested that the midship frame should be placed forward to decrease the ship's resistance and increase its velocity in moving through the water; however, he preferred an even keel.<sup>38</sup> As in the previous treatises, Stalkartt reinforced the stern with several transoms bolted to the sternpost, essentially serving the function of the breasthooks in the bow.<sup>39</sup>

While these various treatises provide an overview of whole molding and give some ideas about how English ships were designed, the most specific information on actual construction details comes from the writing of a French eighteenth-century



shipwright named Blaise Ollivier. Ollivier was serving as Master Shipwright in France's Royal Dockyard in 1737 when he received a secret commission to visit the major dockyards of England and Holland and provide a report on their shipbuilding practices and navies. His manuscript was not intended for publication and only two or three original copies were made; the text was printed as an edited book only as recently as 1992, under the title *18th Century Shipbuilding: Remarks on the Navies of the English and the Dutch from Observations Made at Their Dockyards in 1737 by Blaise Ollivier, Master Shipwright of the King of France*.<sup>40</sup> Ollivier visited Deptford, Woolwich, Chatham, Portsmouth, and Sheerness Dockyards and made detailed observations of what he saw, often including comments on whether he thought the French should adopt a similar method. For the most part, the vessels he examined were large warships of 50 to 100 guns, but occasionally smaller frigates were in port also. His notes reveal several interesting features of English ships that are not usually discussed in the contemporary treatises.

Ollivier's observations at Woolwich and Deptford confirm the use of whole molding and master frames in English ships, as discussed in the treatises above. At Woolwich, he saw that the master or mold frames were set up along the keel 7 to 9 ft (2.1 to 2.7 m) apart, depending on the size of the ship. The floors were placed first and often the floors of the filler frames were installed also, followed by a floor ribband to fair the floors. Because the radius of the sweep appeared to be the same for most of the floors, Ollivier assumed the English were using whole molding. After securing the floors, the first and second futtocks of the master frames were installed; the upper

futtocks could be placed once these timbers were faired with a ribband. The planking was fastened into place prior to adding the top timbers. To install the filler frames, the second and fourth futtocks were attached to the floors; next, the first futtocks were placed in the space between the floors so that they divided it equally. Thus, unlike in the master frames, the first/ third futtocks were not fastened in any way to the floors/ second futtocks. After the first futtocks were in place, the third futtocks and top timbers could be installed. For all of the frames, the scarfs between timbers consisted of a large chock secured with three treenails; this arrangement allowed the English to use smaller compass timbers and more straight pieces. With this method of framing, leaving space between timbers and using treenails as fasteners, Ollivier thought the English could build lighter ships with less frames and they saved on the cost of iron.<sup>41</sup> He did observe, only in Deptford, that some of their ships had no space between frames up to the head of the lower futtocks; any gaps were filled with small filler pieces.<sup>42</sup> Cant frames were used in the bow and stern; Ollivier refers to them as futtocks rather than floors, suggesting they were half-frames. These timbers butted against the deadwood.<sup>43</sup>

The English ships at Deptford had deadwood or rising wood overlaid on their keels to the same thickness as the keel. Extra deadwood and a stern knee were employed in the stern. The sternpost was composed of two timbers but an inner sternpost was not used. The stem post increased in thickness towards the top to provide support for the bowsprit.<sup>44</sup> False keels were used on all of the English ships.<sup>45</sup> The keelsons on the ships at Deptford were twice as thick as the French keelsons and were built from two timbers scarfed horizontally along their length, similar to the French style for scarfing keels,

according to Ollivier. The keelsons at Woolwich were not scored to fit over the frames unless some of the floors were not fair.<sup>46</sup> The external planking was applied to the frames before the ceiling planking was installed. No iron bolts were used, but only two treenails per plank per frame; the strakes were caulked after the treenails were inserted. Planking timber was used completely dry, with any cracked sides placed against the frames. A layer of pitch was applied between the frames and the planks.<sup>47</sup>

Ollivier also recorded information on the fittings of English ships. On the ships at Chatham, the fore and mainmast steps consisted of a single transverse timber notched to fit over the keelson and cut with a mortise for the mast heel. The mizzen step, however, was like the French steps, being made of multiple timbers.<sup>48</sup> The ship rigs Ollivier examined were lighter and less costly than French rigs for comparably sized vessels, with smaller masts, yards, and even cables. Ollivier thought this lighter rig would allow the English vessels to carry their sail better, respond more quickly to the helm, and sail faster.<sup>49</sup> He observed that on the larger ships, the main capstan consisted of a single drum, in order to take up less deck space. The main pumps were chain pumps rather than suction, composed of an iron chain with leather plates to raise the water. The sailors turned an iron winch to move a series of iron gears to turn the chain; water raised from the bilges emptied into a wooden cistern on the gundeck.<sup>50</sup>

The overall shape of the English ships was very different from French vessels. Rather than preferring the sharp lines seen in French ships, the English used very full floors with a medium hold depth, allowing the ships to carry sail well with less ballast. The ships also tended to have more tumblehome.<sup>51</sup> According to Ollivier, some English

shipwrights began to experiment with this standard shape in 1732, just prior to his visit. They increased the breadth of their ships while maintaining the same length and hold depth in an effort to reduce hogging and make the ships sail better. To increase the breadth, they lengthened the midship floor, but at the same time increased the deadrise; as Ollivier points out, greater deadrise essentially canceled out the benefits of a longer floor, leaving the breadth the same. Additionally, while the concept of an increased beam would yield better sailing vessels, the English concurrently increased the size of the masts and spars in proportion to the larger breadth, again negating any initial benefits by making the rigging heavier.

These changes were based on Newton's theory of the solid of least resistance and were meant to allow the ship's underbody to cleave through the water better. The shipwrights tried to make the bow and stern fuller by applying Newton's sweeps, but found that the shapes were not suitable for sailing; realizing this problem, Deptford shipwrights experimented with different shaped blocks of wood to come up with appropriate sweeps. The final change was the addition of an extra false keel to help prevent leeward drift, but Ollivier believed that the extra depth would do more to inhibit good sailing by increasing resistance. In the end, he summed up his opinion of the new English ships by saying, "Thus, the English have made, with their new manner of building, ships which cost them much more than did their former ships...yet which will be no more weatherly nor sail any faster..."<sup>52</sup>

As can be seen from this brief survey of eighteenth-century treatises relating to British naval architecture, the shipwright had only a few major literary resources. In

many cases, the books were reprinted well after their initial publication or contained information that was already obsolete at the time they were written. Most of the material covered was theoretical in nature, involving the use of geometry and arithmetic in ship design, although several of the texts included tables of dimensions. Despite the overall lack of details on actual construction methods, these books provide evidence regarding the types of framing used on vessels and the order of construction. They also offer a picture of how the shipwright viewed vessel design and what qualities were most important in a new ship. Details from these sources can be compared to the archaeological record to see how prevalent the authors' suggestions were and to better understand how actual ships were designed and built.

## Endnotes

<sup>1</sup> As quoted on p. 10 of B. Lavery's introduction to *Marine Architecture* (Anonymous 1993).

<sup>2</sup> Lavery 1986.

<sup>3</sup> Lavery 1986, 7-8.

<sup>4</sup> Sutherland 1711, preface.

<sup>5</sup> Several different terms for frames exist and are often confusing. Morris et al. (1995, 125, 128) differentiate between *single* frames and *double* frames, with the former consisting of a floor and futtocks in a single line and the latter consisting of two rows of timber, with the floor and second futtocks next to the associated first and third futtocks. This definition of double frames has been adopted for this study, so that a complete set of frame timbers, whether actually touching or not, is called a double frame. These frames can be further distinguished by whether the rows of timber have significant gaps between them – an *articulated* frame is one in which the timbers are intentionally placed closely together or even laterally fastened, while in a *disarticulated* frame the floors and first futtocks are separated by a gap. In the case of the articulated frames, these were almost always the master or mold frames, designed on a draft or mold loft and placed first to set the shape of the hull. Disarticulated frames were then added as filler or intermediate frames, although articulated frames could have been used if all frames in the vessel were designed on a draft prior to installation. The terms “articulated” and “disarticulated” have been adopted from Kenchington (1993, 39, note 27). A final set of definitions regard the orientation of the frames to the keel: *square* frames were placed perpendicular to the keel, whereas *cant* frames were placed at an acute angle.

<sup>6</sup> Sutherland 1711, 25-6.

<sup>7</sup> Kenchington (1993, 14-7) gives an interpretation of Sutherland's bow framing, suggesting his version of canting meant to rotate the timbers slightly on an axis square to the keel, rather than to place them at an acute angle to the keel. In addition, the timbers were to be raked to keep the room and space equal at the head and heel, but it is unclear how this could have been accomplished in a real vessel. Interestingly neither Kenchington's interpretation nor true canting is seen on the Ronson ship, the vessel closest in date to Sutherland's treatise. As will be discussed below, the bow frames are square, or placed perpendicularly to the keel.

<sup>8</sup> Sutherland 1711, 26-7.

<sup>9</sup> See Kenchington 1993, 9-14 for a detailed analysis of Sutherland's framing in the run of the hull.

<sup>10</sup> Sutherland 1711, 77-82.

<sup>11</sup> Sutherland 1711, 78.

<sup>12</sup> Sutherland 1711, 35, 39.

<sup>13</sup> Sutherland 1711, 47, 54.

<sup>14</sup> Sutherland 1711, 27-8.

<sup>15</sup> See Lavery's introduction for more details on the original works (Anonymous 1993).

<sup>16</sup> Anonymous 1993, 12, 15, and Lavery's introduction.

<sup>17</sup> Murray 1765, 133-5.

<sup>18</sup> Murray 1765, 154.

<sup>19</sup> Murray 1765, 142.

<sup>20</sup> Murray 1765, 143-4, 164.

<sup>21</sup> Chapman 1971, 75-7.

<sup>22</sup> Chapman 1971, 83-4.

<sup>23</sup> Hutchinson (1794, 36) suggests a curvature of 2 in (5.1 cm) upward per 30 ft (9.1 m) of keel length in merchant ships.

<sup>24</sup> Hutchinson 1794, 19-20.

<sup>25</sup> Hutchinson 1794, 21.

<sup>26</sup> Hutchinson 1794, 35-6.

<sup>27</sup> From D. Roberts' foreword to *The Shipbuilder's Repository* (Anonymous 1992).

<sup>28</sup> Anonymous 1992, 41-4. Quote from p. 44.

<sup>29</sup> Anonymous 1992, 46.

<sup>30</sup> It seems that the body plan must have been taken off the draft and drawn on the mold loft floor, as the author recommended for the entire head of the ship in making its timbers (Anonymous 1992, 423).

<sup>31</sup> Anonymous 1992, 370-80.

<sup>32</sup> Anonymous 1992, 385.

<sup>33</sup> Anonymous 1992, i.

<sup>34</sup> Stalkartt 1991, 1, 6, 11.

<sup>35</sup> These reasons for using cant frames are strikingly similar to those given in the *Repository* (Anonymous 1992, 385) – to some extent they are a direct copy, although Stalkartt has simplified the explanation (Stalkartt 1991, 47-8).

<sup>36</sup> Stalkartt 1991, 12, 15.

<sup>37</sup> Stalkartt 1991, 26.

<sup>38</sup> Stalkartt 1991, 30, 32.

<sup>39</sup> Stalkartt 1991, 72.

<sup>40</sup> Roberts 1992.

<sup>41</sup> Roberts 1992, 65-7.

<sup>42</sup> Roberts 1992, 48.

<sup>43</sup> Roberts 1992, 68.

<sup>44</sup> Roberts 1992, 46-7.

<sup>45</sup> Roberts 1992, 84.

<sup>46</sup> Roberts 1992, 45, 49, 70.

<sup>47</sup> Roberts 1992, 52, 70-1, 74.

<sup>48</sup> Roberts 1992, 87.

<sup>49</sup> Roberts 1992, 163-5.

<sup>50</sup> Roberts 1992, 159.

<sup>51</sup> Roberts 1992, 137.

<sup>52</sup> Roberts 1992, 181-4. Quote from p. 184.

CHAPTER V  
COLONIAL AMERICAN AND ENGLISH SHIPWRECKS: THE  
ARCHAEOLOGICAL EVIDENCE

The archaeological evidence for Anglo-American ship construction in the eighteenth century comes through a variety of excavations in North America. A wide range of information has been preserved through archaeological reports; some of the excavations were complete, multi-year projects and others were conducted in a matter of days in an attempt to gather as much data as possible before the site was destroyed by modern construction. Even minimally studied vessels are important to consider in an attempt to gain a broader picture of merchant ship construction and so they are included in this study. In addition to the positively identified American and British ocean-going merchant vessels, a few warships and smaller riverine craft have been included for comparative purposes. These vessels were also either British or American and were used in the New World. The riverine craft were separated from the other merchant vessels based on their design suited for protected waters and function as local river traders. A brief account of each ship and the pertinent archaeological finds are discussed below.

**Merchant Vessels**

*The Phips Shipwreck*

In 1994, a sport diver discovered the remains of a late seventeenth-century shipwreck at Anse aux Bouleaux, or Birch Cove, in Quebec, Canada. The diver notified



Parks Canada's Underwater Archaeological Services and after a brief survey, it was determined that the vessel might be part of Sir William Phips's 1690 fleet and would be worth further study. As a result, a complete survey of the site was conducted in 1995, followed by excavation and reburial of the site from 1996 to 1997.<sup>1</sup> The results of the excavation confirmed that the Anse aux Bouleaux wreck was one of four vessels lost in Phips's fleet, possibly the 45-ton New England-built *Elizabeth and Mary*.<sup>2</sup>

Sir William Phips organized a fleet of more than 30 vessels in 1690 to set out from Massachusetts and attack the French city of Quebec in Canada. This action was taken in response to French and Indian raids on New England outposts made during the previous year, precipitated by the War of the League Augsburg fought between England and France from 1689 to 1697. Phips's fleet, mainly composed of poorly armed merchant vessels, arrived ill-prepared before Quebec in New France after facing disease and several setbacks. Phips quickly realized that they were incapable of taking the city and shortly afterwards turned his vessels back to New England. Four ships were lost during the voyage, one of which disappeared with no survivors. Evidence from artifacts recovered during the 1995 survey confirmed that the Anse aux Bouleaux remains were of a late seventeenth-century British colonial military vessel; initials on two objects match those of known soldiers who participated in Phips's expedition.<sup>3</sup>

The extant length of the hull remains was about 27 ft 10.6 in (8.5 m), consisting of two major internal planks, framing, and three external planks (fig. 14).<sup>4</sup> No keel, keelson, stem, or stern timbers were found, making information such as the framing pattern difficult or impossible to interpret. Even though no evidence relating to the mast

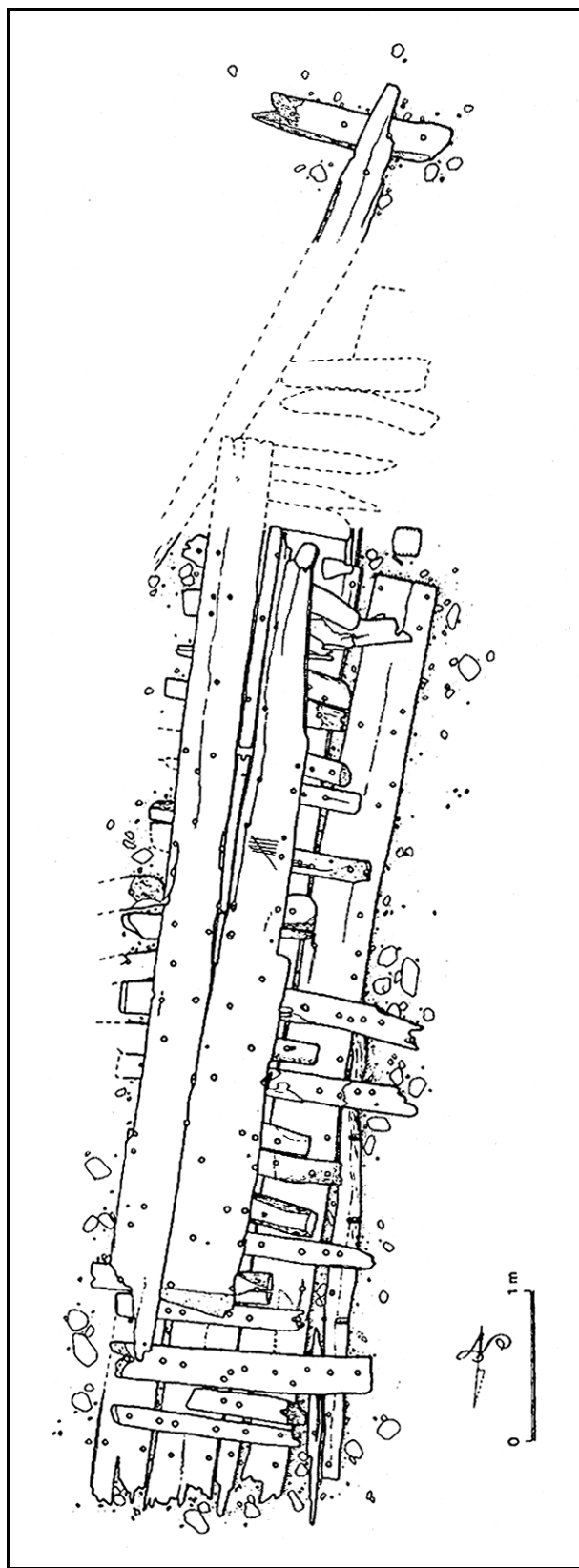


Figure 14. Hull remains of the Phips shipwreck. (After Waddell 1997, 80).

steps was found, the vessel's small size suggests it would have been single-masted, probably rigged as a sloop. Prior to its military career in Phips's fleet, it most likely would have been used for coastal, short-distance trade.

There were 31 white oak futtocks associated with the remains; no floors could be identified because of the limited preservation of the hull.<sup>5</sup> The futtocks appeared to be independent of each other, with no horizontal joinery. Some of the futtocks were installed closely together while others are separated by large gaps. It is unclear how the futtocks would have been attached to floors, in what order they would have been installed, or whether the frames were originally articulated or not. The futtocks consistently had greater sided dimensions than molded; they averaged 4.7 in (11.9 cm) molded with the sided dimension varying between 6.3 to 10.2 in (16 to 25.9 cm). Apparently the shipwright was not concerned with careful finishing of the frames, as indicated by the variation in dimensions and the presence of cambium and bark on some. This approach clearly was different than the standardization required of naval vessels and lends support to the notion that the Phips wreck was a merchant ship.<sup>6</sup>

The three major external planks were also of white oak and measured about 2 in (5.1 cm) in thickness by 17.7 in (45 cm) in width. A small fragment measuring 4 in (10.2 cm) in thickness probably represents a wale. The planks were secured to the frames by wedged treenails; both square and diamond-shaped wedges were uncovered. Two major ceiling planks were found, each measuring 1.6 in (4.1 cm) in thickness; wood analysis on one of the planks revealed it to be built of eastern white pine. The two planks were tightly fitted at one end but began to separate part way through their length; the gap was

filled with three smaller planks joined end-to-end. This feature appears to be original, suggesting again that the builder was more concerned with economically constructing a strong, capable vessel than with finished details or meeting strict specifications.<sup>7</sup>

### *The Ronson Ship*

The Ronson ship, an eighteenth-century merchant vessel, was discovered in New York City in 1981 when developer Howard Ronson applied to the city to build a skyscraper on Water Street. He contracted with Soil Systems Inc. to conduct the required pre-construction archaeological survey, which consisted of a thorough investigation of part of the site and deep test trenches throughout the rest of the area. In the final test trench the remains of a wooden vessel were discovered, apparently scuttled and filled during the eighteenth century to form cribbing for a wharf. Nautical archaeologists Warren Riess and Sheli Smith were called to examine the vessel and together with Soil Systems decided to ask the developers and the New York Landmarks Commission for more time to excavate. Their proposal was approved and in February of 1982 the excavation was conducted, although the starboard and stern portions could not be studied because they were located under Front Street. The exposed bow was removed for conservation following the excavation.<sup>8</sup>

Although the excavators were unable to directly measure the keel, assumed dimensions based on the stem scarf were 12 in (30.5 cm) sided by 14 in (35.6 cm) molded. The length was estimated to be 68 ft (20.4 m), composed of an indeterminate number of pieces.<sup>9</sup> The stem was built using two pieces, with the lower post measuring

14 ft 2 in (4.3 m) in length. The post had a maximum sided dimension of 11.4 in (29 cm) and tapered in its molded dimension from 31.3 in (79.5 cm) at the keel scarf to 25.6 in (65 cm) near its preserved upper limit. An apron, also made of two pieces, was attached to the inner surface of the stem. The upper piece was rectangular in section and measured 12 in (30.5 cm) sided and 7.9 in (20 cm) molded. The lower piece was slightly larger, molded 10.8 in (27.5 cm) and trapezoidal in section, with the forward face sided 9.1 in (23 cm) and the aft face sided 11.4 in (29 cm).<sup>10</sup>

Each of the vessel's frames consisted of a square-shaped floor and six futtocks that, with the exception of the frames farthest forward, were horizontally secured together.<sup>11</sup> White oak or possibly live oak was used for the frame construction.<sup>12</sup> Average dimensions were similar for the floors and futtocks, measuring 8.5 in (21.6 Cm) sided and 8.5 in (21.6 cm) molded, with spacing between frames averaging 6 in (15.2 cm). The forwardmost bow floors and futtocks averaged 6.7 in (17 cm) sided and varied from 7.9 to 9.8 in (20 to 25 cm) molded. These bow frames were square, or positioned perpendicularly to the keel, rather than canted, but the futtocks were cut in a diamond shape to better fit the complex curves of the bow. The heels of the first futtocks met over the keel. The floors were cut from the crotch of a tree, with unequally sized arms; the heavier arm alternated from side to side throughout the framing pattern. No chocks were used, so gaps were left between frame and ceiling planking where timbers did not exactly fit the required curve. One pair of half frames was used in addition to the full frames. This set was located between the second and third frames in the bow and

measured 8.7 in (22 cm) molded and 4.7 to 5.1 in (12 to 13 cm) sided, filling the space between the full frames.<sup>13</sup>

The keelson was made of white oak and was bolted to the frames and keel. External and ceiling planking were made also made of white oak. The outer strakes averaged 2 in (5.1 cm) in thickness, with the width varying from 8 to 14 in (20.3 to 35.6 cm). Three wales, forming a tight band just below the gunports, each measured 4 in (10.2 cm) in thickness. Thick outer planks located directly above the wales tapered from 3.5 in (8.9 cm) down to the standard 2 in (5.1 cm) thick planks. The ceiling planks inside the hull were also 2 in (5.1 cm) thick. A 3 in (7.6 cm) thick deck clamp and waterway paralleled the external wales and along with three 4 in (10.2 cm) thick stringers provided additional longitudinal support. All planking was fastened to the frames by means of octagonal unwedged trenails measuring 1.2 in (3 cm) in diameter; these fasteners, driven through augered holes, were primarily of white oak, but examples were found of white pine, southern pine, hickory, juniper, and ash. Both the outer and internal planking were caulked with oakum driven between the seams. The exterior of the hull was coated with pitch and animal hair and covered with thin wood sheathing. Strips of lead sheeting secured with iron nails were found at the bow.<sup>14</sup>

The Ronson ship had two decks, lower and upper. Deck beams measuring 12 in (30.5 cm) square were dovetailed into deck clamps on the sides of the hull. The lower beams were braced with lodging knees while hanging knees supported the upper beams. Forward of midships the knees were secured to the aft side of the beams, whereas aft of midships they were attached to the forward side. The lodging knees butted against the

next beam, thereby forming a continuous band of timber around the hull. Also supporting the decks were 12 in (30.5 cm) wide by 3 in (7.6 cm) thick carlings that ran fore-and-aft and sat in slots in the beams. Ledges ran parallel to the deck beams and were the same size as the carlings, providing additional support between the knees and carlings. The red or scotch pine deck planking was 1.5 in (3.8 cm) thick, except for the 2 in (5.1 cm) thick nibbing strake next to the waterway. The waterways were 6 in (15.2 cm) wide by 4 in (10.2 cm) thick at the bulwark, tapering to the thickness of the nibbing strake. The lower deck had two hatches, a main hatch measuring 6 ft (1.8 m) long by 5 ft (1.5 m) wide and a forward hatch 5 ft (1.5 m) long by 4 ft (1.2 m) wide. Both hatches had a monkey post, or carved stanchion with footholds, serving as a ladder.<sup>15</sup>

The vessel was ship-rigged, with three masts and a bowsprit. Two mast steps for the foremast were found in the bow, one sitting atop the other as a replacement. The lower, first step extended fore-and-aft and had a 7.3 in (18.5 cm) by 13.8 in (35 cm) mortise cut to a depth of 7.1 in (18 cm) forward and 5.1 in (13 cm) aft. A longitudinal split in the step was visible, suggesting a reason for the addition of the second step. The upper step sat on the lower perpendicularly or athwartships and was secured in place by various iron fastenings. Its mortise measured 7.5 in (19 cm) by 8.9 in (22.5 cm) cut to a depth of 4.5 in (11.5 cm) at its center. No information was gathered on the steps for the other masts, but the lower end of the mizzenmast was recovered. The softwood mast, probably made of white pine, was octagonal in section with a diameter of 14.2 in (36 cm) across the flats. The bowsprit, foremast, and mainmast had all been removed sometime earlier, most likely in the eighteenth century prior to scuttling the vessel.<sup>16</sup>

A jeer capstan and its step were found in the forward part of the ship. Cut from a single piece of elm, the capstan was 7.6 ft (2.3 m) in length, divided equally between to the barrel and the spindle. The head of the barrel was cut with two square holes, oriented perpendicularly to one another, into which long bars would have been inserted in order to turn the capstan. Beneath these holes and attached to the barrel by treenails and iron nails were five long, wooden whelps shaped like half-arrows. Two rows of chocks between the whelps helped secure them in place. The 9.8 in (25 cm) diameter spindle beneath the barrel was secured to the capstan step. The step measured 28.1 in (71.5 cm) long, 12.8 in (32.5 cm) wide, and 3.9 in (10 cm) thick. It was cut with a vertical hole 5.1 in (13 cm) in diameter near its center; this hole may have contained an iron fastener used to secure the spindle. The step was secured to a large bed by four iron fastenings. The bed measured 3.3 ft (1 m) long, 15.7 in (40 cm) wide, and 8.7 in (22 cm) thick. A treenail, two bolts, and nails were found in the bed, perhaps used to secure it to the inside of the hull.<sup>17</sup>

Part of the ship's port bilge pump, located next to the mainmast, was also recovered. The tube was cut from a softwood, probably southern hard pine, and had a maximum width of 14.8 in (37.5 cm) with a 4.9 to 5.1 in (12.5 to 13 cm) diameter hole bored throughout its length. This hole was noticeably off-center, causing variation from 3.1-6.3 in (8-16 cm) in the thickness of the tube's walls. An outflow hole cut perpendicularly to the central bore was 2.3 in (5.8 cm) in diameter and cut 3.2 ft (1 m) from the top of the 5 ft (1.5 m) pump fragment.<sup>18</sup>



The Ronson ship originally would have measured 82 ft (25 m) in length between perpendiculars, or about 100 ft (30.5 m) overall, with a beam of about 27 ft (8.2 m) and a draft of 11 ft (3.4 m). Beneath the lower deck, the 7.5 ft (2.3 m) deep cargo hold was divided into three compartments by two bulkheads, one located 10 ft (3 m) aft of the stem and the other 8 ft (2.4 m) aft of the mainmast. The central cargo area, measuring 44 ft (13.4 m) in length, appeared to be undivided. The overall measured tonnage would have been about 260 tons. The ship had six gun ports on the lower deck, designed to carry six-pounder guns; this small amount of artillery suggests the Ronson ship was a merchant frigate rather than a warship, as does the caulking in the ceiling planking of the hold. As a merchant vessel, the Ronson ship would have required more men to work its rig and guns than other types, and its shallow draft would have limited cargo capacity, but it would have been capable of transoceanic voyages and protecting whatever it carried.<sup>19</sup>

Artifacts associated with the site range in date from 1670 to 1770, with most clustering in the 1740s, and appear to be British or American. Two objects with dates on them were found – a lead weight from 1746 and a ceramic jug from 1747. These artifacts suggest the vessel was buried after 1747, perhaps in the 1750s. Repairs to the vessel, including the replaced foremast, suggest the ship was buried because of old age rather than fire or other severe damage. The sacrificial sheathing appeared to have been replaced once, suggesting a lifetime of four to eight years for the vessel; however, the ship could have been retired to the harbor and used as a storage hulk for several years before being scuttled as fill, leaving a possible date range from the early 1700s to the 1740s for its construction.<sup>20</sup>

Identification of wood samples from the shipwreck revealed several wood types to potentially be of American origin, including live oak and southern hard pine. These samples suggest that the Ronson ship was built in the southern American colonies, possibly Virginia or the Carolinas. Based on the limited number of ships built in the Carolinas in the early eighteenth century, the excavators believe the vessel was built in Virginia. Because Virginia's main export at the time was tobacco, it is possible the ship was built as a tobacco carrier, an idea further supported by the caulking in the hold ceiling planking to keep cargo dry. Analysis of the teredo worms found in the wood indicates that the vessel had been in a warm water port in the last three years of its sailing life.<sup>21</sup>

At 260 tons, the Ronson ship was a large vessel for the colonial period. With its ship rig, artillery, and solid construction, it was designed for seaworthiness and long-distance trade. Its shallow draft would have allowed access to inland waters for pick up of its cargo. Despite its seaworthiness, there was some evidence of sloppiness in construction, such as variations in frame size and spacing, lack of finishing on some timbers, and treenails missing their target frames.<sup>22</sup> These flaws were probably the result of attempting to economize in construction, further evidence that the Ronson ship was not originally a warship.

### *The Rose Hill Shipwreck*

In 1987, local divers found a wooden shipwreck and eighteenth-century artifacts at a site on the Northeast Cape Fear River near Wilmington, North Carolina. The area

was known as the Rose Hill landing and had once been part of a colonial plantation. The divers reported the find to North Carolina's Underwater Archaeology Unit; in response, UAU staff spent a week in May of 1988 conducting a major investigation of the site, working at a depth of about 18 ft (5.5 m) below the river surface. The archaeologists recovered artifacts and recorded the visible hull remains, but did not excavate the site. They concluded that the vessel dated to the eighteenth century and appeared to have been New England-built, although outfitted for southern waters. The estimated original size of the vessel was 67 ft (20.4 m) in overall length and 22 ft (6.7 m) in beam with a tonnage of about 103 tons. The site plan is shown in figure 15. With a single mast, the Rose Hill wreck appears to have been a sloop.<sup>23</sup>

The full length of the hard maple keel was preserved, measuring 54.5 ft (16.6 m) in length, 15 in (38.1 cm) molded, and 8 in (20.32 cm) sided. The molded dimension may include a false keel. Securing the keel to the stempost was a horizontal nibbed scarf fastened with three iron bolts of 0.75 in (1.9 cm) diameter. The apron, resting on the keel and stem, measured 8 in (20.3 cm) molded and 12 in (30.5 cm) sided; it was cut with three 1 in (2.5 cm) deep and 11 in (27.9 cm) wide notches to receive the floor timbers in the bow. Part of the red oak sternpost remained but was badly deteriorated. The deadwood in the stern measured 10 in (25.4 cm) sided and was cut with 2 in (5.1 cm) deep notches to hold the heels of the lower futtocks. A long timber running between the apron and the stern deadwood was set directly on the keel and formed the area to which the garboard strake was attached, although the rabbet was located 2 in (5.1 cm) down from the top of the keel. This deadwood timber, called the rising wood or hog in the

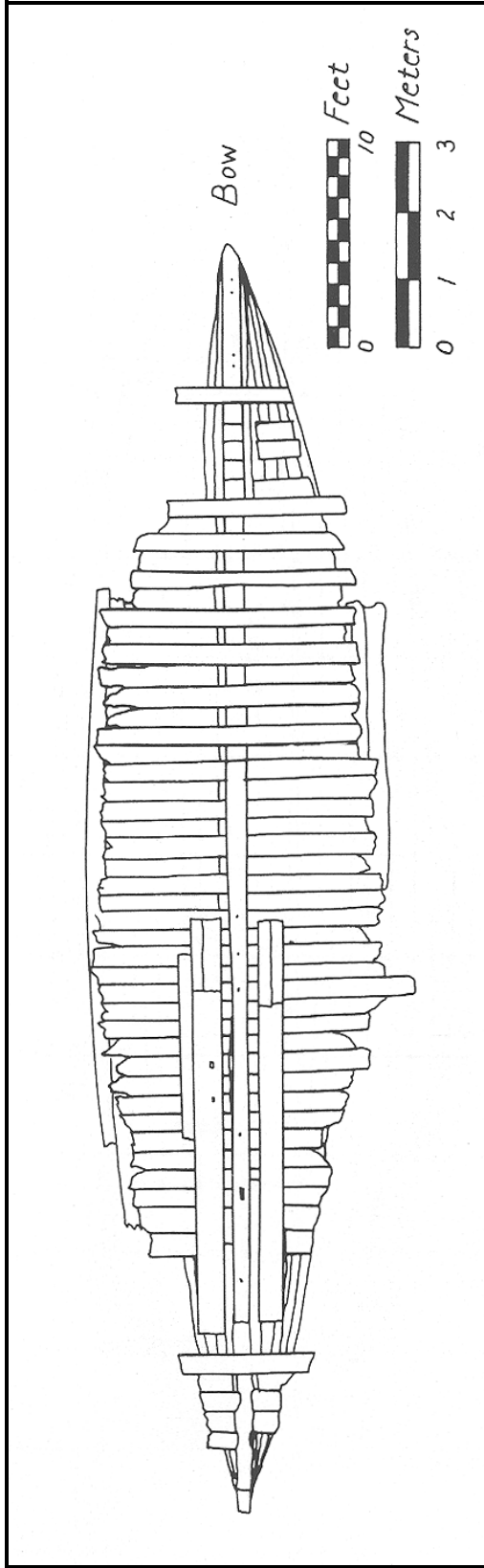


Figure 15. Hull remains of the Rose Hill shipwreck. (From Cook 1997, 118).

excavation report, was molded 2 in (5.1 cm) and sided 10 in (25.4 cm) and was not recessed to receive the floors.<sup>24</sup>

Random measurements of the 23 preserved floors revealed average dimensions of 10.5 in (26.7 cm) molded and 11 in (27.9 cm) sided. Floors were constructed using both beech and white oak. Spacing was 22 in (55.9 cm) between the centers of the floors, which were notched to fit over the rising wood. These notches continued past the centerline timber an additional 2.5 in (6.4 cm) on each side to form limber holes. Removal of one of the floors revealed a chock still attached to the planking, apparently used to make a better fit between the floor and the external strakes. The futtocks matched the floors in dimensions and were offset 11 in (27.9 cm) from the centerline. With a sided dimension of 11 in (27.9 cm), the futtocks completely filled the space between the floors, giving the vessel equal room and space. No evidence was found to indicate that the floors and futtocks were laterally fastened together, suggesting the futtocks were installed after the floors and part of the planking. Deadrise measured at the flattest floor was 5°.<sup>25</sup>

The white oak keelson, measuring 12 in (30.5 cm) molded by 10 in (25.4 cm) sided, was secured to the frames and keel with 0.75 in (1.9 cm) clenched iron drift bolts driven through pre-drilled holes. The surviving length of the keelson measured 28 ft 9 in (8.8 m) and stretched from floor 11 forward of midships to floor 27 in the stern. While the forward keelson end was fractured, the aft end appeared finished, indicating the keelson was intentionally stopped short of the stern deadwood. No evidence was found

on this extant length of a mortise or other type of mast step, suggesting the vessel had only a single mast step located forward of floor 11.<sup>26</sup>

The ceiling planking, made of red oak, averaged 2 in (5.1 cm) in thickness and varied from 3.5 to 15 in (8.9 to 38.1 cm) in width. The external planking was constructed of white oak and varied in width from 7 to 17 in (17.8 to 43.2 cm). The single plank removed for analysis was 2.4 in (6.1 cm) thick and the inside face showed damage from fire, appearing to be from accidental burning rather than intentional heating to assist with bending the plank. The external planking was covered with pine tar and animal hair and overlaid with 0.5 in (1.3 cm) thick sacrificial hard pine sheathing that was attached with iron nails in a random pattern. Internal and external planking was held in place by means of white oak wedged treenails measuring 1.25 in (3.2 cm) in diameter. The removed sample plank had two treenails driven into each floor and futtock. In addition, 0.25 in (0.6 cm) diameter square iron nails were spaced about every 5 ft (1.5 m).<sup>27</sup>

The remains of a suction bilge pump were found on the starboard side of the hull between floors 18 and 19, fitting between the associated futtock and the keelson. The wooden block was almost square in cross-section, measuring 5.75 in (14.6 cm) by 6 in (15.2 cm) at the bottom and 6 in (15.2 cm) by 7.5 in (19 cm) at the top of its preserved 21 in (53.3 cm) height. The block was bored with a 2 in (5.1 cm) hole throughout its length and had a notch at the bottom near the planking to allow entrance of water. The upper remains of the pump show extensive charring, suggesting it was burned to its preserved height.<sup>28</sup>

Also recovered from the shipwreck were four cast iron plates believed to be part of a cookstove. The plates, each 0.5 in (1.3 cm) thick, were found on the starboard side 36 ft (11 m) from the bow, near midships. Two of the plates were the same shape and size, measuring about 32 in (81.3 cm) long by 20 in (50.8 cm) wide. These two plates and at least one of the others were originally attached to each other by means of square rivets and iron bars. Square holes in the two matching plates may have held bars for iron grates and rings to secure the stove to the planking.<sup>29</sup>

Due to poor stratigraphy and a lack of datable artifacts in the hull, the excavators of the Rose Hill wreck have dated it to the second quarter of the eighteenth century based on construction features. They point to the equal room and space, the gaps between the first futtocks and the keelson, and the fact that the keelson stops short of the deadwood as evidence for the vessel's construction prior to 1750.<sup>30</sup> Because the hull must be dated based on its features, one cannot securely use it as evidence for construction methods during a specific period, other than as being representative of general eighteenth century techniques.

At about 100 tons, the Rose Hill vessel was fairly large for a sloop. Its draft would have been at least 8 ft (2.4 m) with a hold depth of about 8.5 ft (2.6 m), suggesting a merchant ship too large for local river trade. In addition, the fairly heavy construction with no space between the frames, the use of sacrificial sheathing, and the presence of a cookstove all lend support to the idea that the sloop was engaged in some form of distance trade. The 3:1 length to beam ratio and very small deadrise would have maximized cargo space, while the heavy framing provided support for weighty cargo.

The types of wood used in the sloop's construction, including red and white oak, hard maple, and beech, suggest it was built in the northern American colonies. Its presence in North Carolina may be indicative of its use in the inter-colonial trade or possibly in trade with the West Indies.<sup>31</sup>

### *The Terence Bay Shipwreck*

In May of 1980 divers from the Underwater Archaeology Society of Nova Scotia (UASNS) discovered the remains of a mid-eighteenth century fishing schooner near Halifax, Nova Scotia. After finding the wreck, it was learned that sport divers had recovered a bottle and two spoons in the 1970s; examining these artifacts showed they dated to the mid-eighteenth century, suggesting the site would be worth further investigation. Between 1980 and 1983, UASNS surveyed the hull remains and excavated test trenches in the bow and the midships section; however, as none of the timbers were dismantled, the available information is limited.<sup>32</sup>

The site was located in 10 to 13 feet (3 to 4 m) of water and about 328 feet (100 m) from shore. Two English coins showing little wear and dating to the 1749 and 1752 suggest the vessel sank in the 1750s. The ballast stones and the types of wood used in the vessel's construction, including white oak, red or Scots pine, and larch, provide evidence for a home port in New England. Fishing-related artifacts and thousands of cod bones found in the bilges indicate the schooner was used for fishing.<sup>33</sup>

The hull remains include about 70% of the port side of the vessel, but the keel was missing (fig. 16). The report estimates the schooner's original size to have been



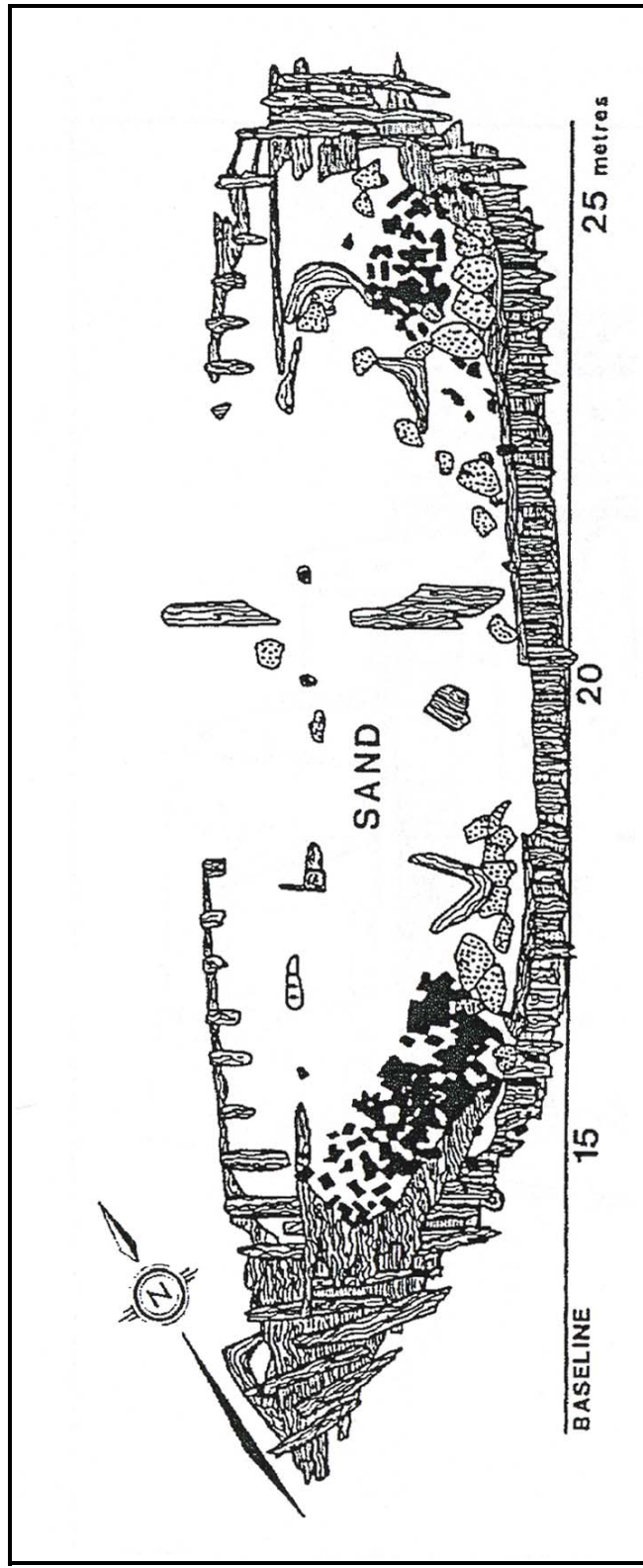


Figure 16. Site plan of the Terence Bay wreck. The bow is to the right. (From Carter and Kenchington 1985, 16).

about 70 ft (20 m) in length with a tonnage of 100 to 120 tons. It appears to have had a complete deck and a bulwark above deck level. The deck beams, measuring 8 in (20.3 cm) sided and molded, were supported by large hanging and lodging knees, the latter forming a solid band of timber around the hull. The lodging knees were approximately 6 in (15.2 cm) molded. Notches were cut into the knees to hold the ends of the ledges that provided additional support for the deck. Chips of red or scotch pine found in the hull suggest the deck was made of pine. The uppermost strake had a decorative molding, which seems unusual for a working vessel in the fishing industry.<sup>34</sup>

Fifty-three oak frame timbers were found along the edge of the wreck where the keel would have been attached. Only two of these appeared to be articulated frames, with the floor and first futtock treenailed together laterally. The rest were independent of each other and fastened only to the planking. The timbers were placed closely together, however, with an average space of 2 in (5.1 cm) between frames. At their heads, the floors measured on average 8 in (20.3 cm) sided and 6 in (15.2 cm) molded. The top timbers above deck level averaged 7 in (17.8 cm) sided and 5 in (12.7 cm) molded. Whereas the majority of the frames lay perpendicular to the centerline, the frames in the stern were placed at various angles away from the sternpost, the opposite from a typical cant frame pattern (fig. 17). Because these timbers appear to be secured only to the planking, they must have been added after the stern was planked to provide extra support for the planking ends.<sup>35</sup>

The outer and ceiling planking were also constructed of oak and measured 2 in (5.1 cm) thick. The ceiling planking was not caulked and the outer planking appeared

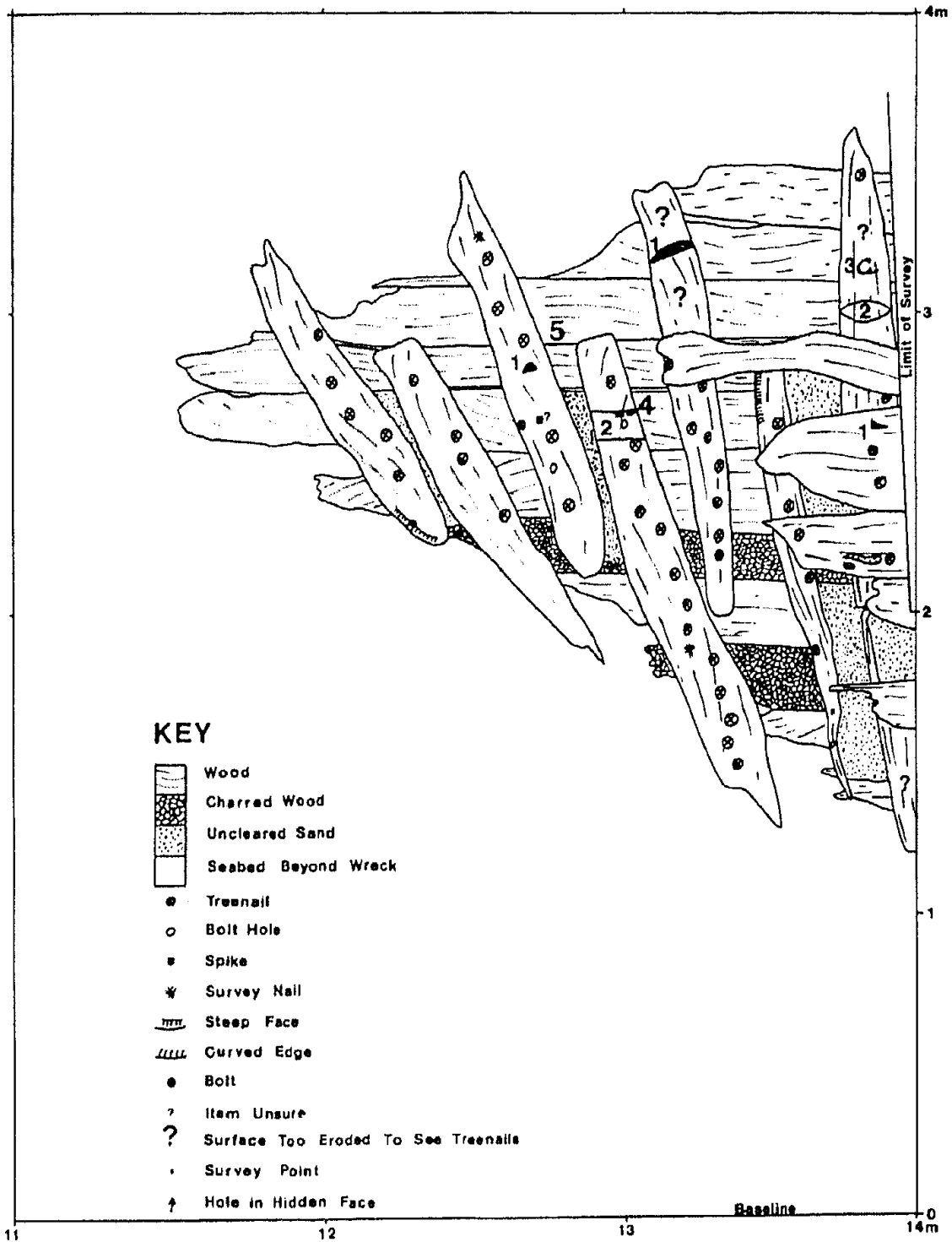


Figure 17. Stern frames on the Terence Bay vessel. (From Carter and Kenchington 1985, 19).

charred on the inside faces, probably to aid in bending the strakes. In the bow, two oak beams were attached to the ceiling and supported the remains of a larch platform.

Fasteners used in the vessel's construction included 1.5 in (3.8 cm) diameter treenails, 0.75 in (1.9 cm) diameter iron bolts, and 0.25 in (0.6 cm) by 0.5 in (1.3 cm) iron spikes.<sup>36</sup>

The only rigging items found included a deadeye and a channel that apparently carried two deadeyes.<sup>37</sup> If only two shrouds were used, this arrangement would have been more appropriate for a fore-and-aft rig rather than square sails. Additionally, the channel was placed far enough forward to suggest a second mast would have been needed towards the stern. Based on this evidence, the excavators believe the vessel was rigged as a schooner. In addition, the vessel's size and reconstructed hull section from the bow area are similar to those of the *Chaleur*, a Marblehead fishing schooner purchased in Boston by the Royal Navy in the 1760s.<sup>38</sup>

The hull remains indicate an odd combination of quality and careless construction, perhaps an attempt on the builder's part to economize, or the result of different styles among builders working on the vessel. Decorative elements such as the molding on the uppermost strake and a carefully cut concave end to the channel appear incongruous with the vessel's function, but serve to show the shipwright's skill. The bulwark stanchions and the joints between the planks were also carefully finished and smooth. On the other hand, many of the frames were cut too small to be properly squared and often did not touch both the external and ceiling planking. In addition, bark was found on one of the lodging knees and at least one treenail protruded above the level

of the ceiling planking.<sup>39</sup> It is difficult to draw conclusions about these strange features because of the limited excavation at the site, but perhaps the decorative pieces were reused from another vessel or were all that was available to the builder. Alternatively, the vessel may have been originally intended for a different purpose, and after changing its use to the fishing industry, the focus shifted to economizing in construction. A final possibility is that the builders or owner were concerned with having an attractive external, visible appearance, but not with the internal areas that would not be seen.

#### *The Reader's Point Vessel*

During a survey for the Columbus Caravels Archaeological Project in 1991 and 1992, archaeologists from the Institute of Nautical Archaeology (INA) at Texas A&M University discovered the remains of six eighteenth-century vessels in St. Ann's Bay, Jamaica. The remains were found off of a spit of land called Reader's Point, an area that was part of a large sugar plantation during the seventeenth and eighteenth centuries. Test trenches on the Reader's Point site indicated that it would prove to be an interesting example of eighteenth-century construction, having a good degree of hull preservation and sufficient artifacts for dating the site. As a result, a complete excavation was conducted in 1994 by archaeologists from INA, the Jamaican National Heritage Trust, and East Carolina University.<sup>40</sup>

The shipwreck was buried under 3 to 6 ft (0.9 to 1.8 m) of sediment in about 3 ft (0.9 m) of water. The preserved vessel was 56 ft 6 in (17.22 m) in length with a beam of 14 ft 4 in (4.34 m) (fig. 18). A single mast step was found, indicating that the vessel was

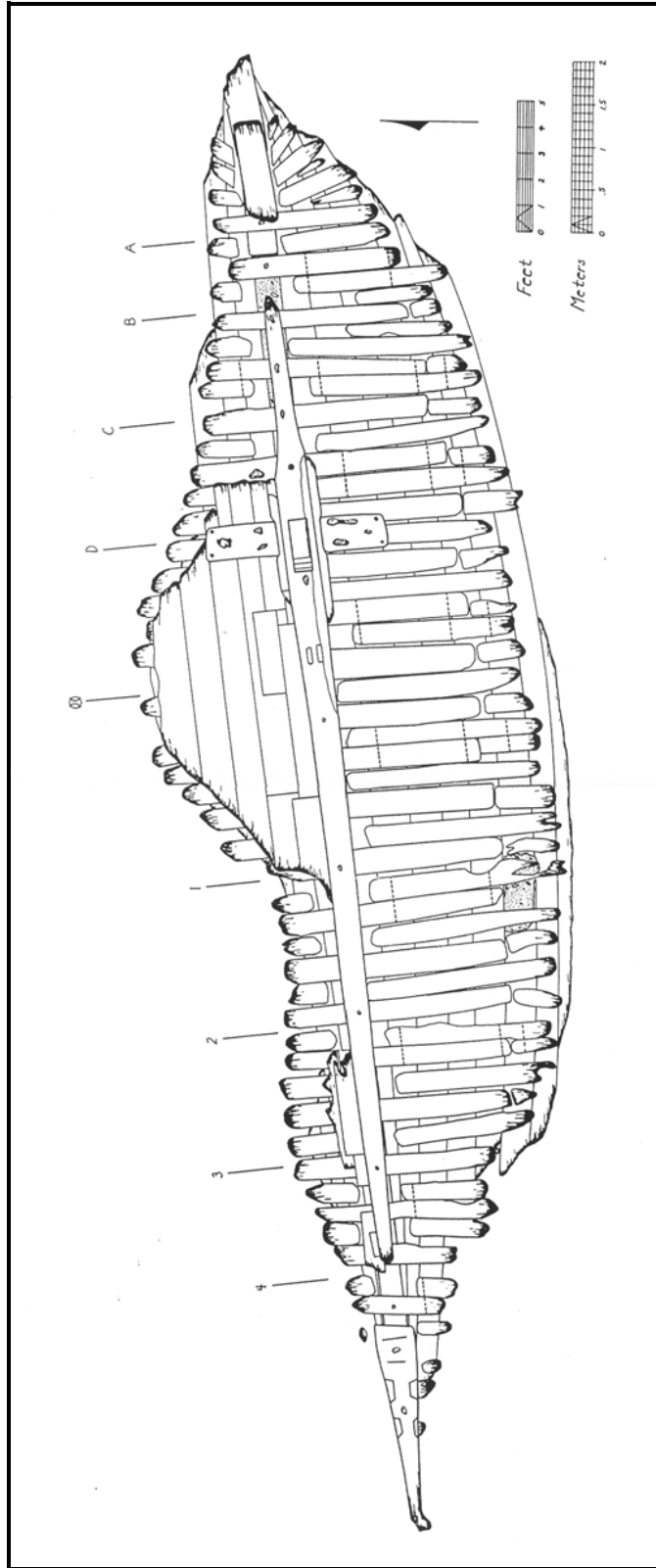


Figure 18. Hull remains of the Reader's Point vessel. (From Cook 1997, 107).

rigged as a sloop. The hull was constructed mainly of white oak with a keel of hard maple, suggesting that it was built in the northern American colonies. A few timbers of hickory and southern yellow pine also point to colonial construction.<sup>41</sup>

The scarcity of artifacts, signs of heavy wear, and multiple repairs suggest the sloop was intentionally abandoned after a long career. The pumps and mast were salvaged and most remaining artifacts were broken fragments found among the ballast of in the bilges.<sup>42</sup> Repairs included reinforcement of ceiling planking, a lead patch to secure a weak area of the outer hull planking, and strengthening of the mast step after the keelson split.<sup>43</sup> Faunal evidence, the use of tropical hardwoods for some of the repairs, and the location of the wreck suggest that the sloop traded in the Caribbean and along the southeastern coast of the American colonies.<sup>44</sup> The dates of the artifacts indicate that the vessel sank after 1765, with most of the dates in the area of 1775. The artifact assemblage is representative of typical eighteenth-century English colonial material.<sup>45</sup>

The keel was made of hard maple and measured 9.6 in (24.5 cm) sided by 10.9 in (27.5 cm) molded, with a preserved length of 42 ft 5 in (12.9 m). No scarfs were found, suggesting that the keel was made of a single piece. A V-shaped rabbet for the garboard staves measured 1.75 in (4.5 cm) in width. There was no evidence to indicate a false keel had been present; however, the keel was coated with pitch and hair and overlaid with 0.25 in (0.6 cm) thick white oak sacrificial planking. In the bow, the stem had apparently been salvaged already, as it was completely absent. At the point where the stem would have joined the keel, a tropical hardwood block was found attached to the

port side of the keel. This timber may have been a repair to secure the scarf between the keel and stem.<sup>46</sup>

While the stem was absent, three other timbers in the bow were found, including the apron and two pieces of a stemson. The apron was 14.5 in (37 cm) sided and 6 in (15 cm) molded. It would have been attached to the stem by two 1 in (2.5 cm) diameter iron bolts. The upper surface of this timber was notched to receive the first floor. The stemson was fixed to the apron with 1 in (2.5 cm) iron bolts and would have scarfed to the keelson, but this area was not preserved. The stemson was very eroded and had a molded dimension of 11 in (28 cm). All three of the bow timbers were of white oak.<sup>47</sup>

The only timber found in the stern was the stern knee, made of a single white oak compass timber. It was fastened to the keel with two iron bolts and measured 7 ft 11 in (2.43 m) long with 16.25 in (41.3 cm) sided and 14 in (35.5 cm) molded dimensions. The timber was notched to receive a floor and futtocks and outer hull planking was treenailed to its sides.<sup>48</sup>

Twenty-three white oak floors are preserved in the hull. These timbers were spaced on 22 in (55.9 cm) centers with an average space of 12.25 in (31.1 cm) between floors. Sided dimensions averaged 9.5 in (24.1 cm) but varied from 7.25 to 12.25 in (18.4 to 31.1 cm). Molded dimensions averaged 10 in (25.4 cm) with variation from 8.5 to 13.5 in (21.6 to 34.3 cm). The floors were secured to the keel with iron drift bolts. Limber holes measuring 1.25 in (3.2 cm) high by 3 in (7.5 cm) wide were cut into the floors about 17 in (43 cm) on either side of the keel. The first futtocks were offset from the centerline by about 12 in (30.5 cm). They averaged 8.9 in sided (22.5 cm) and 8.5 in



(21.5 cm) molded, with actual measurements varying by 3 to 4 in (7.5 to 10 cm) between timbers. The second futtocks averaged 6.5 in (16.5 cm) sided by 6 in (15.3 cm) molded, again with about 4 in (10 cm) in variation between timbers.<sup>49</sup> Although the variations in futtock dimensions left some space between frames, the vessel was almost solidly framed from bow to stern.

Nine frames appeared to be articulated, with the floors and futtocks fastened together laterally by treenails. These frames were evenly spaced, located at every second floor in the bow and stern and every third floor towards midships, where the curvature of the hull is reduced. These frames would have been erected first on the keel, followed by the remaining floors. The outer planking would then be added until the additional first futtocks could be secured to it with treenails, followed by more planking and the second futtocks. The futtock placement changed at the midship frame – the first futtock was aft of the floor forward of midships and forward of the floor aft of midships. Six pairs of cant frames supported the bow structure. These timbers were treenailed to the outer planking and were not secured to any other frames. The frames did not butt against the apron and a few were wedge-shaped and ended in points near the apron.<sup>50</sup>

The keelson was made of a single piece of white oak and measured on average 10.9 in (27.7 cm) sided by 9.6 in (24.4 cm) molded; these dimensions increased to 12.6 in (32 cm) sided and 11.5 in (29 cm) molded at the mast step. The keelson was notched to fit over the floors and was secured to frames 2-6 with iron bolts and bolted to every third floor aft of the mast step. The mast step mortise, cut directly in to the keelson, measured 17.5 in (44.5 cm) long by 8 in (20.5 cm) wide by 6 in (15.3 cm) deep. The

mortise was placed 18 ft 2.5 in (5 m) from the bow, about one third the length of the hull remains. Southern yellow pine chocks were found inside the mortise, perhaps to keep the mast in position.<sup>51</sup>

The major repair to the sloop involved the mast step, which apparently suffered a severe crack along the keelson at some point. Two iron spikes were driven horizontally through the keelson to try to close the split. Small sister keelsons, one of white oak and one of hickory, were then placed on either side of the keelson at the mortise and secured with iron spikes to the keelson. The sister keelsons were each supported with a white oak buttress timber; these timbers were secured to the floors beneath them with iron spikes. Because one of the sister keelsons overlaps one of the gap-closing spikes, it appears that these timbers were added as repairs and that the initial mast step was a simple mortise cut into the surface of the keelson.<sup>52</sup>

The external planking was of white oak and measured 2 in (5.1 cm) in thickness. The planks varied from 8 to 18 in (20.3 to 45.7 cm) in width and were fastened to the frames with treenails. A layer of pitch and animal hair was coated on the planking and covered with 0.25 in (0.5 cm) thick hard pine sacrificial planking. The ceiling planking was also made of white oak and averaged 2 in (5.1 cm) thick and 14 in (35.5 cm) in width. The ends of the planks were beveled to make an overlap where two planks were joined together. The interior planking was attached to the frames with treenails and iron nails. A few planks were made of southern yellow pine.<sup>53</sup>

The Reader's Point sloop would originally have measured about 60 ft (18.24 m) in length with a beam of 18 ft (5.49 m) and a displacement of 100 tons. The sloop's full

shape with fairly flat floors and slack bilges point to its use as a seaworthy cargo carrier, with a shallow enough draft to navigate coastal North American and Caribbean waters.<sup>54</sup> Cook suggests that this hull shape reflects typical New England design with an emphasis on tonnage rather than speed. Flat floors and little deadrise would have increased the cargo capacity, while the shallow draft would have enabled the sloop to access coastal waters; however, the vessel's large size and use of sacrificial sheathing indicate that it was intended for deep sea travel as well.<sup>55</sup>

#### *The Bermuda Collier*

During a 1992 survey off Chubbs Head Cut, Bermuda, a team of staff and students from East Carolina University's Program in Maritime History and Nautical Archaeology discovered the remains of an eighteenth-century British collier. Because of the site's potential importance, the Bermuda Maritime Museum applied for and was granted permission to document the shipwreck; the investigation was carried out in September of 1993 by ECU staff and students. The vessel was located at a depth of 29 ft (8.8 m) and was covered amidships by a large, undisturbed pile of heavy ballast. The exposed extremities were cleared of sediment and carefully documented, as were other sections of the hull where possible (fig. 19); however, a complete excavation was not conducted.<sup>56</sup>

The extant keel was 69 ft 9 in (21.3 m) in length and made of elm. The sided dimension was 16 in (40.6 cm) and the molded dimension was more than 12 in (30.5 cm). Like the rising wood of the Rose Hill vessel, the Bermuda collier had a long timber

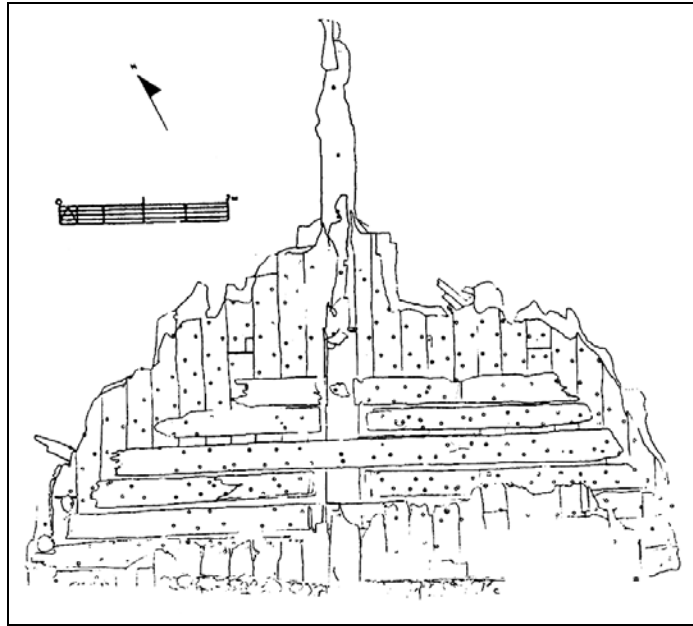
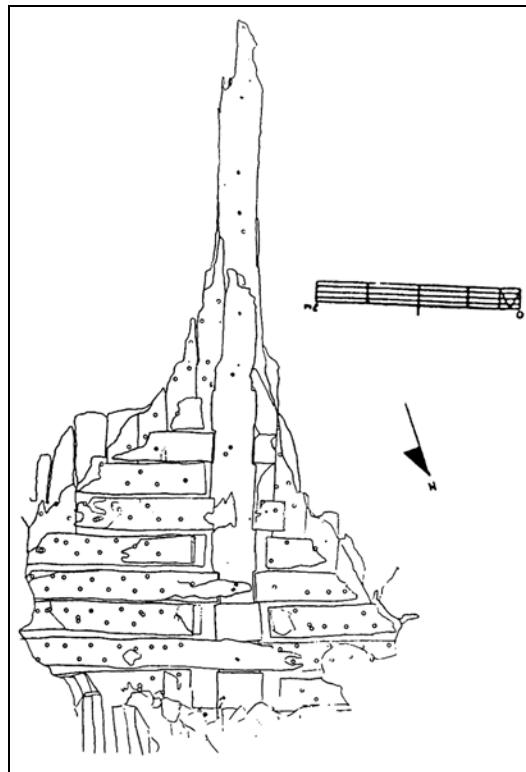
**A****B**

Figure 19. Ends of the Bermuda collier wreck. **A**, North end of the site (bow); **B**, South end of the site (stern). (From Krivor 1994, 42).

laid upon the keel that formed part of the rabbet; in this case, the excavators refer to it as a hogging piece. The timber measured up to 19.5 in (49.5 cm) sided, overhanging the keel to form the rabbet, and 10 in (25.4 cm) molded. It was notched 0.75 to 1 in (1.9 to 2.5 cm) deep to receive the floor timbers; on both sides of each notch an additional 1.75-2 in (4.4-5.1 cm) was cut away to fit bottom fillets seated underneath the floors and form limber holes.<sup>57</sup>

The framing pattern consisted of alternating white oak floors and futtocks that were not fastened to each other horizontally. The floors averaged 12 in (30.5 cm) sided and 12 to 13 in (30.5 to 33 cm) molded. To increase the vessel's deadrise, bottom fillets of white oak were placed under the floors on both sides of the keel. Dimensions of the fillets were about 12 in (30.5 cm) sided and 8 in (20.3 cm) molded. Second futtocks were joined to the floors by a diagonal treenailed scarf, apparently without the use of chocks. The first futtocks were placed between the floors and were offset from the hogging piece or rising wood by 6 to 8.5 in (15.2 to 21.6 cm). They measured 10 in (25.4 cm) sided and 4 to 10 in (10.2 to 25.4 cm) molded. Space between the floors and first futtocks varied from 1 to 4.5 in (2.5 to 11.4 cm). Oak top fillets were placed on top of the first futtocks on both sides of the centerline to make them even with the tops of the floors. These timbers, like the bottom fillets, were sided to correspond with their futtocks and varied from 4 to 9 in (10.2 to 22.9 cm) molded. As the stem and stern areas were not preserved, it could not be determined whether cant frames had been used in the extremities of the vessel.<sup>58</sup>

The white oak keelson was secured through every floor to the rising wood and keel with 1.25 in (3.2 cm) diameter copper drift bolts peened over copper washers.<sup>59</sup> It measured 18 in (45.7 cm) sided by 12.5 in (31.8 cm) molded and was notched 1 to 1.5 in (2.5 to 3.8 cm) to fit over the floors. Because only a limited length of the keelson was exposed and little excavation was conducted, no mast steps were found; however, a small curved mortise found at one end of the site appears to have been cut for a deck stanchion.<sup>60</sup>

External planking was also of white oak and averaged 3 in (7.6 cm) thick and 11.9 to 12.25 in (30.2 to 31.1 cm) in width. It was secured to the frames by oak trenails 1.5 in (3.8 cm) in diameter and by occasional iron spikes. The hull was protected from teredoes by an application of felt and pitch between the outer strakes and 1 in (2.5 cm) thick scotch pine sacrificial sheathing. The sheathing planks measured approximately 10 in (25.4 cm) in width and were secured to the hull by means of iron tacks. Like the outer planking, the ceiling was also made of white oak. Tightly placed strakes measured 3 in (7.6 cm) thick and varied from 5.5 to 12.5 in (14 to 31.8 cm) in width. The ceiling was attached to the frames with 1.5 in (3.8 cm) oak trenails and periodic iron spikes. Limber boards were 12.5 in (31.8 cm) in width and 2 in (5.1 cm) thick, being brought up to the level of the rest of the ceiling by 1 in (2.5 cm) thick by 1.5 in (3.8 cm) wide battens.<sup>61</sup>

The remains of a bulkhead were found at the north end (bow) of the vessel. The bulkhead was built of spruce planks measuring 10 in (25.4 cm) wide and 1 in (2.5 cm) thick. Vertical stanchions provided additional support for the planks. Apparently the bulkhead functioned as a retaining wall for the ship's ballast.<sup>62</sup>

A wooden lower valve from a suction bilge pump was found near the vessel's keel at the opposite end of the site from the bulkhead. It was circular with an indentation around its circumference and a hollow oval-shaped center. Two square holes were cut through the valve, one on each side of the hollow center. For this type of pump, a piece of cordage around the indentation would have formed a watertight seal between the valve and outer box. A large iron staple would have fit through the square holes, providing a place to hook the valve from above and remove it for inspection and cleaning. The wooden valve, when covered with a leather flap, would have provided a one-way entrance for water into the pump tube from the bilge, from which it could be lifted through the upper valve and discharged overboard.<sup>63</sup>

The maximum preserved length of the Bermuda vessel was 69 ft 9 in (21.3 m) with a beam of 24 ft (7.3 m). The excavators estimate the original keel length to have been 72 ft (21.9 m) based on the beam, with a hold depth of 11.5 ft (3.5 m) and an estimated tonnage of 170 to 210 tons. They have identified the vessel as a collier based on the similarity of its hull characteristics to the typical collier form – very heavy construction capable of carrying large loads, flat floors, and a shallow draft for ease in grounding. Additionally, the estimated tonnage fits within the common size range for English-built colliers. As the mast steps were not located, the vessel's rig cannot be conclusively determined; however, colliers were typically rigged as brigs or barks to allow the use of a smaller crew.<sup>64</sup>

Analysis of artifacts found at the site lends support to the idea that the collier was British-owned and operated during the second half of the eighteenth century. Ceramics

were all English styles post-dating 1750. Glassware dating to the 1770s-1790s was also recovered, along with lead shot typical of English naval pistols after 1759. A copper barrel hoop bearing the broad arrow of the British government suggests a military affiliation with the collier.<sup>65</sup> Based on the date, hull type, and artifact assemblage of the Bermuda collier, the vessel was likely employed by the Royal Navy or Army as a military transport at the time it sank. Although built as coal carriers, colliers were desirable for use as military transports to move men and supplies during the Revolutionary War. Their heavy construction and flat floors provided significant carrying capacity and their simple rigs required fewer men than other vessel types. Their shallow draft allowed them to be easily run aground for unloading. Historical records indicate that several English vessels, including transports, were lost near Bermuda from 1770 to 1796.<sup>66</sup>

### *The Betsy*

In 1978, the Yorktown Shipwreck Archaeological Project was organized to survey and investigate the remains of sunken vessels from the 1781 Battle of Yorktown in Virginia. Although historically it was known several ships had sunk in the area, little archaeological work was conducted until disturbance by sport divers became a major threat. In 1976 and 1977, Virginia Research Center archaeologists led a survey of the York River between Yorktown and Gloucester Point and located several possible shipwrecks. Test excavations conducted by the Institute of Nautical Archaeology were carried out on one of the sites, called the Cornwallis Cave Wreck. The results of these



investigations led to the proposal of an extensive survey, which was approved in 1978 and conducted from 1978-1981, leading to the discovery and study of nine shipwrecks associated with the British fleet of 1781. The best preserved of these wrecks, site 44YO88, was completely excavated between 1982 and 1988. Because of high currents and poor visibility in the York River, a wet cofferdam was built around the vessel, allowing the water inside to be continually filtered and the excavation conditions to improve dramatically. Based on artifacts, the hull remains, and historical research, the vessel has been identified as the collier-brig *Betsy*, built in 1772.<sup>67</sup>

The *Betsy* and the other Yorktown shipwrecks were part of a British fleet commanded by Major General Charles Cornwallis sent in 1781 to create fortified base for attacking the Americans in the Chesapeake Bay area. The fleet consisted of five warships and several hired merchant vessels, mostly serving as transports for men and supplies. Under siege by the American troops in Yorktown, Cornwallis' fleet became trapped when a well-prepared French fleet prevented the British naval reinforcements from reaching Cornwallis. In order to prevent the French from staging a landing on the bank of the British position, Cornwallis intentionally sank several of his vessels along the shore to form a barrier; the French and American allies destroyed or captured the rest of the fleet. The British surrendered to General George Washington on October 19, 1781 in one of the most decisive battles of the Revolutionary War. The French were given salvage rights to Cornwallis' fleet and conducted some work between 1781-1782, but several vessels remained undiscovered.<sup>68</sup>

The shipwreck remains measured about 72 ft (22 m) in length and 23 ft 7.25 in (7.2 m) in breadth (fig.20). The vessel was constructed mainly of oak and appeared to be less than 15 years old at the time it sank, based on the quality of the timbers and lack of repairs. The hull was preserved to the waterline, with two masts, a bilge pump box, two bulkheads, and part of the lower deck still present. The frames and planking were built of white oak.<sup>69</sup>

Preserved to its original length, the oak keel measured 68 ft 2.5 in (20.8 m) in length and 14.4 in (36.6 cm) sided by 13.25 (33.7 cm) molded. No false keel was present and wear was clearly evident on the bottom of the keel towards the bow, perhaps from grounding the vessel without a false keel. Two horizontal bolts in the keel near the heel of the stem may have once secured a false keel prior to the end of the ship's career. The stem was constructed using two pieces of oak attached to each other by two filler pieces or large chocks (fig. 21). The lower section, measuring 16.75 in (42.5 cm) molded by 12 in (30.5 cm) sided, was secured to the keel by two iron bands and a pine fishplate. On the exterior of the stem was the gripe, made of oak and measuring 8.4 in (21.3 cm) sided at the base and 10.25 in (26 cm) sided at the top. The forward face of the gripe had a partial cutwater. A 1.25 in (3.2 cm) gap was present between the forward end of the keel and the after end of the gripe, apparently caused by wear to the bow timbers. Roman numeral draft numbers were carved into the post, exactly one foot apart, to mark the height above the keel.<sup>70</sup>

The sternpost assembly, composed of an inner and outer post, was of oak and raked aft at an 11° angle. The inner post was molded 14.4 in (36.6 cm) at the bottom,

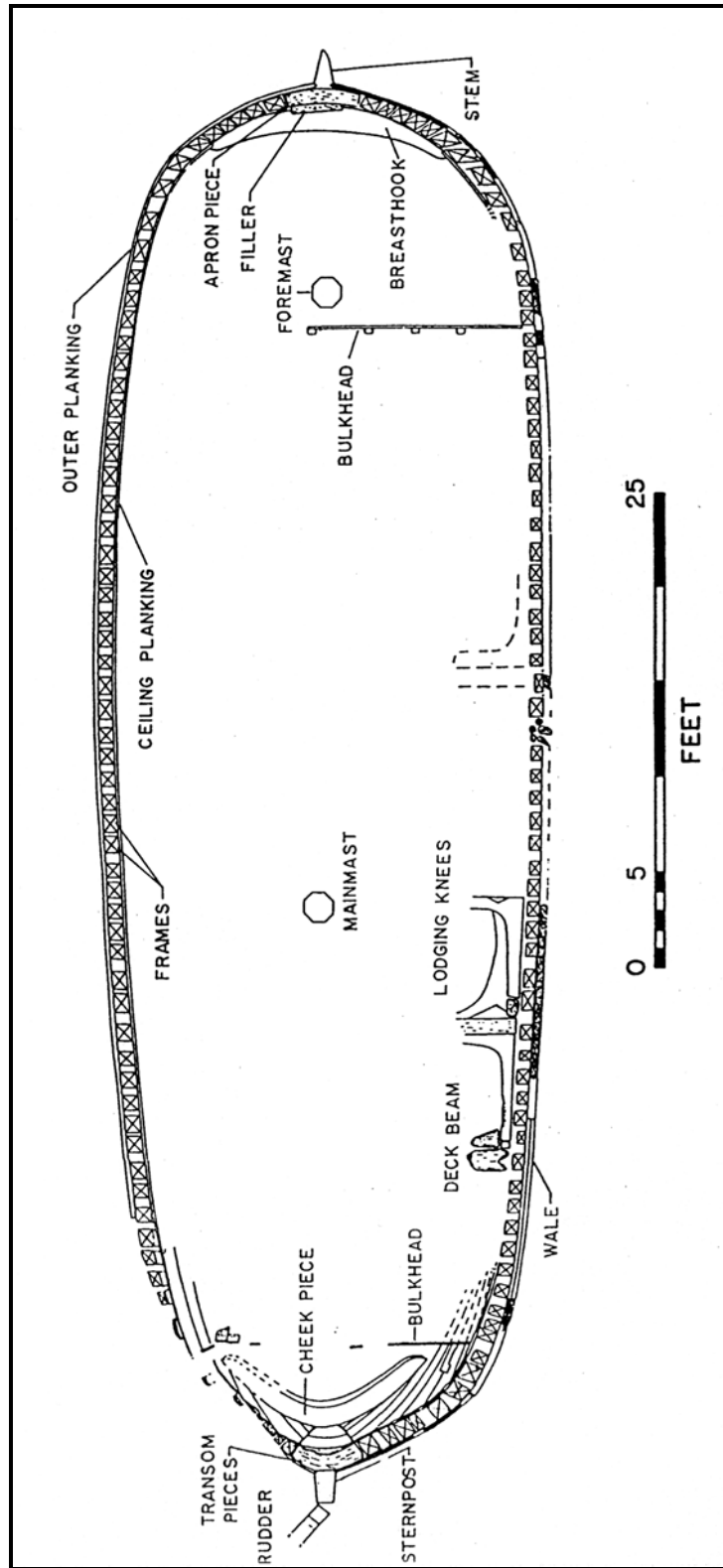


Figure 20. Hull remains of the *Betsy*. (From Morris 1991, 94).

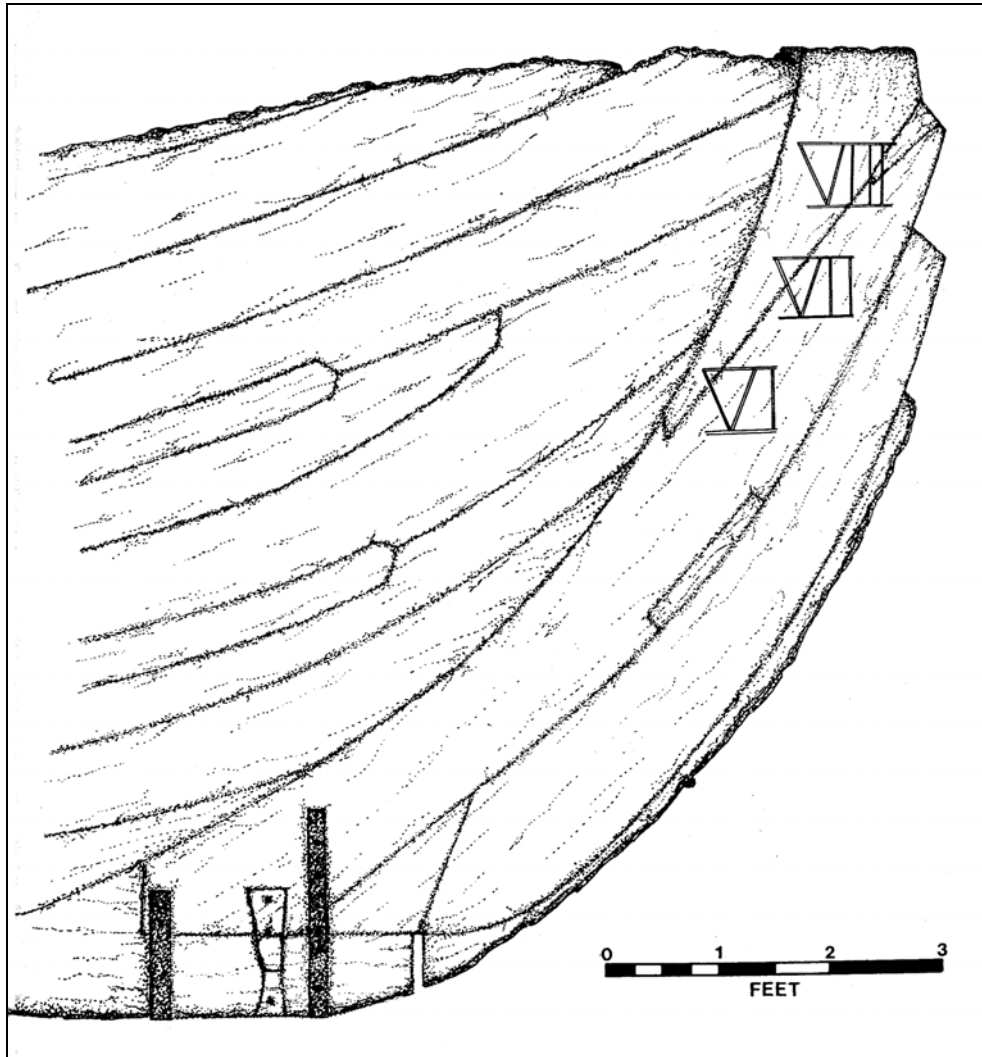


Figure 21. Stem structure of the *Betsy*. (From Morris 1991, 96).

decreasing to 13 in (33 cm) at the top. Its sided dimension was 10.75 in (27.3 cm) aft to the rabbet and the same as the outer post on the other side of the rabbet. Similar to the bow assembly, a pine fishplate protected bolts securing the inner post to the keel, most likely driven into a mortise and tenon type scarf. An oak filler piece was present between the inner and outer posts, measuring 4.75 in (12.1 cm) thick at the bottom and tapering to 1.25 in (3.2 cm) at the top. The outer post was molded 14.4 (36.6 cm) at its base, decreasing to 2.4 in (6.1 cm) at its preserved top. It was square at the bottom, with a sided dimension of 14.4 in (36.6 cm), tapering to 12 in (30.5 cm) at the top. As with the stem, Roman numeral draft numbers were inscribed on the inner sternpost.<sup>71</sup>

Both the bow and stern showed a unique construction feature in the use of horizontal transverse chocks or timbers instead of the typical apron and sternson. In both cases, the chocks were not fastened to each other, but only bolted to the end posts. In the bow, seven apron chocks were present; six were secured to the stem with 1.25 in (3.2 cm) iron bolts and one was attached by treenails alone. The lowermost chock met the deadwood in the bow and the uppermost was at the preserved height of the vessel. All of the apron chocks measured about 9.6 in (24.4 cm) in thickness and varied in shape. The hood ends of the external planking were secured to the chocks by treenails. The chocks in the stern followed a similar pattern to those in the bow, securing the hood ends of the planking by treenails and averaging 9.6 in (24.4 cm) in thickness. Only four chocks were present, with the lowermost overlapping what appeared to be the stern knee. All of the stern chocks were attached to the sternpost by 1.25 in (3.2 cm) diameter iron through bolts.<sup>72</sup>

Other preserved supporting timbers in the vessel's ends included the lowermost breast hook in the bow and an oak crutch in the stern, mirroring the bow construction. The oak breast hook was a single compass timber and measured 12 ft 6 in (3.8 m) in length and 14.4 in (36.6 cm) in width at its widest. It was crudely sided at 18 in (45.7 cm) thick at its thickest. The timber was secured to the bow framing by seven 1.25 in (3.2 cm) diameter iron bolts and the ceiling planking fit into its underside. The crutch in the stern, also a single, crudely sided compass timber, measured 10 ft 7.1 in (3.2 m) in length and was bolted directly to the stern frames with seven 1.25 in (3.2 cm) diameter iron bolts. The timber was 1.75 in (4.4 cm) wide at its centerline, with an average thickness of 11.4 in (29 cm). The ceiling planks were beveled into its underside, as with the breast hook. For both the breast hook and crutch, a small filler piece was used to fill the gap between the timber and the uppermost chock.<sup>73</sup>

Segments of oak deadwood were clearly visible in the bow and stern and into the run of the hull, attached directly to the stem and stern assemblies and keel. This deadwood may be comparable to the rising wood seen on other vessels, but the excavators do not make it clear whether the deadwood extends the full length of the vessel. In the bow, the deadwood fitted between the lowermost apron chock and forwardmost frame, decreasing in thickness to 6 in (15.2 cm) further aft towards midships. The width of the timber was the same as the keel, 14.4 in (36.6 cm) sided. The stern deadwood was made up of at least five pieces, including the stern knee. The knee was scarfed to the lowermost stern chock. All of these timbers maintained the 14.4 in (36.6 cm) sided dimension, while varying in thickness.<sup>74</sup>

Framing on the *Betsy* was heavy and tightly spaced. Square double frames were present throughout the run of the hull, switching to cant frames in the bow and stern. The double frames consisted of a floor and second futtock scarfed together with a chock and a first futtock scarfed with a chock to a third futtock. Seven of the frame sets were articulated or master frames; these sets were the only frames in which the components were bolted together. On average, there were four intermediate frames between each master frame. First futtocks were offset from the centerline by about 10.75 in (27.3 cm) and were always located aft of the associated floor. Measurements taken of the upper futtocks showed them to vary from 7 to 9 in (17.5 to 22.5 cm) molded and 9 to 10 in (22.5 to 25.4 cm) sided. The sided surfaces were only partially shaped, as reflected in offsets between neighboring futtocks. As in the Bermuda collier, top and bottom fillets were used in the framing pattern. Floor fillets, fastened to the bottom of the floors by 1.1 in (2.8 cm) diameter oak treenails, were present only in square frames near the bow and stern. Throughout the rest of the hull, top fillets secured to the first futtocks were used instead where necessary to provide a smooth run for the ceiling planking. The frames were centered 28.25 in (71.8 cm) apart on average, with room and space varying from 25 to 30 in (63.5 to 76.2 cm).<sup>75</sup>

In the extreme ends of the vessel, radial oak cant frames were used instead of square frames. In the bow, several of the frames butted against the apron chocks or deadwood, with the rest coming to a point before reaching the center timbers. These frames were tightly fitted together but were not fastened to each other or the apron chocks; instead, they were secured to the planking by 1.1 in (2.8 cm) diameter treenails.

The cant frames in the stern mirrored the pattern seen in the bow, except they were angled differently to fit the narrower stern.<sup>76</sup>

The keelson overlaid the frames and was composed of four pieces of pine and oak, measuring 56 ft 10.6 in (17.3 m) in overall length and curving upward at its ends. The largest component, 50 ft 4.75 in (15.4 m) long, was cut from pine and varied in molded dimensions from 18.6 in (47.2 cm) near its center to 4.25 in (10.8 cm) towards the stern. A 46 ft 1.75 in (14.1 m) long, 4.25 in (10.8 cm) molded piece of oak overlaid the pine component. The two remaining components, made of oak, formed the foremast step mortise and the mainmast step mortise. All components were consistently sided 14.4 in (36.6 cm), the same as the keel and deadwood. Five deck stanchion steps were located on the keelson, all composed of two semi-circular pieces of oak secured by three square iron spikes.<sup>77</sup>

External planking on the *Betsy*, sawn from oak, was spiked and treenailed to the frames and measured 2.25 to 2.5 in (5.6 to 6.3 cm) in thickness. Widths averaged 10 in (25.4 cm) at the bow and 5.75 to 6.75 in (14.4 to 16.9 cm) in the stern. Stealers and tapering hood ends were used to fit the curves in the bow and stern where the planking met the posts. Planking ends were secured with 1.1 in (2.8 cm) diameter treenails and 0.5 in (1.3 cm) square spikes. The main wale, composed of three oak timbers, was still preserved on the starboard side of the hull. It varied in width from 10.75 to 12 in (27.3 to 30.5 cm) and was 5 in (12.7 cm) thick. The outer planking was coated with tar and felt and then overlaid with pine sacrificial planking measuring 1.25 in (3.2 cm) thick. This sheathing was attached to the hull by 0.25 in (0.6 cm) square iron tacks and covered the



keel, stem and sternposts, and rudder in addition to the planking. Roman numeral draft numbers were inscribed on the pine sheathing to match those on the stem and sternposts. The ceiling planking was also made of oak and secured to the frames with oak trenails and iron spikes. The seams were not caulked but the planks were tight with no gaps. They averaged 2.5 in (6.4 cm) in thickness, with the width varying from 8 to 12 in (20.3 to 30.5 cm). Several incised construction marks were visible on the ceiling planks.<sup>78</sup>

As evidenced by remains of a deck structure, the vessel had at least one deck. An oak clamp, measuring 4.75 in (12.1 cm) sided at the top and 9.75 in (24.8 cm) molded, was still in place on the starboard side; the three remaining deck beams sat in 1.6 in (4.1 cm) deep notches in the clamp. The best preserved of the oak beams measured 9.6 in (24.4 cm) sided and 9.75 in (24.8 cm) molded. Bracing the beams were oak lodging knees, which overlapped to form a thick band of timber around the hull. The knees were bolted to the beams and frames by 1.25 in (5.2 cm) diameter iron bolts. Notches cut into the knees held ledges, transverse support timbers for the deck planking. Only disarticulated deck planks were found within the hull and these were all made of pine.<sup>79</sup>

The *Betsy* had two masts, a foremast and a mainmast, that were stepped on the keelson in mortise mast steps. The stumps of both pine masts were preserved – these were octagonal in section and had iron bands around their bases. The foremast was perpendicular to the keel, having no rake, and measured 14.75 in (37.5 cm) in diameter at its preserved upper limit. At the base, the mast tapered to a 4.9 in (12.4 cm) wide and 14.4 in (36.6 cm) long tenon that sat in the 5.4 to 6 in (13.7 to 15.2 cm) deep step mortise. Two oak chocks fitted at the forward edge of the mast helped secure it in place.

The mainmast had a rake of  $1.89^{\circ}$  and a diameter of 16.9 in (42.9 cm) at its preserved top. The tenon at the mast's base measured 6 to 6.25 in (15.2 to 15.9 cm) in width and 14.4 in (36.6 cm) in length and sat in a 7.4 in (18.8 cm) deep mortise. An oak chock sat against the forward face of the mast and a thin oak shim had been worked in against the after face. The mainmast was located 30 ft. 11 in (9.4 m) from the stern perpendicular, while the foremast sat 62 ft 7.75 in (19.1 m) forward of the stern. Based on the locations of the masts, the *Betsy* was most likely rigged as a brig, or possibly a snow.<sup>80</sup>

The vessel's pump well, composed of several timbers, was also preserved. At the base, a rectangular chock was nailed to the top of the keelson to provide an attachment point for the fore-and-aft spacer boards. Transverse boards, meeting the forward and after edges of the spacer boards, were notched to fit over the keelson and extended 5 to 6 in (12.7 to 15.2 cm) past the sides of the keelson. Two quarter round chocks nailed to the keelson supported the front and back walls from the fore and aft. Side boards were nailed to the edges of the front and back walls 5 to 6 in (12.7 to 15.2 cm) past the sides of the keelson. These boards created starboard and port chambers on the sides of the central chamber formed by the spacer boards. A lead tube, probably part of the pump tube, was found in the starboard chamber.<sup>81</sup>

Originally, the *Betsy* would have measured 73 ft 1.6 in (22.3 m) in length between perpendiculars, with a beam of 23 ft 7.25 in (7.2 m), a draft of 9 ft 6 in (2.9 m), and a hold depth of 9 ft 10 in (3 m). Its estimated tonnage was about 180 tons.<sup>82</sup> The ship had the typical characteristics of a collier, including heavy construction with large timbers, closely spaced frames, and thick planking. The hull was boxy and flat-floored

with harder bilges, fairly straight sides, and a bluff bow, but it had a fine run at the stern. For thicker framing, fillets were used and the sided surfaces of the frames were only roughly shaped in order to leave the maximum amount of wood in each timber;<sup>83</sup> both of these traits could also represent a shortage of compass timber or an attempt to economize. These possibilities might also explain the unusual use of transverse chocks in the bow and stern instead of the traditional apron and sternson. As with the Bermuda collier, the construction of the *Betsy* was meant to optimize cargo capacity and enable the vessel to carry heavy loads of coal in the open ocean. The British government chose it also for use as a military transport because of these qualities.

#### *The Otter Creek Shipwreck*

The Otter Creek wreck was discovered near Oriental, North Carolina in a 1986 survey conducted by staff archaeologists of the North Carolina Underwater Archaeology Unit in response to a request for a permit to dredge a channel. Test excavations revealed a wooden hull constructed with iron spikes and treenails, probably dating to the late eighteenth century or early nineteenth. In light of the wreck's potential importance, the site was partially excavated and completely mapped during two weeks in the summer of 1988. The work was conducted by a group of international students and headed by archaeologists from the Underwater Archaeology Unit and the North Carolina Maritime Museum. Figure 22 shows the extent of the hull remains.<sup>84</sup>

The vessel was constructed almost exclusively of white oak. The keel measured 49 ft 3 in (15 m) long and 12 in (30.5 cm) molded. The sided dimension varied from 10

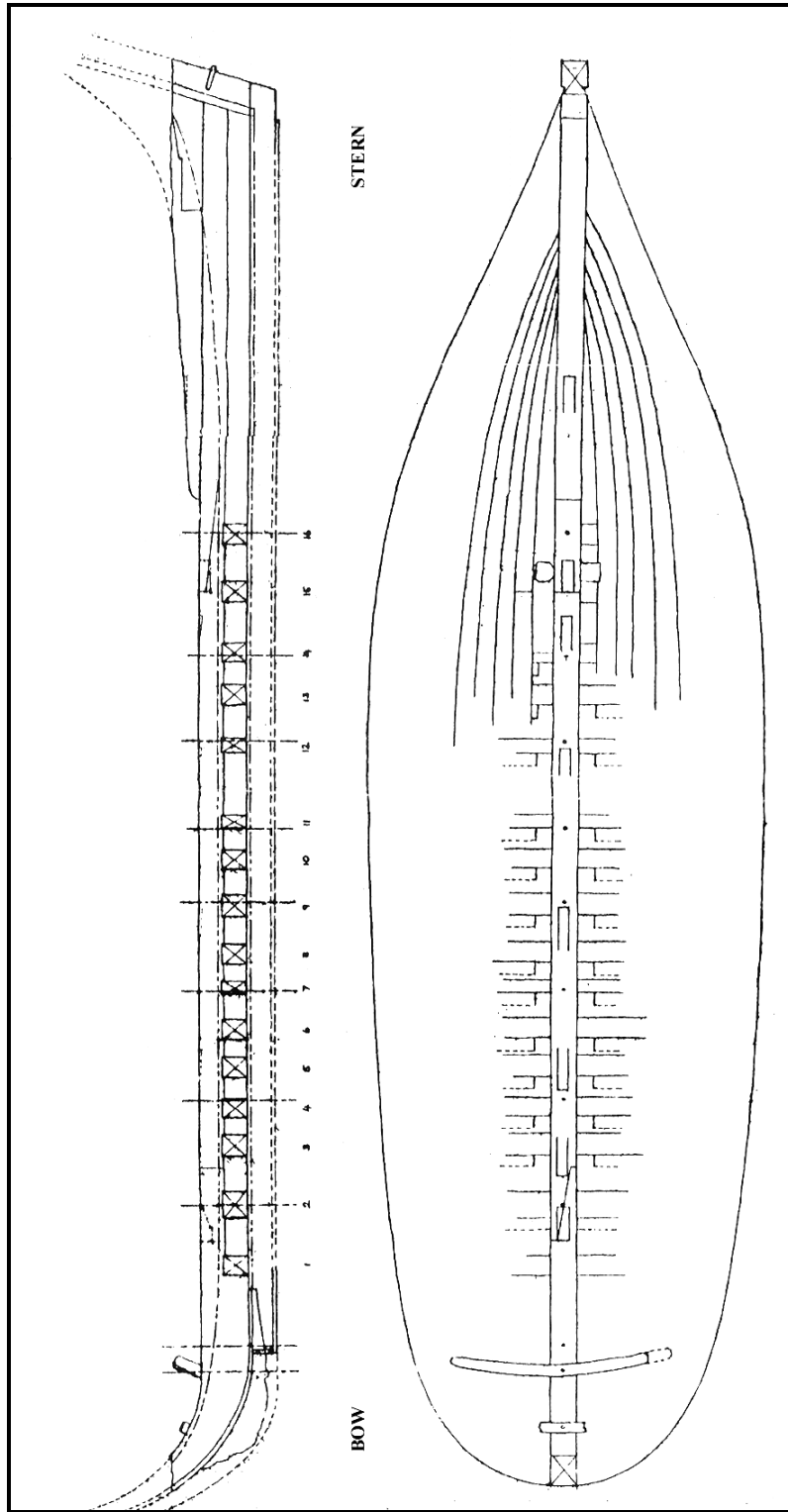


Figure 22. Hull plan of the Otter Creek wreck. (After Jackson 1991, 62).

in (25.4 cm) forward to 12 in (30.5 cm) amidships to 9 in (22.3 cm) aft. A false keel was present, with a 3 in (7.6 cm) molded dimension. Iron plates were used to secure the scarf between the forward end of the keel and the stem.<sup>85</sup> The remaining bow assembly included a small part of the stem and the apron. The stem measured 12 in (30.5 cm) molded by 10 in (25.4 cm) sided at the forward end of the keel. The apron was attached to the after face of the stem and was scarfed to the keelson. Two breast hooks were secured to the apron; the lower timber was attached by means of an iron bolt through its midpoint.<sup>86</sup> The surviving sternpost was raked 6° aft and measured 16 in (40.6 cm) molded. The rabbet for the hood ends was located 12 in (30.5 cm) forward of the aft face of the post. A gudgeon was found attached two feet from the bottom of the sternpost; it was secured to the post with two 0.5 in (1.3 cm) diameter iron bolts and one iron spike. The stern knee began directly behind the after mast step and measured 16 ft (4.9 m) long. Its sided dimension matched the keelson.<sup>87</sup>

The frames were only available for measurement where ceiling planking was missing. Dimensions of the sixteen documented floors ranged from 12 to 13 in (30.5 to 33 cm) molded and from 6 to 13 in (15.2 to 33 cm) sided. Placement of the frames on the keel appeared to be random, with room and space varying from 1 ft 3 in to 3 ft 3 in (38.1 to 99 cm). The first futtocks were always placed forward of the floors, with no space between paired floors and futtocks. The first futtocks were offset by 13.5 in (34.3 cm) from the centerline and had an average molded dimension of 12 in (30.5 cm). Because the site was not completely excavated, it could not be determined whether the floors and futtocks were laterally attached to each other or if chocks were used in the joints. Decay

and the nature of the site prevented access to the stern and bow frames to ascertain if they were canted. Limber holes were V-shaped cuts located on the bottom face of the floors 0.5 in (1.3 cm) from the keelson.<sup>88</sup>

The keelson was notched to fit over the floors and was secured to every other floor with 0.75 in (1.9 cm) iron bolts driven through auger holes; several of these bolts were off-center rather than going through the centerline. The keelson was made from two timbers scarfed together. Its molded dimension averaged 12 in (30.5 cm) and the sided dimension averaged 13.5 in (34.3 cm). The vessel's two mast steps were cut into the keelson over the keelson scarfs. The forward step mortise measured 16.25 in (41.3 cm) long by 6 in (15.2 cm) wide by 5.5 in (14 cm) deep forward and 1 in (2.5 cm) deep aft. The aft step mortise measured 15 in (38.1 cm) long by 6 in (15.2 cm) wide by 5.25 in (13.3 cm) deep. Five shallow notches were cut into the keelson for stanchions; a sixth was cut into the stern knee. These measured 5.25 in (13.3 cm) wide, 1.25 in (3.2 cm) deep, and varied from 15 to 21 in (38.1 to 53.3 cm) in length.<sup>89</sup>

Internal planking was secured to the frames by a random arrangement of treenails and iron spikes. White oak planks measuring 16 to 20 ft (4.9 to 6.1 m) long, 8 to 11 in (20.3 to 27.9 cm) wide, and 2 in (5.1 cm) thick were butt-joined to form the ceiling. Adze marks up to 0.75 in (1.9 cm) deep were cut across the grain of the strakes to assist with bending the wood to the hull's curvature. The limber boards measured 5 to 8 in (12.7 to 20.3 cm) in width.<sup>90</sup> The external planking was made of white oak and one recorded sample was found to be 2 in (5.1 cm) thick. The planking was coated with a

layer of hair or fiber, over which 0.9 in (2.3 cm) thick pine sacrificial sheathing was laid. Thin pieces of lead recovered from the site may have served as patching for the hull.<sup>91</sup>

Fasteners found on the site consisted of wooden treenails and wrought iron nails, spikes, and bolts. One treenail was identified as white oak. The treenails ranged from 1 to 4 ft (0.3 to 1.2 m) in length with a diameter of 0.5 to 2 in (1.3 to 5.1 cm). They were driven from the outside of the planking and were generally wedged. Three iron bolts recovered from the wreck were 0.75 in (1.9 cm) in diameter with extant lengths varying from 4.5 to 9.5 in (11.4 to 24.1 cm). Iron spikes were found with round, rose, square, and T-shaped heads and ranged from 1.1 to 7 in (2.8 to 17.8 cm) in length; nails had rose or square heads and ranged from 0.9 to 2.4 in (2.3 to 6.1 cm) long.<sup>92</sup>

The presence of a deck beam, a wooden knee, and stanchions suggest the vessel had at least one deck. The cambered half-beam measured 3.5 in (8.9 cm) molded by 4 in (10.2 cm) sided with a preserved length of 5.5 ft (1.7 m), for a full deck width of at least 11 ft (3.4 m). The knee had a maximum width of 14 in (35.6 cm) and was 4.5 in (11.4 cm) thick. Displaced from its original position, it was originally attached to the hull with three iron bolts. Notches in the keelson indicated the location of the stanchions.<sup>93</sup>

As noted above, two mast steps cut into the keelson indicate the Otter Creek wreck originally had two masts. Several hickory mast hoops were found on the site; one nearly complete example measured 18 in (45.7 cm) in diameter, suggesting its mast was 15 in (38.1 cm) in diameter. The excavators believe that the vessel was rigged as a schooner based on the presence of mast hoops on the site.<sup>94</sup>

Evidence was found for the presence of two suction pumps on the vessel. Two holes with a maximum width of 9 in (22.9 cm) were cut into the ceiling between floors 15 and 16, directly on either side of the keelson and the main mast step. The starboard well was cut to fit an octagonal pump tube and contained a leather piece that may be the remains of the pump boot. Eleven nail holes were cut into the leather and one nail measuring 1.25 in (3.2 cm) long was still attached. The port well contained wooden pieces that may have been part of the pump casing.<sup>95</sup>

The remains of the Otter Creek schooner suggest that it was originally at least 58 ft (17.7 m) long and 16 ft (4.9 m) in beam, with an estimated draft of 9 ft (2.7 m), hold depth of 6.5 ft (2 m), and tonnage of 100 tons. The excavators believe the vessel was built prior to 1800, based on the use of wooden knees, wrought-iron nails, and the bolting of every other floor to the keelson rather than every floor, as was common in the 19th century. They also suggest that, while the use of white oak does not indicate an origin for the vessel, the use of hickory mast hoops suggests the vessel was constructed in North America.<sup>96</sup> Ceramic artifacts associated with the wreck ranged in date from 1762 to 1820 for periods of usage; clay pipe stems dated from 1710 to 1800. A button made from a coin dates to 1772, indicating the vessel sank afterwards.<sup>97</sup> The presence of coconut shells suggests the schooner traded with the Caribbean;<sup>98</sup> this idea is further substantiated by the vessel's size and rig, as well as the presence of sacrificial sheathing.



### *The Privateer Defence*

The Revolutionary War privateer *Defence* was discovered in 1972 in Maine's Penobscot Bay during a sonar search conducted by MIT and the Maine Maritime Academy. Two seasons of preliminary investigations revealed artifacts from the eighteenth century, including a cannon made in Massachusetts in 1778. In 1975, a full excavation was organized by the Maine State Museum and also included the Maine Maritime Academy, the Institute of Nautical Archaeology, and the Maine Historic Preservation Commission. The work was concluded in 1981 after the partially intact hull was fully recorded.<sup>99</sup>

*Defence* was one of twelve privateers that sailed with the Penobscot Expedition in July of 1779. Assembled by the State of Massachusetts and commanded by Dudley Saltonstall, the fleet's purpose was to attack a British fort that was being built in Maine's Penobscot Bay. Rather like the Phips expedition almost a century earlier, the siege was a disaster, as the arrival of a handful of British naval vessels caused an American retreat up the Penobscot River after two of their vessels were captured. The remainder of the fleet was scuttled or run aground and burned to prevent capture by the British. *Defence* sank in Stockton Harbor after an explosion on board, probably in the powder magazine.<sup>100</sup> The expedition may have been the 170-ton brig's maiden voyage following its launch at Beverly, Massachusetts.<sup>101</sup>

The wreck site was located in 24 ft (7.3 m) of water and in some places buried up to 6 ft (1.8 m) deep. The remains stretched 72 ft (21.9 m) from bow to stern with a maximum breadth of 22 ft (6.7 m) (fig. 23). The hull was built mainly of oak, including

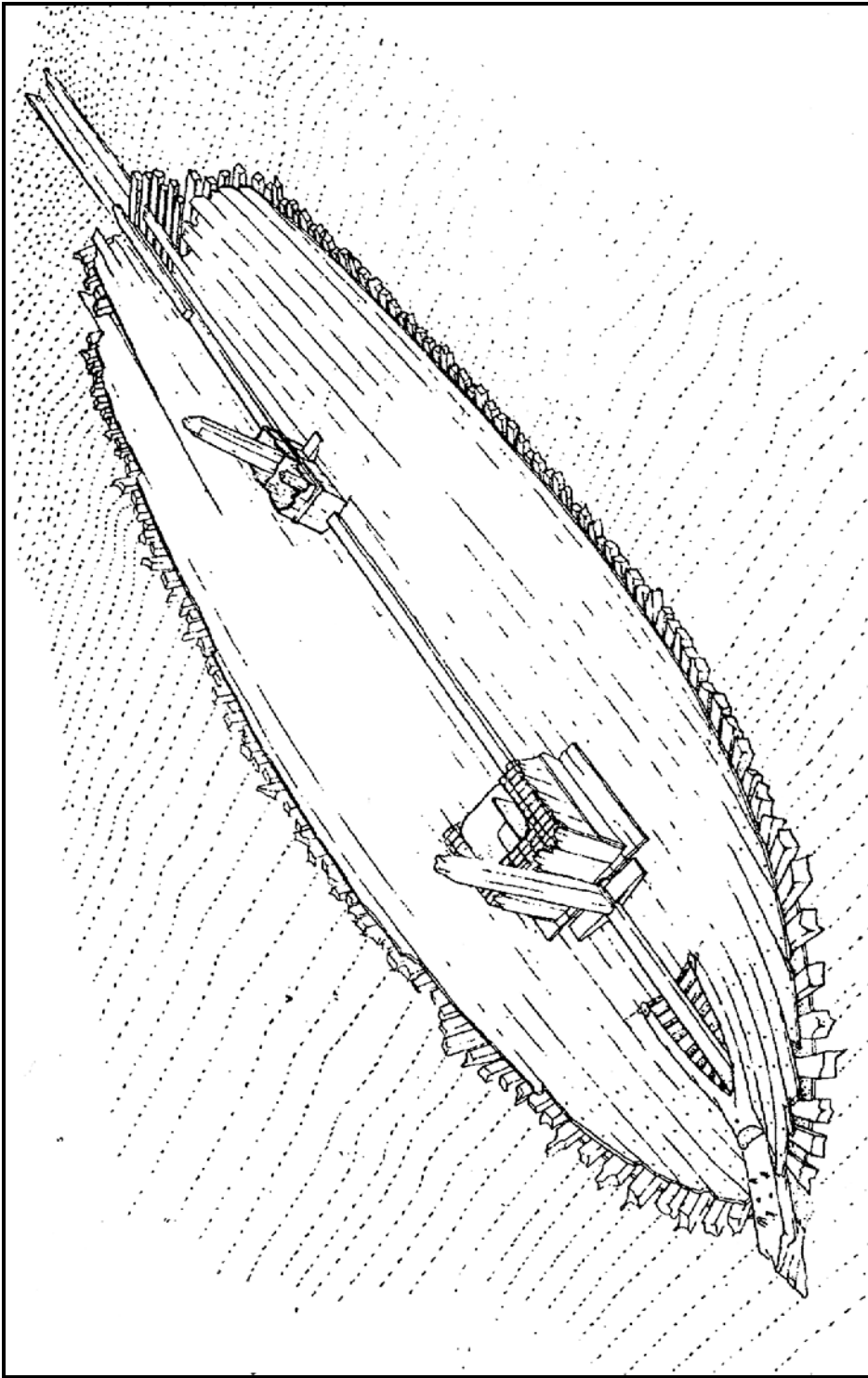


Figure 23. Hull remains of the privateer *Defence*. (From Switzer 1983, 49).

the frames, deck beams, deadwood, and planking, but samples of pine and possibly larch were also found. The masts were made of pine, which was also used for the bulkheads and other internal structures. The ship was originally armed with 16 six-pound cannon.<sup>102</sup>

The keel of *Defence* was 8 in (20.3 cm) sided by 14 in (35.6 cm) molded. The keel was notched to receive the floor timbers, which varied from 8 to 9 in (20.3 to 22.9 cm) molded forward to 15 in (38.1 cm) aft. First futtocks measured 8 in (20.3 cm) square, with the rest of the futtocks averaging 8 in (20.3 cm) molded and 4 to 5.5 in (10.2 to 14 cm) sided at the uppermost preserved limit. The frames were closely positioned, with 5 in (12.7 cm) gaps visible between the futtocks at the rot line. Removal of a section of ceiling planking showed that articulated double frames, serving as mold frames, were located every 4 to 5 ft (1.2 to 1.5 m) and were secured through the floors to the keel with 0.75 in (1.9 cm) diameter iron bolts. Apparently, the intermediate frames took the form of half frames, lacking floors and with futtocks put into place as the vessel was planked. Treenails used to secure the frames to the planking were octagonal and measured 1.1 in (2.8 cm) in diameter. Bark still remained on some of the frames and many appeared to have been cut from unseasoned wood, suggesting hasty or cheap construction. The builder clearly used compass timbers for the floors, futtocks, and other curved timbers such as the breast hooks.<sup>103</sup>

Bolted through the frames and keel, the keelson measured 11.5 in (29.2 cm) sided and 8 in (20.3 cm) molded. Mortises serving as steps for the fore and main masts were cut into the keelson; for reinforcement of the steps, oak chocks were placed on

either side of the keelson and secured to floors with iron bolts. Still present were the stumps of the two masts, made of white pine and measuring 18 in (45.7 cm) in diameter.<sup>104</sup>

The outer hull planking was attached to the frames using 1.1 in (2.8 cm) diameter octagonal treenails. The heads of the treenails had been cut with 1.5 in (3.8 cm) deep square or diamond mortises so that they could be wedged into place. The first four lower strakes were 12 in (30.5 cm) wide, while the remaining planks averaged 8 in (20.3 cm) in width; all planks averaged 2 to 2.5 in (5.1 to 6.4 cm) in thickness. The ceiling planking was fastened to the frames with square spikes measuring 0.4 to 0.5 in (1 to 1.3 cm) in diameter. In the bow, the ceiling was nailed to every other frame, but further aft this pattern shifted to a single nail in every third or fourth frame, which again seems indicative of hasty construction.<sup>105</sup>

Internal fittings on the vessel included a shotlocker, a bilge pump box, and a cookstove. Heavy white pine boards were used to construct the shotlocker and pump well, with the mainmast contained in the locker and the pump well located forward of the mainmast. The structure measured 5 ft (1.5 m) in length and 2.5 ft (0.7 m) in width and was preserved to a height of 4 ft (1.2 m). Several of the boards used to build the locker apparently were mismeasured and other boards were missing nails. The structure's placement around the mainmast on top of the keelson and ceiling suggests it was built after the vessel was launched, perhaps as a last-minute addition.<sup>106</sup> By contrast, the brick cookstove was carefully constructed. The stove was built on a platform of heavy oak planks laid across the keelson and ceiling and measured 5 ft (1.5 m) high. The

brick structure held a permanently fitted 68 gallon (257.6 Liter) copper cooking cauldron.<sup>107</sup>

*Defence* was built specifically as a privateer, as evidenced by its sharp bow designed for speed and some of its construction characteristics. While some of the features represent hasty or careless work, other elements illustrate extra attention. Several of the timbers, including the keelson, the chocks reinforcing the mast steps, and the upper deadwood, were chamfered along the edges to remove sharp corners on the interior of the vessel. Some of the timbers had decorative trim and other ornamental details.<sup>108</sup> From these features and the cookstove, it is clear that the shipwright was at least concerned with the interior appearance of the vessel; however, the presence of bark on some of the frames shows he was striving for economy as well. Alternatively, the owner may have wanted to cut corners where possible, considering that his new privateer might have a short lifespan.

### *The Nancy*

The eighteenth-century British schooner *Nancy* was excavated and raised in 1927 from the Nottawasaga River in Ontario, Canada. The hull was placed on display at the Nancy Island Historic Site and still remains open to the public. Thorough documentation of the timbers did not occur until 1997, when graduate students from the Nautical Archaeology Program at Texas A&M University completely examined and recorded the hull. Historical research and surviving documentation from the original excavation allowed the vessel to be placed in its historical context.<sup>109</sup>

The *Nancy* was constructed in 1789 in Detroit under the supervision of John Richardson of the trading company Forsyth, Richardson, and Co. Even though Detroit was officially part of America following the 1783 Treaty of Paris, the British resisted turning over the city because of its importance in controlling the Northwest trades. The city became an important center for English shipbuilding on the Great Lakes, both for the government and for trading companies such as Richardson's.<sup>110</sup> The *Nancy*, rigged as a schooner, was intended for use in the fur trade on Lakes Erie and Huron.<sup>111</sup> After the vessel's launch in 1789, it was employed on several separate occasions between 1794 and 1803 as a hired transport for the British government.<sup>112</sup> The *Nancy* was hired again by the British during the War of 1812 for service as a transport on Lakes Huron and Erie. During the fighting in 1814, the schooner was burned to the waterline near Georgian Bay in the Nottawasaga River.<sup>113</sup> The hull remains captured silt and debris from the river, eventually leading to the formation of a small island. Its location never completely forgotten, the *Nancy* was initially excavated in 1925 and then completely recovered in 1927.<sup>114</sup>

The hull remains of the *Nancy* measured 68 ft (20.7 m) in length and 22 ft (6.7 m) in beam (fig. 24). The vessel was constructed out of high quality oak and red cedar, with components fitted tightly together and well fastened.<sup>115</sup> Compass timbers were used for curved pieces such as the frames. Because of the hull's 70 years out of the water, most of the wood showed signs of drying and cracking.<sup>116</sup>

The *Nancy's* keel was built from a single piece of wood measuring 59 ft 9 in (18.2 m) in length. The molded dimension varied from 14.75 in (37.5 cm) forward to 13

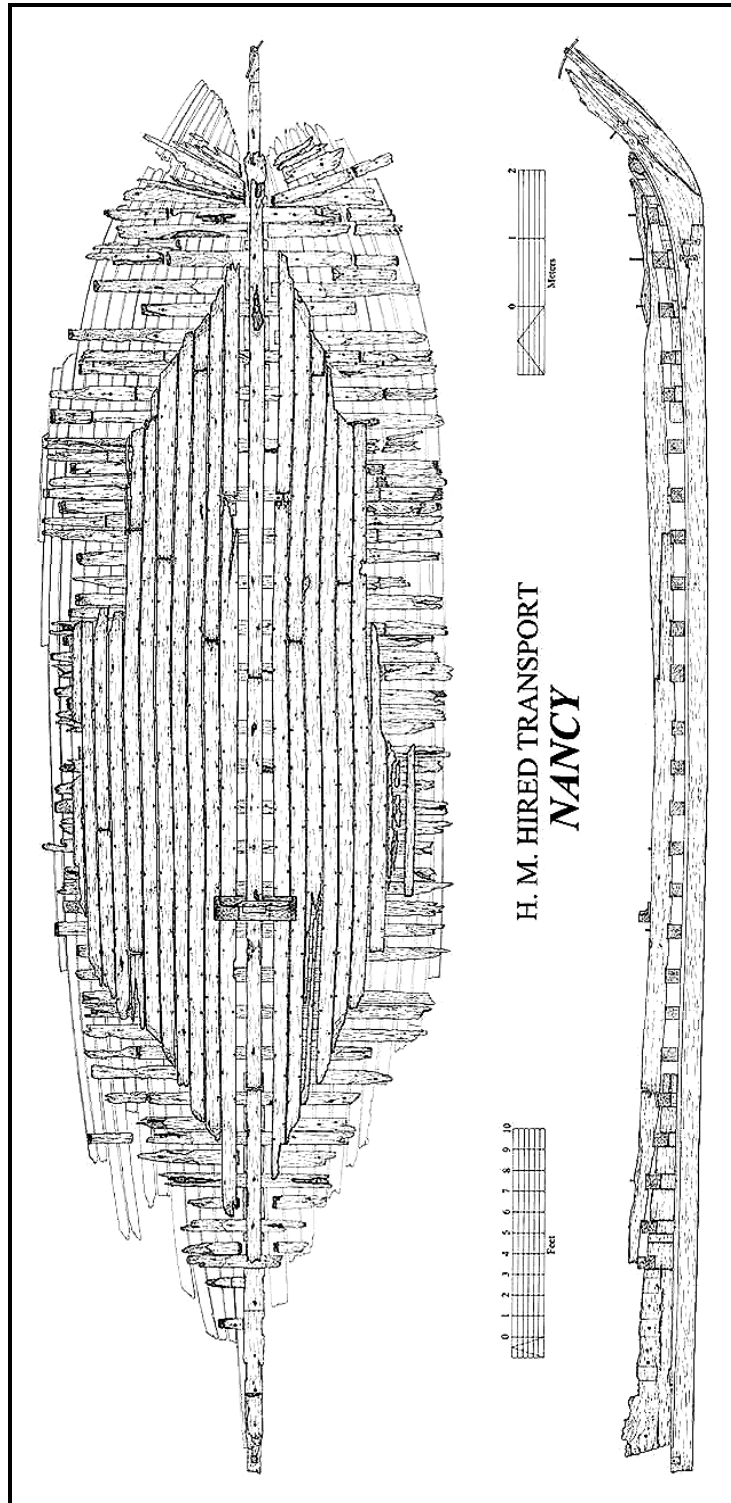


Figure 24. Hull remains of the *Nancy*. (From Sabick 2004, 86).

in (33 cm) amidships to 12 in (30.5 cm) aft. Also varying over the length of the keel, the sided dimension ranged from 9.5 in (24 cm) forward to 8.75 in (22.2 cm) amidships to 8 in (20 cm) towards the stern. The bottom of the keel was cut with several holes that appeared to have contained wooden treenails at some point. In locations where the treenails had fallen out, bolts were visible inside the holes. Most of these bolts were in positions where they could have secured the keel to the floors, but they were not present beneath every floor.<sup>117</sup> This feature is unlike any seen on the other vessels; it appears that the holes were augered into the underside of the keel and the bolts driven in from beneath to secure the floors in these locations. Recessing the heads of the bolts into the keel would have prevented them from being damaged if the vessel ran aground. Treenails were then used to plug the holes and protect the bolt heads. It is unclear what advantage would be found in attaching the framing in this apparently cumbersome manner, unless perhaps it was a later addition to provide strength to the aging hull. Alternatively, the bolts may indicate that a false keel was attached at one point and then later removed. The bolts may have been driven deeper into the keel and the holes plugged to protect the keel.

The stem structure consisted of the post, an apron, and a gripe. The stem, a single compass timber, measured 23.5 in (59.7 cm) molded at its maximum and 7.25 in (18.4 cm) sided; it was attached to the keel by a hook scarf secured with two pairs of fishplates. The apron, keelson, and gripe were secured to the stem with iron bolts.<sup>118</sup> The apron, measuring 13 ft (3.9 m) in length, 7 in (17.8 cm) molded, and 15 in (38.1 cm) sided, was cut from a single compass timber. It was notched to receive the floors.<sup>119</sup>



The sternpost and inner sternpost did not survive, but mortises cut into the keel indicate their positions; these joints were secured with a pair of fishplates. The inner sternpost would have measured approximately 4 in (10.1 cm) molded by 8 in (20.3 cm) sided. The main sternpost would have been about 12 in (30.5 cm) molded and 8 in (20.3 cm) sided, to match the sided dimension of the keel. A single deadwood timber supported the stern structure. This piece was trapezoidal in section partway through its length to form the rabbet for the garboard strake in the stern. The timber, which was 17 ft 9.6 in (5.4 m) in length, was cut from a single piece of naturally curved wood and was mortised to accept the floors.<sup>120</sup>

Framing on the *Nancy* consisted of square frames in the run of the hull and cant frames in the bow. The schooner originally had 28 floor timbers spaced on average 25 in (63.5 cm) apart on their centers. Floors varied in size from 7.5 to 9 in (19 to 22.9 cm) molded and 8 to 9 in (20.3 to 22.9 cm) sided. Triangular limber holes were cut into the floors on each side of the centerline. First futtocks, averaging 8 in (20.3 cm) molded and sided, were offset from the keel by 7 to 10 in (17.8 to 25 cm). Ten of the frames were articulated master frames, with floors and first futtocks closely fitted and fastened together. Evidence suggests that these fasteners were originally treenails; however, iron bolts were also present, driven in from an angle as if they were a later addition. The rest of the full frames were disarticulated intermediate frames, with a space of 5 to 8 in (12.7 to 20.3 cm) separating the floors from the first futtocks. In these frames, the first futtocks were not fastened to the floors, but only to the hull planking. For all frames, first futtocks were placed aft of the floors forward of midships and forward of the floors aft of

midships. Upper futtocks were diagonally scarfed to the lower timbers. In addition to the full frames, 15 irregularly spaced filler pieces were located near midships and the bow. These futtocks varied in length and position, but all were fastened to the planking only. It is unknown whether these pieces were installed at the time of initial construction or as a later addition to support the aging hull.<sup>121</sup>

Four pairs of radial cant frames were present in the bow. These frames did not cross the centerline, but rather butted up against the sides of the apron. Only one of the pairs was actually seated in notches in the apron. The aftermost pair formed a triangular wedge filling the gap between the forwardmost square frame and the first full radial frame.<sup>122</sup>

The keelson, composed of two timbers, measured 53 ft (16.2 m) in length, 12 in (30.5 cm) molded, and 9 in (22.9 cm) sided. Notched to fit over the floors, the keelson was bolted with 0.75 in (1.9 cm) diameter bolts through most of the floors and into the keel. A semicircular notch on the port side of the keelson aft of midships most likely was cut to accommodate the pump well.<sup>123</sup>

External strakes were each composed of two planks and varied in width from 6 to 10 in (15 to 25 cm). Averaging 2 in (5 cm) in thickness, the planking was fastened to the frames with 0.5 in (1.3 cm) diameter iron spikes.<sup>124</sup> Holes found in some of the frames suggested that treenails may have been the original fasteners for the planking.<sup>125</sup> Present between planking seams was caulking, most likely hemp and tar.<sup>126</sup> The ceiling planking was somewhat thinner than the outer planking, averaging 1.5 in (3.8 cm) in thickness

and 7 to 9 in (17.8 to 22.9 cm) in width. Attaching the ceiling to the frames were iron spikes measuring 0.5 in (1.3 cm) in diameter.<sup>127</sup>

As a schooner, the *Nancy* had two mast steps. The foremast step was a simple mortise cut directly into the keelson. The mainmast step, to the contrary, consisted of a large, semicircular block of wood placed transversely to the centerline and notched to fit over the keelson. The step mortise was cut into the block perpendicularly to the centerline. The mortise measured 13 in (33 cm) wide by 5 in (12.7 cm) long by 4.75 in (12.1 cm) deep.<sup>128</sup>

With a length of over 68 ft (20.7 m) and beam of about 22 ft (6.7 m), the *Nancy* had a hold depth of 7 ft 6 in (2.3 m) and measured 100-120 tons.<sup>129</sup> The schooner's hull shape was typical for a merchant vessel on the Great Lakes, where shallow waters demanded a shallow draft. In addition, carrying capacity and stability under sail were emphasized over speed, as reflected by the *Nancy's* bluff bow and fairly flat floors.<sup>130</sup> Later in its career, the *Nancy* had gunports and was armed with cannon, although the sizes of the guns are uncertain.<sup>131</sup> The vessel was well-built and received quality maintenance, lasting through a long trading career and several years of military service for the British.

#### *The Clydesdale Plantation Vessel*

The Clydesdale Plantation vessel was a late eighteenth-century coastal sloop that had been intentionally abandoned and used to form part of a levee in the Back River, a tributary of the Savannah River in Georgia. The sloop was one of several abandoned

vessels found during a 1991 survey of the Back River conducted by Tidewater Atlantic Research, Inc. The hull appeared to be southern colonial-built based on the use of yellow pine, live oak, and cypress in its construction and the shape of the visible timbers suggested it was a deep-keeled coastal vessel rather than a flat-bottomed river barge. Because of the site's potential, its excavation was undertaken in the summer of 1992 by archaeologists and students from the Institute of Nautical Archaeology, Texas A&M University, the South Carolina Institute of Archaeology and Anthropology, and the Coastal Heritage Society.<sup>132</sup>

The vessel remains were buried deep in mud in the side of a bank above the tide level. The site plan of the hull remains is shown in figure 25. Several artifacts were found in the area, mostly dating to the mid to late eighteenth century. The assemblage suggested that someone wealthy, apparently a slave owner, lived nearby and the vessel was most likely used to repair a hole in the bank. The hull itself was intentionally damaged, including partial dismantling of the sides and removal of the entire bow section, in order to make it fit in the bank.<sup>133</sup>

The keel was constructed of a single piece of yellow pine and appeared larger than necessary for the vessel's small size, perhaps to improve lateral resistance. The external planking was also of pine; individual planks were long and wide, indicating they came from large trees. The strakes were secured to the frames mainly with iron nails, but also with randomly placed trenails. The ceiling planks were made of similar pieces of pine nailed to the frames. They were caulked and carefully positioned against one another, apparently in an effort to keep the hold watertight; additionally, the limber

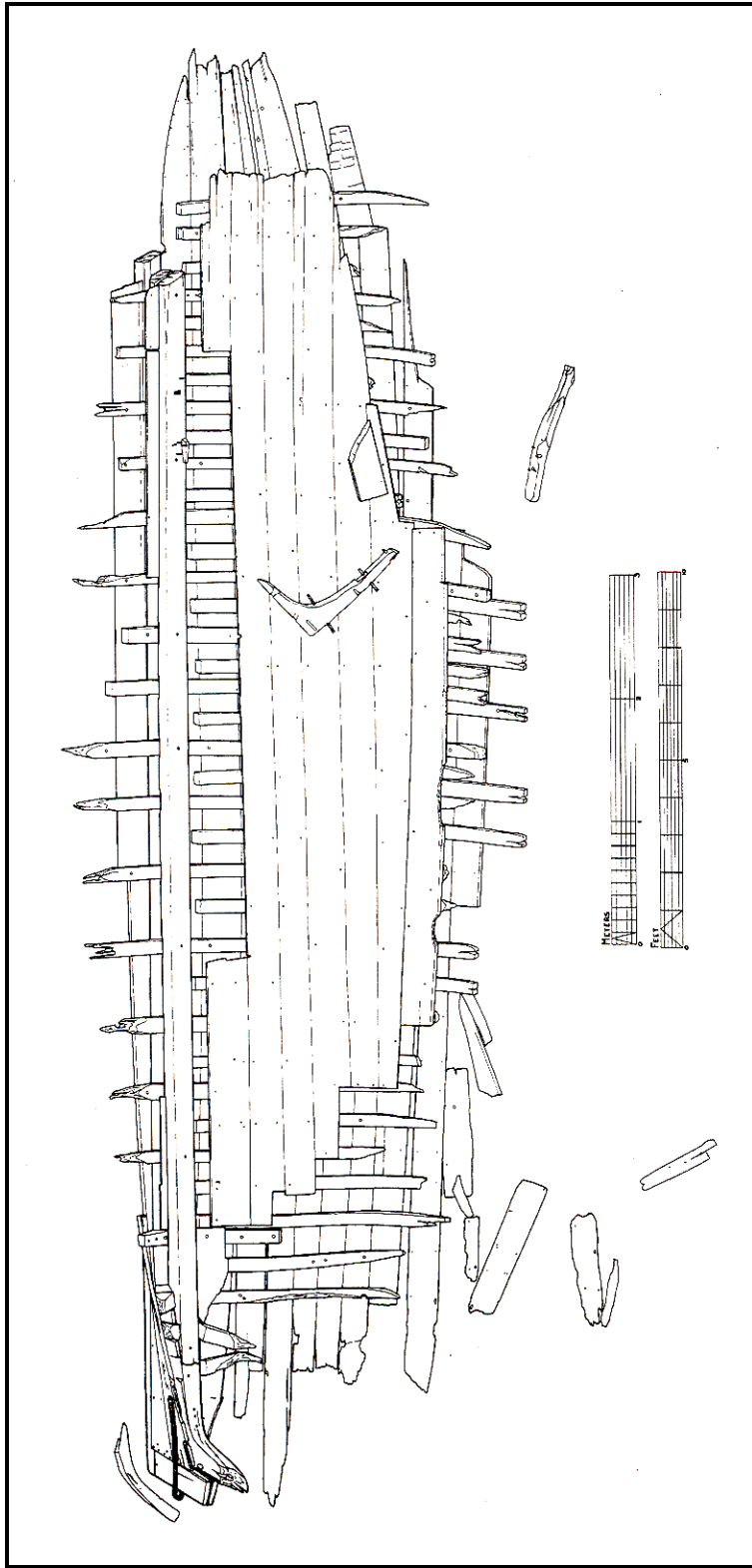


Figure 25. Site plan of the Clydesdale Plantation vessel. (From Cook 1997, 116).

boards were nailed into place. These precautions suggest the sloop may have been built to carry rice as its cargo, a common agricultural product in the region that was highly susceptible to damage from moisture.<sup>134</sup>

Frames were built using live oak, another southern species. Unlike the typical floor and futtock pattern seen in most vessels of the period, the Clydesdale sloop had evenly spaced floors alternating with half frames. Futtocks in line with the floor timbers supported the planking up to the deck level; separate top timbers between the floors and half-frames supported the upper works. No mold or master frames appear to have been used, as none of these timbers were secured to each other, but rather only to the keel and planking. The floors were notched to fit over the keel and apron and secured using iron spikes. A pine keelson sat over the floors and was bolted to every third or fourth frame.<sup>135</sup>

According to the excavators, the vessel was rigged as a sloop with its single mast set far forward. The original hull would have measured about 43 ft 9 in (13.4 m) in length, 15 ft 5 in (4.7 m) in beam, 6 ft 3 in (1.9 m) in depth amidships, and 20-25 tons burden.<sup>136</sup> A reconstructed section of the sloop shows it to have a soft turn of the bilge with a fair amount of deadrise at the floors. It would have had one deck and a fine run at the stern. The shape seems to be an attempt to balance a shallow draft with good sailing qualities, perhaps typical of a small North American coastal sloop.<sup>137</sup>

## Naval Warships

### *The Port Royal Ship*

During the 1989 and 1990 excavations at the seventeenth-century British city of Port Royal, Jamaica, a shipwreck was found among the underwater structural remains of the city. The archaeological work, conducted as a field school by Texas A&M University and the Institute of Nautical Archaeology, was being carried out on the brick buildings of the city that sank in a 1692 earthquake. Based on the shipwreck's location, it appeared to have washed into one of the buildings in a surge accompanying the earthquake. Although only a small portion of the hull remained, it was investigated during the last two seasons of the field school (fig. 26).<sup>138</sup>

A 74 ft (22.6 m) long section of the keel survived, with an attached false keel. The keel, made of at least two slippery elm timbers joined by a vertical scarf, measured about 8 in (20.3 cm) square in section. Rather than having a rabbet, the upper edges of the keel were beveled to accept the garboards. The false keel was also cut from slippery elm and measured 2.5 in (6.4 cm) molded and 8 in (20.3 cm) sided. It was fastened to the keel by iron staples and spikes. Several white oak deadwood timbers were found in the stern, but none was present along the length of the keel.<sup>139</sup>

The white oak frames consisted of alternating floors and futtocks, with no horizontal fastenings between the two. The preserved dimensions of the timbers averaged 8 in (20.3 cm) molded and 9 in (22.9 cm) sided near the keel, but it was readily apparent they had suffered damage from teredo worms. The floors were cut with rectangular or triangular limber holes and were bolted to the keel with 1 in (2.5 cm)

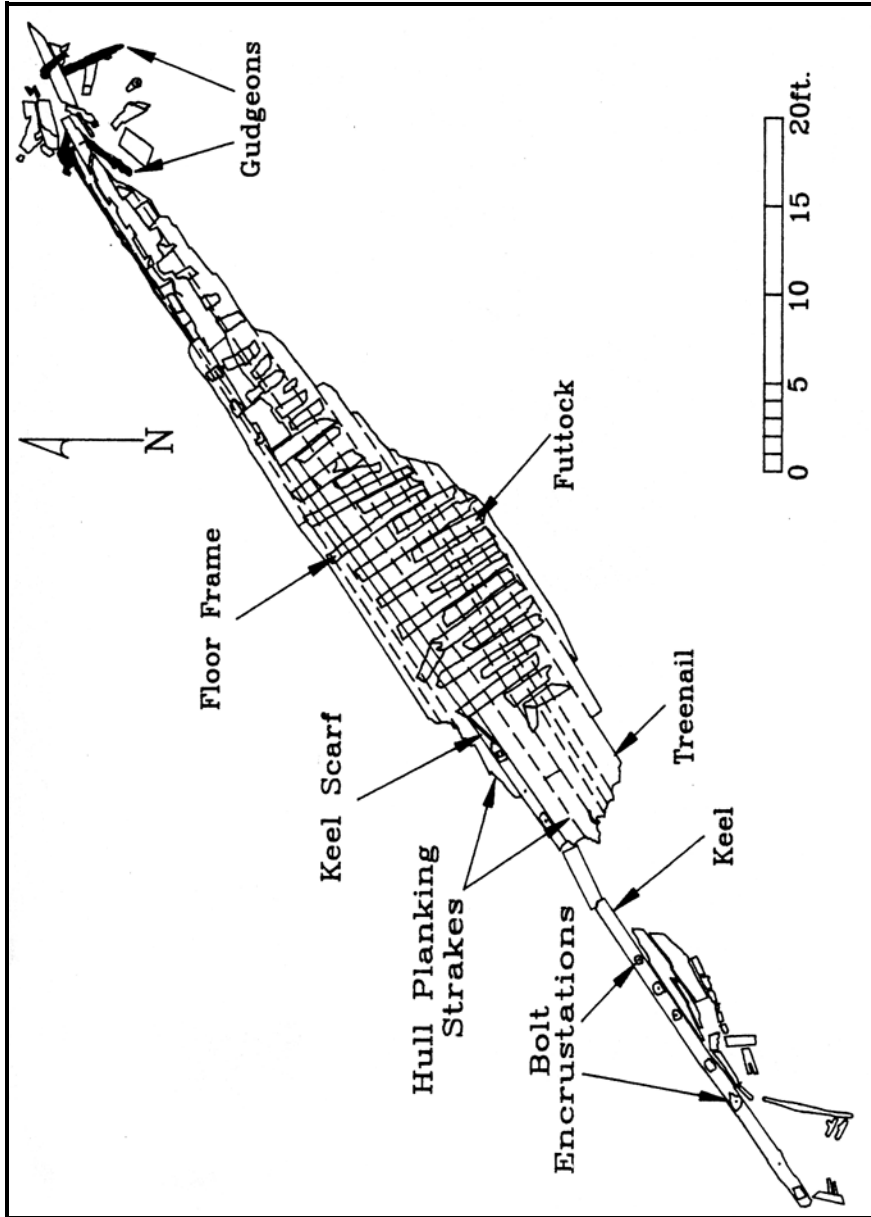


Figure 26. Site plan of the Port Royal wreck. (From Clifford 1991, 82).



diameter iron spikes; placement varied from 18 to 30 in (45.7 to 76.2 cm) on the centers. The first futtocks were offset from the keel by about 20 in (50.8 cm) and were placed forward of their associated floors throughout the preserved examples. Although little remained of the bow or stern frames, it appeared that cant frames may have been used with square frames in the stern. The keelson did not survive.<sup>140</sup>

External strakes were attached to the frames with 1.5 in (3.8 cm) diameter treenails, generally using one per plank per frame, and iron spikes. The planks averaged 8 in (20.3 cm) in width and 3 in (7.6 cm) in thickness, with the garboard strake measuring up to 4 in (10.2 cm) thick. No caulking or sheathing was found. Interestingly, even though a small amount of ballast was found in the bottom of the hull, no evidence of ceiling planking was discovered. Ceiling planking would normally be present to protect the interior of the hull and prevent ballast from clogging the bilges; possibly it had been removed from the vessel during careening or during salvage operations following the earthquake.<sup>141</sup>

Radiocarbon dating and artifacts found in the hull support a seventeenth-century date for the vessel.<sup>142</sup> The most abundant artifact type, lead shot, indicated the ship was armed, either for protection as a merchant ship or as a naval vessel. The disposition of the wreck, apparently crashed into one of the buildings, does suggest a potential identity for the vessel as HMS *Swan*. *Swan*, originally a merchant ship, was purchased by the Royal Navy and used as a fifth rate frigate of 32 guns. The ship was described as having a keel length of 74 ft (22.6 m), a beam of 25 ft (7.6 m), and a tonnage between 246 and

305 tons. Sent to Port Royal in 1690, *Swan* was being careened in 1692 when post-earthquake surges washed it into the town.<sup>143</sup>

### *HMS Boscawen*

The Anglo-American warship *Boscawen* was built by colonial American shipwrights under the direction of Royal Navy Captain Joshua Loring in 1759 and launched in as little as three weeks to take part in a British campaign on Lake Champlain during the French and Indian War. Until its discovery in 1983, all that was known about the vessel was that it was rigged as a sloop, carried 16 guns, measured 115 tons, and sank at the Fort Ticonderoga dockyards in the 1760s. Excavation and documentation of the hull were conducted during the summers of 1984 and 1985. The site plan is shown in figure 27.<sup>144</sup>

*Boscawen's* white oak keel was about 65 ft (19.8 m) long; it was molded 14 in (35.6 cm) and sided 10.5 in (26.7 cm) at the stem, tapering to 9.5 in (24.1 cm) sided at the stern. The sloop's stem was composed of a gripe, main post, and apron, all made of white oak and fastened together with 1 in (2.5 cm) diameter iron bolts. The main post, flat-scarfed to the keel, measured 5.5 in (14 cm) sided and 11 in (27.9 cm) molded forward of the keel. The gripe was sided 3.75 in (9.5 cm) and molded 6 in (15.2 cm) at the keel scarf, increasing to 11 in (27.9 cm) molded. A much larger timber, the apron was 16 in (40.6 cm) square. In the stern, the white oak sternpost was fastened to the keel by two iron dovetail plates. The post measured 6 in (15.2 cm) sided and 19 in (48.3 cm) molded at the base, narrowing to 13 in (33 cm) molded. Four deadwood timbers,

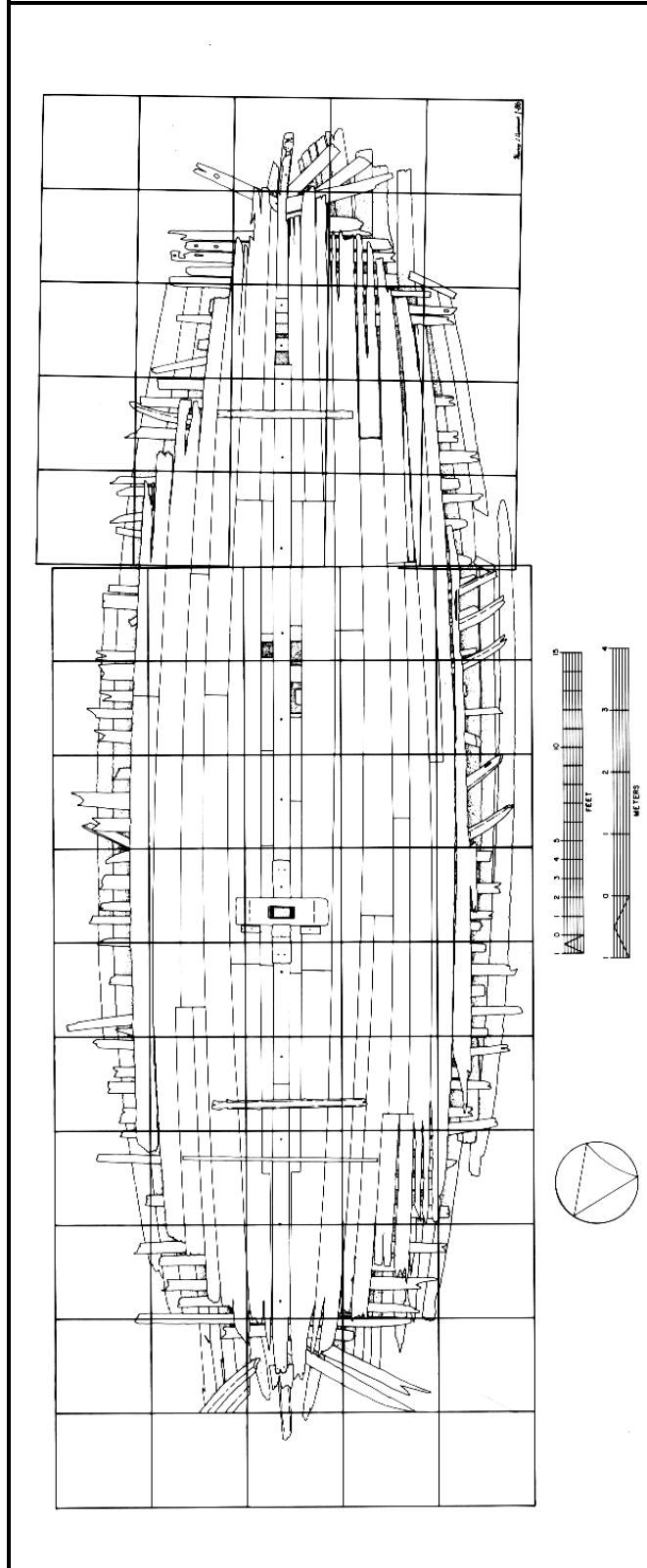


Figure 27. Site plan of *Boscawen*. (Drawing by Kevin Crisman).

including the stern knee, reinforced the sternpost and were attached to the keel by iron bolts. The knee was cut from a naturally curved section of a tree and measured 6 in (15.2 cm) sided and 11 in (27.9 cm) molded near the top of its upper arm.<sup>145</sup>

Framing on *Boscawen* displayed evidence of the sloop's quick construction. The spacing was erratic but averaged 28 to 34 in (71.1 to 86.4 cm) between centers. The 26 white oak frames consisted of floors fastened to the keel with a single bolt, alternating Fig 23. Site plan of Boscawen with first futtocks. Every fourth frame on the vessel was articulated, but in the rest these components were not laterally fastened and gaps existed between them.<sup>146</sup> When the sloop was built, the master frames were bolted to the keel first. The rest of the floors may have been installed next, or the lower planking could have been put on first. Once the planking was high enough, the first futtocks of the disarticulated frames were attached to the strakes with treenails and iron bolts. This pattern continued until all the upper futtocks were in place. Because it was not important for the floors and alternating futtocks of the intermediate frames to fit together tightly, they could be crudely shaped. The floors, each cut with limber holes, averaged 8.5 to 10 (21.6 to 25.4 cm) sided and were molded 12 in (30.5 cm) at the keel, decreasing to 7 in (17.8 cm) molded at their heads. First futtocks were less finished, varying from 4 to 8 in (10.2 to 20.3 cm) sided and 7 to 10 in (17.8 to 25.4 cm) molded. Several timbers still had bark on their surfaces. In the bow were two cant frames, which butted against the keelson rather than crossing the keel, as if added after the other frames. Four to five similar half frames were found in the stern; these timbers butted against the deadwood and were angled aft.<sup>147</sup>

The 53 ft (16.2 m) long keelson was also of white oak and was secured to every other floor timber by iron bolts. Rather than extending all the way to the stern, the keelson stopped about 3 ft (0.9 m) short of the stern deadwood, or 10 ft (3.5 m) from the sternpost. There was no clear reason for this gap, but perhaps a suitable additional length of timber was not available. The keelson measured 6 in (15.2 cm) molded and 10 in (25.4 cm) sided near the bow and 10 in (25.4 cm) molded and 11 in (27.9 cm) sided towards the stern.<sup>148</sup>

External and ceiling planking were of white oak and measured 2 in (5.1 cm) in thickness. The external strakes averaged 11 to 15.5 in (27.9 to 39.4 cm) in width and were fastened to the floors and futtocks with iron spikes and trenails of white oak and white ash. Ceiling planking varied from 12 to 20 in (30.5 to 50.8 cm) in width and was secured to the frames with randomly placed iron spikes.<sup>149</sup>

The sloop's single mast step consisted of a large white oak block notched over the keelson one-third of the vessel's length aft of the stem. The block measured 4 ft 3 in (1.3 m) long, 18 in (45.7 cm) wide, and 16 in (40.6 cm) in height. It sat perpendicularly to the keelson and was secured in place by two wedges of wood placed longitudinally along the keelson, one on either side of the block. Two chocks were attached to the ceiling forward of the step to prevent it from twisting. The step's mortise was 16 in (40.6 cm) long, 8.5 in (21.6 cm) wide, and was cut entirely through the block to the keelson.<sup>150</sup>

Two white pine orlop deck beams, consisting of unfinished round logs, were found at the site. These logs measured 5 to 7 in (12.7 to 17.8 cm) in diameter and had

been adzed flat on the upper surface to allow the decking to lie evenly. The deck planking was 0.75 in (1.9 cm) thick and made of white oak.<sup>151</sup>

The archaeological work done on *Boscawen* has confirmed the vessel's identity and revealed several construction shortcuts that could be taken by shipbuilders when necessary. Many of the timbers varied in size for no clear reason and often were not consistently spaced. An overall lack of finishing was apparent, as evidenced by the deck beams and frames. Additionally, securing the futtocks only to the planking, rather than attaching them to each other fore-and-aft, probably hastened the sloop's completion. Despite these shortcuts, *Boscawen* was originally a sturdy and battle-worthy warship.<sup>152</sup>

#### *The Deadman's Island Shipwreck*

In 1988, a survey conducted by archaeologists from the University of West Florida revealed the remains of a wooden shipwreck off Deadman's Island, located in Pensacola Bay, Florida. This area, called Old Navy Cove on early maps, became a popular careenage and shelter from winter storms for English ships during the English occupation of western Florida from 1763 to 1781. The shipwreck remains were located in only three feet of water and had become exposed by winter storms. Preliminary investigations suggested the ship was a British naval vessel associated with a regiment stationed at Pensacola from 1776 to 1781. The absence of ballast and any type of mast step indicated the vessel had been stripped and intentionally abandoned. Complete excavation of the site was conducted during a field school in the summer of 1989

sponsored by the Florida Bureau of Archaeological Research, the University of West Florida, and the City of Gulf Breeze.<sup>153</sup>

The vessel was constructed entirely of white oak. Figure 28 shows the site plan of the shipwreck. The keel measured 50 ft 10 in (15.5 m) in length and 9.5 in (24.1 cm) sided by 20 in (50.8 cm) molded. An iron strap secured the scarf between the keel and stem. The stem measured 8 in (20.3 cm) sided at its forward end and 19 in (48.3 cm) molded. The gripe or forefoot, attached to the forward face of the stem, was molded 6 in (15.2 cm) and sided 7.5 in (19 cm) on the inner face, tapering to 4.5 in (11.4 cm) on the outer, forward face. The stemson, on the inner face of the stem, appeared to be notched on the underside to fit over the floor timbers.<sup>154</sup>

The stern assembly was well preserved, consisting of the sternpost and a heavy stern knee. The sternpost was sided 8 in (20.3 cm) forward, tapering to 6.5 in (16.5 cm) aft and was 19 in (48.3 cm) molded. A 2 in (5.1 cm) rabbet had been cut into the post to receive the hood ends of the external planking. The stern knee appeared to be fashioned from compass timber and was bolted to the keel. The lower arm of the knee was sided 11 in (27.9 cm) forward and 5.5 in (14 cm) aft; it supported at least two of the aftermost floor timbers.<sup>155</sup>

The hull remains included 27 floors and 22 futtocks. The frames were roughly square, averaging 8 in (20.3 cm) molded and sided, but the sided dimension varied from 6 to 9 in (15.2 to 22.9 cm). The spacing between frames was irregular and averaged 12 to 14 in (30.5 to 35.6 cm). The floors in the bow and midships were notched to fit over the keel and had V-shaped limber holes cut into their undersides. Several of the floors

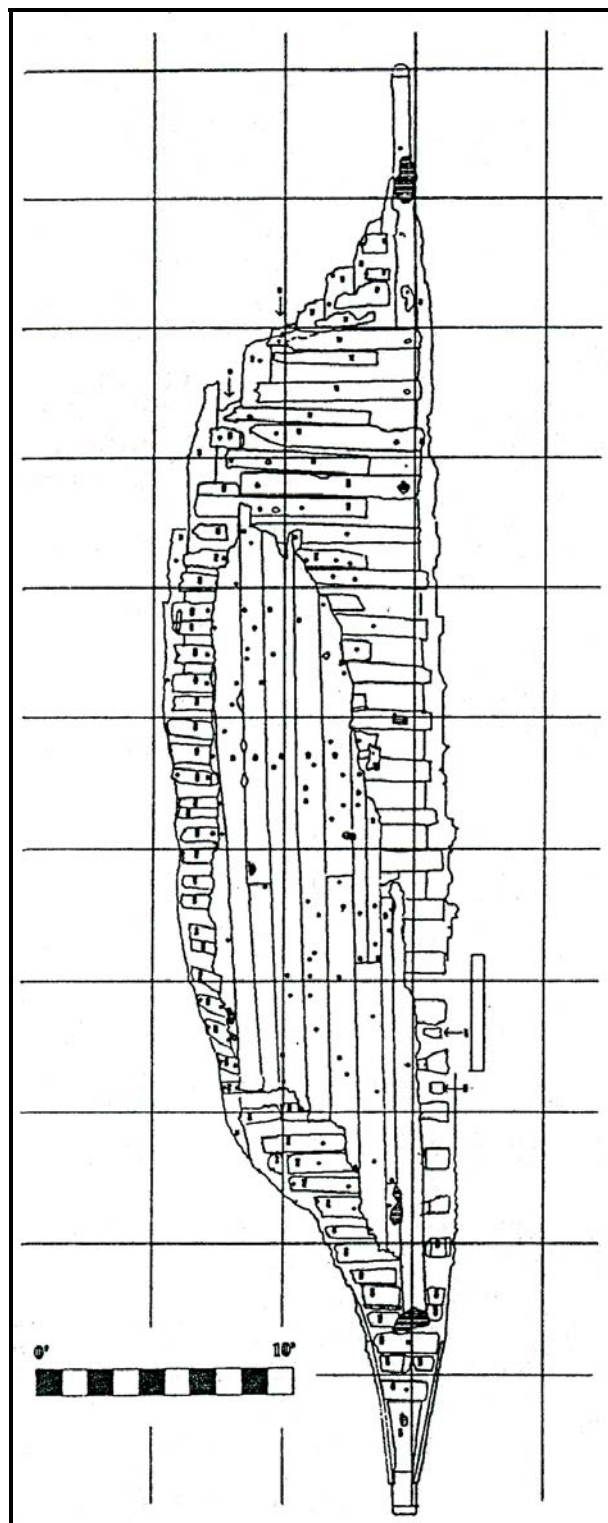


Figure 28. Hull remains of the Deadman's Island wreck. (From Smith 1990, 114).



were joined to their associated futtocks with transverse treenails measuring 2 in (5.1 cm) in diameter, forming articulated mold frames. At one of these master frames, located at midships, the futtock positions change from forward of the floors to aft of the floors.<sup>156</sup> No information was given regarding the nature of the frames in the bow and stern, but the surviving frames appear to be square rather than canted on the site plan.<sup>157</sup>

The keelson was notched to fit over the floors and measured 11 in (27.9 cm) sided by 9 in (22.9 cm) molded. No mast step assembly or rigging material was found to indicate the rig type. The external planking averaged 1.5 in (3.8 cm) in thickness and 8 to 10 in (20.3 to 25.4 cm) in width; it was fastened with treenails and iron nails. There was no evidence of sacrificial wood sheathing, but fragments of lead strips were found near the bow and copper tacks were found in the bilge.<sup>158</sup> One of the garboard strakes had been fitted with a small filler piece near midships, probably a repair of damaged wood. The ceiling planks were the same thickness as the outer planks and were fastened with alternating treenails and iron nails.<sup>159</sup>

The presence of uniform buttons from the British Army's 60th Regiment of Foot point to the vessel's use in a military capacity. It may have been constructed as a merchant vessel and then employed as a troop transport, or it could have been built and used as an armed naval ship. Two candidates for the vessel's identity have been suggested – the sloop HMS *Stork* and the schooner HMS *Florida*, both armed with 14 guns.<sup>160</sup> Not enough remains were found to clearly determine the ship's use or identity, but a few aspects of the hull construction suggest it was not built to naval standards. Many of the frames were roughly shaped and varied in sided dimensions and spacing,

suggesting regularity in construction was not a concern. Additionally, the mold frames appeared to be set apart on 5 ft (1.5 m) centers, farther than typical English naval vessels.<sup>161</sup>

Based on the length of the keel, the original vessel was probably about 100 tons with a length between 60 to 70 ft (18.3 to 21.3 m). It was most likely rigged as a sloop or schooner. According to preliminary lines, the stern would have had a fine run, which would have increased the vessel's speed.<sup>162</sup> With a 20 in (50.8 cm) molded dimension, the keel was deep and would have helped prevent lateral drift, a feature typical of seaworthy ocean-going vessels. The planking was fairly thin for the ship's size and the frames were widely spaced, but the frame dimensions appear typical. The deep keel and lighter construction could potentially have increased the vessel's speed and made it more seaworthy.

### *The Cornwallis Cave Wreck*

The Cornwallis Cave wreck, located off of Yorktown, Virginia, was part of Cornwallis' fleet in the Battle of Yorktown, along with the *Betsy*. It was the first vessel of the fleet to be discovered when sport divers found it in 1974 and recovered several artifacts from the site. These artifacts dated to the Revolutionary War, leading archaeologists and the State of Virginia to initiate protection and surveying of the area in 1976. Although less than 10% of the original hull remained, the Cornwallis Cave wreck was investigated through a series of test trenches by archaeologists and students from the Virginia Research Center and the Institute of Nautical Archaeology in May of 1976.

Although initially thought to be a merchant vessel, investigators now believe the shipwreck is the remains of HMS *Fowey*, General Cornwallis' 24-gun warship, based on its size and location.<sup>163</sup> The vessel's preserved beam was 28 ft 9 in (8.8 m), suggesting an original beam of 32 ft (9.8 m). The length between perpendiculars was 111 ft 9 in (34.1 m) with a length on the main deck of about 118 ft (36 m). A ship of this size would have had a minimum hold depth of 11 ft (3.4 m), a length on the main deck of about 118 ft (36 m), and a tonnage of at least 550 tons.<sup>164</sup>

In the bow, the apron, inner and outer posts, and gripe were partially preserved. The sided dimension measured 13 in (33 cm) for all timbers except the gripe, which was narrower. The apron was 19.5 in (49.5 cm) molded and the stempost was 12 in (30.5 cm) molded. The stern was not as well studied as the bow, but it appeared to be heavily constructed with a post and several pieces of deadwood. Because the stern became too angular to fit frames, a 15 in (38.1 cm) wide crutch was installed over the ceiling planking to help hold the sides of the stern together, similar to a breast hook or the oak crutch on the *Betsy*.<sup>165</sup>

Square double frames were present throughout the run of the hull, while cant frames appeared to be used in the bow and stern (fig. 29). Frames in the starboard bow were measured along the rot line and found to be 10.5 in (26.7 cm) molded and 10.5 to 12 in (26.7 to 30.5 cm) sided, although this variation may not be original. Spacing between the futtocks of the square frames averaged 2 in (5.1 cm), indicating very closely spaced frames. Because the ceiling was not removed, the cant frames could not be closely examined. Excavators believe they may have been canted half frames rather than

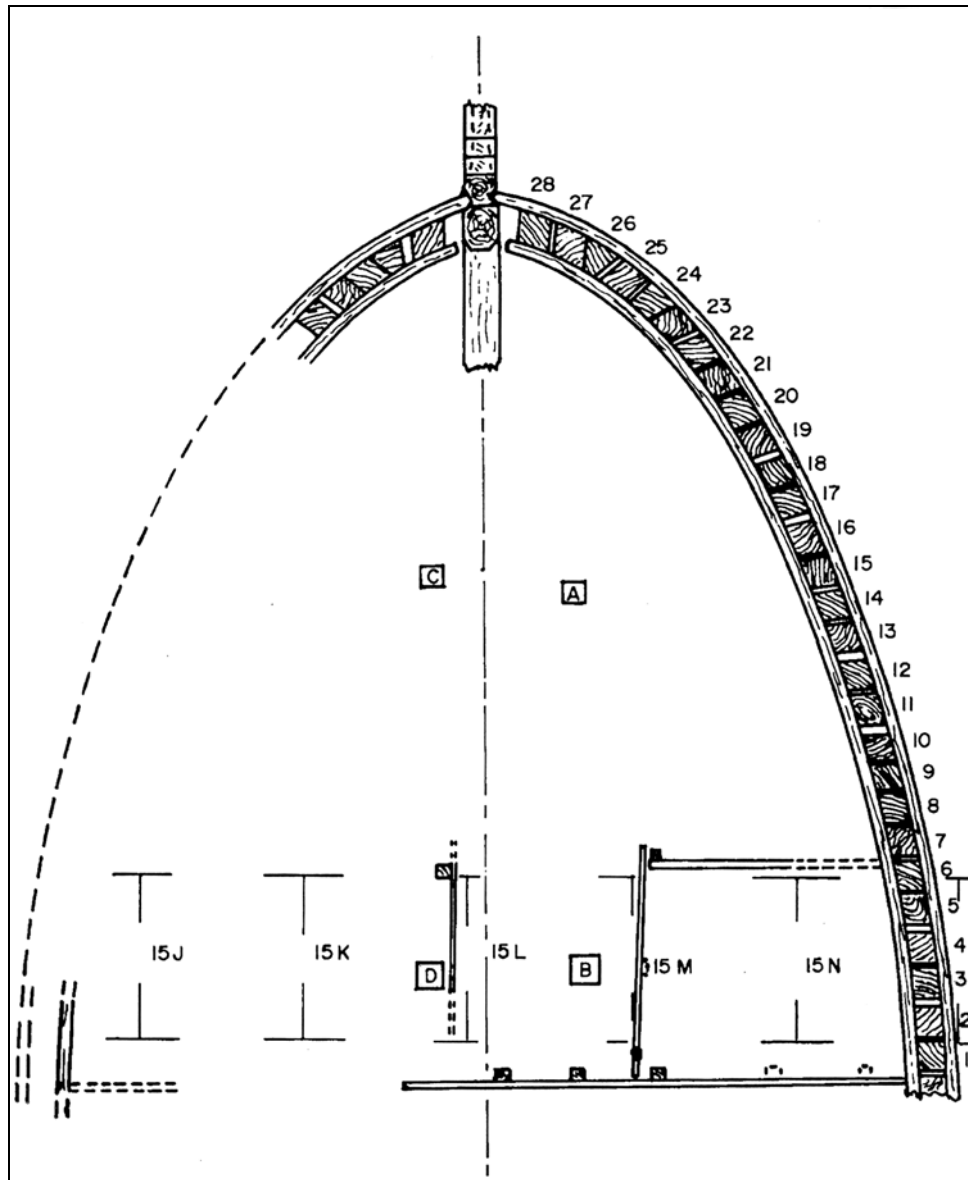


Figure 29. Bow structure of the Cornwallis Cave wreck.  
(From Johnston et al. 1978, 214).

double frames because spacing was often less than 1 in (2.5 cm) between these frames. Running parallel with the stem were hawse pieces and a knighthead, fore-and-aft frames that helped support the bowsprit and form the curves of the bow.<sup>166</sup>

The keelson, measured in the stern, was 14 in (35.6 cm) sided; the molded dimension was not recorded. A 6 in (15.2 cm) square mortise was cut into the keelson, probably to hold a deck stanchion. The external planking was 3 in (7.6 cm) thick and was sheathed with 1 in (2.5 cm) thick wood planking. This sacrificial planking was found in the stern along with a metallic surface and concretion, possibly the remains of copper sheathing. If so, this evidence would help substantiate the idea that the Cornwallis Cave wreck was a warship. The ceiling planking was thicker than the external planking, measuring 3.5 in (8.9 cm). A heavier 5 in (12.7 cm) thick ceiling strake was probably a sleeper or footwale. The ceiling was attached to the frames with 1.5 in (3.8 cm) diameter unwedged treenails and varied in width from 8 to 11.5 (20.3 to 29.2 cm). In the extreme bow and stern, compartment decks covered the keelson and joined into the ceiling; their planks were 10 in (25.4 cm) wide.<sup>167</sup>

A vessel of such large size would most likely have been ship-rigged. As a warship, the Cornwallis Cave vessel could have carried up to 32 guns.<sup>168</sup> The regular spacing and dimensions of timbers also are indicative of warship construction, although too little remains of the vessel to gather further evidence from construction techniques. Artifacts found at the site, including British military buttons, clearly point to the ship's use during the Revolutionary War.<sup>169</sup>

### *HMS Charon*

The remains of *Charon*, a 44-gun warship in Cornwallis' 1781 Yorktown fleet, were discovered in 1978 and partially investigated in the summer of 1980. The 1980 field school included staff from the Virginia Research Center for Archaeology and faculty and students from Texas A&M University. The goal of the work was to determine if the site, called GL136, was indeed the wreck of *Charon*. The fifth rate warship was built in Harwich, England, in 1778 and sank off of Yorktown, Virginia, after being set alight by from French artillery during the Battle of Yorktown. After locating several key features on the wreck and comparing them to a builder's draft of *Charon*, investigators were able to determine that the tentative identification was correct. According to the builder's plans, the warship measured 140 ft (42.7 m) in length on the gundeck, with a beam of 38 ft (11.6 m), a draft of 16 ft (4.9 m), and a tonnage of 880 tons. Artifacts with a date range concentrating on 1760-1780 helped confirm the identity of the vessel.<sup>170</sup>

The extant length of the keel could not be measured, but the plans called for a length of 115 ft (35.1 m). Aft of midships it was 15 in (38.1 cm) square, with a 6 in (15.2 cm) molded false keel beneath it. The rabbet was formed by the upper edge of the keel and the lower edge of a 6 in (15.2 cm) molded deadwood timber, which extended at least 65 ft (19.8 m) in length, similar to the rising wood seen on other vessels. The sides of the keel and garboard strake were sheathed in copper, but the false keel and bottom of the keel were not covered.<sup>171</sup>

Frames were perpendicular to the keel and consisted of floors alternating with futtocks that did not cross the centerline. Upper futtock heels were attached to the ends of lower timbers by scarfing and by chocks secured with trenails. Sided dimensions of the timbers varied from 10-14 in (25.4-35.6 cm), although deterioration had reduced several from their original sizes. Room and space also ranged from 27.5-31.5 in (69.9-80 cm). The floors in the bow were set in notches in the deadwood; although it is likely cant frames were present, the frames in this area were not closely examined.<sup>172</sup>

The keelson was bolted through every other floor timber with 1.25 in (3.2 cm) diameter bolts. The exterior bottom planking was made of oak, measured 3 in (7.6 cm) in thickness, and was fastened to the frames by 1.5 in (3.8 cm) diameter trenails. The ceiling planking was also secured by trenails and ranged from 2.5 to 3 in (6.4 to 7.6 cm) in thickness. The outside of the hull was sheathed with copper sheets measuring 5 ft (1.5 m) long by 18 in (45.7 cm) wide, as determined by remains of tacks and copper fragments.<sup>173</sup>

Lower portions of two of the ship's bilge pumps were found, including the in situ lower sections of the starboard suction pump and chain pump and displaced portions of the port pumps. Located on both sides of the keelson aft of the mainmast, the suction pumps consisted of a tube seated in a 10.5 to 11 in (26.7 to 27.9 cm) diameter hole cut between two adjacent frames. The tubes were octagonal on the outside with a diameter of 7.5 to 8 in (19 to 20.3 cm) across the flats and a bored center of 2.75 in (7 cm) diameter. The chain pumps were seated behind the suction pumps, each in a rectangular hole 22 in (55.9 cm) long by 14 in (35.6 cm) wide cut from two adjacent

frames. Support walls were placed at the front and the back of the hole; each wall was further secured with a 5 in (12.7 cm) wide wooden piece on the inside surface. A spinning drum, used to guide the chain up the tube, was located in the hole between the walls. The ascent tube for the chain had a bore of 7 to 7.75 in (17.8 to 19 cm) in diameter. The chain was formed of alternating double and single links with small cylindrical discs. The location and types of pumps found on the shipwreck helped confirm it was *Charon*.<sup>174</sup>

*Charon's* hull was typical for a frigate, full-beamed and full at the bow, with a substantial amount of tumblehome. The survival of the original builder's plans allowed archaeologists to confirm that the shipwreck at site GL136 was HMS *Charon*. Comparing the archaeological remains to the plans showed that the builder's draft and associated naval regulations were closely followed in the construction of the ship, as one might expect on a British naval vessel.

## **Riverine Craft**

### *The Brown's Ferry Vessel*

A sport diver discovered the Brown's Ferry vessel in 1971 in the Black River, near Georgetown, South Carolina. The diver reported the find to the South Carolina Institute of Archaeology and Anthropology and the excavation and recovery of the hull were conducted in 1976. Artifacts found at the site suggested a colonial date for the craft, sometime near 1740 or 1750. Along with artifacts, the entire extant hull was removed



from the river in August of 1976 and underwent conservation in polyethylene glycol, a process that was completed in 1990. Figure 30 shows the hull plan of the vessel.<sup>175</sup>

Rather than having a traditional keel, the Brown's Ferry vessel had a flat-bottomed structure composed of three large pine planks. The planks were each single pieces of timber measuring 2.75 to 4 in (7 to 10.2 cm) thick and up to 18.75 in (47.6 cm) wide at their centers. These planks were not edge-joined in any way but were secured together by the vessel's 20 frames treenailed to them. The live oak stem and the sternpost were treenailed to the bottom planks.<sup>176</sup>

The vessel's frames were also made from live oak and consisted of a floor timber with a pair of futtocks placed aft of the floor. In 5 of the 20 frames, the floor was fastened to the associated futtocks with treenails and iron nails. These five articulated frames, including the midship frame, were fairly evenly spread across the length of the hull and most likely served as master frames for shaping the rest of the hull. Analysis of the recorded data on the frame curvatures suggests that the frames were designed by whole molding, where a single shape was used for the turn of the bilge curve throughout the vessel. In addition to the regular frames, pairs of free futtocks were placed in approximately every third room. Floors were spaced on about 24 in (61 cm) centers and were fastened to the bottom planks using 1.1 in (2.8 cm) treenails; in many places the floors were joggled to fit flush over uneven areas of the bottom and all were cut with a rectangular limber hole near the centerline. Sided dimensions varied from 4 to 6.5 in (10.2 to 16.5 cm) and the molded dimension averaged 4.5 in (11.4 cm). The futtocks

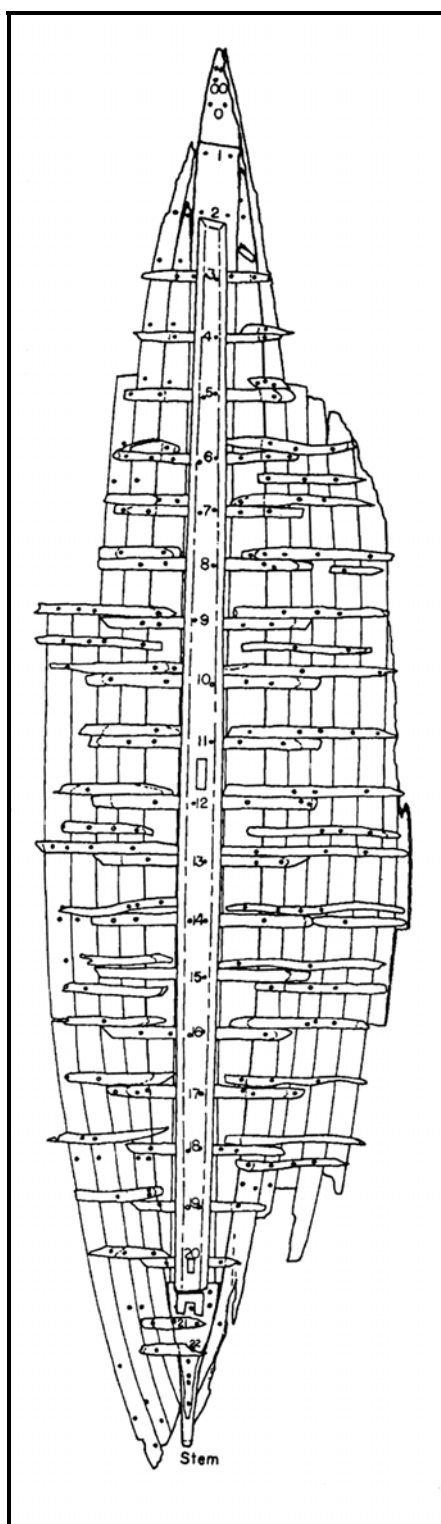


Figure 30. Hull remains of the Brown's Ferry vessel. (From Albright and Steffy 1979, 130).

were slightly smaller, measuring 3.5 to 5 in (8.9 to 12.7 cm) sided, and several had sapwood and bark in places.<sup>177</sup>

Laid over the frames was the keelson, a single piece of cypress sided 15.75 in (40 cm) and molded 4 in (10.2 cm). The keelson was treenailed through almost all frames to the bottom timbers. Mortises for the mainmast and foremast steps were cut into the keelson, the former measuring 12 in (30.5 cm) by 4 in (10.2 cm) and the latter 5.75 in (14.6 cm) by 3.1 in (7.9 cm).<sup>178</sup> As a small river trader, the vessel was most likely fore-and-aft rigged, possibly as a schooner, for ease in handling.<sup>179</sup>

The exterior hull planking consisted of pine strakes measuring 1.1 to 1.25 in (2.8 to 3.2 cm) thick and up to 11.25 in (28.6 cm) in width. The strakes were fastened to the frames by iron nails and treenails and were adzed in several places to fit the curvature of the frames, suggesting the planking was put up after all the frames were installed.<sup>180</sup> In contrast, the free futtocks were adzed to fit the planking, indicating they were added afterwards. A cypress wale, measuring 4 in (10.2 cm) wide and 3.5 in (8.9 cm) thick, was also present. Although some fragments of ceiling planking were found, no fastening marks were found on the inside of the frames to indicate this planking was permanent.<sup>181</sup>

Originally, the vessel would have been about 50 ft 3 in (15.4 m) in length and 14 ft 2 in (4.3 m) in beam, with a hold depth of about 3 ft (0.9 m). With an estimated tonnage of 25 tons and very shallow draft, the small ship would have had very little freeboard, making any oceanic or coastal travel difficult. In addition, the use of three keel-planks rather than a true keel indicates the builder intended for the vessel to be used in shallow, calm areas where lateral drift was not a problem. The flat bottom would also

have allowed the vessel to be grounded easily for lading of cargo. The sides of the hull were kept full to include more cargo area, but the run was long and fine. Built from cypress, pine, and live oak, all wood types local to South Carolina, the vessel represents a typical small river trader of the southern colonies.<sup>182</sup>

### *The Town Point Vessel*

The shipwreck at Town Point, off of Pensacola, Florida, was located in 1991 during the first year of the Pensacola Shipwreck Survey conducted by the Florida Bureau of Archaeological Research. After test trenches revealed interesting features of the vessel, a full-scale excavation was proposed by the surveyors and undertaken by Southern Oceans Archaeological Research archaeologists. Although the site had been previously disturbed, enough artifacts remained in context to date the vessel to the last quarter of the eighteenth century. The extant shipwreck, consisting of the keel and starboard side, measured 35 ft 4.4 in (10.8 m) in length, 7 ft 6.5 in (2.3 m) in beam, and 3 ft 11.5 in (1.2 m) in maximum depth (fig. 31). Based on these dimensions, the hold depth was estimated at 6 ft 3 in (1.9 m) and the tonnage at about 30 tons. The location of the wreck, at a colonial careenage site, suggests it was intentionally beached for careening and then abandoned after examination.<sup>183</sup>

The vessel's keel consisted of two timbers, one atop the other for the length of the keel, attached together by iron plates and spikes. The lower component was made of southern hard pine and measured 34 ft 9.3 in (10.6 m) in length, 6.5 in (16.5 cm) molded, and 5.5 in (14 cm) sided. The white oak upper timber contained the rabbet and

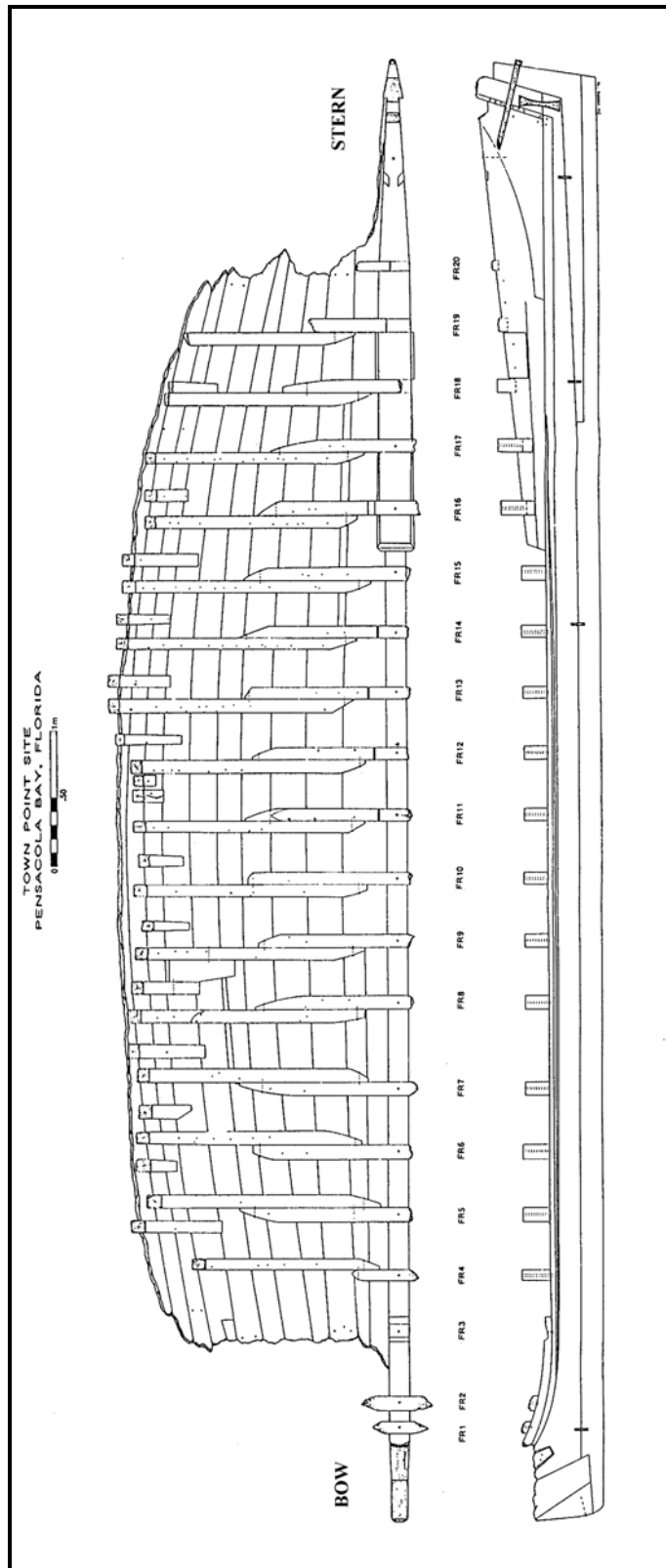


Figure 31. Hull remains of the Town Point vessel. (From Morris and Franklin 1995, 23).

was 33 ft 7.5 in (10.25 m) long and 9.4 in (24 cm) molded on average, with a maximum sided dimension of 5.5 in (14 cm). In both the bow and stern, the two keel timbers supported and secured the components of the end post assemblies. The bow assembly included a gripe, a hard pine stem raked forward 27°, and a white oak apron that was mortised to accept floor timbers. The stern assembly consisted of a tropical hardwood outer sternpost knee, the main sternpost, an inner white oak knee, and a single white oak deadwood timber. The horizontal arm of the outer stern knee was scarfed between the two keel timbers and secured with iron plates to strengthen the post arrangement. The stern deadwood timber served to form the upper part of the rabbet throughout its length.<sup>184</sup>

The vessel originally had 20 frames, including 3 half frames in the stern and 17 disarticulated frames throughout the rest of the hull. These frames consisted of a floor bolted to the keel with a corresponding first futtock bolted to the floor. The second futtocks were not attached to the frames, but were secured to the planking between the frames. In the bow, the first futtocks were aft of the floors, but forward of midships and after the first seven frames the futtocks were forward of the floors. All of the frames were perpendicular to the centerline and most were of white oak, with one of red mulberry and another of white ash. Floors averaged 4 in (10.2 cm) sided, ranging from 3.1 to 4.3 in (7.9 to 10.9 cm). The molded dimension varied from 2 to 8.25 in (5.1 to 21 cm), with an average of 6.9 in (17.5 cm). First futtocks averaged 3.1 in (7.9 cm) sided and 4.3 in (10.9 cm) molded. The distance between frame centers averaged 15.75 in (40 cm).<sup>185</sup> No evidence was found for the presence of a keelson on top of the frames,

although it seems odd that the vessel would not have had one. Perhaps the timber was recovered for another use before the hull was abandoned, but then bolt holes should be present in the upper surfaces of the floors where the keelson was once attached.

Exterior planking was cut from southern pine and white oak and was fastened to the frames with 0.5 in (1.3 cm) square iron spikes. The strakes measured 1.2 in (3 cm) in thickness. The remaining ceiling planking was white oak and included a clamp. Strakes varied from 0.8 to 1.4 in (2 to 3.6 cm) in thickness, with the clamp thickening to 2 in (5.1 cm).<sup>186</sup>

Mast location was determined from the remains of one mast buttress and indentations left by two others; these timbers supported the mast step. Based on these timbers, the mast appeared to be located between the ninth and twelfth frames from the bow, at the midship frame or slightly forward of this location. With a single mast, the vessel was most likely rigged as a sloop or cutter.<sup>187</sup> A component of the pump well, made of bald cypress, was found aft of the mast step and measured 17.75 in (45.1 cm) long, 7.25 in (18.4 cm) wide, and 1 in (2.5 cm) thick.<sup>188</sup>

Artifacts from the site point to a date range of 1750-1783 and were mainly British in style and origin. The British used the site where the shipwreck was found as a careenage during their occupation of West Florida from 1763-1781, further suggesting the vessel was abandoned during this period. The hull remains indicate that the small sloop or cutter was flat-floored with a bluff bow and a fine run aft. The one preserved clamp probably supported a quarterdeck; considering the vessel's small size, it seems likely the main cargo area was undecked. With a large area of the ship open, the vessel

would have been better suited for coastal or inter-island travel than trans-oceanic voyages. The types of woods used in the ship's construction point to British colonial origins. The outer stern knee was more similar to Iberian techniques than typical British building patterns, perhaps reflecting Spanish influence on the builder. The extensive use of iron fasteners, with almost no treenails, may indicate the craftsman was not actually a trained shipwright, as shipbuilders generally favored treenails. Alternatively, the shipwrights may have access to cheap iron, making iron fasteners a more economical option. As indicated by the hull remains and artifactual evidence, the Town Point vessel was a small trading craft built in the British colonies and used for coastal travel.<sup>189</sup>

### **Endnotes**

<sup>1</sup> Bernier 1997, 72-6. See also Waddell 1997, 77-83 and 1999, 85-92.

<sup>2</sup> Waddell 1999, 85.

<sup>3</sup> Bernier 1997, 74-5; Waddell 1999, 85.

<sup>4</sup> Waddell 1997, 81.

<sup>5</sup> Bernier 1997, 73; Waddell 1997, 81.

<sup>6</sup> Waddell 1997, 81-2.

<sup>7</sup> Waddell 1997, 81-2.

<sup>8</sup> Riess 1987b, 185-6. See also Smith 1988 and Riess and Smith 1983 for more information on the discovery and excavation of the site.

<sup>9</sup> Riess 1987a, 23-4.

<sup>10</sup> Rosloff 1986, 7-11. See Rosloff 1986 for a detailed analysis of the recovered bow.

<sup>11</sup> Rosloff (1986, 17), writes that "the frames were assembled with iron fastenings 2.5 to 2.8 cm in diameter running fore-and-aft," while Riess (1987a, 24-5) states that the frames were treenailed together fore-and-aft.

<sup>12</sup> Riess 1987a, 48; Jaegels 1988, 141.



- <sup>13</sup> Rosloff 1986, 11, 16-8; Riess 1987a, 24.
- <sup>14</sup> Riess 1987a, 24, 26, 48, 75-7; Jaegels 1988, 141.
- <sup>15</sup> Riess 1987a, 26, 28-9.
- <sup>16</sup> Rosloff 1986, 26-7, 48; Riess 1987a, 21, 23, 48.
- <sup>17</sup> Rosloff 1986, 43-6, 76-7.
- <sup>18</sup> Riess 1987a, 29, 48; Rosloff 1986, 46-8.
- <sup>19</sup> Riess 1987a, 23, 29, 34, 38.
- <sup>20</sup> Riess 1987a, 44, 46.
- <sup>21</sup> Riess 1987a, 50-2, 54-6. It should be noted that these conclusions are tenuous, based on the possible identification of much of the vessel's oak as live oak.
- <sup>22</sup> Riess 1987a, 77, 79.
- <sup>23</sup> Wilde-Ramsing et al. 1992, 1-4.
- <sup>24</sup> Wilde-Ramsing et al. 1992, 37-9, 40.
- <sup>25</sup> Wilde-Ramsing et al. 1992, 40, 42.
- <sup>26</sup> Wilde-Ramsing et al. 1992, 42, 53, 56.
- <sup>27</sup> Wilde-Ramsing et al. 1992, 43, 46.
- <sup>28</sup> Wilde-Ramsing et al. 1992, 47.
- <sup>29</sup> Wilde-Ramsing et al. 1992, 49, 51-2.
- <sup>30</sup> Wilde-Ramsing et al. 1992, 52-3.
- <sup>31</sup> Wilde-Ramsing et al. 1992, 54-6.
- <sup>32</sup> Carter and Kenchington 1985, 13-5.
- <sup>33</sup> Carter and Kenchington 1985, 13, 23-5.
- <sup>34</sup> Carter and Kenchington 1985, 15-6.
- <sup>35</sup> Carter and Kenchington 1985, 16, 20.
- <sup>36</sup> Carter and Kenchington 1985, 15-6, 20.
- <sup>37</sup> Carter and Kenchington (1985, 18) write that the channel carried at least two deadeyes, but the spacing for carrying a third would have produced shrouds spread over two meters, excessive for a vessel this size.

- <sup>38</sup> Carter and Kenchington 1985, 18, 20-1.
- <sup>39</sup> Carter and Kenchington 1985, 16-7.
- <sup>40</sup> Cook 1997, 1-2; Cook and Rubenstein 1995, 101-2.
- <sup>41</sup> Cook 1997, 2, 59.
- <sup>42</sup> Cook 1997, 3.
- <sup>43</sup> Cook 1997, 56-7; Cook and Rubenstein 1995, 104.
- <sup>44</sup> Cook 1997, 3; Cook and Rubenstein 1995, 105.
- <sup>45</sup> Cook 1997, 3, 44.
- <sup>46</sup> Cook 1997, 47-8.
- <sup>47</sup> Cook 1997, 49-50.
- <sup>48</sup> Cook 1997, 50.
- <sup>49</sup> Cook 1997, 51-2.
- <sup>50</sup> Cook 1997, 53.
- <sup>51</sup> Cook 1997, 53-4.
- <sup>52</sup> Cook 1997, 57-8.
- <sup>53</sup> Cook 1997, 54-6.
- <sup>54</sup> Cook 1997, 70, 92.
- <sup>55</sup> Cook 1997, 69-70, 87.
- <sup>56</sup> Krivor 1998, 8-9, 16; 1994, 40; Watts and Krivor 1995, 97-100.
- <sup>57</sup> Krivor 1998, 16-7, 24; Watts and Krivor 1995, 100.
- <sup>58</sup> Krivor 1998, 17-9, 24; 1994, 42.
- <sup>59</sup> The presence of copper drift bolts suggests that the hull was intended to be sheathed in copper at some point. Copper sheathing did not become common practice on warships until the late 18th century, making it unlikely a merchant ship of the same period would be coppered. Possibly, then, this vessel dates to the early 19th century, but artifact dates cluster in the late 18th century.
- <sup>60</sup> Krivor 1998 19, 21, 24; 1994, 42.
- <sup>61</sup> Krivor 1998, 19-21, 24; 1994, 43.
- <sup>62</sup> Krivor 1998, 21, 24.

- <sup>63</sup> Krivor 1998, 45-6; Watts and Krivor 1995, 106.
- <sup>64</sup> Krivor 1994, 40; 1998, 122-4, 133.
- <sup>65</sup> Krivor 1998, 131-3.
- <sup>66</sup> Krivor 1994, 40; 1998, 133; Watts and Krivor 1995, 107.
- <sup>67</sup> Broadwater 1980, 228-9; 1995, 59, 62; Broadwater et al. 1985, 301, 303-4. The vessel was identified based on pewter uniform buttons, cask heads bearing the initials of the *Betsy*'s owner, and details of the hull construction.
- <sup>68</sup> Broadwater 1980, 227; 1989, 121; 1995, 58-9; Johnston et al. 1978, 205-8.
- <sup>69</sup> Broadwater 1995, 59; Broadwater et al. 1985, 308.
- <sup>70</sup> Morris 1991, 50, 52-4.
- <sup>71</sup> Morris 1991, 51-2.
- <sup>72</sup> Morris 1991, 55-6.
- <sup>73</sup> Morris 1991, 56-7.
- <sup>74</sup> Morris 1991, 57-8.
- <sup>75</sup> Morris 1991, 58-61; Broadwater et al. 1985, 304.
- <sup>76</sup> Morris 1991, 61-2.
- <sup>77</sup> Morris 1991, 63-4.
- <sup>78</sup> Morris 1991, 67-9.
- <sup>79</sup> Morris 1991, 66-7.
- <sup>80</sup> Morris 1991, 65-6, 82-3.
- <sup>81</sup> Morris 1991, 71.
- <sup>82</sup> Morris 1991, 49.
- <sup>83</sup> Morris 1991, 76.
- <sup>84</sup> Jackson 1991, 41-58.
- <sup>85</sup> Jackson 1991, 69, 71.
- <sup>86</sup> Jackson 1991, 72-3.
- <sup>87</sup> Jackson 1991, 73-4.

<sup>88</sup> Jackson 1991, 76-8.

<sup>89</sup> Jackson 1991, 80-4.

<sup>90</sup> Jackson 1991, 79-80.

<sup>91</sup> Jackson 1991, 102, 104, 107-8.

<sup>92</sup> Jackson 1991, 122-30.

<sup>93</sup> Jackson 1991, 92-3.

<sup>94</sup> Jackson 1991, 116.

<sup>95</sup> Jackson 1991, 84, 86-7.

<sup>96</sup> Jackson 1991, 61, 139-40. The construction features that the excavators used to date the vessel can be found on 19th-century craft as well, making the artifactual evidence a better indicator of age. In addition, white oak for construction could be found easily in North America as well as England and hickory hoops could have been imported to England, so it is difficult to conclude the region of construction based on this evidence.

<sup>97</sup> Jackson 1991, 234-6.

<sup>98</sup> Jackson 1991, 239.

<sup>99</sup> Switzer 1981, 91; 1983, 44.

<sup>100</sup> Switzer (1981a) provides a detailed evaluation of the stern area of the *Defence*, including an assessment of damage and evidence for an explosion.

<sup>101</sup> Switzer 1981b, 91; 1981a, 144-5; 1983, 43; Sands 1996, 155.

<sup>102</sup> Switzer 1981b, 92; 1983, 45; Sands 1996, 156.

<sup>103</sup> Switzer 1981b, 94-5, 98; 1981a, 149; 1983, 50; Wyman 1978, 5.

<sup>104</sup> Switzer 1981b, 93, 98.

<sup>105</sup> Switzer 1981b, 93-5.

<sup>106</sup> Switzer 1981b, 95-6.

<sup>107</sup> Switzer 1981b, 93, 96-7.

<sup>108</sup> Switzer 1981b, 97-8.

<sup>109</sup> Sabick 2004, 1-2.

<sup>110</sup> Sabick 2004, 17, 19.

<sup>111</sup> Sabick 2004, 16.

- <sup>112</sup> Sabick 2004, 26.
- <sup>113</sup> Sabick 2004, 38, 43, 63.
- <sup>114</sup> Sabick 2004, 70-2, 76.
- <sup>115</sup> Sabick 2004, 21, 84. Historical sources document the use of oak and red cedar to build the schooner.
- <sup>116</sup> Sabick 2004, 84.
- <sup>117</sup> Sabick 2004, 85.
- <sup>118</sup> Sabick 2004, 87.
- <sup>119</sup> Sabick 2004, 91.
- <sup>120</sup> Sabick 2004, 89-90.
- <sup>121</sup> Sabick 2004, 92-9.
- <sup>122</sup> Sabick 2004, 99-100.
- <sup>123</sup> Sabick 2004, 101.
- <sup>124</sup> Sabick 2004, 104.
- <sup>125</sup> Sabick 2004, 99.
- <sup>126</sup> Sabick 2004, 104.
- <sup>127</sup> Sabick 2004, 105.
- <sup>128</sup> Sabick 2004, 102.
- <sup>129</sup> Sabick 2004, 109. The tonnage measurement comes from an historical account; see Sabick 2004, 36.
- <sup>130</sup> Sabick 2004, 109.
- <sup>131</sup> Sabick 2004, 123.
- <sup>132</sup> Hocker 1992b, 12-3.
- <sup>133</sup> Hocker 1992b, 14.
- <sup>134</sup> Hocker 1992b, 15-6; Amer and Hocker 1995, 299.
- <sup>135</sup> Hocker 1992b, 16; Amer and Hocker 1995, 299.
- <sup>136</sup> Amer and Hocker 1995, 299.
- <sup>137</sup> Hocker 1992b, 15.

- <sup>138</sup> Clifford 1991, 80.
- <sup>139</sup> Clifford 1993, 82; 1991, 80.
- <sup>140</sup> Clifford 1991, 80-1; 1993, 89-90.
- <sup>141</sup> Clifford 1991, 80; 1993, 87, 89, 91, 104-5.
- <sup>142</sup> Clifford 1991, 80; 1993, 143-4.
- <sup>143</sup> Clifford 1991, 80, 82-3; 1990, 10; 1993, 107.
- <sup>144</sup> Crisman 1985, 357, 367; 1996, 142-3.
- <sup>145</sup> Crisman 1985, 358-60.
- <sup>146</sup> Crisman 2004, personal communication.
- <sup>147</sup> Crisman 1985, 361-4; 1996, 146.
- <sup>148</sup> Crisman 1985, 364.
- <sup>149</sup> Crisman 1985, 364-5.
- <sup>150</sup> Crisman 1985, 365.
- <sup>151</sup> Crisman 1985, 365, 367.
- <sup>152</sup> Crisman 1985, 369-70.
- <sup>153</sup> Smith 1990, 110-2.
- <sup>154</sup> Smith 1990, 113; Finegold 1990, 26, 28-9.
- <sup>155</sup> Smith 1990, 114; Finegold 1990, 30.
- <sup>156</sup> Finegold 1990, 26-8; Smith 1990, 114.
- <sup>157</sup> Smith 1990, 114.
- <sup>158</sup> Copper sheathing would probably not have been used at this early date, so the copper tacks were likely used for some other purpose, such as for the pump assembly or a copper lining in the magazine (Crisman 2004, personal communication).
- <sup>159</sup> Smith 1990, 114; Finegold 1990, 28-9.
- <sup>160</sup> Finegold 1990, 30-1; Smith 1990, 115.
- <sup>161</sup> Finegold 1990, 28.
- <sup>162</sup> Finegold 1990, 31.

- <sup>163</sup> Broadwater 1996, 301.
- <sup>164</sup> Johnston et al. 1978, 209, 211, 220.
- <sup>165</sup> Johnston et al. 1978, 215, 217-20.
- <sup>166</sup> Johnston et al. 1978, 213-5.
- <sup>167</sup> Johnston et al. 1978, 217-9.
- <sup>168</sup> Johnston et al. 1978, 220.
- <sup>169</sup> Johnston et al. 1978, 224.
- <sup>170</sup> Steffy et al. 1981, 114-6, 140.
- <sup>171</sup> Steffy et al. 1981, 124, 126, 132.
- <sup>172</sup> Steffy et al. 1981, 129-30.
- <sup>173</sup> Steffy et al. 1981, 126, 130-1. Built in 1778, the *Charon* would have been one of the early ships sheathed in copper, as the Royal Navy did not order the coppering of all its warships until the following year in 1779.
- <sup>174</sup> Steffy et al. 1981, 134-5, 137-9.
- <sup>175</sup> Albright and Steffy 1979, 121-5; Hocker 1992a, 20; Amer and Hocker 1995, 297.
- <sup>176</sup> Albright and Steffy 1979, 127; Hocker 1992a, 21; Amer and Hocker 1995, 297.
- <sup>177</sup> Albright and Steffy 1979, 130-2; Hocker 1992a, 22-3; Amer and Hocker 1995, 297-8.
- <sup>178</sup> Albright and Steffy 1979, 135; Hocker 1992a, 23.
- <sup>179</sup> Albright and Steffy 1979, 141; Amer and Hocker 1995, 298.
- <sup>180</sup> Amer and Hocker (1995, 298) suggest that the five master frames were installed first, followed by the garboard strake, which was used as a guide for fitting the rest of the floors.
- <sup>181</sup> Albright and Steffy 1979, 136; Hocker 1992a, 23.
- <sup>182</sup> Albright and Steffy 1979, 137-8; Hocker 1992a, 21, 24.
- <sup>183</sup> Morris and Franklin 1995, 1-3, 22, 24, 51, 57.
- <sup>184</sup> Morris and Franklin 1995, 25-8, 30-4.
- <sup>185</sup> Morris and Franklin 1995, 22-3, 35, 36-8.
- <sup>186</sup> Morris and Franklin 1995, 38, 40, 42-3.
- <sup>187</sup> Morris and Franklin 1995, 43-4, 57.

<sup>188</sup> Morris and Franklin 1995, 40.

<sup>189</sup> Morris and Franklin 1995, 53-4, 56-7, 60-1.



## CHAPTER VI

## COMPARATIVE ANALYSIS OF EIGHTEENTH-CENTURY SHIPS

The fundamental question of how ships were built in the eighteenth century can only be answered through an analysis of archaeological remains. Although a variety of other sources exist on shipping and the shipbuilding industry, none of them can provide as much specific information on construction methods. Treatises and written reports like Ollivier's, perhaps the second best source for information, are usually too theoretical, too vague, or too limited in their scope to be of much help; in addition, it is difficult to know if the concepts described in treatises were actually put into practice. Treatises, along with contracts, often provide overall dimensions and scantlings, but do not elaborate on how to assemble the timbers. Paintings, another major source on ships from the period, are useful for their presentation of exterior details, such as rigging, decorations, armament, and the general shape of a vessel. They may also depict exterior planking and details of the head and the rudder, but the underbody of a vessel is typically hidden beneath the water. The question of the artist's accuracy in his work must also be considered. Line drawings, many of which were preserved by the Royal Navy, are also useful for looking at the shapes of hulls, but individual timbers are usually not depicted. Other literary sources, including sailors' journals, ships' logs, letters, and newspaper articles, offer valuable information regarding rigging and outfitting, day-to-day operations, and the size and cost of construction, but do not cover many specifics on building techniques. Newspapers, contracts, and shipping records are much more helpful in studying the

shipping and shipbuilding industries as a whole in terms of economics and overall development.

While a variety of sources are available, the archaeological evidence is critical in understanding how merchant ships were built in practice. As even the best literary and iconographic sources paint only a fragmentary picture, study of the archaeological record becomes a necessity to fill these gaps. The variety of Anglo-American shipwrecks that have been excavated to date cover a range of ship types, functions, dates, locations of construction, and sizes. Comparisons among these vessels help to illustrate which construction techniques were standard and which methods varied based on these differences. In addition, such comparisons provide information about the major trends in eighteenth-century ship construction and how vessels were designed differently depending on their intended trade. It should be noted, however, that despite the importance of archaeology in addressing these issues, some limitations exist. Each shipwreck is only an isolated example and thus may not be typical; with so few examples of each, it is difficult to make decisive statements about specific ship types or answer questions conclusively. The incomplete nature of some of the excavations and lack of preservation of shipwreck material also contribute to forming only a partial data set. Material from the rigging and upper works of ships usually does not survive, so only the lowest parts of the hull can be effectively studied. Even with these limitations, the collection of data as a whole offers ground for analysis. Tentative conclusions from this study can provide a clearer direction for future research and offer a framework for incorporating new data.

As discussed in the chapter on historical background of eighteenth-century merchant shipping, several factors may have influenced ship design and construction during the period and should be considered when analyzing the archaeological data. First, because the transition in English merchant ships from defensive-style ships to bulk carriers occurred in the late seventeenth century, both types were likely still in use in the beginning of the 1700s. The sharp lines and heavy armament of the early merchant vessels made them hard to differentiate from warships of similar size, but the distinction first became apparent at some point during the eighteenth century. Second, the timber shortage in Europe and relative abundance in the New World would have affected what materials were available to shipwrights for construction. The growing costs of compass timber, in particular, could potentially have limited its use in merchant vessels where economy was essential. Third, such attempts to economize should be more evident in merchant ships than in naval vessels, where standardization took priority. In addition, warships required more hull strength to carry heavy armament and governments were better able to pay for higher quality construction than merchant owners. Fourth, shipping records have indicated an overall increase in vessel size, a trend that may or may not be seen in the archaeological record. Additionally, records suggest that British merchant vessels were generally larger than colonial craft. Fifth, in addition to potential distinctions between English and colonial vessels because of timber availability, American ships may have differed based on trade and the increasing necessity of speed during and after the Revolutionary War. With these factors in mind, the ship remains will be discussed in the general order of construction, beginning first with overall hull

shape and size. Possible methods for design will be considered in the discussion of framing.

### **Hull Shape and Size**

Understanding how the overall design of a merchant vessel reflected its intended trade can be extremely useful in looking at the details of ship construction.

Unfortunately, this area of analysis is based on the least reliable data, because in almost all cases the excavators of a vessel must infer the original dimensions, shape, and trade of the ship based on deteriorated, partial shipwreck remains and artifacts. In the absence of artifacts, inferences about the shape and size may be used alone to interpret the trade for which the vessel was built, leading to circular reasoning when trying to compare shape in relation to use. Where the vessel can be historically identified, or preservation is good, the archaeologist is at a significant advantage. As the shipwrecks considered in this study were no doubt interpreted with varying degrees of accuracy, only general conclusions about hull size and shape can be drawn.

#### *Vessel Size*

Of the ten major merchant ships under consideration, none were larger than 300 tons. In comparison to the rest of the English merchant fleet, especially the East Indiamen of several hundred tons, these vessels were quite small. The largest was the Ronson ship at 260 tons, followed by the two British colliers and the privateer *Defence*, in the range of 170 to 200 tons. Another five of the ships fell in the mid-size range of

about 100 tons, and the remaining two were very small, with the Phips wreck at 45 tons and the Clydesdale Plantation wreck at 20 to 25 tons. This last vessel was no larger than the two riverine craft, but its other features indicate it was capable of sea-going voyages.

The four largest vessels would have been the best suited for trans-oceanic travel by virtue of their size. Two of these vessels, the colliers, were British-built and owned, supporting the idea that British merchants owned larger vessels than the colonists. If the Ronson ship was used as a tobacco carrier, as the investigators suggest, or even for rice, it may have been British-owned as well, as the English merchants tended to dominate the trans-oceanic trade with the southern colonies. If so, this possibility would also support the view that the largest colonial-built vessels were constructed for British owners. After the Ronson ship, *Defence* was the largest of the colonial-built vessels and was American-owned and operated. Compared to typical European privateers, it probably would have been considered small, but it was large in comparison to most of the American vessels under consideration and could carry sixteen cannon.

Of the five ships of about 100 tons, four were American-built, suggesting this size was the most common for American-built trading vessels. Three of these ships, including the Rose Hill wreck, the Reader's Point sloop, and the Otter Creek wreck, appear to all have been used in the inter-colonial and West Indies trades. These vessels probably represent typical sloops and schooners used for colonial trade. The fourth vessel, the Terence Bay wreck, was utilized in the fishing industry and most likely would have been rigged as a schooner for easier handling and more maneuverability along the coast. The last vessel, the *Nancy*, was British-built for use on the Great Lakes.

Its smaller size relative to the two British colliers probably reflects its use on the lakes instead of at sea.

The smallest vessels were the Phips wreck at 45 tons and the Clydesdale Plantation wreck at 20-25 tons. Based on their small size, these craft would have been better suited to coastal trade over short distances rather than trans-oceanic voyages, although such small vessels as the 40-ton *Godspeed* and 20-ton *Discovery* had crossed the Atlantic a century earlier (fig. 32).<sup>1</sup> Based on their small sizes, the Phips and Clydesdale Plantation vessels probably had only a single mast each, with a sloop rig.

The naval vessels, in contrast to the merchant ships, ranged from mid-size to very large. The two smallest were *Boscawen* and the Deadman's Island vessel. The small size and sloop rig of *Boscawen* would have helped facilitate its hasty construction and use on an inland lake. The Deadman's Island vessel was probably also rigged as a sloop, or possibly a schooner, and although its use is unknown, it was associated with a regiment of infantry.<sup>2</sup> The Port Royal ship, with an extant keel length of 74 ft, was larger than these two vessels and may have been used as a frigate. The last two naval ships, the Cornwallis Cave wreck and *Charon*, were much larger than any other vessels considered in this study and would have served as ships-of-the-line with full ship rigs.

The two river traders, in contrast, were smaller than all of the merchant ships except for the Clydesdale Plantation vessel. The British-built Town Point vessel was comparable to the colonial-built small craft in size. The two vessels would have been too small to carry large amounts of cargo or to routinely travel long voyages. Instead, these craft would have been used for local trade along inland waterways or perhaps between

**A****B**

Figure 32. Replicas of two early seventeenth-century ships at Jamestown.  
**A**, the 40-ton *Godspeed*; **B**, the 20-ton *Discovery*.

nearby cities along the coast. With one or two masts, they would have had simple fore-and-aft rigs.

With such a small sample size, it is difficult to determine how average vessel size changed over the course of the century. Both the small Phips wreck and the comparatively large Ronson ship date to the early part of the century. The vessels from the middle of the period are small to medium sized, while three of the four largest vessels date towards the end of the century, around the Revolutionary War. This last grouping of large vessels may indicate a trend towards increasing size, but the sample size is too small to be statistically significant. It is clear, however, that craft of various sizes were employed throughout the period and intended use was probably one of the key factors in determining size.

### *Hull Shape*

In the same way that intended use influenced decisions about vessel size, the archaeological remains indicate that hull shapes were also related to trade. Figure 33 shows the frame shape near midships for several of the vessels. The two colliers exhibited the typical traits of bulk cargo carriers: heavy construction to carry large loads, a shallow draft to make grounding easier, and shaped to maximize cargo capacity. Flat floors reduced the draft and increased hold space, as did a bluff bow, full run, and fairly straight sides, although at the expense of speed. The overall shape was probably something similar to a bark, except with slack bilges instead of hard; in addition, the cant frames in the stern suggest a round-sterned ship rather than square.<sup>3</sup> Not enough of the



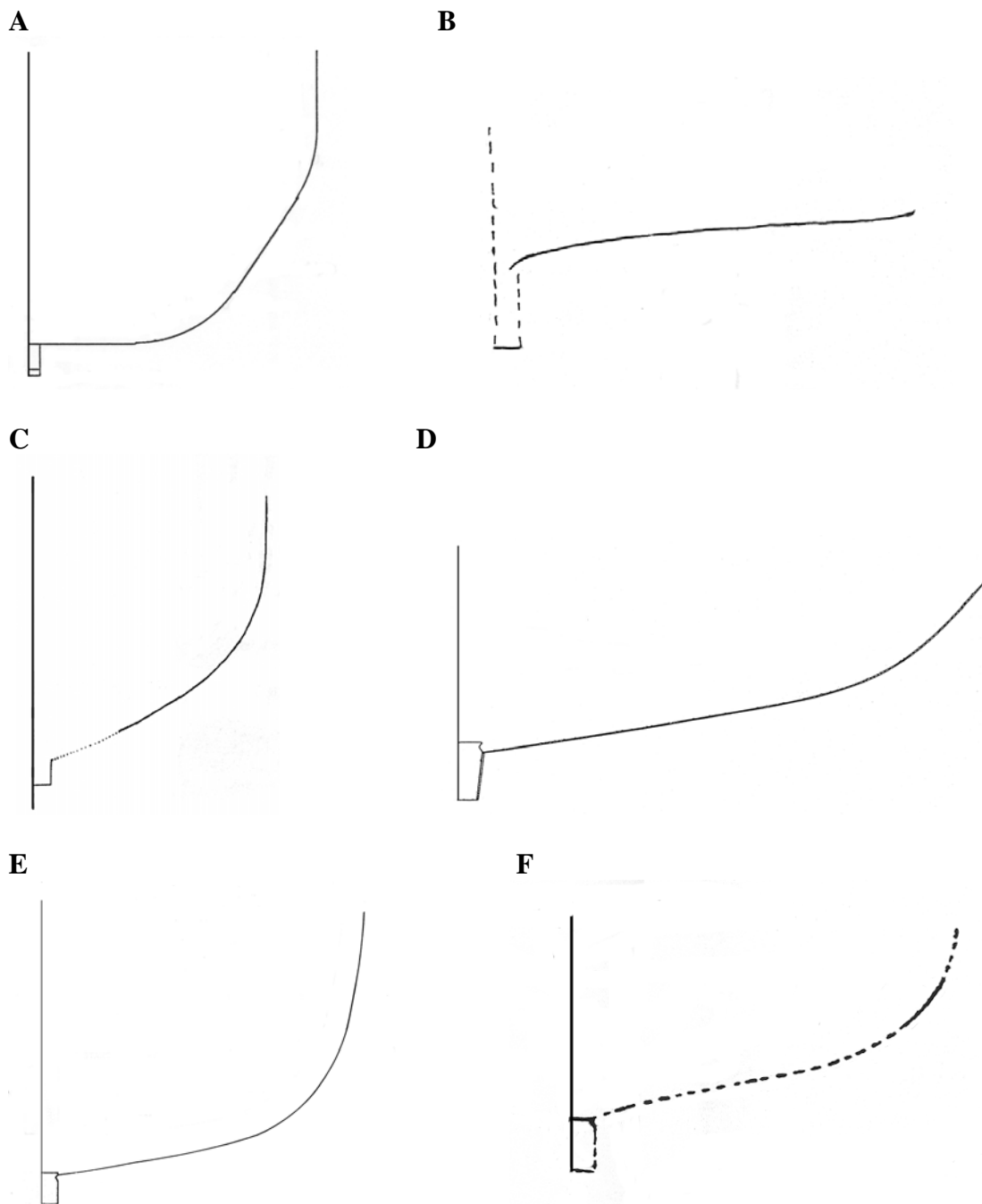


Figure 33. Vessel cross-sections near midships. Not to scale. **A**, Ronson ship (After Riess 1987, 122); **B**, Rose Hill wreck (After Wilde-Ramsing et al. 1992, 38); **C**, Terence Bay wreck (After Carter and Kenchington 1985, 21); **D**, Reader's Point vessel (After Cook 1997, 111); **E**, *Betsy* (After Morris 1991, 100); **F**, Otter Creek wreck (After Jackson 1991, 62).

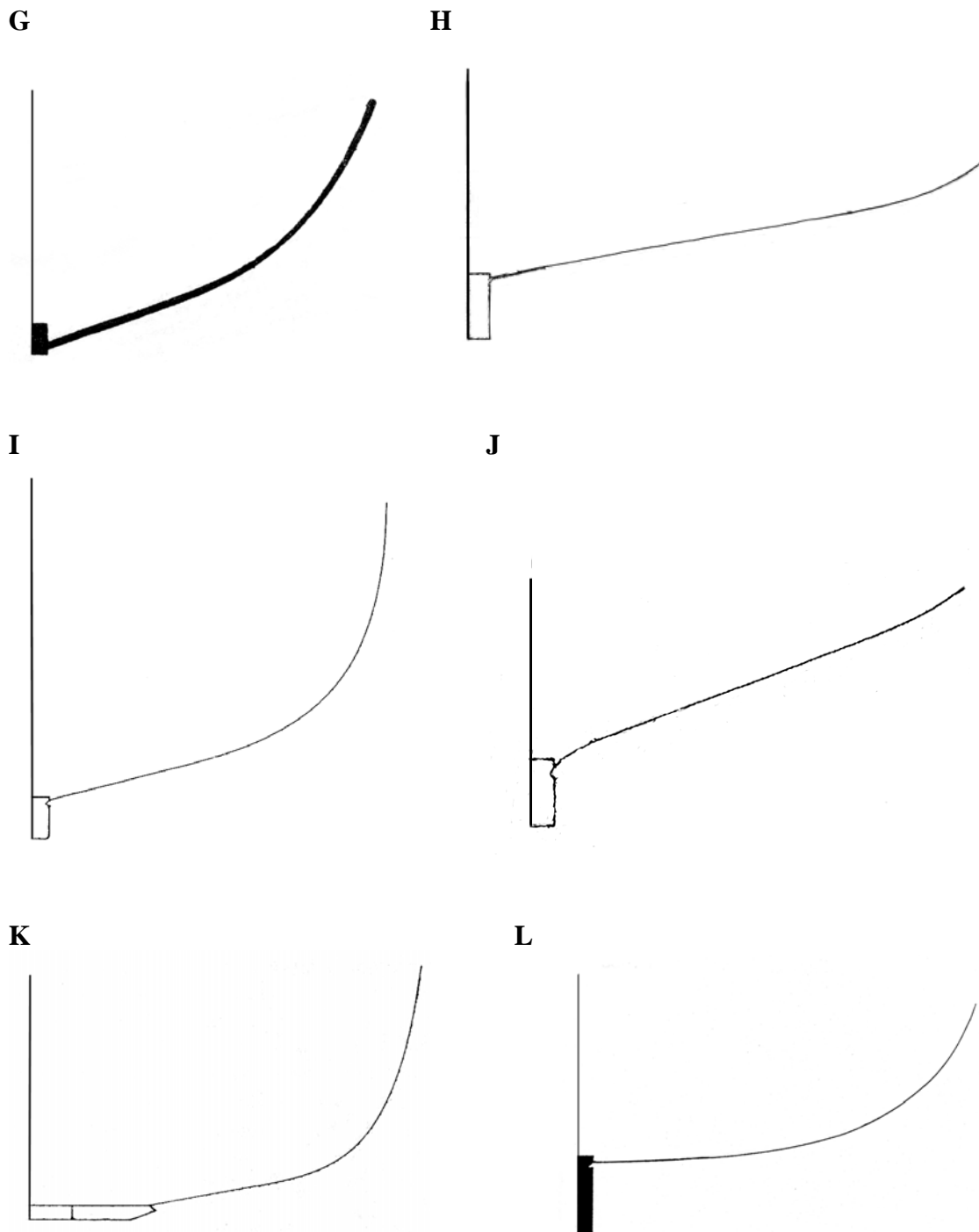


Figure 33 Continued. **G**, *Defence* (After Switzer 1983, 45); **H**, *Nancy* (After Sabick 2004, 108); **I**, Clydesdale Plantation vessel (After Hocker 1992, 16); **J**, *Boscawen* – section in the bow (After Crisman 1985, 361); **K**, Brown's Ferry vessel (After Hocker 1992, 20); **L**, Town Point vessel (After Morris and Franklin 1995, 56).

stern remained on either vessel to determine the shape of the transom tuck. Both the colliers had a length to beam ratio of about 3:1, producing a hull shaped for cargo space more than speed. They also would most likely have had a single deck to keep the hold as deep as possible and a simple rig to reduce crew size. These characteristics would have made the vessels sturdy and economic coal carriers with moderate sailing qualities.

The Ronson ship also had flat floors and a bluff bow to increase cargo capacity. The vessel's shape combined features of a frigate mixed with a flyboat. The entrance was full but the run was finer even though the stern was wide, like the shape of Chapman's frigates. The section, however, was more like a flyboat's, with flat floors, slack bilges, and greater tumblehome, although it was not as full. The main cargo hold was not as deep as that of the colliers, because the Ronson ship had two decks; presumably, both could have been used to stow cargo. The ship's relatively shallow draft in relation to its size would have enabled it to enter coastal waters. The higher length to beam ratio of 3.7:1 would have made it a better sailer than the colliers; in addition, the full ship rig would have helped compensate for the full cross-section by making the vessel faster. The drawback to this rig was the extra men required to operate it, but the additional crew have been useful for manning the guns the ship could carry. The armament and better sailing qualities would have allowed the Ronson ship to protect its cargo more efficiently than the colliers, especially useful if it was carrying a high-value commodity such as tobacco. It may also have been common to carry armament on the routes the Ronson ship traveled.

The design of the *Nancy* reflected its use as a trading vessel on the Great Lakes. Used both in lakes and in shallower connecting rivers, the schooner had a shallow draft to avoid running aground. As seen in the hull section, deadrise was limited to keep the draft shallow while maximizing cargo space. The bilges were fairly hard to accommodate the straight sides of the vessel. The bow was bluff but the run was fine. The *Nancy* would have been a good trading vessel, but was probably not very fast.

The hull design for the majority of the vessels, serving as inter-colonial traders, depended on whether the owner anticipated danger; they could be built for speed and maneuverability, to outrun pirates and privateers, or they could be constructed with a boxy shape to maximize cargo space at the expense of speed. The Rose Hill ship, with its heavy construction, flat floors, and 3:1 length to beam ratio was designed with the latter consideration in mind. The flat floors would have reduced its draft, allowing access to shallow areas. Likewise, the Reader's Point sloop was built to favor cargo capacity, as evidenced by its little deadrise and flat floors, although a slightly higher length to beam ratio may have improved its sailing qualities. The builder of the Otter Creek wreck may have favored speed more, giving the vessel a 3.6:1 length to beam ratio, some deadrise, and a fine run. The vessel's shallow hold depth would have limited its cargo capacity. The Clydesdale Plantation vessel was designed with a mixture of qualities. Its deep hold and 2.8:1 length to beam ratio would suggest a slow vessel, but its fine run, moderate deadrise, and deep-sitting stern would have made it fairly fast. All these vessels indicate the variety of choices available to merchants and shipwrights in designing a new ship; no rule seems to have been followed in making the decisions.

*Defence*, intended for use during war, was designed specifically as a privateer. In section, it had a fair amount of deadrise and slack bilges. A sharp bow, fine run, and lighter construction would also have helped make it a faster sailer. The vessel was fitted with 16 cannon for armament, necessary for its function as a privateer. The general design of this vessel was probably close to a naval ship of its size, although less regular in its construction. The excavated warships would probably have had similar qualities, such as the fine run of the Deadman's Island wreck; unfortunately, most of these remains were too partial to elaborate on the hull shapes. *Boscawen*, built for use on a lake, had a shallow draft like the *Nancy*. The section in figure 33, taken from the bow, shows considerable more deadrise than was present amidships. With little deadrise, *Boscawen* would have been better suited for shallow areas in the lake the other sea-going warships would have been.

The two riverine craft, although similar to the Clydesdale Plantation vessel in size, were shaped for travel in protected waters. The Brown's Ferry vessel, in particular, with its flat bottom, flat floors, full sides, and low freeboard, would not have been able to travel at sea unless conditions were very calm. A 3.5:1 length to beam ratio and a fine entrance with a narrow stern would have compensated somewhat to make the craft move through the water better. The Town Point vessel also had flat floors with no tumblehome but was very beamy with a 2.5:1 length to beam ratio and had a bluff bow. It must have been capable of coastal travel, as it was found off of Pensacola, Florida, and had a deep keel, but it may not have been a good sailing ship, especially if the main cargo area was open as suggested by the excavators.

### **Keel, Stem, and Stern Construction**

The keel was the first component to be laid for any ship, followed by the placement of the stem and sternpost. Figure 34 shows cross-sections of several of the keels. The archaeological remains indicate that keels could be made of a variety of wood types. White oak appeared to be the predominant choice, used in the *Betsy*, *Defence*, the Otter Creek vessel, the *Nancy*, and at least two of the warships. This wood type was standard for most timbers in English construction because of its durability, strength, and resistance to decay.<sup>4</sup> Two of the English vessels, the Bermuda collier and the Port Royal ship, used elm instead of oak. This wood was the type recommended by Sutherland in his table of scantlings for a 500-ton ship.<sup>5</sup> Hard maple, used on the Rose Hill and Reader's Point vessels, was another good alternative for keels because maples could reach heights of 100 ft (30.5 m) and generally had straight grain. Maple was heavy and strong like oak, but much more prone to decay.<sup>6</sup> The last wood type seen in the archaeological examples was pine, used on the smaller North American-built Clydesdale Plantation, Brown's Ferry, and Town Point vessels. Being a softwood, pine was not as good for keel timber as the other types, may have been most readily available for the builders of these vessels.

The Town Point vessel, interestingly, had a keel composed of two longitudinally attached timbers – the lower one of pine and the upper of white oak. These timbers were attached together by iron plates and spikes. In the stern, the lower arm of the outer stern knee was scarfed between the two keel pieces, suggesting the design was original, rather than the pine piece being a later addition. Although timber shortage should not have

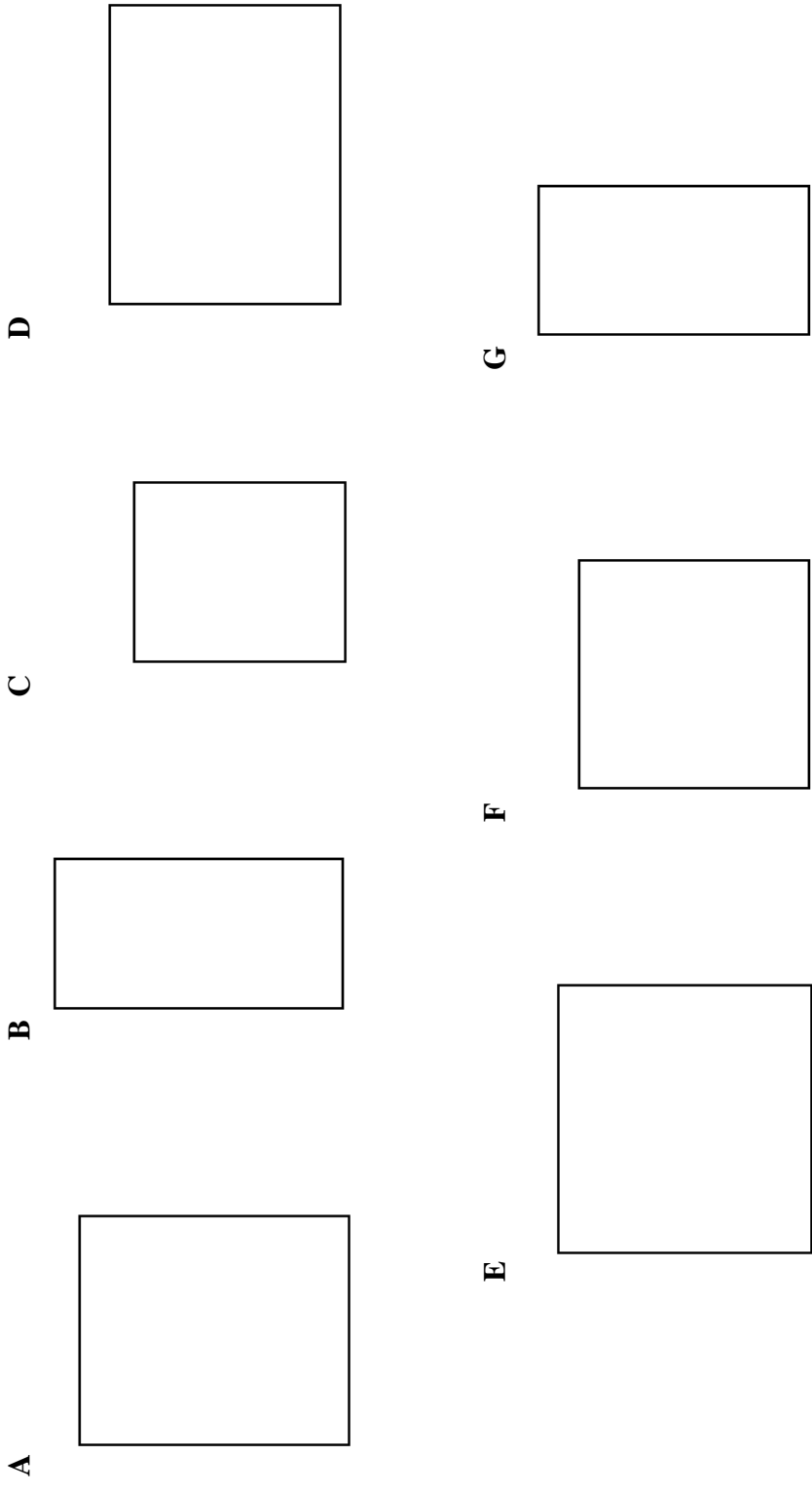


Figure 34. Cross-sections of keels near midships. Drawn at 1:10 scale without rabbets. **A**, Ronson Ship; **B**, Rose Hill wreck; **C**, Reader's Point vessel; **D**, Bermuda collier; **E**, *Betsy*; **F**, Otter Creek wreck; **G**, *Defence*.

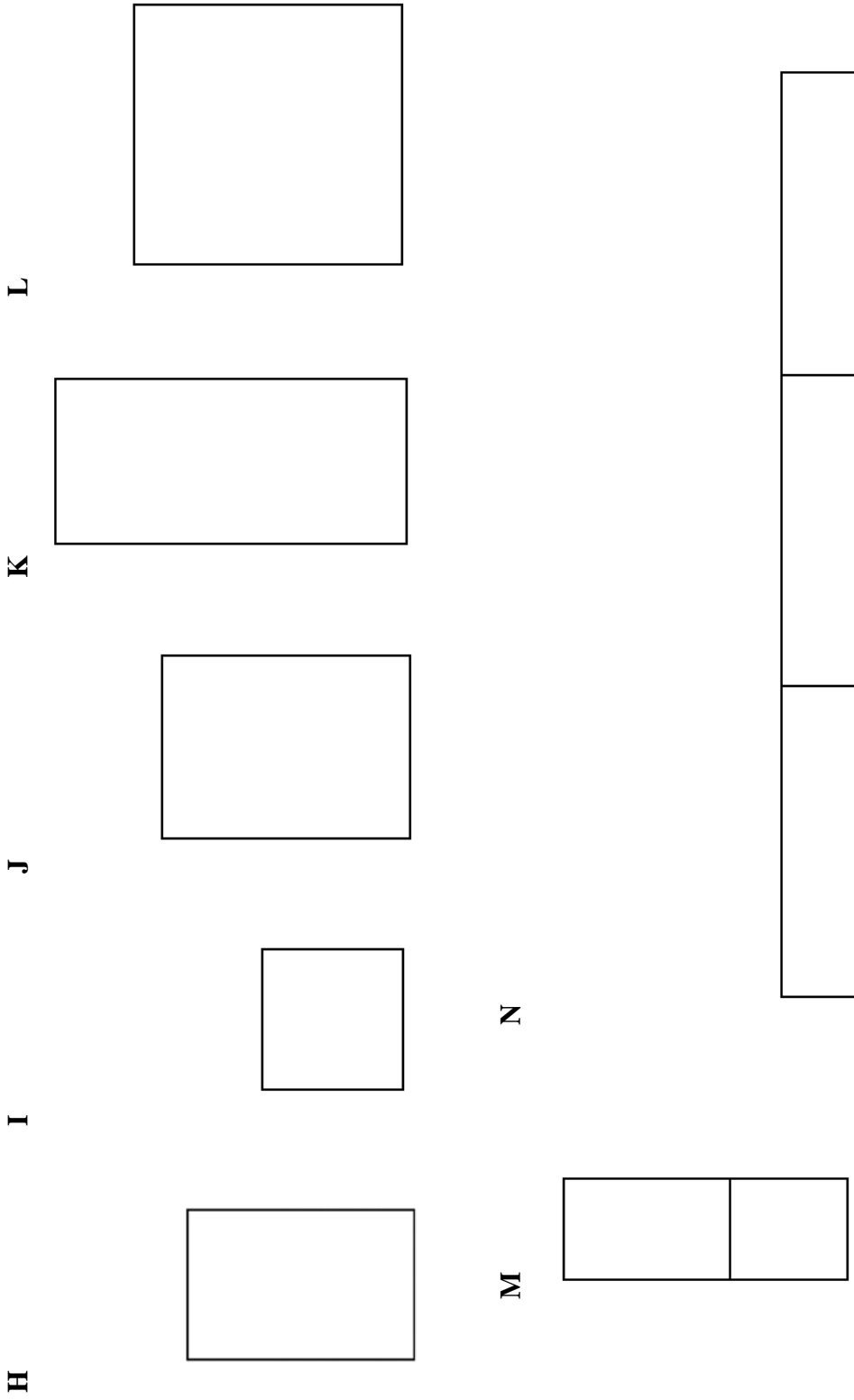


Figure 34 Continued. **H**, *Nancy*; **I**, Port Royal ship; **J**, *Boscawen*; **K**, Deadman's Island wreck; **L**, *Charon*; **M**, Town Point vessel; **N**, Brown's Ferry vessel.



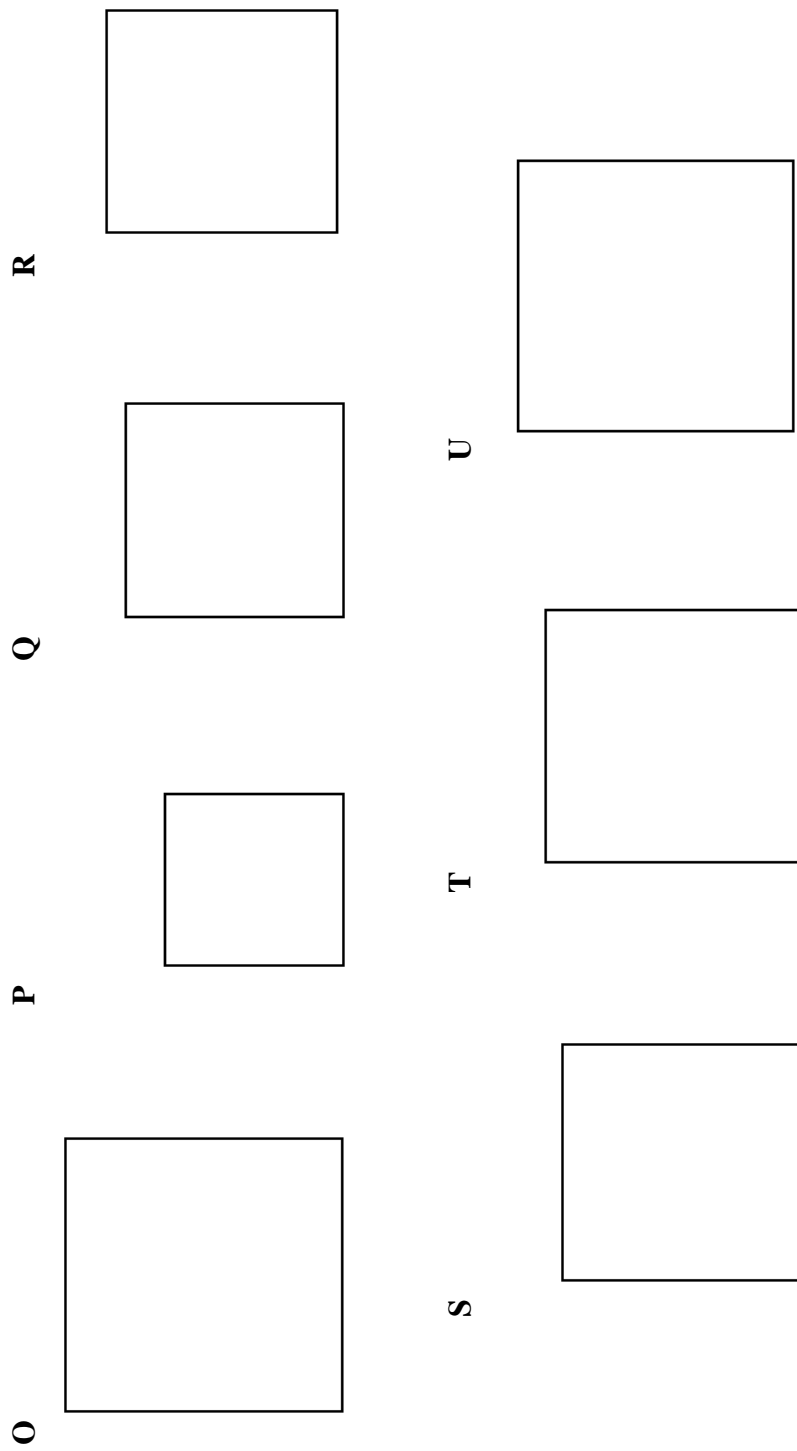


Figure 34 Continued. **O**, Sutherland's 500-ton ship; **P**, Murray's 70-ton merchant ship; **Q**, Murray's 100-ton ship; **R**, Murray's 200-ton ship; **S**, Murray's 300-ton ship; **T**, Murray's 400-ton ship; **U**, Murray's 600-ton ship.

been an issue in the New World, the builder of the vessel may have been trying to economize. According to Blaise Ollivier, horizontal scarfing along the length of the keel was typical for French ships because it prevented leakage through the scarf bolts. He observed this type of construction in English keelsons at Deptford, but did not mention seeing it on keels.<sup>7</sup> The Town Point ship is the only example in this study to show this kind of keel.

The Brown's Ferry vessel also had an unusual centerline arrangement, with three keel planks instead of a true keel. These planks were very wide but not thick, indicating the builder was not concerned with preventing lateral drift or helping the vessel cut through the water by means of a keel. The planks were not fastened together, but were secured only by the frames attached to them. This type of construction reflects the vessel's use in a river trading capacity, as it would have been a poor sailer in the open sea.

The remainder of the vessels had keels composed of one or more pieces and scarfed end-to-end. The late seventeenth-century Port Royal ship had a keel composed of at least two timbers and secured with a vertical scarf. Likewise, the stem of the Bermuda collier was attached to its keel by a vertical scarf. On the Rose Hill and Otter Creek wrecks, the stem was attached by a horizontal nibbed scarf. Fishplates or iron bands secured the stem/ keel joint in the *Betsy*, the Otter Creek ship, the *Nancy*, *Boscawen*, and the Deadman's Island wreck, suggesting this method could be used in both merchant vessels and naval craft.

Shape of the keel would have influenced a vessel's sailing ability, with a deeper keel helping to prevent lateral drift and a shallower keel allowing a vessel to access shoal waters. As shown in figure 34, the Deadman's Island vessel had the deepest keel, with its molded dimension twice its sided. This shape would have improved its sailing on the open sea and would fit with its possible use as a naval ship. The Rose Hill sloop had a keel comparable in shape to the keel of *Defence*; both were somewhat narrow for their size but deep. The Clydesdale Plantation vessel also had a deep keel for its size, improving its sailing qualities. *Boscawen* and the *Nancy* also had similar keels to each other, although the *Nancy's* was smaller. Both were deeper than they were wide, perhaps to improve sailing qualities in light of their shallow drafts. The keels of the two colliers were different from these vessels in that the sided dimension was greater than the molded dimension, a shape that would have allowed them to enter shallow areas but still provided heavy construction. None of the vessels appeared to follow Murray's guidelines for merchant vessel keels. The Otter Creek vessel had a square keel, but it was the size Murray suggested for a 300-ton ship. The keel of the Reader's Point sloop was slightly smaller than what Murray recommended for a ship of its size, fitting with its lighter construction relative to the other vessels.

Stem and stern remains were not well preserved, but typically consisted of a gripe, stem, and an apron in the bow and a knee with deadwood and the sternpost in the stern. The stern knee was composed of compass timber in at least two of the vessels. In the *Betsy*, the stem was built from two pieces of oak with two filler chocks; likewise, the sternpost was made of an inner and outer post with a filler piece between the posts. This

use of multiple smaller pieces of wood probably reflects a shortage of timber of the appropriate sizes. In addition, the apron and sternson were composed of multiple small transverse chocks rather than single timbers, again suggesting an attempt to use less expensive, more readily available pieces of wood. Not enough remained in the bow and stern of the Bermuda collier to see if these same techniques were used in its construction.

With inconsistent preservation and published information, it is difficult to determine whether some of the features were typical or not. There was clearly no evidence of a false keel on the Reader's Point vessel or the *Betsy*, although one would have been particularly useful on the latter as a collier. The Otter Creek vessel did have a false keel, as did the Port Royal ship and *Charon*, a feature to be expected on warships. For the rest of the craft, it is unclear whether a false keel would have been used or not. On top of the keel, three of the vessels had a piece of deadwood or rising wood that ran the entire length of the hull. In the Rose Hill sloop, this timber was slightly wider than the keel but much thinner, serving essentially as the attachment point for the garboard strake. The Bermuda collier also had a full-length deadwood timber, but it was significantly larger, molded only slightly less than the keel and wider in some places. This timber would have strengthened the already heavily built backbone of the collier and allowed it to take the ground better. The *Betsy* had deadwood in the bow and stern, but it was unclear if it extended the full length of the vessel as in the Bermuda collier. The final vessel with a rising wood was *Charon*, but its deadwood timber was smaller than that of the Bermuda collier, despite the warship being much larger. The Bermuda

collier's deadwood was notched to receive the floors, whereas the Rose Hill wreck's was not. The keel of *Defence* was also notched for the floors. It is unclear whether this feature was present in the other vessels, but it appears that notching was not always used. Similarly, false keels and full-length deadwood timbers seem to have been optional rather than consistently used.

### **Framing**

The framing patterns on the archaeological examples present the best clue to the possible design methods used on the hulls. The frames may also reflect the vessel's trade and the availability of timber, as well as providing shortcuts for the builder to save costs. All of the vessels had double frames that were placed square to the keel throughout the run of the hull, whereas the extreme ends showed a mixture of techniques. The framing was almost entirely of white oak, with live oak used on the Brown's Ferry vessel and the Clydesdale Plantation vessel, and some beech used on the Rose Hill wreck.

#### *Framing in the Run of the Hull*

Frames throughout the run of the hull were set perpendicularly to the keel. Dimensions of the timbers typically matched the overall construction of the vessel. For example, the heavily built Rose Hill sloop had large floor and futtock timbers; the frames were also closely spaced to form a continuous wall of timber. By contrast, the Ronson ship had lighter frames, even though its tonnage was over twice as much as the Rose Hill ship. In this case, the lighter construction would have helped the Ronson ship

sail better and would have reduced building costs, yet still retain sufficient strength to transport the cargo. The Otter Creek wreck, like the Rose Hill vessel, had heavy frames for its size, although the dimensions varied significantly between timbers and the frames were unevenly spaced. The two colliers had large timbers as well, but the frames were closely spaced on these vessels to support the heavy loads of coal they carried. Framing on the warships was not as regular as expected, but this apparent lack of standardization may be the result of deterioration, or, in the case of *Boscawen*, hasty construction.

Figure 35 shows the framing patterns as found on site for several of the shipwrecks. The Phips wreck, the earliest of the merchant ships, was poorly preserved but had futtocks without any horizontal joinery, separated by gaps of varying size. These spaces and the lack of joinery suggest that the floors were installed first, with futtocks added as the hull was planked. The futtocks also clearly showed a lack of standardization, as the dimensions varied greatly and some of the timbers still had cambium and bark. The frames in the Rose Hill wreck also did not have lateral fasteners, so they too must have been installed as the hull was planked. Two articulated frames were found on the Terence Bay vessel, but as the rest were disarticulated, these two probably did not serve as mold frames. In the Clydesdale Plantation vessel, floors with futtocks above them alternated with half frames; top timbers were placed separately between the floors and half frames. As none of these timbers were fastened together, they all appear to have been installed as the planking went up. The Bermuda collier also had only disarticulated frames, with some space between the floors and first futtocks. Vertical components were joined at the heads and heels by diagonal scarfs, so that no

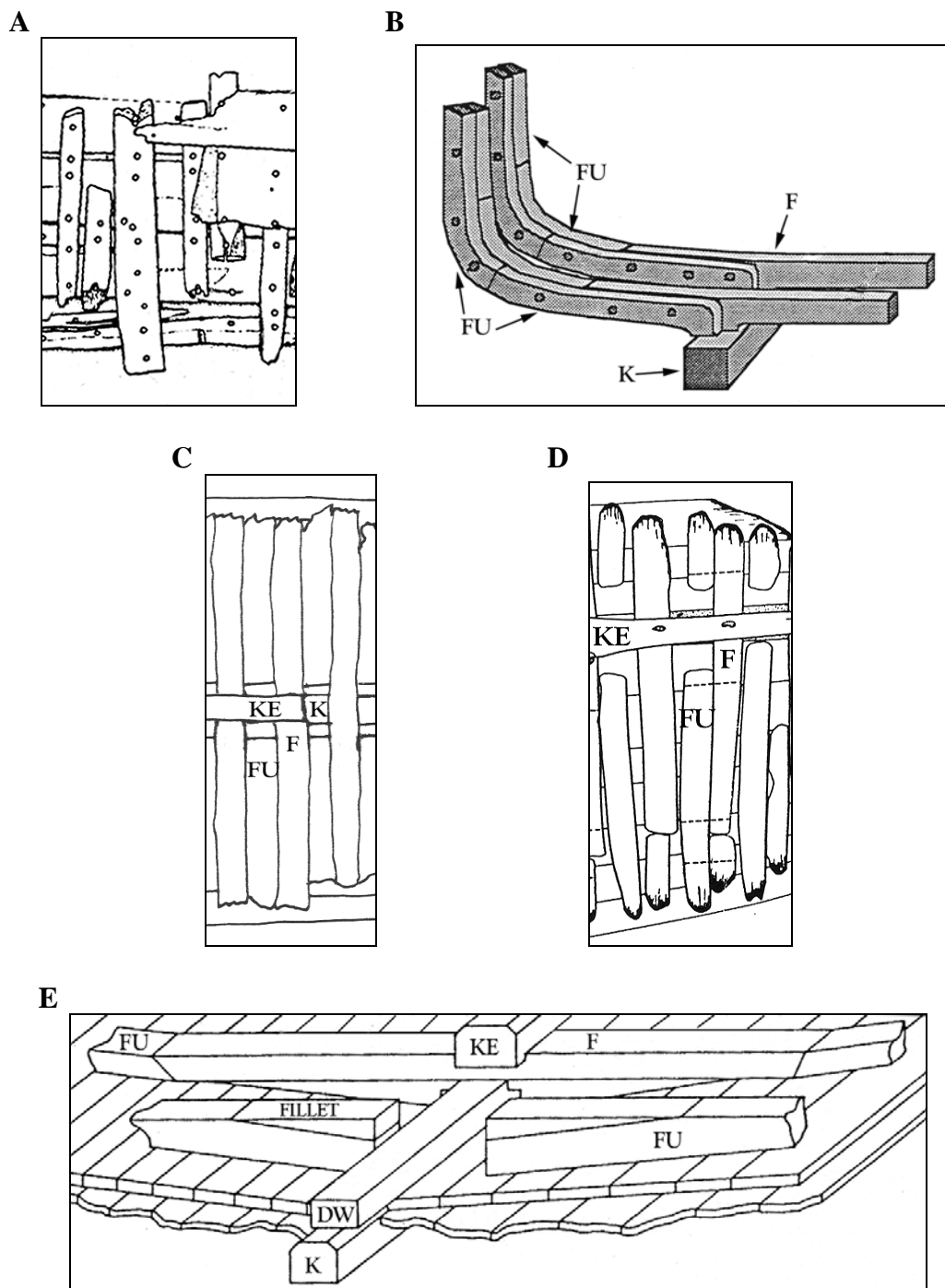


Figure 35. Framing patterns. Not to scale. K=keel, DW=deadwood, KE=keelson, F=floor, FU=futtock, and HF=half-frame. **A**, Phips wreck (After Waddell 1997, 80); **B**, Ronson ship (After Riess 1987, 25); **C**, Rose Hill wreck (After Wilde-Ramsing et al. 1992, 38); **D**, Reader's Point vessel (After Cook, 1997, 106); **E**, Bermuda collier (After Krivor 1998, 18).

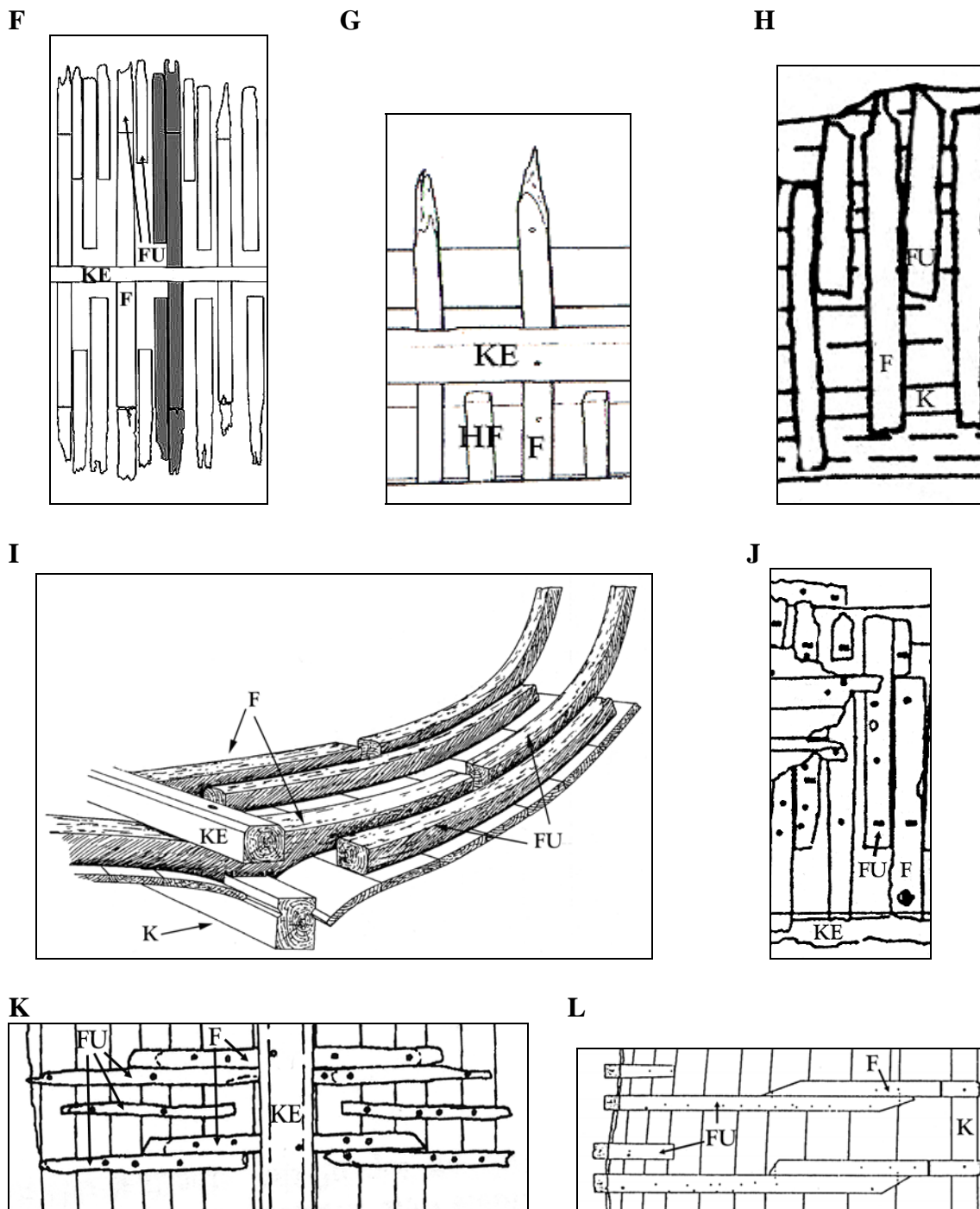


Figure 35. Continued. **F**, The *Nancy* (After Sabick 2004, 94); **G**, Clydesdale Plantation vessel (After Cook 1997, 116); **H**, Port Royal ship (After Clifford 1991, 82); **I**, *Boscawen* (After Crisman 1985, 362); **J**, Deadman's Island wreck (After Smith 1990, 114); **K**, Brown's Ferry vessel (After Albright and Steffy 1979, 130); **L**, Town Point wreck (After Morris and Franklin 1995, 23).



gap was present. In addition, bottom and top fillets were used to make the timbers thicker near the centerline, reducing the size of required compass timber pieces.

The Port Royal warship and the Town Point vessel also had only disarticulated frames. For all of these vessels lacking articulated frames, the complete frames could not have been assembled prior to installing on the keel, but would have been placed piece by piece as the hull was planked. This method could have been similar to what Sutherland described, in which mold frames were designed on a draft or mold loft and then their floors placed first, using ribbands to fair the intermediate timbers. After all the floors were installed, the second and fourth futtocks (if used) could be joined to the floors of the master frames, but the first and third futtocks could not be installed until the planking was attached. On the other hand, it is possible no mold frames were used and timbers were added by eye and shaped using ribbands. This method of using only disarticulated frames could save time and money during construction, as the timbers did not need to be carefully shaped to fit closely together. Pieces could be left closer to their original shapes, requiring smaller compass timbers to meet the necessary size requirements.

The rest of the vessels had at least some articulated frames, assumed to serve as mold frames. On the Ronson ship, all of the frames, except for those farthest forward, were horizontally fastened together and did not have gaps between the heads and heels of the components. The floors were compass timbers cut from crotches of trees, with the heavier arm alternating sides through the length of the hull. With the space between frames being less than the lengths of the treenail fasteners, it appears that each frame was fully assembled prior to being placed on the keel. In this case, each frame would

have been designed on the draft using sweeps or molds and then constructed at full scale on a mold loft. The slight variations between the frames may have been accidental, or may have resulted from shifting the frames slightly to produce a fairer curve. The Reader's Point vessel had nine articulated mold frames with horizontal fastenings. These frames would have been designed and installed first, with the intermediate frames added as the planking was installed. The floors of the mold frames could have been placed first, as described by Sutherland, or the entire frame assembled prior to erecting it on the keel. These frames did not have any spaces between the heads and heels of timbers. Frames on the Otter Creek wreck were fitted with no space between the floors and associated first futtocks, but it could not be determined if they were laterally fastened. With varying space between frames, it is clear each floor/ futtock set was considered as a unit and may have been installed as such.

The *Betsy* had seven articulated master frames, unlike the Bermuda collier. Similar to the other collier, however, some of the *Betsy's* frames were built using top and bottom fillets to increase timber sizes. Individual vertical timbers were scarfed together with no gaps, with chocks used in the joint between the heads and heels. On *Defence*, mold frames were placed evenly along the keel, but half frames and futtocks were used as intermediate frames. Some of these timbers still had bark on them, suggesting either hasty construction or an attempt to reduce costs. The *Nancy* had articulated frames at every third frame, with intermediate frames a few filler futtocks between them. Of the warships, the Deadman's Island wreck and *Boscawen* were the only ones that definitely had mold frames. Vertical components were joined together, often with treenails.

*Boscawen's* mold frames were placed in every fourth frame position. The Brown's Ferry vessel had five mold frames along its length.

While attempts have been made to delineate a pattern of framing evolution over the eighteenth century,<sup>8</sup> these examples do not suggest any obvious pattern. Most of the earliest vessels did have only disarticulated frames, but the Ronson ship and Brown's Ferry vessel from the same period had articulated frames. Vessels from the mid to late part of the century generally had at least some mold frames, with disarticulated frames in between. Frames over the entire period were almost always double, with a floor and associated futtock side-by-side. Only the Clydesdale Plantation vessel had a pattern close to single frames, with floors and futtocks alternating with half-frames, and this vessel was built late in the period. While there may have been some type of transition from disarticulated to articulated frames during the period, the most common method appears to have been the use of regularly spaced mold frames with intermediate filler frames. Double frames appear to have been the standard throughout the period. Spacing between frames generally was small, but varied widely. The earlier vessels appear to have had less space between frames than later vessels.

Most of the vessels exhibited some degree of offset between the heels of the first futtocks and the centerline. Morris et al. have interpreted the changes in offset between vessels as an example of framing evolution, with the distance from the centerline diminishing over the eighteenth century until the futtocks butt together under the keelson.<sup>9</sup> In the Port Royal ship, the earliest vessel in the present study, the first futtocks did have the largest offset from the centerline, but in all of the rest of the vessels the

offset appears to vary without a clear trend. The Rose Hill ship, one of the next earliest vessels, had an offset of 11 in (27.9 cm), while the Ronson ship of about the same period or perhaps earlier had no offset at all, with the first futtocks butting together under the keelson. The *Betsy* from 1772 had an offset almost as large as that of the Rose Hill ship, but less than the Bermuda collier, the Reader's Point ship, and the Otter Creek wreck, all from the 1760s and 1770s. While it is possible that the excavation of more vessels will confirm a trend, in these examples it appears that the amount of offset was individually determined.

In addition to providing clues to ship design, the frames indicate the quality of timber used for construction, whether this choice was based on expense or availability. Using frames of smaller scantling, spacing frames farther apart, and canting timbers in the extreme ends were all ways to reduce the costs of timber. Breaking up frames into smaller components was another way to save materials, as a wider range of timber shapes could be employed. The use of chocks in the scarf joints between timbers, as on the *Betsy*, would have helped minimize the size of individual pieces. Top and bottom fillets, as seen on both the colliers, allowed smaller pieces of compass timber to be used; these fillets filled in the gaps to give the planking a smooth run. As compass timber was the most expensive wood for construction, reducing the needed size produced a large cost advantage. Alternatively, if a timber shortage reduced availability, these techniques would allow the shipwright to make use of a limited supply. As chocks in the joints were used on *Charon*, it appears that some of these methods were applied to warships as well.

The use of chocks and fillets occurred almost exclusively on the British shipwrecks, suggesting a shortage of suitable compass timber for frames was becoming an issue.

### *Framing in the Bow and Stern*

The extreme ends of the vessel were the hardest to frame because of the severe curvature of the hull and planking. Two main methods for dealing with this problem are seen in the archaeological examples: either 1) square frames were used to the very ends, with vertical hawse pieces running parallel to the keel supporting the planking near the posts, or 2) the frames were canted or angled to remain flush with the planking. The former method required a great bevel for the timbers to let the planking run smoothly, using an excessive amount of timber to avoid the sapwood. In some cases, the shipwright developed a variation of one of these techniques in an attempt to improve them. Unfortunately, in many of the shipwrecks, the frames in the extreme bow and stern did not survive or could not be examined, limiting the amount of available evidence.

The Ronson ship, with its excellent preservation in the bow, had the most obvious example of square frames (fig. 36). To fit the complex curves of the bow, these frames were beveled to a diamond shape, making them significantly weaker than if they were square. To support the very front of the ship, six hawse pieces were positioned on each side of the stem.<sup>10</sup> The Rose Hill and Deadman's Island sloops appeared to have square frames as well, based on their site plans, but poor preservation made this difficult to determine. The same was true for the Port Royal ship, but again, the preservation was quite limited. Frames were also square on the Town Point vessel. The Terence Bay

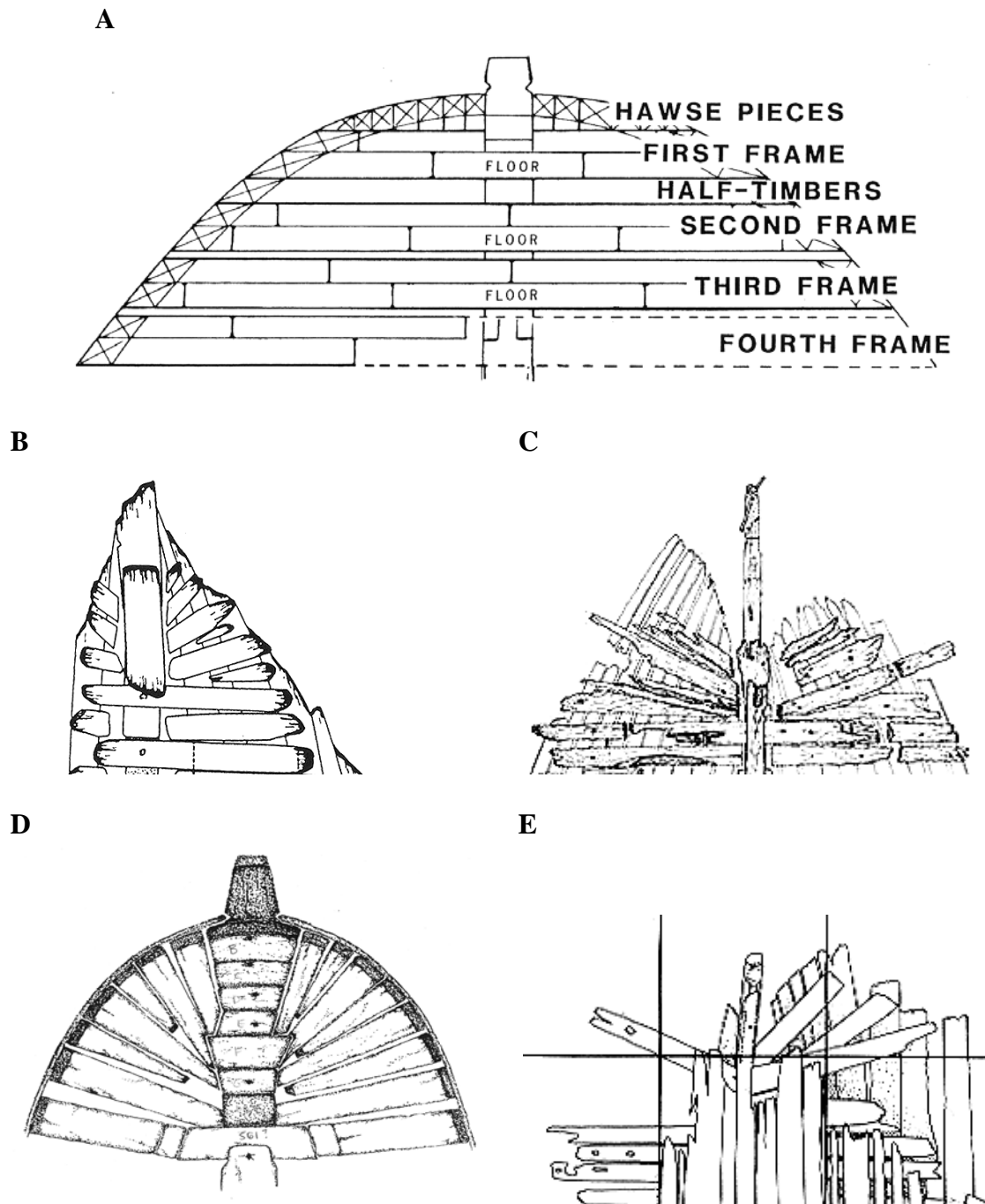


Figure 36. Patterns of bow framing. **A**, Square frames on the Ronson ship (From Rosloff 1986, 52); **B**, Cant frames on the Reader's Point vessel (From Cook 1997, 107); **C**, Cant frames on the *Nancy* (From Sabick 2004, 86); **D**, Cant frames and apron chocks on the *Betsy* (From Morris 1991, 97); **E**, Cant frames on *Boscawen* (From drawing by K. Crisman).

wreck exhibited a version of square frames in which the stern frames were raked forward, away from the sternpost (see fig. 17). This positioning might be similar to Sutherland's description of raking the frames to keep them evenly spaced at the heads and heels.

The Reader's Point vessel, the *Betsy*, and the *Nancy* all had obviously canted frames (fig. 36). These timbers took the form of half-frames that were fastened directly to the planking after it was installed, but were not attached to each other or the centerline structure. In the Reader's Point vessel and the *Nancy*, the cant frames were only apparent in the bow, whereas in the *Betsy* they were clearly used in both bow and stern. In all three vessels some of the timbers came to a wedged point before touching the apron, while the other frames butted against it. The ends of the Bermuda collier were not well enough preserved to determine the frame type. The Cornwallis Cave ship appeared to have canted frames as well, but hawse pieces were also used. A few canted half-frames were used in the bow and stern of *Boscawen*. The Brown's Ferry vessel, with its minimal framing, had a single canted half-frame on each side of the stem, along with a single longitudinal, vertical frame.

From these examples, it is apparent that both framing styles were used on warships, small craft, and among the larger merchant vessels. There was also no clear differentiation based on nationality. The first clear examples of cant framing come from *Boscawen* and the Reader's Point vessel, dating to just after the middle of the century. The earliest craft, the Ronson ship and Rose Hill sloop, had square frames, but this type continued to be used later in the period as evidenced by the Deadman's Island sloop and

Town Point vessel from the last quarter of the eighteenth century. The examples do suggest that cant frames were a later development than square frames, although from these data it is impossible to define the transitions to the degree that Morris et al. do in their paper.

### **Keelsons and Mast Steps**

The keelson was the next major timber to be installed, providing extra longitudinal support to the hull. Two principal types of timber were used in the shipwrecks under study – oak (usually white oak) and pine. Cypress was used on one case, on the Brown's Ferry vessel. Keelsons were either cut from a single piece or composed of multiple pieces, usually scarfed together end-to-end. The Reader's Point vessel's white oak keelson was cut from a single timber, requiring a large, straight piece of wood. The keelson of the *Betsy*, by contrast, was made from two long components, with one of oak overlaying one of pine. This arrangement was similar to the keel of the Town Point vessel and may have been used if large enough individual pieces were not available or were too expensive. The oak cap would have provided the strength needed to support deck stanchions and the mast steps. Ollivier observed keelsons of this type on the ships at the Royal Dockyard of Deptford. The Otter Creek vessel had a more traditional multi-component keelson, with two pieces attached at their ends; *Charon* had a similar keelson but of five timbers.

Keelsons for these vessels were generally large in dimension and often larger than the keel amidships. In the case of the Rose Hill vessel, *Defence*, *Boscawen*, and the



Deadman's Island wreck, the keelson was wider than the keel but not as thick. The keelsons of the Reader's Point sloop, the Bermuda collier, the *Betsy*, and the Otter Creek vessel were at least as large as the keel, if not larger, at midships. Sutherland, in his scantlings list for a 500-ton ship, recommended the keelson be 1 in. (2.5 cm) wider than the keel but the same in thickness.<sup>11</sup> Murray, writing 50 years later, suggested the keelson should be molded the same as the keel, but sided slightly less – the opposite of Sutherland.<sup>12</sup> As none of the vessels had a keelson that was sided less than its keel, it appears that Murray's advice was not widely followed. Rather, keelsons were generally at least as large as the keel in the sided dimension and sometimes in the molded as well.

The keelsons were typically notched to fit over the frames and were secured at least through some of the frames and into the keel with bolts. The most common fastening pattern was to place the bolts in every other frame, as found on the Otter Creek wreck, *Boscawen*, and *Charon*. Iron bolts were used on both the Otter Creek wreck and *Boscawen*. On the heavily constructed Bermuda collier, the keelson was bolted to every floor with copper drift pins. The keelson of the Reader's Point vessel was fastened to every floor forward of the mast step and every third floor aft. On the small Clydesdale Plantation vessel, the keelson was bolted only to every third or fourth frames. In general, the more lightly built ships seem to have had less points of attachment than the heavier craft. The Bermuda collier, the Otter Creek vessel, the *Nancy*, and the Deadman's Island wreck had keelsons that were notched to fit over the floors; excavation reports on the other vessels did not specify whether their keelsons were notched or not.

Interestingly, on two of the vessels, the keelson was stopped short of the deadwood in the stern, leaving a gap of at least a few feet. This type of keelson was found on the Rose Hill ship, potentially dating to the first half of the eighteenth century, and on *Boscawen* from 1759. There is no clear reason for shortening the timber, especially considering it would have provided a stronger backbone for the vessel if it were full length, and no references have been found in the contemporary literature. The answer may lie in the fact that the Rose Hill vessel was a merchant ship and *Boscawen* was constructed in haste – perhaps the shipwrights used whatever timber was available, choosing to overlook the fact that the piece was too short. More examples might help clarify this puzzling feature.

Another important component of the keelson was the mast steps. As shown in figure 37, different configurations for the steps were used on these shipwrecks. The simplest type of step was a mortise cut directly into the keelson. This type was seen on the Reader's Point vessel, *Defence*, the Otter Creek wreck, the foremast step of the *Nancy*, and the Brown's Ferry vessel. Inherent with this type of mortise was a weakening of the keelson, a central timber to the backbone of a ship. In the Reader's Point sloop, a longitudinal crack had formed at some point in the keelson and was repaired by means of a buttress timber and two sister keelsons placed alongside the main keelson. Preventive measures had been taken on *Defence* by the placement of oak chocks on both sides of the keelson mortises; these chocks were bolted to the nearby floors. The mortises on the Otter Creek wreck did not show signs of damage, but were

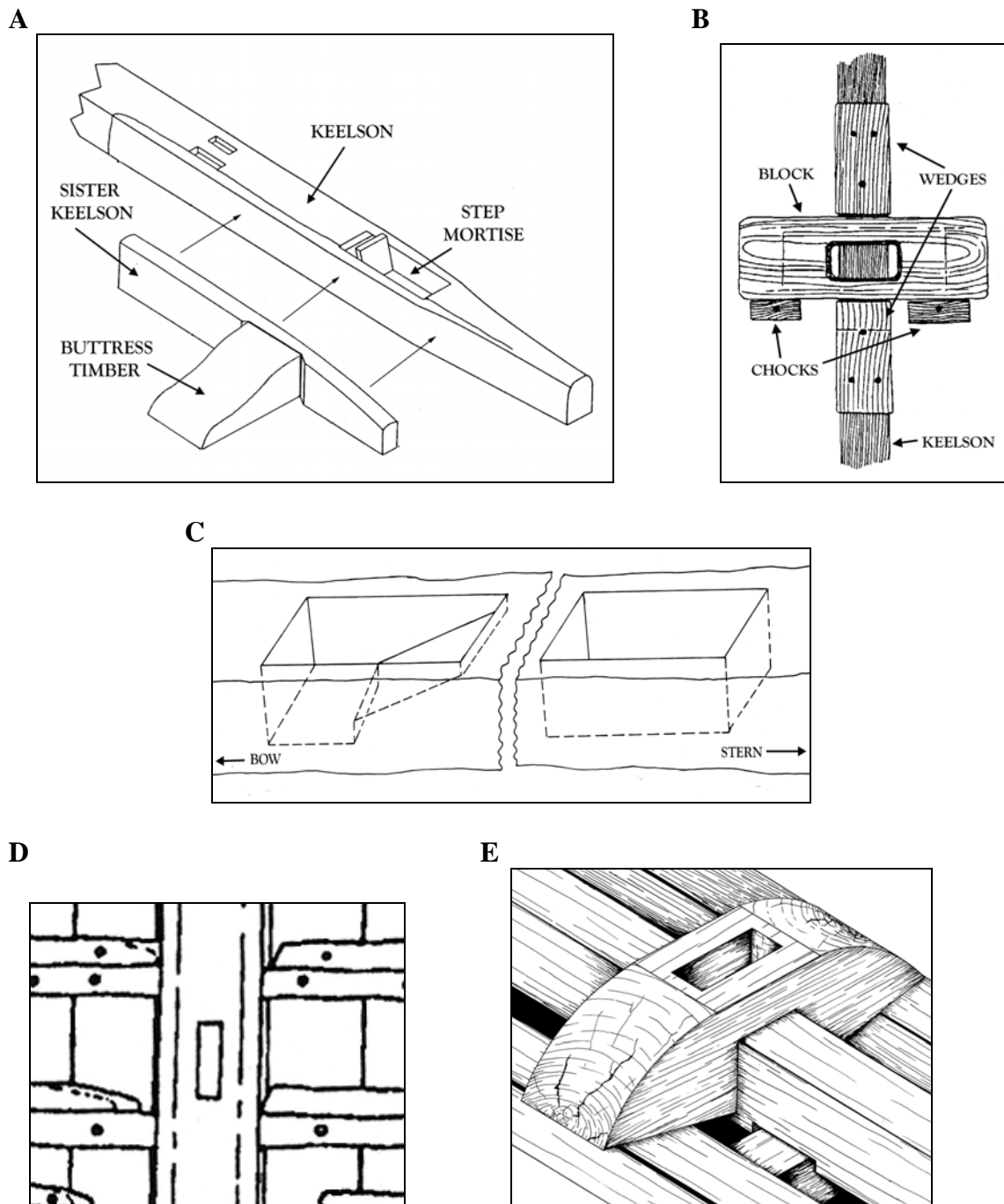


Figure 37. Mast steps. Not to scale. **A**, Mast step of the Reader's Point vessel, showing the crack in the keelson and repair timbers (After Cook 1997, 112); **B**, Transverse or saddle type step of *Boscawen* (After Crisman 1985, 366); **C**, Fore and main steps of the Otter Creek wreck (After Jackson 1991, 85); **D**, Main step of the Brown's Ferry vessel (After Albright and Steffy 1979, 130); **E**, Saddle type main step of the *Nancy* (From Sabick 2004, 117).

oddly placed directly over the keelson scarfs, in what would seem to be an already weak part of the structure.

Rather than cutting the mortise directly into the keelson, in some of the vessels a smaller longitudinal timber was fastened on top of the keelson and the mortise was cut into it instead. The steps on the *Betsy* consisted of longitudinally positioned timbers atop the keelson, with the mortises being cut through to the top of the main keelson component. This method was also used on the Ronson ship for the original foremast step. The timber had cracked at some point, however, resulting in a second mast step being installed on top of it. Perhaps to prevent another similar split along the grain of the wood, the new step was placed transversely across the keelson and secured with iron fastenings. Athwartships or “saddle type” steps were seen also on the *Nancy* and *Boscawen*. *Boscawen*'s step was held securely in place by fore and aft wedges of wood and secured with chocks to prevent it from twisting on the keelson. The mortise was cut entirely through the block so that the heel of the mast rested on the keelson. The mainmast step on the *Nancy* was a semicircular block of wood with the mortise cut partway through the timber. It is unclear how the block was originally fastened to the hull, but wedges like those that attached *Boscawen*'s step were not used.

Intuitively it would seem that the transversely placed saddle type mast step would come as a later development, being stronger than the longitudinal mast step because the wood grain ran perpendicularly to the main forces placed on the mast. In addition, saddle steps could be moved and repositioned if the rake or location of the mast needed adjustment. If mast steps developed along the lines of increasing complexity, the

least advanced type should be the simple mortise cut directly into the keelson. Looking at the archaeological examples, however, it is clear from the Otter Creek wreck and *Defence* that this method was still in use near the last quarter of the eighteenth century. The first appearance of the transverse step occurred on the Ronson ship with the replacement step; depending on the age of the vessel, this repair probably occurred towards the middle of the century. The use of this type of step as a repair, as well as its use on the *Nancy* in the last quarter of the century, lends support to the idea that it came into use later than the longitudinal steps.

### **External and Internal Planking**

Planking was typically attached to the frames with wooden treenails, either wedged or unwedged, and iron nails. Treenails were the main type of fastener utilized on these vessels; however, the Clydesdale Plantation and Town Point wrecks used iron nails almost exclusively. This deviation from the common pattern may indicate that craftsmen without formal training in shipbuilding constructed these vessels; alternatively, the choice could have been made to save expense or time, as large auger-drilled holes were required for treenails. The type of timber employed for the planking was white oak in most of the vessels, although red oak and pine were also used.

External and ceiling planking thickness were fairly consistent, averaging 1.5 to 3 in (3.8 to 7.6 cm) for the larger vessels and 1.1 to 1.25 in (2.8 to 3.2 cm) for the riverine craft. Murray suggested in his treatise that planking should be 3 in (7.6 cm) thick on a 100-ton merchant ship, 3.5 in (8.9 cm) thick on a 200-ton merchantman, and 4 in (10.2

cm) thick on larger vessels.<sup>13</sup> From this table of dimensions, it appears that he recommended the same thickness for both the inner and outer planking. Sutherland preferred slightly thinner planking, suggesting a thickness of 2.5 in (6.2 cm) for a 250-ton vessel.<sup>14</sup> In the archaeological examples, the 100-ton merchant vessels all had inner and outer planking of about 2 in (5.1 cm), as did *Boscawen*. The 100-ton Deadman's Island wreck had thinner planking for its size; at 1.5 in (3.8 cm), this planking was closer to the dimensions used on the much smaller river traders, making it unusual for a naval vessel. This thin planking, along with the relatively small scantlings of the keelson and frames, would have made the vessel lighter and faster. The 260-ton Ronson ship also had light planking for its size, measuring only 2 in (5.1 cm), the same as vessels less than half its tonnage. As in the Deadman's Island wreck, this smaller dimension matched the ship's lighter scantlings for other timbers. Even the merchant vessels with the thickest planking, the two colliers, still had thinner strakes than what Murray recommended for their size. Thick planking would have benefited the colliers in supporting the heavy cargoes they were designed to carry. The ceiling planking was the same thickness as the external planking in most of the shipwrecks, except for the Phips wreck, Rose Hill vessel, and the *Nancy*, where it was thinner.

On the Phips wreck, three small filler planks were joined end-to-end to fill a gap between two of the strakes. This feature appeared to be original, suggesting it was within the tolerable range of error to the shipwright. A few of the vessels showed indications of how their planking was bent to fit the curves. On the Terence Bay vessel, the outer planking had been charred in a fire to make it easier to shape. Ceiling strakes on the

Otter Creek wreck were adzed across the grain to help with bending; the same type of cutting was used on the outer planking of the Clydesdale Plantation vessel.

### **Hull Protection: Caulking and Sheathing**

It was standard practice to caulk the seams of the outer hull planking on wooden ships to prevent leakage. Two of the vessels, however, had caulking applied to the ceiling in addition to the external planks. Oakum caulking was used on the Ronson ship to protect its cargo from water damage, leading excavators to suggest the main cargo may have been tobacco. The ceiling of the Clydesdale Plantation vessel, which may have carried rice, was caulked also. These vessels were the only two examples with caulked internal planks, suggesting this added precaution was only taken if the primary cargo could be damaged by moisture.

The majority of the vessels also had some type of coating and wood sheathing to protect hulls from shipworm. Pitch or pine tar was usually combined with animal hair or felt and layered over the outside of the hull to prevent worms from penetrating the hull. Some type of wood or metal sheathing was then placed over the anti-worm coating to protect it and keep it in place.

Wood sheathing or “sacrificial planking” was found on 6 of the 10 major merchant vessels and on the Cornwallis Cave wreck, but not on the other warships or riverine craft. Sheathing was typically attached to the outer planking with small iron tacks or nails. The most common wood type was pine, although white oak was used on the keel only of the Reader’s Point vessel. Oak may have been chosen for this vessel

because the keel was maple, potentially more prone to rot than a typical oak keel. The only other vessel reported to have sheathing on the keel was the *Betsy*; the ship's posts and rudders was sheathed also. Sheathing varied widely in thickness, ranging from 0.25 in (0.6 cm) on the Reader's Point vessel to 1.25 in (3.2 cm) on the *Betsy*. The thickest sheathing was on the two colliers and the Otter Creek wreck, all heavily built in their other scantlings as well. As most of the vessels had sheathing, it appears to be standard on merchant ships of the period, especially for those in the transatlantic and West Indies trades. No mention was made of sheathing in the excavation reports of the Phips wreck, the Terence Bay vessel, or *Defence*; as these three were all built and operated in cold New England waters, it seems likely they would not have needed it.

Copper sheathing did not become common on merchant vessels until the nineteenth century, so it is not surprising to find only wood sheathing on these vessels. Lead strips or patches were found in association with the Ronson ship, the Otter Creek wreck, and the Deadman's Island vessel; these lead pieces were probably used as patches to cover leaks or damaged areas. Remains of copper sheathing were found on *Charon*, including the sides of the keel and the garboard strakes; this warship was one of the first to be coppered. Concretions found near the Cornwallis Cave wreck suggest it may have been sheathed with copper in addition to wood.

### **Ships' Equipment**

Every vessel carried a variety of equipment for tasks such as steering, raising and lowering the anchors, and keeping the inside of the hull dry. Much of this machinery is

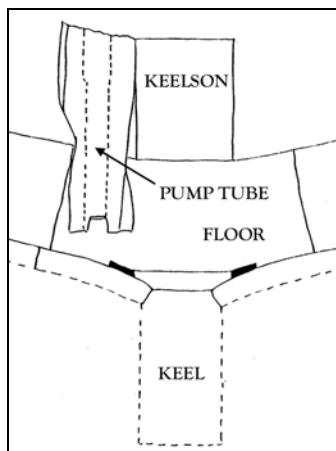


not preserved in the archaeological record, however, because it was either located too high in the hull to be preserved or often it was salvaged around the time the vessel was lost. In these shipwrecks, remaining equipment includes parts of bilge pumps, capstans, and cookstoves. Bilge pumps, essential for removing water from the bilges, were the most common item found; these would have been necessary for any vessel sailing beyond protected waters. Two examples of cookstoves were found, as well as one jeer capstan, used to raise the anchors.

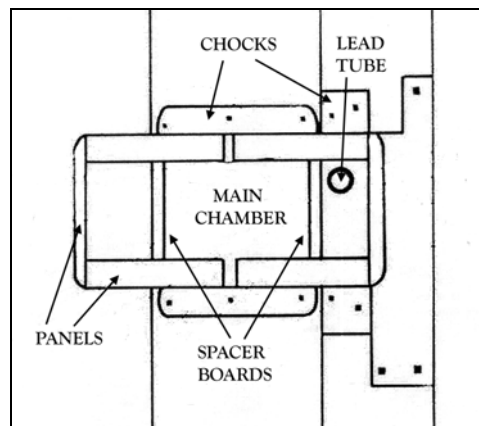
### *Bilge Pumps*

The limited preservation of most of the pumps makes any direct comparison difficult, but they do show pump configurations used during the period.<sup>15</sup> Pump fragments were found on the Rose Hill wreck, the Ronson ship, the Bermuda collier, the *Betsy*, *Defence*, the Otter Creek wreck, *Charon*, and the Town Point vessel (fig. 38). The merchant vessels would have carried suction or common pumps, because chain pumps, found on naval vessels, were more expensive and required more maintenance. The Rose Hill vessel's pump was a suction pump located aft of midships. The remaining pump fragment consisted of a bored square block with a narrow hole running its length through which the water was moved. The Ronson ship probably had more than one pump, based on its size, but only part of one was recovered. Located near the mainmast, the wood pump tube had a hole bored through it that was two and half times larger in diameter than the hole of the Rose Hill wreck's pump. Apparently the pump was still considered usable, even though the hole was off-center.

A



B



C

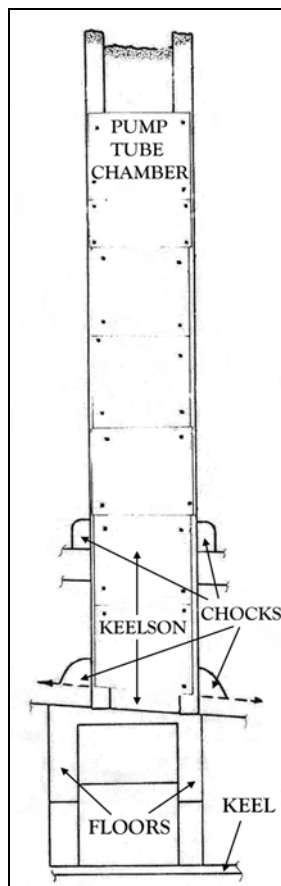


Figure 38. Suction bilge pumps. Not to scale. **A**, Starboard pump tube on the Rose Hill wreck (Wilde-Ramsing et al. 1992, 48); **B**, Top view of pump on the *Betsy* (After Morris 1991, 110); **C**, Side view of the *Betsy's* pump (After Morris 1991, 109).

The Bermuda collier also had a suction pump, as evidenced by the wooden lower valve found at the site. This piece was disarticulated from the hull, so the location of the pump within the vessel could not be determined. The circular wooden lower valve, when paired with a leather flap, would have fitted inside the pump tube and prevented water from leaking back out the bottom of the tube. On the other collier, the *Betsy*, the starboard and port pump boxes were preserved. This structure, composed of several boards and chocks, was built onto the keelson and stood separately from the masts. These chambers protected the tubes and the collection area for the water. The pump tubes appear to have been lead, unlike the wood tubes seen on the earlier Ronson ship and Rose Hill wreck.

The pump remains on *Defence* also consisted of the pump box, located forward of the mainmast. The box was built in conjunction with the privateer's shotlocker using heavy boards. As with the *Betsy*, tubes were placed inside the box to carry the water. Evidence of the pumps on the Otter Creek wreck included two holes cut through the ceiling and part of a leather pump boot. The holes were cut on both sides of the mainmast step; one was octagonal, suggesting it would fit a tube of this shape. A wooden box probably surrounded the tubes, as seen on *Defence* and the *Betsy*.

As a large warship, *Charon* had both suction and chain pumps. Two suction pumps were located aft of the mainmast on both sides of the keelson. As in the Otter Creek vessel, the tubes were octagonal on the outside. The circular center hole was closer in diameter to the narrow hole of the Rose Hill wreck than that of the Ronson ship. The two chain pumps were located aft of the suction pumps and each consisted of a

wooden rectangular box surrounding a spinning drum and an ascent tube. The metal chain had cylindrical discs that carried the water up to deck level as the chain was raised through the ascent tube.

The only riverine vessel with evidence for a pump was the Town Point wreck. The remains consisted of a wooden pump well collar found aft of the mast step. Even though none of the structure was preserved, the collar indicates that a pump was used on the vessel. As it was found off Florida and must have crossed the open water on short voyages, a pump would have been a necessary addition to the ship's equipment.

### *Cookstoves*

Two examples of cookstoves have been found on eighteenth-century shipwrecks: the Rose Hill sloop and *Defence* (fig. 39). A cookstove was an essential feature for vessels intending to spend prolonged periods away from the shore. Coastal or riverine traders could potentially come ashore for cooking, but vessels making longer trading voyages, or in the case of *Defence*, involved in privateering, needed a way to prepare food while at sea. Most of the ships examined here likely had some type of cookstove, but this item may have been salvaged or not preserved on the other wrecks. A riverine trader like the Brown's Ferry vessel probably would not have needed one.

The cookstove on *Defence* was a large, carefully built structure. It was made of bricks, placed on a heavy oak platform, and fitted with a copper cauldron for cooking. This stove would have been a permanent fixture on the vessel, suggesting the owner must have expected long voyages at sea, making the expense a necessary one. By

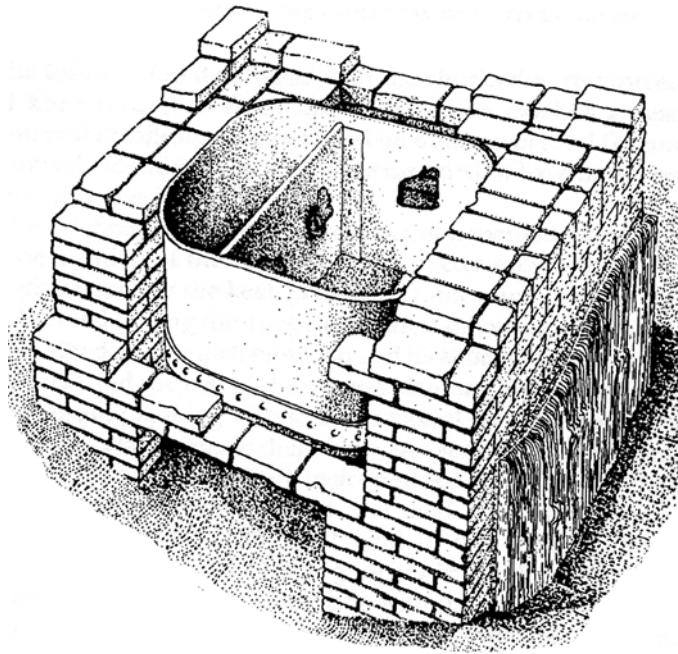
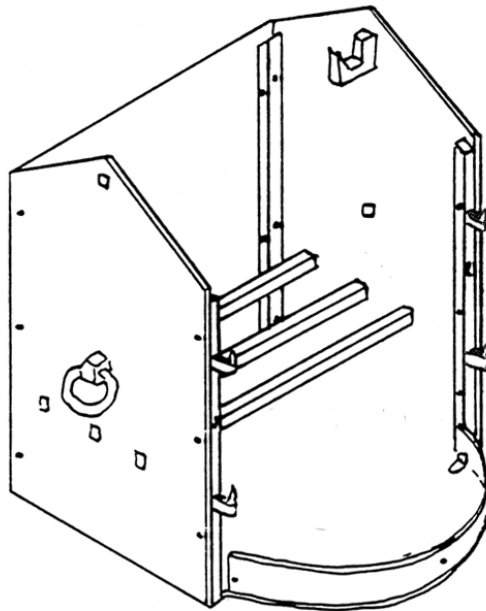
**A****B**

Figure 39. Reconstructed cookstoves. Not to scale. **A**, Stove from *Defence* (After Switzer 1981b, 97); **B**, Stove from the Rose Hill wreck (After Wilde-Ramsing et al. 1992, 51).

contrast, the tentatively identified, smaller cookstove of the Rose Hill wreck was built from cast iron plates and would probably have been less expensive and easier to remove. Bars spanning the plates would have supported a cooking pot and the fire would have been built in the bottom. The front of the stove, probably consisting of doors, was not found, nor was the flue. The stove would have been lashed to the deck by means of iron rings.

### *Jeer Capstan*

The Ronson ship provided the only example of a capstan (fig. 40), but this piece of equipment, or its horizontal equivalent, the windlass, would have been important on larger sea-going vessels. The Ronson ship's capstan was a single capstan, meaning it had only a single row of holes for the bars used to turn the capstan, and so it could be used only on one deck. To secure it to the hull, it was seated in a step on top of a heavy bed. The capstan was cut from a single piece of elm and rather than being fitted at the top with an external drumhead, two holes for the bars were cut directly through the upper part of the spindle, referred to as the barrel by the excavators of the vessel. Five whelps were attached to the barrel and secured with two rows of chocks. As a cable was hauled in, it was wrapped around the whelps; these helped widen the capstan so the number of turns was reduced and they helped move the cable up or down, thereby tightening it.<sup>16</sup> This capstan's design of running the bars directly through the spindle was an older style, as the torque on the spindle eventually caused the wood to split, necessitating a replacement of the whole piece. The invention of the drumhead in the late

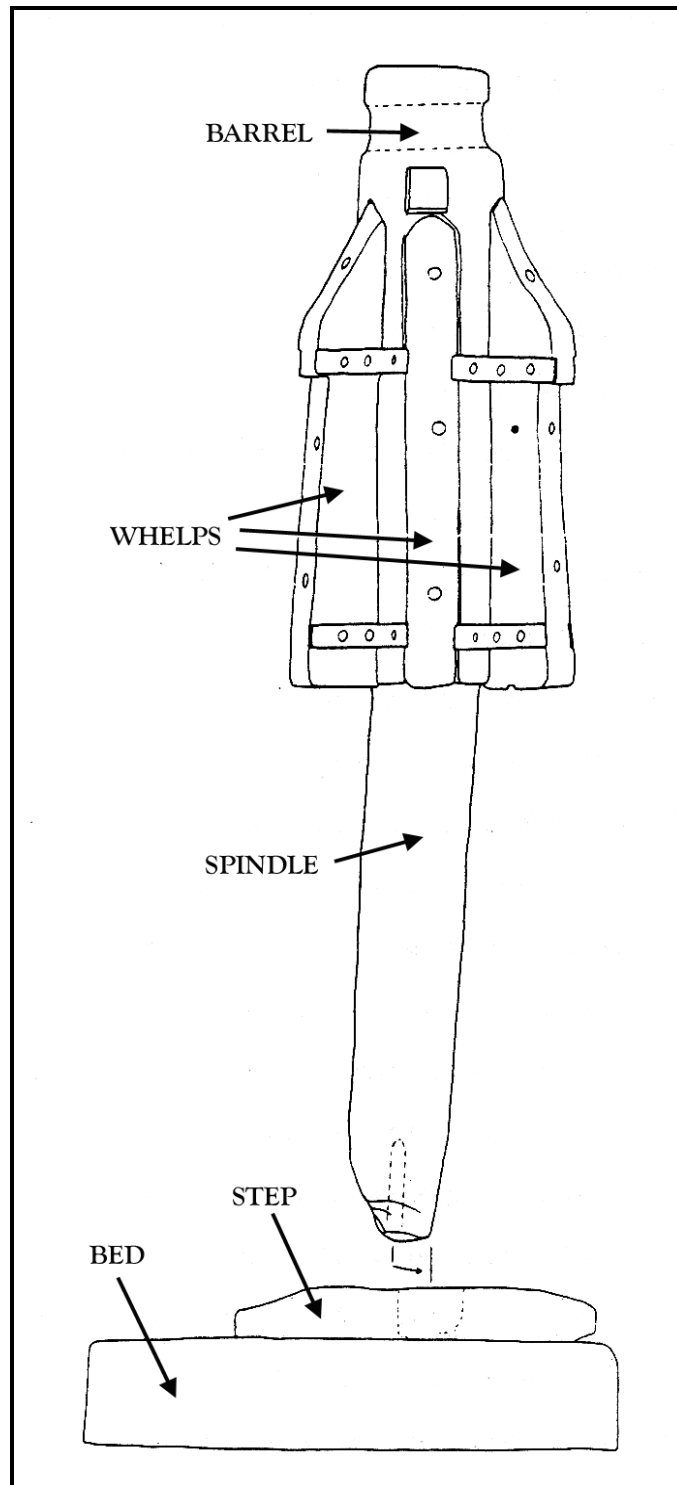


Figure 40. Jeer capstan from the Ronson ship. (After Rosloff 1986, 44).

seventeenth century provided a way to preserve the spindle, as the removable drumhead could be replaced when it became damaged.<sup>17</sup> The drumhead also allowed for the use of a greater number of bars; thus, more men could turn the capstan at the same time. The use of the earlier style on the Ronson ship helps confirm a date for the vessel in the early eighteenth century. As merchant ships often ran technologically behind naval vessels, it is not surprising the owner would have fitted his vessel with a slightly outdated style of capstan.

#### Endnotes

<sup>1</sup> Steffy 1996, 111. These two ships accompanied the 100-ton *Susan Constant* to Jamestown in 1607.

<sup>2</sup> Although the excavators believe this vessel was a warship, it may have been a merchant ship hired as a transport, similar to the *Betsy*.

<sup>3</sup> According to MacGregor (1988, 30), round-sterned ships had vertical cant frames in the stern rather than the horizontal transoms and fashion piece of square-sterned ships.

<sup>4</sup> Sutherland (1711, 49) wrote that oak was the strongest wood, followed by elm, beech, and fir.

<sup>5</sup> Sutherland 1711, 69.

<sup>6</sup> Cook 1997, 58-9.

<sup>7</sup> Roberts 1992, 45, 49.

<sup>8</sup> See Morris et al. 1995.

<sup>9</sup> Morris et al. 1995, 125-8.

<sup>10</sup> Rosloff 1986, 18.

<sup>11</sup> Sutherland 1711, 71.

<sup>12</sup> Murray 1765, 187.

<sup>13</sup> Murray 1765, 187.

<sup>14</sup> Sutherland 1717, 43.

<sup>15</sup> For a detailed explanation and history of suction and chain pumps, see Oertling 1996.



<sup>16</sup> Goodwin 2001, 145.

<sup>17</sup> Goodwin 2001, 145-6.

## CHAPTER VII

### CONCLUSIONS

The main purpose of this study was to look at how ships were built in the eighteenth century as indicated by the archaeological and literary evidence. With a limited number of shipwreck excavations from the period, only tentative conclusions can be drawn about differences between ship types and the evolution of shipbuilding techniques. This kind of analysis is still useful, however, in adding to the overall knowledge of eighteenth-century shipbuilding and providing a framework for interpretation of future shipwreck excavations.

#### **Factors Related to Ship Construction**

Several factors were mentioned in the previous chapter as potentially influencing ship construction methods. The first of these, the transition in English ships from sharp lines to greater capacity and fuller lines, was difficult to examine because of the limited number of vessels, especially those with early dates. The Rose Hill vessel had flat floors and a low length to beam ratio, suggesting the boxy shape had already been adopted by the time of its construction in the second quarter of the eighteenth century; as this date is based solely on construction features, however, it would be circular logic to use this vessel as evidence for the dates of specific features. The Ronson ship, dated to the early part of the century based on artifacts, provides better evidence for the use of the new shape by this time with its cross-section similar to a flyboat. A better date for the

transition cannot be determined based on these shipwrecks, but it is clear that these merchant vessels could have easily been distinguished from warships of similar sizes. Only *Defence*, built as a privateer, was constructed with sharp lines and could carry a large complement of cannon.

These shipwrecks do seem to indicate that some form of timber shortage was occurring in Great Britain. It was evident on the vessels built in England that an attempt was being made to assemble ships from smaller or less suitable pieces of timber because these pieces were more available. The most costly timbers for shipwrights to purchase were compass timbers and long, straight pieces, such as for keels. On the *Betsy*, multiple, small transverse chocks were used in place of the apron and sternson, allowing the builder to use less expensive pieces rather than the large compass timbers typically required. The keelson was assembled from two components scarfed one on top of the other, requiring thinner, less expensive timber than if the keelson was a single piece. Because a softwood was used for the main piece, an oak cap was placed on top to provide necessary strength. On both colliers, fillets were used in association with the floors and first futtocks to make the heels larger in dimension, again allowing for the use of smaller compass timbers.

Attempting to economize was important for all merchant vessels, but American builders, with a plentiful supply of timber, probably focused more on economizing labor than materials. Altering construction techniques to save costs was one of the major differences between the hulls of the merchant ships and the warships. Although oak was the preferred wood for shipbuilding, many of the merchant vessels incorporated other

types such as pine, maple, and beech because they were readily available in the New World. Timbers were occasionally left unfinished to keep them as large as possible and reduce the time required for completion. In addition, shipbuilders of the merchant vessels seemed to have a higher tolerance for error than builders of warships, where standardization was more important than economy. Allowable errors included such examples as the gap in the planking of the Phips wreck filled in by small stealers and the hole of the bilge pump on the Ronson ship that was not bored straight. While these problems could have been corrected, they were left because they did not affect the vessels' ability to function.

Another factor under consideration was the increase in the size of vessels during the eighteenth century as indicated by shipping records. These shipwrecks did not show any trend toward increasing size over time, most likely because of the small sample size. Instead, size appeared to be more related to use, with transatlantic trading vessels being the largest and the West Indies traders being smaller. The archaeological remains indicate that 100-ton vessels may have been the most popular size in the colonies, but smaller coastal craft such as the Phips wreck and larger merchantmen such as the Ronson ship were also used during the eighteenth century. The British-built vessels were the largest, possibly reflecting demand for large vessels to supply England with goods from distant shores. The colonial-built Ronson ship, the largest of the merchant vessels, may have been constructed for a British purchaser.

The final potential influence on ship construction was the American search for speed around the time of the Revolution. The only archaeological examples from this

period were *Defence* and the Otter Creek wreck. *Defence* was obviously built for speed for its career as a privateer, so it does not provide much evidence that Americans were seeking to build faster merchant vessels. The Otter Creek wreck, on the other hand, although intended for use as a trading vessel, appeared to have been built with speed in mind as well. Indications of this design included more deadrise to the frames and a higher length to beam ratio than the other colonial merchant vessels. Although this vessel does seem to indicate speed became a factor in ship design by the Revolutionary period, no claims can be made based on the evidence of a single vessel.

### **Construction Trends**

The first of the three major questions addressed in this study was whether any trends in construction were clear from the archaeological record. Among the keels, sizes and shapes varied and a variety of wood types were used. Keels were usually built from a single piece or a few joined end-to-end; in the case of the Town Point vessel, two lengths of timber were fastened one atop the other for the vessel's length. The rabbet was usually cut into the keel, but some of the ships had a full-length deadwood timber used to form the rabbet with the keel. Most of the vessels did not have a false keel.

Many of the vessels were built with double articulated and intermediate frames and were probably designed using some form of whole molding, either from the midship frame alone or from several frame curves on a draft. Spacing between frames varied but usually at least some gap was present between double frames, as recommended by Sutherland for ventilation. The Ronson ship had only articulated frames with no

distinction between mold and intermediate frames, suggesting all the frames were designed on a draft or else they were built sequentially into place. Other vessels had no clear mold frames at all, with the frames built by adding components as the hull was planked. In the extreme ends, canting was clearly used by the mid-eighteenth century, but square frames were retained on some of the smaller craft such as the Town Point vessel.

On most of the vessels, individual frames were built by scarfing vertical components together without gaps between the heads and heels. As the heads and heels of timbers on the Ronson ship were attached, this style had already come into use by the early eighteenth century, sooner than Murray's documentation of it in 1765. Chocks were used in the scarf joints only on the *Betsy* and *Charon*. First futtocks were offset from the keel in most cases, but the distance varied with no clear trend. Dimensions of the frames varied with intended use and matched the overall scantlings of the vessels. The colliers, designed to carry heavy cargoes, had large frames, while the more lightly built Ronson ship and Reader's Point vessel had lighter frames.

Keelsons were generally oak or pine and were notched to fit over the frames in some cases. They were often larger than the keel and like the keels, most were either a single timber or a few pieces scarfed end-to-end. The keelson of the *Betsy*, like the keel of the Town Point vessel, was made from two lengths of timber fastened one on top of the other, like the keelsons Ollivier observed at Deptford. Keelsons were, in most instances, carried as far aft as the stern deadwood and either scarfed to the sternson or the stern knee.

Mast steps on these vessels occurred in three styles – either a simple mortise cut directly into the keelson, a longitudinal step atop the keelson, or an athwartships step. There did not appear to be any trend by date, but it seems most logical that the mortise cut directly into the keelson would be the earliest type based on its simplicity and inherent flaws, which were corrected in the other designs. Most of the vessels carried either one or two masts, probably representing sloop and schooner rigs, but ship and most likely brig rigs were used also. The fore-and-aft rigs would have been most versatile for coastal sailing and would have reduced the necessary crew size.

Planking was generally cut from oak or pine and was attached with treenails and iron spikes. The ceiling tended to be the same thickness as the external planking; both were thinner than the dimensions recommended in the treatises. Thickness appeared to be related to the type of cargo carried and the overall scantlings of the vessel. Most of the vessels had a coating of pitch or tar and animal hair on the outside of the planking covered by a layer of thin wood sheathing. The sheathing thickness varied, but it was usually a quarter to a third the thickness of the planking.

Equipment found on these shipwreck sites included bilge pumps, cookstoves, and a capstan. Bilge pumps were present on almost all of the vessels. As an essential piece of equipment, they originally would have been present on all of the larger sea-going craft; if missing, they had probably been salvaged prior to excavation. Most of the remaining pumps had some type of wooden casing and wooden tube, although there was one example of a lead tube. No evidence of chain pumps was found on the merchant vessels,

as might be expected because chain pumps cost more and required more maintenance and more men to operate than suction pumps.

### **Comparison with the Literary Evidence**

The second major question was whether the archaeological evidence reflects methods described in the contemporary treatises. This question is hard to address because of the theoretical nature of the written evidence and the difficulty of determining design theory from construction alone, but some comparisons can be made. The use of mold frames and whole molding was similar to descriptions in the treatises. Articulated frames, as described by Murray, were used in several of the vessels. In addition, the gaps between floors and first futtocks in some of the vessels reflect Ollivier's observations of English ships at Woolwich and Deptford. The chocks used in the joints of the *Betsy* and *Charon* were similar to the methods observed by Ollivier. Canting of frames at the ends, as described by Murray and recorded by Ollivier, was also used in some of the vessels.

The long, full-length deadwood timber of some of the vessels matches Ollivier's descriptions of English keels and deadwood. Notching of the keelsons to fit over the floors was similar to what Sutherland described. Murray's recommendation of bolting the keelson through every other floor was seen in some of the vessels. Finally, the athwartships mast steps were similar to those recorded by Ollivier.



### **Divergence Between British and Colonial American Vessels**

The third and final major question considered in this study was whether the archaeological record showed a divergence between the British and colonial-built vessels. Differences in construction appeared to be related more to vessel type than nationality, although the British and colonial-built ships did diverge on a few points. The clearest differences were in the types of timber used, the sizes of timber, and the size of the vessels. The colonial-built vessels used a wider range of wood types, including many specific to their regions of build in the New World. Colonial-built ships also tended to use larger pieces of compass timber, whereas the British vessels attempted to conserve timber by breaking up typically large pieces into multiple smaller ones. Finally, the British-built vessels appeared to be larger in size overall, but with such a small sample of wrecks it is difficult to make a conclusive statement. The general shapes of vessels and construction methods, however, tended to vary without clear distinction between regions of build or even between the two nationalities. These variations appeared to relate more to vessel type or perhaps the individual practices of shipwrights than location of construction.

Merchant ships of both nationalities were designed with the qualities of cargo capacity, speed, and small crew size in mind. These qualities were balanced to meet the needs of the owner, depending on the vessel's intended trade. Of the wrecks examined, most were intended for use in the West Indies or inter-colonial trade and were built to balance large cargo capacity with suitable speed. Vessels of both nationalities demonstrated a desire on the part of the owner to reduce costs where possible by leaving

details unfinished and minimizing timber consumption. The excavation of more eighteenth-century shipwrecks in the future should help to further understand the design and construction of merchant ships from this period.

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APPENDIX A  
TABLES OF SCANTLINGS

Table A-1. Summary of scantlings for the major merchant vessels.

Shipwreck	Phips	Ronson	Rose Hill	Terence Bay	Reader's Point
Date of build	Pre-1690	1700s-1740s	1725-1750?	Pre-1750s	Pre-1765
Nationality	Colonial – Massachusetts	Colonial – Virginia?	Colonial – Northern?	Colonial – New England	Colonial - Northern
Tonnage	45 tons	260 tons	103 tons	100-120 tons	100 tons
Length Overall		100 ft	67 ft	70 ft	60 ft
Length b/n perpendiculars		82 ft			
Beam		27 ft	22 ft		18 ft
Length to Beam Ratio		3.7:1	3:1		3.3:1
Draft		11 ft	8 ft		
Hold Depth		7.5 ft	8.5 ft		
Keel Length		68 ft	54.5 ft		42 ft 5 in*
Keel Molded		14 in	15 in		10.9 in
Keel Sided		12 in	8 in		9.6 in
Keel Wood Type			Hard maple		Hard maple
Keelson (L)			28 ft 9 in*		
Keelson (M)			12 in		9.6 in
Keelson (S)			10 in		10.9 in
Keelson Wood Type		White oak	White oak		White oak
Floor (M) Avg.		8.5 in	10.5 in	6 in	10 in
Floor (S) Avg.		8.5 in	11 in	8 in	9.5 in
Futtock (M) Avg.	4.7 in	8.5 in	10.5 in		8.5 in
Futtock (S) Avg.	6.3-10.2 in	8.5 in	11 in		8.9 in
Futtock Offset from Centerline		0 in	11 in		12 in
Avg. Space b/n Frames	Various	6 in	0 in	2 in	0-4 in
Frame Wood Type	White oak	White or live oak	Beech and white oak	Oak	White oak
External Planking Thickness	2 in	2 in	2.4 in	2 in	2 in
Ext. Plank Wood Type	White oak	White oak	White oak	Oak	White oak
Internal Planking Thickness	1.6 in	2 in	2 in	2 in	2 in
Int. Plank Wood Type	White pine	White oak	Red oak	Oak	White oak, yellow pine
Fasteners	Treenails	Iron, treenails	Iron, treenails	Iron, treenails	Iron, treenails
Sheathing		Thin wood	0.5 in hard pine		0.25 in pine, oak on keel
Number of Masts	One?	Three	One	Two?	One
Armament		6-6 pdrs.			
Vessel Type/ Trade	Coastal trader	Tobacco/trans-oceanic	West Indies or inter-colonial	Fishing	West Indies or inter-colonial

\* = Preserved Length

Table A-1. Continued.

Shipwreck	Bermuda Collier	The <i>Betsy</i>	Otter Creek	<i>Defence</i>
Date	Pre-1770s	1772	1770s	1779
Nationality	British	British	Colonial	Colonial - Massachusetts
Tonnage	170-210 tons	180 tons	100 tons	170 tons
Length Overall			58 ft	72 ft*
Length b/n perpendiculars	Over 72 ft	73 ft 1.6 in		
Beam	24 ft*	23 ft 7.35 in	16 ft	22 ft*
Length to Beam Ratio	> 3:1	> 3.2:1		> 3.3:1
Draft		9 ft 6 in	9 ft	
Hold Depth	11.5 ft	9 ft 10 in	6.5 ft	
Keel Length	69 ft 9 in*	68 ft 2.5 in	49 ft 3 in*	
Keel Molded	12 in	13.25 in	12 in	14 in
Keel Sided	16 in	14.4 in	9-12 in	8 in
Keel Wood Type	Elm	White oak	White oak	Oak
Keelson (L)		56 ft 10.6 in		
Keelson (M)	12.5 in	8.5-23 in	12 in	8 in
Keelson (S)	18 in	14.4 in	13.5 in	11.5 in
Keelson Wood Type	White oak	Pine and oak	White oak	Oak
Floor (M) Avg.	12-13 in		12-13 in	8-15 in
Floor (S) Avg.	12 in		6-13 in	
Futtock (M) Avg.	4-10 in	7-9 in	12 in	8 in
Futtock (S) Avg.	10 in	9-10		8 in
Futtock Offset from Centerline	6-8.5 in	10.75	13.5 in	
Avg. Space b/n Frames	1-4.5 in	1-5 in	3-27 in	5 in
Frame Wood Type	White oak	White oak	White oak	Oak
External Planking Thickness	3 in	2.25-2.5 in	2 in	2-2.5 in
Ext. Plank Wood Type	White oak	White oak	White oak	Oak
Internal Planking Thickness	3 in	2.5 in	2 in	
Int. Plank Wood Type	White oak	White oak	White oak	Oak
Fasteners	Iron, treenails	Iron, treenails	Iron, treenails	Iron, treenails
Sheathing	1 in scotch pine	1.25 in pine	0.9 in pine	
Number of Masts	Two?	Two	Two	Two
Armament				16-6 pdrs.
Vessel Type/ Trade	Collier/ Transport	Collier/ Transport	West Indies	Privateer

\* = Preserved Length

Table A-1. Continued.

Shipwreck	The <i>Nancy</i>	Clydesdale Plantation
Date	1789	1790s
Nationality	British	Colonial - Southern
Tonnage	100-120 tons	20-25 tons
Length Overall	68 ft*	43 ft 9 in
Length b/n perpendiculars		
Beam	22 ft *	15 ft 5 in
Length to Beam Ratio	3.1:1	2.8:1
Draft		
Hold Depth	7 ft 6 in	6 ft 3 in
Keel Length	59 ft 9 in	
Keel Molded	12-14.75 in	
Keel Sided	8-9.5 in	
Keel Wood Type	Oak	Yellow pine
Keelson (L)	53 ft	
Keelson (M)	12 in	
Keelson (S)	9 in	
Keelson Wood Type	Oak	Pine
Floor (M) Avg.	7.5-9 in	
Floor (S) Avg.	8-9 in	
Futtock (M) Avg.	8 in	
Futtock (S) Avg.	8 in	
Futtock Offset from Centerline	7-10 in	
Avg. Space b/n Frames	5-9 in	
Frame Wood Type	Oak, red cedar	Live oak
External Planking Thickness	2 in	
Ext. Plank Wood Type		Pine
Internal Planking Thickness	1.5 in	
Int. Plank Wood Type		Pine
Fasteners	Mainly iron, some treenails	Mainly iron, few treenails
Sheathing		
Number of Masts	Two	One
Armament	Unknown sizes	
Vessel Type/ Trade	Lake trader	Coastal trader

\* = Preserved Length

Table A-2. Summary of scantlings for the naval ships.

Shipwreck	Port Royal	<i>Boscawen</i>	Deadman's Island	Cornwallis Cave	<i>Charon</i>
Date	Pre-1692	1759	1776-1781	Pre-1781	1778
Nationality	British	Colonial – Lake ChAMPLAIN	British	British	British
Tonnage		115 tons	100 tons	550 tons	880 tons
Length Overall			60-70 ft	120-135 ft	
Length b/n perpendiculars				111 ft 9 in*	140 ft
Beam				32 ft	38 ft
Length to Beam Ratio				> 4:1	> 3.7:1
Draft					16 ft
Hold Depth				11 ft	
Keel Length	74 ft*	65 ft	50 ft 10 in		115 ft
Keel Molded	8 in	14 in	20 in		15 in
Keel Sided	8 in	9.5-10.5 in	9.5 in		15 in
Keel Wood Type	Slippery elm	White oak	White oak		
Keelson (L)		53 ft			
Keelson (M)		6-10 in	9 in		
Keelson (S)		10-11 in	11 in	14 in	
Keelson Wood Type		White oak	White oak		
Floor (M) Avg.	8 in	12 in	8 in	10.5 in	
Floor (S) Avg.	9 in	8.5-10 in	8 in	10.5-12 in	10-14 in
Futtock (M) Avg.	8 in	7-10 in			
Futtock (S) Avg.	9 in	4-8 in			
Futtock Offset from Centerline	20 in				
Avg. Space b/n Frames	2-14 in	Various	12-14 in	2 in	3-8 in
Frame Wood Type	White oak	White oak	White oak		
External Planking Thickness	3 in	2 in	1.5 in	3 in	3 in
Ext. Plank Wood Type		White oak	White oak		Oak
Internal Planking Thickness	None found	2 in		3.5 in	2.5-3 in
Int. Plank Wood Type		White oak			
Fasteners	Iron, trenails	Iron, trenails	Iron, trenails	Iron, trenails	Iron, trenails
Sheathing	None found		None found	1 in wood, copper also?	Copper
Number of Masts	Three?	One	One or two?	Three	Three
Armament		16 guns		32 guns?	44 guns
Vessel Type/ Trade	Warship	Warship	Military use/ merchant originally?	Warship	Warship

\* = Preserved Length



Table A-3. Summary of scantlings for the riverine craft.

Shipwreck	Brown's Ferry	Town Point
Date	Pre-1740s	1763-1781
Nationality	Colonial – South Carolina	British
Tonnage	25 tons	30 tons
Length Overall	50 ft 3 in	35 ft 4.4 in*
Length b/n perpendiculars		
Beam	14 ft 2 in	7 ft 6.5 in*
Length to Beam Ratio	3.5:1	
Draft		3 ft 11.5 in*
Hold Depth	3 ft	6 ft 3 in
Keel Length		34 ft 9.3 in*
Keel Molded	3 planks 2.75-4 in thick	15.9 in
Keel Sided	Up to 18.75 in wide	11 in
Keel Wood Type	Pine	Southern hard pine and white oak
Keelson (L)		No keelson found
Keelson (M)	4 in	
Keelson (S)	15.75 in	
Keelson Wood Type	Cypress	
Floor (M) Avg.	4.5 in	6.9 in
Floor (S) Avg.	4-6.5 in	4 in
Futtock (M) Avg.		4.3 in
Futtock (S) Avg.	3.5-5 in	3.1 in
Futtock Offset from Centerline		
Avg. Frame Space	12-16 in	8 in
Frame Wood Type	Live oak	White oak
External Planking Thickness	1.1-1.25 in	1.2 in
Ext. Plank Wood Type	Pine	Southern pine, white oak
Internal Planking Thickness		0.8-1.4 in
Int. Plank Wood Type		White oak
Fasteners	Iron, treenails	Almost all iron
Sheathing	None	
Number of Masts	Two	One
Armament	None	
Vessel Type/ Trade	River trader	Coastal trader

\* = Preserved Length

APPENDIX B  
GLOSSARY OF SHIP TERMS

**Apron** – A curved timber secured to the inside of the stem, serving as an internal stem post.

**Articulated frames** – Frames in which the components (i.e. floors and first futtocks) are horizontally fastened or closely associated with each other.

**Beam** – The breadth of a hull; also an athwartships timber supporting the deck.

**Bilge** – Bottommost part of the internal hull where water tended to collect; also the outer part of the hull where the vessel would rest if run aground.

**Breast hook** – A large, horizontal timber fastened to the stem and ceiling planking of the bow to hold the sides together.

**Butt joint** – The flush joining of two timber ends.

**Cant frame** – Frame placed at an angle to the centerline; usually used in the bow and stern.

**Carling** – A longitudinal timber placed between beams to support the deck.

**Ceiling** – Internal planking.

**Cheek pieces** – Small knees securing the knee of the head to the sides of the bow.

**Chock** – A wedged piece of timber used to fill a gap or separate timbers.

**Clamp** – A thick ceiling strake providing longitudinal support.

**Crutch** – A curved timber used like a breast hook in the stern to hold the sides of the vessel together.

**Deadrise** – The amount of rising of a floor timber above a flat plane.

**Deadwood** – Timbers placed on top of the keel to fill in the lower hull of a vessel, most often in the bow and stern.

**Deal mold** – A mold made from thin fir or pine planks and used to shape framing timbers.

**Disarticulated frames** – Frames in which the floors and first futtocks are separated and appear to have been installed independently.

**Double frames** – Frames made using two rows of vertical timbers with overlapping futtocks.

**Draft** – A drawing or plan of a vessel.

**Fashion pieces** – Timbers running diagonally from the counter to the sternpost, linking the transoms and helping to frame the stern; in the round tuck, instead of being secured to the sternpost, these timbers were attached to frame timbers forward of the post to form the round curve for the planking.

**Floor** – Lowermost component of a frame, placed transversely across the keel.

**Futtock** – Frame component used to lengthen a floor; one of the middle components of a full frame.

**Garboard strake** – Lowermost external hull strake, usually attached to the keel by means of a rabbet.

**Gripe** – A curved timber attached to the outside of the stem post and used to link the keel to the knee of the head.

**Half-frame** – A frame spanning part or all of one side of a hull, but not crossing the keel.

**Hawse pieces** – Vertical timber running parallel to the centerline, placed between the forwardmost frames and the stem to support the bow.

**Hog** – Another term for rising wood or keel deadwood.

**Hooding ends** – Ends of the planking that fit into the stem and stern rabbets.

**Intermediate frames** – Frames used to fill the space between master frames.

**Jeer capstan** – A secondary capstan used to assist the main capstan.

**Knighthead** – Forwardmost frame timber placed on both sides of the stem and used to help support the bowsprit.

**Ledges** – Transverse timbers running parallel to the beams and supported by the carlings; part of the deck support assembly.

**Limber holes** – Holes cut through the frames along the centerline to allow water to move towards the bilge pumps.

**Lines** – Geometric projections of the curves of a hull.

**Midship frame** – The frame with the greatest beam on a vessel.

**Molded dimension** – Measurement of a timber from inside to outside the hull (i.e. the vertical sides of the keel).

**Mold frames** – Designed frames set up along the keel first and used to fair the lines, after which intermediate frames were installed between the mold frames; also called master frames.

**Mold loft** – A large, flat surface in a protected area where a vessel's lines from a draft could be drawn full-scale to cut and assemble the needed timbers.

**Nibbing strake** – A plank set next to the waterway that received the ends of the deck planks.

**Rabbet** – Groove cut into the keel and posts to receive the garboard and hood ends of the planking.

**Ribbands** – Long, flexible strips of wood used to temporarily hold timbers together or to fair the lines of a hull.

**Rising line** – Line on a draft showing the curve of the maximum breadth throughout the run of the hull.

**Rising wood** – A deadwood timber covering the full length of the keel between the bow and stern deadwood; floor timbers were placed on top of it.

**Room and space** – Distance from the molded edge of one frame to the corresponding edge of the next; the area occupied by the frame timbers is called the room and the gap between the frames is called the space.

**Round tuck** – Arrangement of the stern where the transoms curved forward from the sternpost, allowing the planking to run into the wing transom of the counter in a convex curve.

**Scantlings** – The main dimensions of a vessel.

**Scarf** – Type of joint in which two overlapping timbers are fastened together without changing their dimensions; also spelled scarph.

**Sheathing** – Wood or metal covering on the outside of the hull to protect the wood from marine borers.

- Sided dimension** – Measurement of a timber perpendicular to the molded dimension (i.e. across the bottom of a keel).
- Single frame** – A frame having only one vertical row of timbers (i.e. a floor with a first futtock set vertically above it rather than beside it).
- Shroud** – Part of the standing rigging of a vessel, used to support the masts from the sides of a vessel.
- Square frame** – Frame placed perpendicularly to the centerline.
- Square tuck** – Arrangement of the stern in which the counter and transoms were placed perpendicularly to the sternpost, with the planking ending on the fashion pieces.
- Sternson** – A curved timber attached to the top of the stern deadwood and used to join the keelson to the stern knee.
- Strakes** – Continuous lines of planking from bow to stern, either internal or external.
- Top timber** – The uppermost component of a frame.
- Transoms** – Timbers placed transversely to the sternpost and used to support the counter and planking ends.
- Treenails** – Long wooden fasteners, either round or multi-sided in cross-section.
- Tumblehome** – The inward curvature of a vessel's frames and upper sides above the point of greatest breadth.
- Turn of the bilge** – Outer part of the hull where the bottom curved to meet the sides; usually near the heads of the floors.
- Wale** – A thick external strake used to provide extra longitudinal support for the hull.
- Waterway** – Thick internal timber filling the corner between the deck planking and the ceiling.
- Whole molding** – An alternative method for designing hulls without drawing the lines for an entire vessel, in which one or more sets of molds were created and used to determine the shapes of the rest of the frames.
- Wing transom** – The uppermost transom, serving as the foundational component of the counter and stern.

## VITA

Kellie Michelle VanHorn

**Permanent Address:** 77 Crosswinds Dr.  
Noank, CT 06340  
E-mail: tensails@hotmail.com

**Education:** Texas A&M University, M.A., December 2004. Department of Anthropology, Nautical Archaeology Program.

Indiana University, B.S., August 1999. College of Arts and Sciences, Major in Biology and Minor in Classical Civilization.

**Experience:**

August 2002 – May 2003 Graduate Assistant. Conservation Research Laboratory, Nautical Archaeology Program, Texas A&M University.

May – June 2002 Intern. Magnetometer Survey of New Ground Reef. RPM Nautical Foundation, Key West, Florida.