THE PASSENGER STEAMBOAT *PHOENIX*: AN ARCHAEOLOGICAL STUDY OF EARLY STEAM PROPULSION IN NORTH AMERICA

A Dissertation

by

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ABSTRACT

The advent of steam contributed heavily to the economic transformation of early America, facilitating trade through the transportation of goods along the country's lakes, rivers, and canals. Serious experimentation with steam navigation began in the last quarter of the 18th century. By the turn of the 19th century, fledgling US steamboat companies vied for control of navigation rights in the country's northern waterways. The second steamboat to be launched on Lake Champlain, *Phoenix*, operated as a passenger steamer between 1815 and 1819, when she caught fire and sank in the lake. The intention of this study is to advance our knowledge of early steamboat design and use in the United States through the archaeological investigation of the country's earliest-known steamboat wreck. As little is known about the development of these early steam vessels, the study of *Phoenix* offers a unique opportunity to gain new information related to steamboat design in the early 19th century as well as a glimpse into life on the lakes and rivers of North America during this era. The dissertation presents detailed information on *Phoenix*'s construction, operation, and sinking based on historical and archaeological analysis and interpretation. In combination with the available archival record and analytical comparisons with steamboats of similar size and age, a more comprehensive understanding of the developmental phases of steam travel and its impact on early America can be gained.

For Hank

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This project involved a number of unique people and organizations I've had the pleasure to be associated with, and this acknowledgement section only briefly touches upon the immense gratitude I have for them. First and foremost I'd like to thank my committee chair, Dr. Kevin Crisman, for introducing this topic to me and encouraging me to pursue it. Having worked with Dr. Crisman on the excavation of the paddlewheeler *Heroine* on the Red River I gained an interest in and an appreciation for the development of steam propulsion in America. Dr. Crisman offered valuable guidance and supported this project through his academic chair funds as well as letters of recommendation for my successful grant applications. His advice also made the manuscript a much better final product.

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granted access to all of his previous research on *Phoenix*, for which I am grateful. Adam Kane was an invaluable asset to the project, and provided logistical and dive support, archaeological expertise, and advice based on his previous research on western river steamers. I thank Adam and his wife Andrea for their hospitality during my time in Vergennes over the past few years. Likewise, Chris Sabick offered valuable advice, hospitality, and access to collections and lab resources, in addition to archaeological expertise in the field and lab. I also thank the rest of the Lake Champlain Maritime Museum staff, the majority of whom assisted me in one way or another while I conducted my research whether in the museum or in the field.

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One of the chief reasons I was able to conduct field investigations on the *Phoenix*

wreck was through funds granted by the National Geographic Society and Waitt Foundation, organizations that found great interest in this project. I appreciate the assistance from both organizations, and I am especially grateful for the support and guidance of Dr. Dominic Rissolo, Dr. Fabio Amador, and Dr. James Delgado. I believe I was the first student to receive funds through this joint program, and I feel fortunate for the opportunity to conduct this study.

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CHAPTER I

INTRODUCTION

Phoenix Burning

Having stayed up exceedingly late the night before, Captain Richard Sherman descended the staircase to his stateroom, which he shared with the steamer's barkeep, and retired to his berth. It was barely past midnight on the 5th of September, the moon was full and bright, and he had successfully guided the paddlewheeler past the shallow reefs of Colchester. Soon after this exhausting effort the young captain delegated navigation of the boat to his first pilot. Richard had been appointed captain of *Phoenix* this evening as a substitute for his father Jahaziel, the usual master of Lake Champlain Steamboat Company's first passenger steamboat. Jahaziel was presently lying ill in his bed in Burlington, Vermont, and left the steamer in the hands of his 21-year-old son to complete her regularly-scheduled route from Whitehall, New York to St. Johns, Quebec. The steamboat made a brief stop for passengers in Burlington, and was on her way north with a total of 46 people on board (Hemenway 1867:689).

Around 1:00 AM, a clamor outside of the cabin wrenched the younger Sherman from slumber. He immediately noticed the absence of his roommate. His grogginess became unease, and as the captain leapt to his feet the cabin door burst open.

"Fire on deck!" called a frantic voice from the hallway.

Richard strode through the doorway in his nightclothes and met his roommate D.D. Howard in the hallway. After a brief discussion, he and D.D. first scrambled to

rescue the $13,000 that was locked away in Jahaziel Sherman's cabin, but quickly abandoned this effort once they realized how fast the fire was spreading. Climbing on deck the captain rallied his crew and began issuing orders. The fire had already reached the boilers, and, after igniting the surrounding lubricating oil, began to travel rapidly throughout the wooden vessel. Smoke was billowing in dark clouds from below deck where the steam machinery was located, and flames had already begun torching the base of the steamer's mast, climbing steadily towards the furled sail. Meanwhile, the captain was guiding the half-naked and dazed passengers into the suspended life boats, ordering the women and children to enter first. Time was of the essence, and, as the passengers clambered into the boats, the rapidly advancing flames threatened to scorch those who lingered on deck. Richard recalled accounts he had read about exploding boilers aboard western river craft, and had no desire to subject anyone aboard *Phoenix* to such horrors.

Captain Sherman and his crew were successful in getting most of the passengers onto the boats and out of the path of the blazing steamer, which was now thrashing about wildly as she was given over to the mercy of the wind and waves. There were still 11 people on board and the captain swiftly ordered those who remained to abandon ship. After hurling themselves into the frigid waters of the lake, the struggling passengers and crew clung to furniture and ship's timbers to stay buoyant. Six of those victims would drown in their attempts. Richard, clutching a bobbing chunk of smoldering wood, watched helplessly as *Phoenix* continued to brightly burn on the lake. Stupefied, exhausted, and dismayed, the young captain turned away and began the long swim toward Providence Island.

Phoenix continued to burn all the way to the waterline, and her smoking hulk eventually ran aground near Colchester reef. After a long, ice-encrusted winter, she would drift and sink onto a slope at Colchester shoal, a perfectly cold and dark environment for the preservation of a virtual time capsule of early-American steamboat culture (Figures 1-1 and 1-2). Built in the early years of the development of the marine steam engine, the construction, operation, and sinking of *Phoenix* represents an important but little understood stage in the adaptation of steam propulsion in America. As such, the study and interpretation of her extant hull remains became the subject of archaeological investigations nearly 200 years after her untimely sinking in the lake and is the focus of this dissertation research.

Archaeological Investigation of an Early 19th-Century Steamboat

The steam engine was developed in stages during the 17th century, culminating in Thomas Savery's patent in 1698. The device was not successfully applied to ship propulsion, however, until more than a century later. Following a series of failed attempts to perfect the technology and attract customers, a commercially viable vessel finally appeared in 1807 when Robert Fulton and Robert Livingston launched *Steamboat* in the Hudson River. *Steamboat* successfully made the 150-mile (241.4 km) trip from New York City to Albany in 32 hours (Bellico 2001:262). Soon after this achievement, passenger steamboats became an attractive alternative to sailing vessels for transportation on the inland seas and waterways of North America and soon spread to the western rivers where they evolved along a separate path (Marestier 1957:2). The

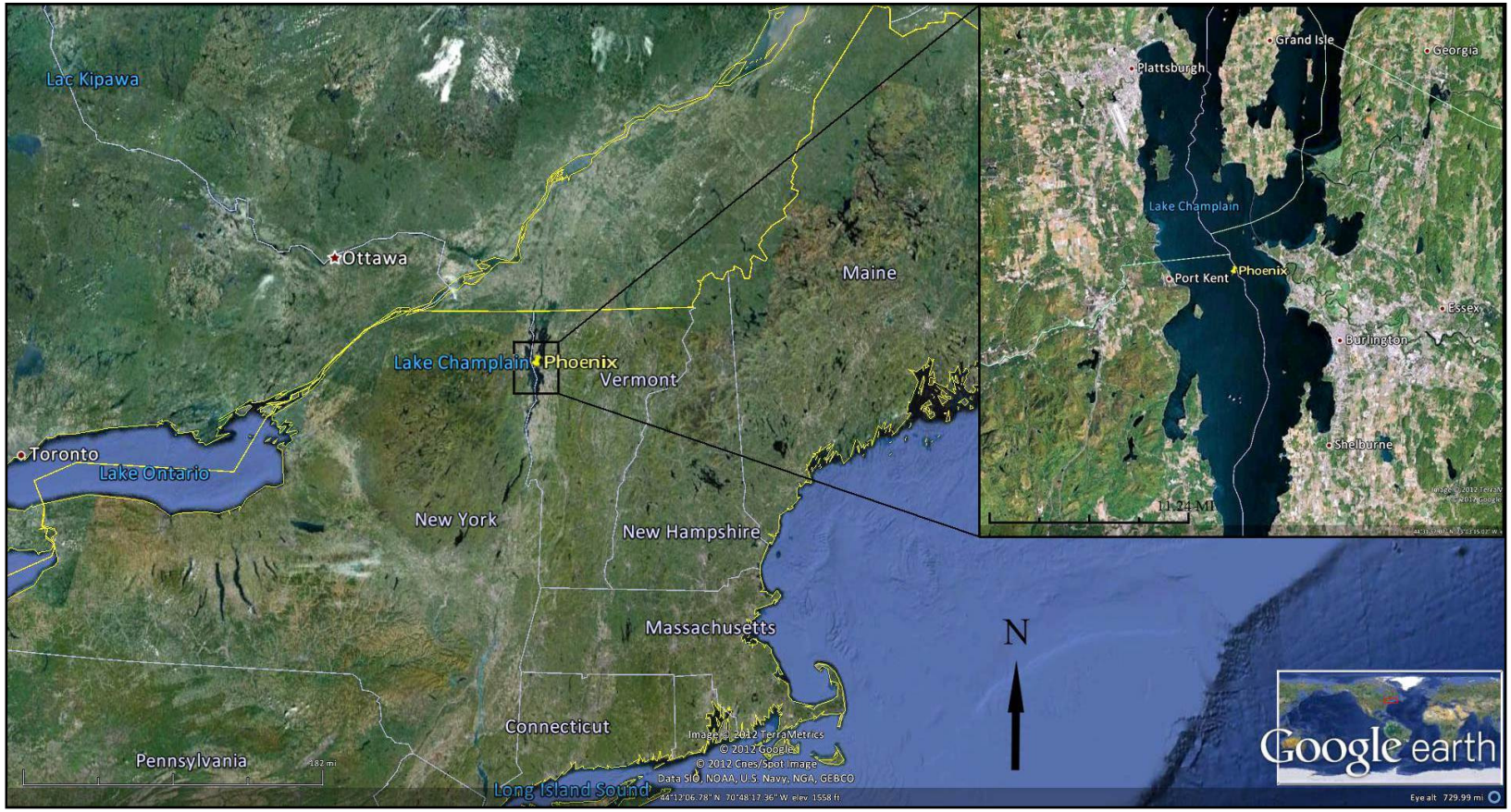


FIGURE 1-1. Location of *Phoenix* wreck site in Vermont. (After Google, 2012.)

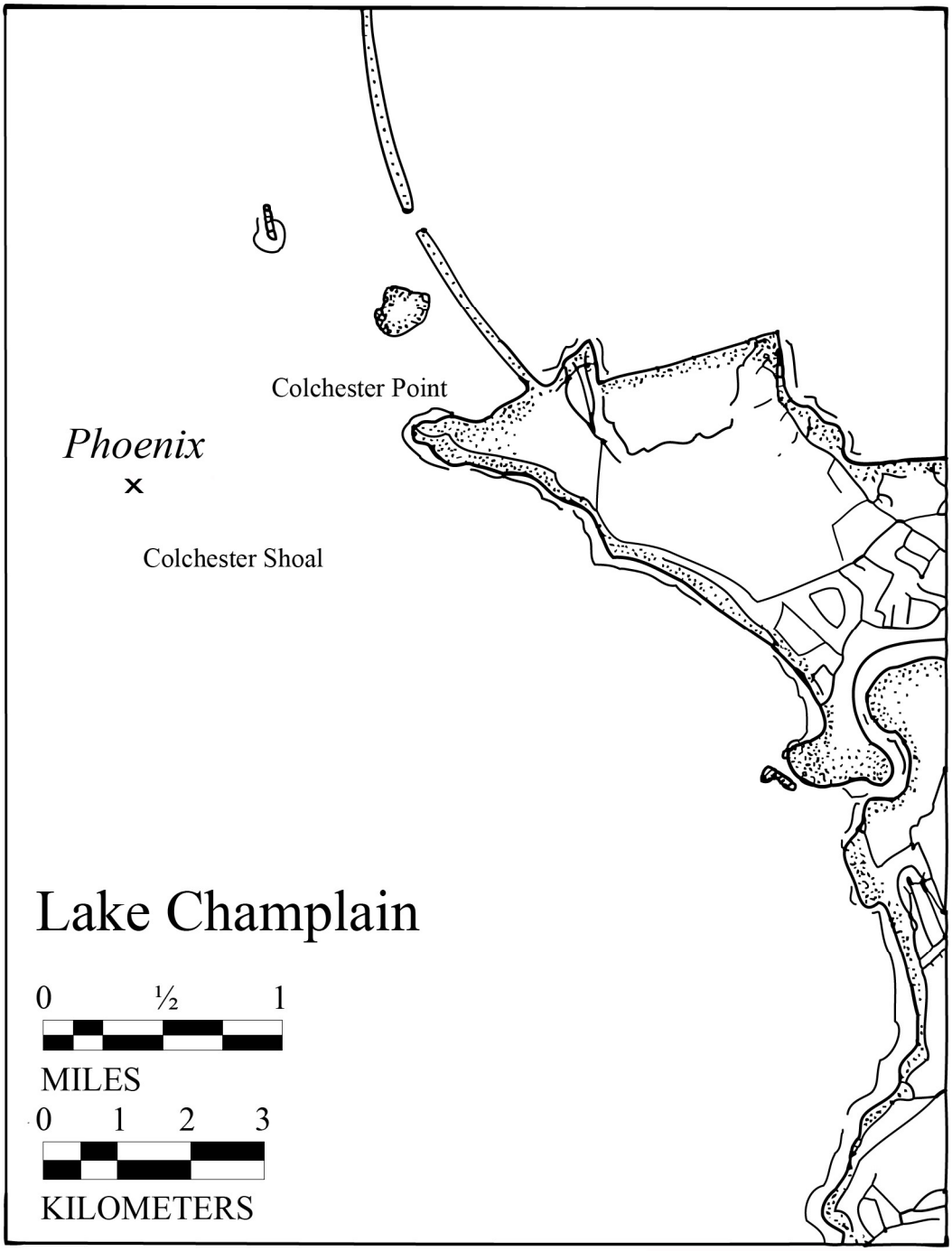


FIGURE 1-2. Location of *Phoenix* wreck site in Lake Champlain.

invention and practical development of steam propulsion led to numerous economic and technological advancements in the United States and created a unique inland maritime culture that flourished until the mid-20th century.

Although steam-propelled vessels were introduced in the United States over two hundred years ago, little information regarding the construction, operation, and navigation of these boats is available today. This is especially true of the steamboats from the first three decades of the 19th century that represent the progressive advancements in early steam navigation. As historians have tended to concentrate on the development of steam navigation up to the popular success of Fulton and Livingston in 1807, little attention has been paid to the practical development of steamboats that followed in their wake. Due in part to a lack of archaeological evidence, relatively few studies have been conducted on the rapid evolution of steam navigation that took place after the success of *Steamboat*.

The study of archaeological steamboat remains can potentially provide researchers with a wealth of information, which can be broken into two main spheres: 1) technological data; and, 2) information regarding the social impact of steamboats on American lifestyles. Examples of technological data include details of steamboat design and construction; boiler and steam engine positioning and use; and, changes in hull design for improved navigation. Relevant social themes include: life aboard early steamers; the effects of steamboat monopolies on interstate commerce and the progression of steamboat design; and public attitudes toward the introduction of this mode of travel.

For this dissertation, the Lake Champlain steamer *Phoenix* was used as a case study into the development of early steamboats. *Phoenix* was laid down in 1814, completed and launched in 1815, and served five years as a passenger vessel. As described above, six passengers perished when the steamboat caught fire en route to Canada in September of 1819. Although the boilers and other machinery were salvaged shortly after her sinking off of Colchester Reef, *Phoenix's* hull is largely unburied and accessible for documentation (Figure 1-3).

FIGURE 1-3. Hull of *Phoenix* resting beneath Lake Champlain. (Photo by Pierre LaRocque, 2000.)

A preliminary archaeological investigation of *Phoenix* was conducted in the early 1980s by the Champlain Maritime Society. This avocational archaeology group

produced a report which included a brief history of the steamer, project logistics, and a conjectural reconstruction (Davison 1981a). In 1983, a second visit to the site by the society was made in an effort to learn more about the vessel's interior layout, and resulted in the recovery of a number of artifacts. These efforts also led to the designation of the site as a Vermont Underwater Historic Preserve and listing on the National Register of Historic Places.

In 2009 and 2010 a renewed archaeological investigation of the steamboat was conducted. The 2009 fieldwork marked the first field season in nearly 30 years for recovering archaeological data from the *Phoenix* wreck site, and was executed under an archaeological research permit granted to the author by the Vermont Division of Historic Preservation (Appendix A). The main objective of the 2009 and 2010 seasons was to record in detail the remains of the extant hull in order to create a complete archaeological site plan of *Phoenix*, which would allow for a ship reconstruction and an analysis of the steamer's design. This Institute of Nautical Archaeology (INA) project was a joint effort among the INA, Texas A&M University, and the Lake Champlain Maritime Museum, with funding provided by the INA, Texas A&M University, Lake Champlain Maritime Museum, and National Geographic Society/Waitt Foundation.

Research Objectives and Methodology

The objectives of the study were to uncover details on the construction, history, and operation of this passenger steamboat. As the second steam-propelled vessel to be launched on Lake Champlain and the earliest-known extant archaeological example of a

steamboat, *Phoenix* represents an invaluable cultural resource for scholars. As such, she is an appropriate focal point for researching the earliest years of steam navigation in North America, as well as the maritime culture that simultaneously developed around this new mode of transportation. While steamboats in America would evolve along separate paths according to the diverse environments in which they operated—the western rivers, Great Lakes, coastal regions, and open seas—the study of this lake steamer provides an opportunity to add to our knowledge of the decades of steamboat development for which we have little information. One example is gaining a better understanding of how American shipwrights adapted steam propulsion to the hulls of sailing and canal boats in the early years of steamboat design. Moreover, as contemporary steamboat remains from other regions such as the western rivers are discovered and examined, the analysis of *Phoenix*'s hull remains can provide for further comparative studies of early steamboat design.

Similar to other archaeological studies of this kind, this project drew from several lines of evidence, including: historical accounts such as contemporary letters and travel journals, early 19th-century periodicals, and shipbuilding and steam engine treatises from the 19th century; representations of early steamers found in paintings, sketches, and technical reports; archaeological data retrieved from the surviving hull of *Phoenix*; and, archaeological parallels found in studies of contemporary steamboat wrecks.

Historical Documents

A considerable number of historical accounts pertaining to *Phoenix* were gathered during the initial studies of the wreck in the early 1980s, and additional research has added to this record. Examination of early 19th-century newspapers has produced glimpses of the steamer's career (Figure 1-4). Articles and advertisements from early papers such as the *Christian Messenger* (1819) from Middlebury, Vermont, and the *Columbian* (1817) and the *Commercial Advertiser* (1815) from New York City provide details about the steamboat and her operation, such as the identity of the captain and crew members; rates for passengers and freight; her regularly scheduled route; descriptions of the interior; the speed of the vessel; opinions of the general public; and repairs made to *Phoenix*. The sinking of the steamer was also described in detail in letters from eyewitnesses that were published in the newspapers.

Published collections of letters were an excellent source of information. A notable collection of letters published in 1819 regarding the patents and steamboat monopolies held by John Fitch, Robert Fulton, and others, were particularly informative. *A Reply to Mr. Coldon's Vindication of the Steam-Boat Monopoly*, by William Alexander Duer (1819), describes steamboat competition in the early 19th century through the words of the first steamboat inventors. In one letter published by Duer, Fulton describes in detail the mechanism by which his steam engine operated and how it was applied to the propelling wheels on the side of the boat. In addition, he defines the mechanical terminology used in steam navigation. He also provides useful technical information such as a "table of friction of plus and minus pressure, and of the

Lake Champlain Steam-Boat.

PHŒNIX,

THE new Steam-Boat *PHŒNIX*, Captain J. SHERMAN, has commenced running on LAKE CHAMPLAIN, and will leave WHITEHALL, every *WEDNESDAY MORNING*, at Nine o'clock, and leave ST. JOHN'S, on *SUNDAY MORNING*, at Nine o'clock, and will stop one hour at Burlington, in passing, each way.

Albany, September 1, 1815 Sept 8—2m

FIGURE 1-4. Advertisement from the *Commercial Advertiser*. (From *Commercial Advertiser*, 18 September 1815.)

resistance of one square foot of propeller" (Duer 1819:viii). Contemporary monographs and treatises on shipbuilding are also invaluable resources, and are discussed in more detail below.

Iconographic and Technical Representations

Although contemporary nautical imagery seldom shows the portions of vessels below the waterline, many artistic and technical depictions provide detailed information about the superstructure, such as the placement of paddlewheels, chimneys, cabins, masts, and rigging elements. Drawings found in patents, for example, often provide a view of a steamboat's intended design. An example of an early steamboat patent illustration is a side elevation drawing of Fulton's *Chancellor Livingston*, built in 1815

by the North River Steamboat Company of New York (Figure 1-5). Other useful representations include early 19th-century paintings of lake and river scenery that feature steamboats, and technical drawings found in contemporary manuscripts on ship design.

Archaeological Data

The fieldwork was designed as a non-intrusive survey to fully record the exposed remains of the hull of *Phoenix*. As noted above, limited artifact recovery took place in the early 1980s, and the ceramic collection became the subject of a master's thesis which helped classify artifact types and describe life aboard early steamboats with regard to food storage and preparation (Haddan 1995). The archaeological interpretation in this dissertation, however, focuses chiefly on the study of structural components and ship design in order to reconstruct the lines of the hull and produce construction drawings. The fieldwork objective was to document design characteristics of the surviving hull timbers, obtain dimensions of all major structural elements, record a representative sample of the existing frame curvatures, collect data on fastening patterns and steam machinery support timbers, and record high-definition digital video of the shipwreck site. In addition to traditional drafting methods, computer software programs were utilized to create three-dimensional digital models of *Phoenix*'s hull remains. The products of the archaeological work include wreck plans and section drawings, reconstructions, and a technical description and analysis of the structural components and hull design.

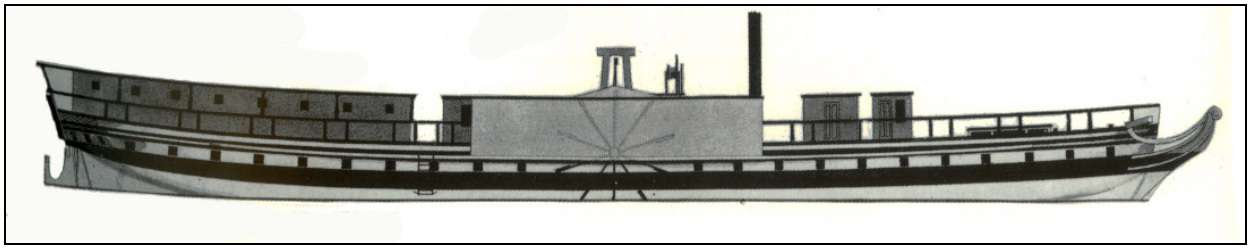


FIGURE 1-5. Copy of a drawing of Fulton's *Chancellor Livingston*. (After a painting from the Peabody Museum of Salem.)

Previous Studies on the Advent and Growth of Steam Navigation

Steam navigation has long been a subject of interest to civil engineers, steamboat pilots, maritime historians, nautical archaeologists, and historians of science and technology, among others. Although there are no known works on the construction and design of lake steamers from the years during which *Phoenix* was built and operated, there are a number of noteworthy sources from the early 19th century pertaining to the study of steam navigation in America. An accumulation of information is available on the development of the marine steam engine, a topic that is well-documented in contemporary treatises as well as recent scholarly studies. The works of learned individuals such as Thomas Tredgold (1827, 1838) and Bennet Woodcroft (1848) from the second quarter of the 19th century track the history and development of early efforts at steam navigation in detail, and provide detailed chapters on the mechanics of the steam engine as well as guidelines for the practical application of steam for numerous purposes. Working from original documents, these authors recorded first-hand accounts of the growth of steam navigation. Later scholarly studies, using these and other original texts, have nicely fleshed out the details and provided thoughtful analyses of the

progression and use of steam navigation in the United States. What follows is a brief survey of these works.

Treatises and Early Works

Perhaps the most useful treatise available today for studying early steamboats in America is the work composed by French royal engineer Jean Baptiste Marestier in 1824. *Memoir on Steamboats of the United States of America* is largely a technical report on the design, construction, and use of steamboats in America in the first quarter of the 19th century. Sent by the French government to observe the steamboats that were operating throughout America's inland waterways, Marestier covered numerous topics, such as the application of steam engines to navigation, the design and dimensions of steamboats, descriptions of specific vessels such as *Chancellor Livingston* and *Fulton*, details on engines from specific steamboats, and notes on numerous steam vessels used in the United States. Included in his treatise are nine plates consisting of multiple views of over a dozen steamers. Manuscripts of this type are extremely rare, and Marestier's report is worthy of careful study as it includes first-hand technical observations pertaining to the early years of American steamboat design.

Tredgold's (1827) *Steam Engine: Comprising an Account of Its Invention and Progressive Improvement* was one of the first technical publications treating not only the history of the steam engine but the mechanics of its operation. Although focused on steam navigation in Great Britain, Tredgold does include the development and use of American steamboats in his study. It was later expanded, updated with contributions

from contemporary scholars, and published posthumously in 1838 as *The Steam Engine: Its Invention and Progressive Improvement*. This book contains a lengthy section on steam navigation in which Tredgold, a British civil engineer by profession, addresses the preferred characteristics of a steamboat, including hull forms, stability, speed, capacity, and strength (Figure 1-6). Much of this treatise, and subsequent technical works by other practical-minded authors mentioned below, is heavily steeped in the mechanics of steam engine operation and is replete with mathematical formulae for calculating such variables as resistance on hull forms, lateral stability, and velocity with which screw propellers and paddle wheels struck the water. Tredgold describes the correct position of paddles on steam driven vessels, examines the appropriate wood to be used for construction, expounds on the application of sails on steamboats, provides general observations on steamboat construction, and provides an appendix full of information pertaining to specifics of marine boilers, the motion of steam vessels, and other relevant details. This two-volume treatise, complete with 125 engravings and woodcuts, represents an enormous early effort at the study of steam navigation. Used by nearly all modern historians of the American steamboat, Tredgold's work stands even today as a primary reference for the early history and growth of the marine steam engine and its practical uses.

A year after Tredgold's first edition of *Steam Engine* (1827), Captain John Ross (1828) of the Royal Navy published *A Treatise on Navigation by Steam*. Written from

FIGURE 1-6. Civil engineer and steamboat chronicler Thomas Tredgold. (From Tredgold 1838.)

the perspective of a naval officer invested in the national defense of Great Britain, the main objective of this work was to demonstrate the importance of the steamship in modern naval tactics. Despite this focus, this manuscript represents another valuable early source on the progressive steps of steam engine design and the mechanics of its operation. Similar to Tredgold's work, a considerable portion of the treatise is dedicated to the technical aspects of the steam engine, such as the principles of the expansive force of steam. Ross's second and third chapters, however, are devoted to steamships and tactics peculiar to steam navigation, in which he covers a number of useful topics, including the recommended proportions of steam-propelled vessels, the rigging peculiar

to a steam ship, observations on steamboat construction, anchors and anchoring, and steam navigation tactics such as lying to in a gale.

It is important to note that the sole existing American shipbuilding treatise from the first half of the 19th century is Lauchlan McKay's *The Practical Shipbuilder*, published in 1839. As the name suggests, this work was prepared for the shipwright interested in the common practice of ship construction, rather than a text on shipbuilding theory. As McKay himself wrote on the first page of the introduction, "the publications of other countries have been large and expensive, full of intricacy, scientific rather than practical, and consequently of little use to the uneducated mechanic" (McKay 1839:n.p.). McKay, a skilled mechanic and carpenter in the U.S. Navy, provided instructions for drafting, lofting and making of molds, and the procedures for the building and outfitting of vessels in America. He also included a section on the form and advantages of steamboats, although his focus was primarily on the western river steamers of his time.

Other notable early technical publications are numerous, and include Dionysius Lardner's (1828) *Popular Lectures on the Steam Engine*, James Renwick's (1830) *Treatise on the Steam Engine*, Peter Hedderwick's (1830) *Treatise on Marine Architecture*, Elijah Galloway and Luke Herbert's (1834) *History and Progress of the Steam Engine*, Lardner and Renwick's (1838) *The Steam Engine: Familiarly Explained and Illustrated*, and P.R. Hodge's (1840) *The Steam Engine*. Although some are more technical than others, these treatises largely follow the pattern of Tredgold's work, including sections on the historical progression of the steam engine, the physics of steam and the mechanics of the steam engine, and its application in marine navigation.

Authored by civil engineers, professors, and other professionals, these treatises are mostly based on a combination of original documents and practical experience and offer valuable insight to the use and operation of the marine steam engine during the first half of the 19th century.

In 1848 Bennet Woodcroft published *A Sketch of the Origin and Progress of Steam Navigation from Authentic Documents*. This remarkable work provides a detailed chronology of the development of steam navigation based almost entirely on original documents, namely letters, patents, and notes of early 19th-century inventors and other individuals involved in the development of steam navigation during this era. Woodcroft's book is less technical than many of the earlier works, and is commonly used as a primary source for the historical development of steam navigation in the United States and Great Britain.

There are a number of other technical works from later in the 19th century on the progression of the marine steam engine and steamship naval architecture, such as John W. Griffiths's (1849) *Treatise on Marine and Naval Architecture*, John Bourne's (1865) *Handbook of the Steam Engine*, and Robert H. Thurston's (1902) *A History of the Growth of the Steam Engine*. These publications, while thorough and informative, are, for the purposes of chronicling the development of early steam navigation, largely updated versions of earlier works detailing the progression of the marine steam engine during the second half of the century.

Another noteworthy mid-19th-century source is James T. Lloyd's (1856) *Lloyd's Steamboat Directory*, a detailed history of steamers with early engravings of vessels

along the western rivers, accounts of numerous steamboat disasters, maps of the Ohio and Mississippi Rivers, descriptions of towns, cities, and landings along the Midwestern rivers, Daguerrean views and sketches of various cities, and a history of all the railroads in the United States at the time. Though focusing primarily on events on the western rivers, the accounts of early steamers nevertheless provide a look at life aboard steamboats, hazards associated with steam machinery, popularity of travel aboard steam vessels, and other aspects of steam navigation in America in the early 19th century.

While these sources have important research value for the study of steamboat development, their true significance lies in their use in conjunction with the other lines of evidence outlined below, particularly the archaeological data, which often provides information contrary to the written sources.

Scholarly Publications

In addition to technical treatises on the subject of the marine steam engine, there are a number of scholarly works on the history of steam navigation from the third quarter of the 19th century through the first quarter of the 20th century. Two notable books from this era include George Henry Preble's (1883) *A Chronological History of the Origin and Development of Steam Navigation 1543-1882* and R.A. Fletcher's (1910) *Steam-Ships: The Story of Their Development to the Present Day*. Preble's book is based on notes collected over 25 years and his personal experience as a rear admiral in the U.S. Navy. He provides a thoroughly-researched and meticulously-detailed account of the history of early steam engine experimenters from the middle of the 16th to the beginning

of the 19th centuries, and continues with the successes of steamboat inventors and notable steamboats of the first half of that century. Fletcher's book, while providing a somewhat less extensive history of steam navigation, contains scores of impressive contemporary plates illustrating steamboats of the 19th century, and has been a good general source for the development of steam-propulsion.

Probably no other source on the origins and development of the early steamboat in America, however, is as extensive and informative as Louis C. Hunter's (1993) seminal work *Steamboats on the Western Rivers: an Economic and Technological History*, originally published in 1949. Though focused on western river steamboats of the 19th century, Hunter's nearly 700-page volume provides an authoritative history of the introduction of the marine steam engine in the United States, illustrates the economic importance of steam navigation in the westward expansion of the country, describes the structural evolution of the western river steamer, provides information on the techniques of steamboat operation, examines the causes and effects of steamboat accidents, outlines the development and organization of steamboat companies, and captures the decline of steamboats in the wake of the railroad, in addition to a range of other topics. *Steamboats on the Western Rivers* stands even today as the primary authority on the development of the western river steamboat in America.

More recent scholarly works on the history of steam navigation are too numerous to list, but some of the noteworthy sources that have discussed the progress of steam navigation based on documentary evidence include John H. Morrison's (1958) *History of American Steam Navigation*, James Thomas Flexner's (1978) *Steamboats Come True:*

American Inventors in Action, R. John Brockmann's (2002) *Exploding Steamboats, Senate Debates, and Technical Reports*, and Andrea Sutcliffe's (2004) *Steam: The Untold Story of America's First Great Invention*.

Archaeological Studies

In addition to technical treatises and scholarly works on the history of steam navigation, a number of archaeological studies have been conducted on western river steamboats and those steam-driven vessels that plied the Great Lakes (Lenihan 1994; Cooper and Labadie 1997:176-180; Corbin 2000; Crisman 2005, 2007; Corbin and Rodgers 2008). Adam Kane's (2004) *The Western River Steamboat*, for example, combines historical research with archaeological data collected from a range of steamboat wreck sites to trace the development of the western river steamboat and explain hull design, progression and use of riverboat steam machinery, use of hogging chains for longitudinal support, and other developmental details. The ongoing study of the western river steamboat *Heroine* (Crisman 2005, 2007) has provided tangible evidence of the steam technology used aboard such vessels during the 1830s and the compatible hull characteristics of the era. Used in conjunction with the available historical documentation for the adaption of steam navigation, the interpretation of this data expands our knowledge of the development of steam propulsion, which often strays from what is written in the treatises and theoretical works of the early 19th century. By incorporating archaeological research into such studies, information recovered from

archaeological sites can be hypothesis tested and compared with historical documents to create a more accurate depiction of our collective cultural and historical background.

Despite the existence of these notable archaeological studies, most of the historical and archaeological studies of shipbuilding and navigational technology on inland waters have focused on steam vessels dating from the 1830s onward for western river boats, and from the 1860s onward for lake steamers. Little research has been centered on lake steamboats in the decades between 1810 and 1830, which are most representative of the transitional stages involving steamboat hull design, improvement in navigation, and passenger amenities. This is chiefly a result of the scarcity of archaeological examples of steamboats from the early 19th century.

In addition to *Phoenix* (1815-1819), the few physical remains of similarly-built vessels from this early period include *Vermont* (1809-1815), *Ticonderoga* (1814-1825), and *Lady Sherbrooke* (1817-1824). Scant evidence exists for the hull characteristics of *Vermont*, the first steamer to be launched on Lake Champlain (Ross 1997:24). Although discovered in the 1950s and raised from the Richelieu River, conservation efforts were nonexistent, and the vessel slowly rotted before a thorough examination and recording of the hull could be completed. Nevertheless, a number of hull construction details are preserved in the unpublished notes of Lake Champlain maritime historian A. Peter Barranco, Jr. (Barranco 1963). *Ticonderoga*, constructed at a shipyard in Vergennes, Vermont, was originally intended as a steamer for Lake Champlain but was purchased by the U.S. Navy and converted to a 17-gun schooner for the War of 1812. Although the hull remains are considerably distorted and lack structural integrity, the surviving

timbers are on display in Whitehall, New York, and were recorded by Kevin Crisman (1983). *Lady Sherbrooke* was discovered in the St. Lawrence River and was archaeologically excavated and recorded in the 1980s (Bélisle and Lépine 1988). Reported to have been built to the design of Fulton's *Chancellor Livingston*, this sunken passenger steamer exhibited informative details about early steamboats and is an excellent comparative example for the study of *Phoenix*. These early steamboat remains are discussed in more detail in Chapter VIII, as they are most representative of the development of the first lake steamers in America.

To Conclude

As outlined in the preceding pages, the objective of this study was to provide a more complete understanding of the advent of steam-propelled vessels in North America, particularly with regard to their construction and use in the inland seas and lakes in the early 19th century. The methodological approach consists of the study and analysis of available primary resources, chiefly historical records, iconographic representations, and archaeological examples of steamboat wrecks from the first quarter of the 19th century. A range of archival documents, including plans and sketches of early steamers, have been gathered for analysis and interpretation, and a number of steamboat wrecks have been identified for comparison with the archaeological study of the sunken Lake Champlain steamer *Phoenix*. As the earliest extant archaeological example of a steamboat in North America, *Phoenix* is an excellent case study for the development of steam propulsion, and the analysis of her construction features and use is

expected to enhance our understanding of this important era in American maritime history. It is hoped that this current study will lay the groundwork for continued research and serve to illuminate the challenges and achievements encountered and gained by those involved in the development of this technology.

CHAPTER II

TRANSPORTATION ON AMERICA'S INLAND SEAS AND WATERWAYS PRIOR TO THE INTRODUCTION OF STEAMBOATS

For thousands of years before the emergence of steam propulsion in North America, the country's vast system of inland seas and waterways were viewed as transportation highways. The Mississippi River and a number of its tributaries were first sighted by Europeans when Spaniard Hernando de Soto recorded his discovery in 1541, approximately 75 years before the Great Lakes were explored by the French (Mills 1976:19). These were already well-traveled waterways, as Native American populations had lived along the Mississippi and its tributaries for over 10,000 years. At the time of the European exploration of the Mississippi basin, Indian nations including the Cheyenne and Sioux were actively trading and fishing on those waters. By the time Samuel de Champlain first glimpsed Lake Champlain in 1609, the Algonquins, Hurons, Montagnais, Iroquois, and generations of their ancestors had long been traveling, trading, fishing, hunting, and engaging in warfare on the northern rivers and lakes in dugout or birch bark canoes. Undoubtedly waterborne activity on these northern waterways reaches back nearly to the dawn of human habitation in these regions of North America, likely during the Paleoindian period (9,500 to 7,000 B.C.).

Champlain explored Lake Huron in 1615 and Lake Ontario in 1617, and was followed by French explorers Étienne Brûle, who first sighted Lake Superior in 1629, and Jean Nicollet, who reached Lake Michigan in 1634. The existence of Lake Erie was

made known in 1669 through the discoveries of Louis Joliet (Mills 1976:19; Bauer 1988:181). At this time the Great Lakes region was occupied chiefly by two great Native American factions: the Algonquins, including the Ottawas, Chippewas, Menomonies, Sacs and Foxes, Miamis, Potawatomies, Illinois, and Kickapoos; and, the Iroquois, encompassing the Senecas, Oneidas, Onondagas, Cayugas, and Mohawks (Mills 1976:28).

Native American watercraft on the northeastern waterways of the continent during the 16th and 17th centuries consisted of floats, rafts, dugout canoes, birch canoes, pirogues, and coracle skin boats called 'bull boats' made of buffalo hide. The type of craft built was determined by the environment, purpose of the vessel, and natural resources and tools available for construction (Leshikar 1996:13-19).

Initially, European explorers, missionaries, traders, and settlers utilized native watercraft in addition to traditional European boat types in their colonial ventures. Eventually boatbuilders developed other craft to suit their needs. From around 1680 French settlers in North America built canoes, flat-bottomed river vessels, and bateau to carry furs, supplies, and soldiers on the northeastern lakes and rivers (Cozzi 2000:21). They introduced the purpose-built bateau in order to travel effectively on virtually any stream in the region. Bateaux were light, keel-less, flat-bottomed boats propelled by oars, poles, or square sails, and steered with an oar or rudder. Often they were equipped with a cabin or awning, and were roughly 40 ft. (12.19 m) long, 9 ft. (2.74 m) in beam, and 32 in. (81.28 cm) deep (Baldwin 1941:42). English settlers used these versatile craft as well, and adapted them to their specific needs. They expanded the size, for example,

and created what was termed the gundelow for transporting people and goods in protected coastal waters, and on rivers and lakes. These vessels were also used during wartime, as in the case of the Continental Navy gunboat *Philadelphia* which sank during the Revolutionary War at the Battle of Valcour Island and was later raised and placed on exhibit in the Smithsonian American History Museum. Gundelow were 40 to 60 ft. (12.19 to 18.29 m) in length, flat-bottomed, double-ended, and typically cutter-, sloop-, or hoy-rigged. They had a shoal draft hull with chine bilges and side frames composed of curved standing knees. Gundelow are known to have been used throughout the northeast on the St. Lawrence River, Lake George, and the James River, and as far west as Illinois territory. These boats were employed on the northern lakes and rivers for a variety of purposes into the 20th century (Chapelle 1976:20; Chapelle 1982:54; Cozzi 2000:9).

American pioneers built and used a variety of other small craft on the inland waterways, each type an adaptation to the environment in which it worked. Such craft included Durham boats, arks, Kentucky boats, keelboats, flatboats, barges, broadhorns, Mackinaw boats, Mohawk boats, New Orleans boats, Ohio packet boats, Schenectady boats, and Susquehanna boats. Although each vessel type was purpose built according to its intended use, they all could be classified into two broad categories of boats: flatboats and keelboats (Cozzi 2000:11). Flatboats were square-ended, flat-bottomed vessels ranging between 20 and 100 ft. (6.1 to 30.48 m) in length and between 12 and 20 ft. (3.66 and 6.1 m) in beam. The average flatboat likely held between four and five hundred barrels (40 to 50 tons), the unit in which capacity was typically expressed. They

were stoutly built and usually roofed over. The bow of the flatboat raked forward to lessen resistance to the water. Steered by means of a 30 to 40 ft. (9.14 to 12.19 m) oar and rarely equipped with sails, flatboats were designed to travel downriver only, where they were sold, cast adrift, or broken apart for building materials. Keelboats were double-ended boats with finer hulls, typically 40 to 80 ft. (12.19 to 24.38 m) long and 7 to 10 ft. (2.13 to 3.05 m) in beam, with a shallow keel and equipped with a cabin for sheltering goods and passengers. They were rowed, poled, and sailed both down and up river, and steered by means of a long oar. Keelboats ranged from between 15 and 50 tons burden (Baldwin 1941:44-48).

Traditional European sailing craft commonly used in North America during the colonial period include the sloop, brigantine, ketch, pink, shallop, bark, brig, and snow. Many of these vessel types were used chiefly along the eastern seaboard as coastal craft or employed in the West Indies trade, and probably closely resembled their European counterparts (Chapelle 1982:13). Although boatbuilders experimented with many vessel types, the schooner appears to have been the first distinctive type of rig the American colonists employed during the 18th century. By the time of the American Revolution, the schooner was in general use and was the most numerous class of carrier. It became the principle sailing rig used on the Great Lakes after its introduction on Lake Erie by the French in 1728. Great Lakes schooners were versatile craft designed with full hulls meant to maximize cargo capacity. They were generally gaff-rigged, carried a topsail, and could be sailed with a small crew which made them economical to operate. The well-preserved and intact remains of two War of 1812 merchant schooners, *Hamilton*

and *Scourge*, rest at the bottom of Lake Ontario at a depth of 299 ft (91 m), and represent the type of craft that was in use on the northern lakes from the 18th century into the 20th (Chapelle 1982:41; Cooper and Labadie 1997:178-179).

On Lake Champlain, sloops were largely used for commercial service, which began to boom shortly after the Revolutionary War. Between 1790 and 1815 approximately 30 ships were launched on the lake. Most of these were built in Burlington, Vermont, shipyards and were modeled after New London, Connecticut, boatbuilder Daniel Wilcox's plans. His design was that of a 30-ton sloop based on a "fast sailing" hull. These sloops chiefly carried goods and people between Burlington and St. Johns, Canada, stopping at lake ports along the way. Later, these craft became the bitter rivals of steamboats, with both vying for control of the lake as the demands of commerce required more capacious and dependable vessels (Ross 1997:18-23; Cozzi 2000:27)

The early 19th century also saw the development and use of horse-propelled craft on the northern rivers and lakes. These vessels were propelled by coercing a team of horses to walk in a circle around a horse whim in order to turn a paddle wheel. Introduced within a decade of the successful employment of steam navigation, horse-powered craft remained in the shadow of the larger, faster, and more technologically complex steamers, which also garnered gruesome headlines when boiler explosions occurred. The relatively inexpensive and safe horse-powered vessels, however, were found to be excellent ferryboats as they were well-suited for travelling short distances, necessitated by the limited endurance of the animals. Initially, ferry owners could not

afford to operate expensive steamboats, but horse-powered vessels were economical and were little affected by wind and current. In this way, steamboats helped push horse-powered vessels into common use as the initial years of steam navigation were fraught with tremendous expense, risky experimentation, difficulty in obtaining machinery, legal issues associated with steamboat monopolies, and havoc-wreaking boiler explosions (Crisman and Cohn 1998:x-28).

In addition to these unique craft, the specialized sailing canal boat was introduced into the country's northern lakes with the completion of canals that connected the upper Hudson River with Lakes Erie and Champlain. On 10 September 1823, the opening of the Lake Champlain Canal finally connected the lake to the Erie Canal, thereby opening navigation and increasing interstate commerce and transportation. This was of significant economic importance as the existing roads made it prohibitively expensive to ship heavy cargos to and from Lake Champlain. Boatbuilders on the lakes developed the sailing canal boat from existing types of inland craft which were modified to suit operation in a canal. The dimensions of the canal's channel and lift locks naturally dictated the shape and size of the vessel. Towed canal boats used on the Champlain and Erie Canals from 1819 to 1830 were approximately 61 ft. (18.59 m) long, 7 ft. (2.13 m) in beam, and 3 ft. 6 in. deep (1.07 m), with a 30-ton capacity. Their sailing cousins originated in Lake Champlain, however, and were of different dimensions. The first account of a vessel to be sailed on the open lake and continue its journey being towed within the narrow confines of the canal was *Gleaner*. This vessel was launched in 1823 and passed directly from St. Albans, Vermont to New York with a

cargo of wheat and potash. *Gleaner* was sloop-rigged, 60 ft. (18.29 m) long, 13 ft. 6 in. (4.11 m) in beam, and 3 ft. 6 in. (1.07 m) deep. The sailing canal boat would develop throughout the years, and was the most numerous class of sailing vessel enrolled on Lake Champlain between 1840 and 1865. Though they were introduced more than a decade after the first successful steamboat on Lake Champlain, they were widely used on the lake where they were seen as an economic alternative to steam technology (Cozzi 2000:iii-67).

From the 16th through the 19th centuries, these and other watercraft were gradually developed to suit the needs of Europeans and colonists and their descendants in North America. Meanwhile, generations of hardworking and innovative individuals in Europe and North America were painstakingly developing a technology that would permit a vessel to be propelled through the water without relying on manual labor or ideal weather and sea conditions. The steamboat had humble beginnings, developing from a technology that was initially applied to more mundane industrial tasks. As a series of inventors and entrepreneurs strove for the perfection of this idea, however, incremental advancements eventually led to the first commercially-successful steamboat in 1807. Most of the watercraft described above continued to be used for commercial and naval purposes alongside the steamer, often as competitors on the country's northern lakes and rivers. The steamboat, however, made a lasting impression that altered the face of national and international waterborne travel. This achievement would result in a pivotal change in the efficiency, safety, and regulation of transportation in America, and

would have an indelible impact on the nation's maritime trade, economic expansion, and social development.

CHAPTER III

THE DEVELOPMENT OF STEAM NAVIGATION IN NORTH AMERICA

The history of steamboat development stretches back to at least the 16th century, and has been recounted in a number of published studies in considerable detail (Preble 1883; Fletcher 1910; Morrison 1958; Flexner 1978; Hunter 1993; Sutcliffe 2004). What follows here is a brief chronology of the evolution of the marine steam engine and the first attempts at steam propulsion, intended to provide a broader context for the study of early lake steamers in North America.

Mechanical Propulsion of Watercraft and the Advent of the Marine Steam Engine

Mechanical propulsion of watercraft is an ancient concept. Perhaps the earliest indication for the application of paddlewheels on boats can be traced to the Roman army under Appius Claudius Caudex in the third century B.C. It is written that oxen-driven wheels were fitted on the vessels that transported Caudex's troops across the Strait of Messina into Sicily during the First Punic War (Figure 3-1; Stuart 1829:97). Further evidence for the early use of mechanical propulsion can be found in Robertus Valturius's *De re militari*, published in 1472. This medieval text includes drawings of two boats, in which one is equipped with five pairs of paddlewheels and the second one is equipped with a single pair (Valturius 1472[2]:2; Woodcroft 1848:1-2). A publication dating to 1782 from a study on China conducted by Jesuit missionaries in Peking describes a *barque à roues* moved by paddlewheels turned by men, perhaps in use as early as the

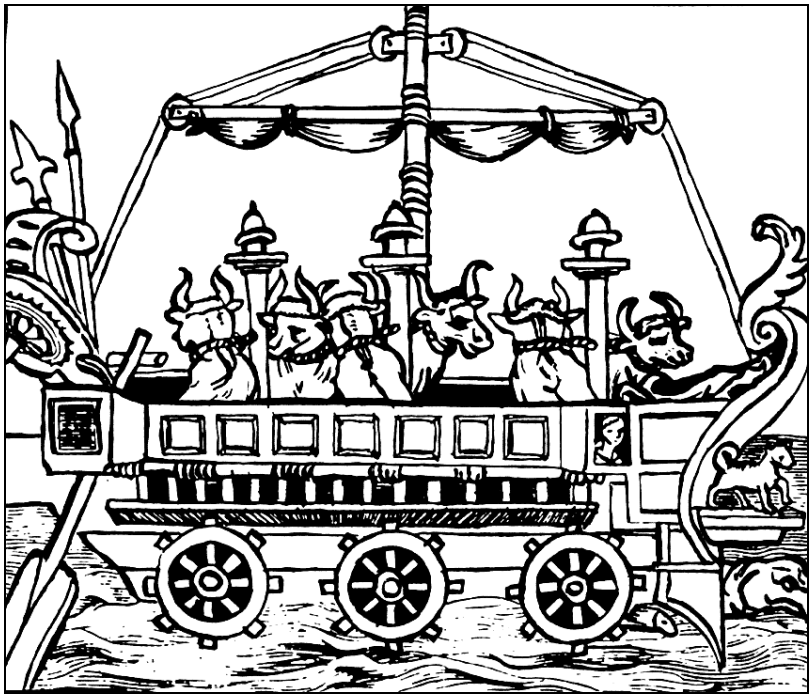


FIGURE 3-1. Early oxen-driven vessel from the third century B.C. (After Ward 1973:16.)

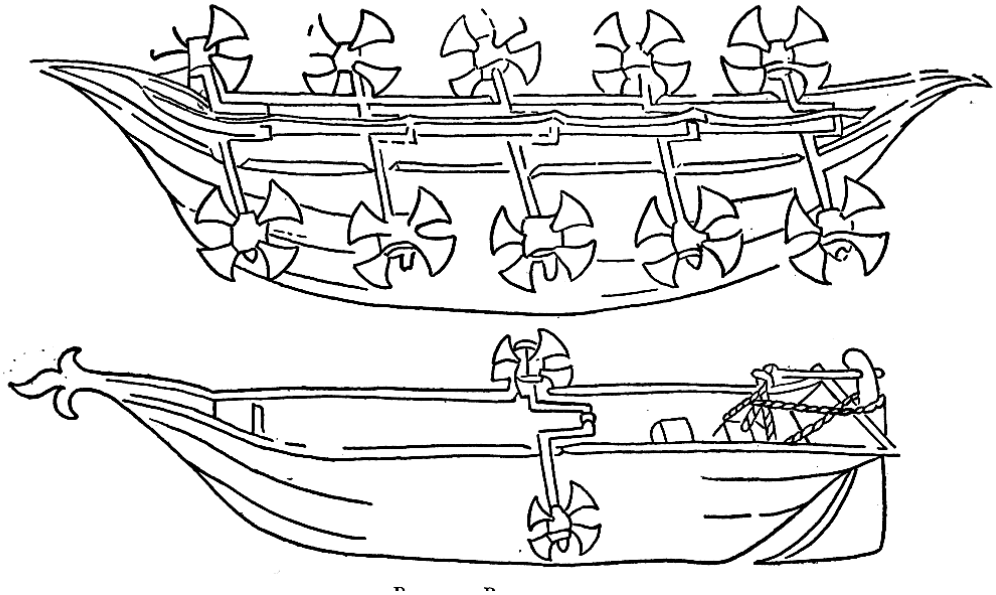


FIGURE 3-2. Sketch of a *liburna* propelled by paddlewheels. (From Fletcher 1910:3)

seventh century. Yet another early example is from the writing of Panciroli in the 16th century, in which he describes a *liburna* propelled by six paddlewheels moved by oxen (Figure 3-2; Fletcher 1910:4-6; Mills 1976:77). Leonardo da Vinci explored the possibilities of paddle-driven vessels as well, and in his scientific notebooks sketched pictures of boats fitted with paddle oars operated by mechanical gears (Figure 3-3; Ward 1973:18). Mechanical methods of propulsion thus were not novel techniques in the era of American watercraft development. What *was* innovative in boatbuilding during this period was the direct application of steam as a provider of force and motion for propulsion.

The success of the 19th-century marine steam engine was gained through gradual technological improvements spanning several centuries. Early attempts to control the power of steam are documented in ancient texts. The description of Hero of Alexandria's steam turbine, or *aeolipile*, from his 120 B.C. treatise on pneumatics demonstrates that experimentation with the expansive nature of steam stretches back over two millennia (Fry 1896:25). The 13th-century writings of Roger Bacon suggest possible testing of steam propulsion, wherein he describes "a vessel which, being almost wholly submerged, would run through the water against waves and winds with a speed greater than that attained by the fastest London pinnaces" (Fry 1896:25). Spanish captain Blasco de Garay (1500-1552) was historically acknowledged as the first to experiment with a "steam" engine—his consisting of a cauldron of boiling water—capable of moving two wheels suspended on either side of a vessel as a means of propulsion. Later studies have discredited this assertion, however, as no records exist describing the actual application

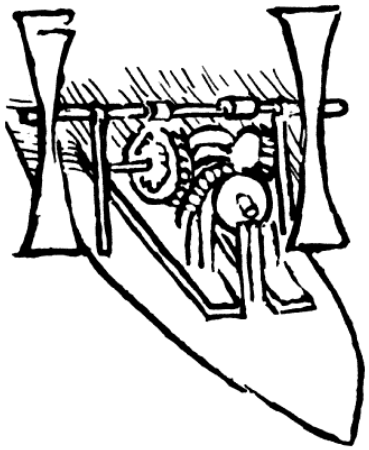


FIGURE 3-3. Drawing of a paddlewheeler from one of da Vinci's notebooks. (After Ward 1973:18.)

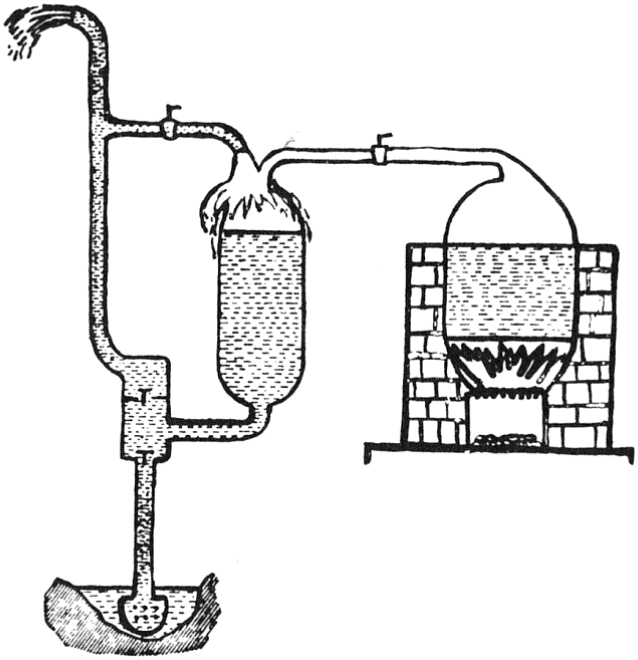


FIGURE 3-4. Design of Savery's early steam pump. (After Ward 1973:25.)

of steam in any of his experiments (Preble 1883:3).

Attempts of a more scientific nature began in the 17th century. In 1630 David Ramsey obtained a patent in England for an invention in which one of its functions was to "make Boats, Ships, and Barges to go against the Wind and Tyde", presumably by the power of steam (Woodcroft 1848:4). The Marquis of Worcester is often credited with the invention of the first practical atmospheric marine steam engine based on his pamphlet published in 1663, although sufficient evidence does not exist to confirm his true accomplishments (Woodcroft 1848:7; Preble 1883:5; Fletcher 1910:10). A number of other patents for steam engine design were taken out in the second half of the 17th century, but it was not until Dr. Denis Papin's construction of an early piston-and-cylinder steam device in 1690—which he suggested could be used to propel a vessel through the revolution of paddlewheels fitted to a boat—were significant advancements toward steam navigation made (Fletcher 1910:11). Papin is also credited with the invention of the safety valve and two-way cock for distributing steam alternately to the top and bottom of the steam cylinder (Ross 1828:10).

In 1698, Englishman Thomas Savery took out a patent for his steam engine, which was designed to "raise water by the impellent force of fire." This was, perhaps, the earliest practical steam pump, and was employed for supplying houses with water, draining fens, and pumping water from ships. Savery was the first person to use the term *horsepower* to compare the power of his engine to the number of horses required to produce the same effect (Figure 3-4; Ross 1828:10; Ward 1973:25). Although later that

year he suggested that the power of steam might be adapted to the propulsion of ships, he never pursued the matter (Preble 1883:6).

Papin is commonly acknowledged as the first to successfully propel a steamboat through water when he demonstrated his small boat on the Fulda River in Germany in 1707. Unfortunately, his steamer was confiscated and destroyed by the envious boatmen of Münden while Papin was en route to London, and nothing significant immediately came of his accomplishment (Preble 1883:6; Fletcher 1910:11-12). In 1712, however, another breakthrough occurred when Englishman Thomas Newcomen modified Savery's engine design by incorporating a piston, which made reciprocating motion possible (Figure 3-5; Marestier 1824:2). Newcomen's engine was probably the first to effectively harness heat energy to produce force and motion.

In 1736, Jonathan Hulls took out a patent for a steamboat, the proposal for which he described in a pamphlet published the following year. His proposal actually concerned four types of steam-powered vessels, including one propelled by paddlewheels and one by poles—a design James Rumsey experimented with in America in the late 18th century. His steamboat design utilized an engine which was an adaptation of Newcomen's invention. Although Hulls's tests generated public and royal interest in Great Britain, his designs were considered impractical on a large scale and he ultimately failed due to a lack of financial support (Flecther 1910:13-15; Ward 1973:28).

Written studies on steam propulsion contributed to the exchange of ideas as well. In 1738, Swiss-Italian Daniel Bernouilli published *Hydrodynamica*, in which he proposed the idea of moving a vessel through a form of jet propulsion in which a

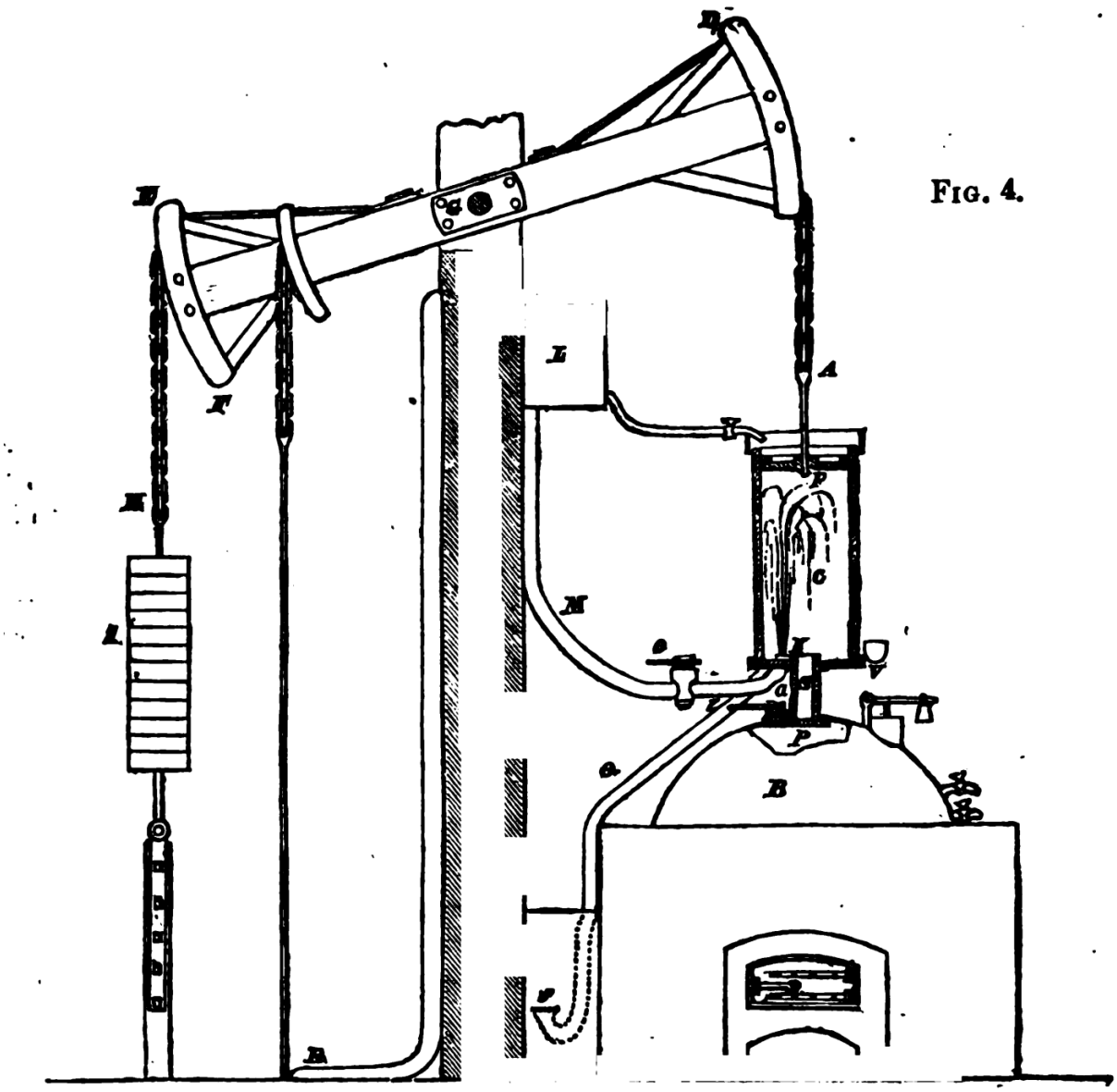


FIGURE 3-5. Newcomen's modification of Savery's engine design. (From Tredgold 1838:10.)

jet of water would be forced through a tube at the bow and out the stern (Sutcliffe 2004:10). Fifteen years later he wrote an essay on the mathematical advantages of using steam engines for vessel propulsion, and obtained a prize from the French Academy of Sciences for this work (Preble 1883:9).

Tinkering with the design of a Newcomen-type engine, in 1778 the Marquis de Jouffroy tested steam-driven vessels operated by duck's feet and paddlewheels to imitate the movements of aquatic birds on the River Doubs in France. His trials, though imperfect, further proved to skeptics that boats could in fact be powered by the force of steam (Fletcher 1910:16-17; Flexner 1978:45).

It was Scotsman James Watt's contributions to the development of the steam engine, however, that resulted in a device that could effectively be used to propel a boat through water. His improvements of the Newcomen engine throughout the 1770s and into the 1780s paved the way for a reliable power-supply for steamboat machinery. The low-pressure engine designed by Watt, and later manufactured by Boulton and Watt in England, was extremely successful and remained the standard engine for industrial purposes for many years. It consisted of a large double-acting cylinder which used only a few pounds of steam pressure per square inch. The exhausted steam passed into a condenser where it was condensed by cold water to create a partial vacuum. A large-diameter cylinder was necessary in order to obtain the needed power since the power for driving the piston was principally supplied by the pressure of the atmosphere rather than the direct pressure of the steam. This was the type of engine used on most early steamboats in North America until the introduction and widespread use of Oliver

Evans's high-pressure, non-condensing engine in the first quarter of the 19th century, chiefly installed and used on western river craft (Figure 3-6; Hunter 1993:123).

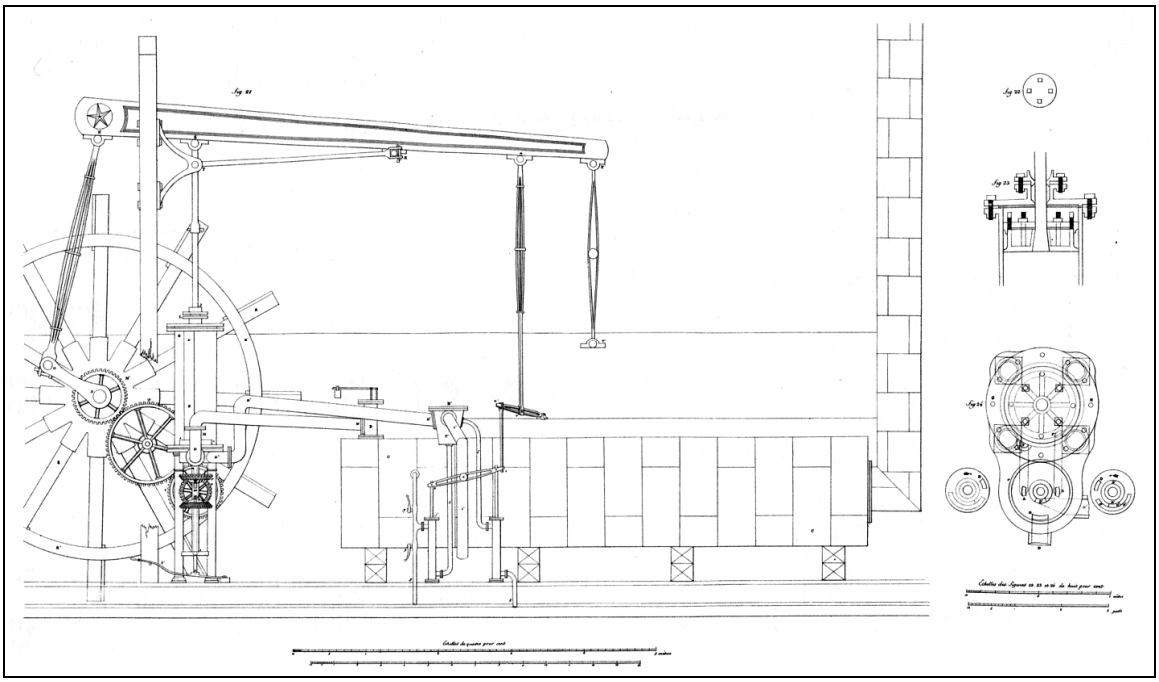


FIGURE 3-6. Plans for Evans's high-pressure, non-condensing engine. (From Marestier 1957:81.)

Development of Steam-Driven Vessels in America

Although the gradual development of steam navigation took place over the course of at least two hundred years, the major breakthroughs in America occurred between the 1790s and 1840s. Watt's revolutionary steam engine design in 1782 provided the necessary power-to-weight ratio that was required for vessel propulsion, and once it became available to experimenters of the late 18th- and early 19th-centuries, developments advanced at a more rapid pace (Bauer 1988:68). In the early years of experimentation, however, Watt's engines were not readily available in North America

due to the implementation of a British law banning the export of this technology. American steamboat builders, as a result, often tinkered with and modified existing engines to devise Watt-type power supplies (Sutcliffe 2004:xii).

While a number of developers contributed to the successful introduction of steam navigation in North America, John Fitch and James Rumsey were two of the most tenacious. As indefatigable rivals, throughout the 1780s and 1790s they struggled to create a practical steam-driven vessel capable of traveling both up and down river independent of wind or current. Working on the rivers of the Atlantic seaboard, where the densest concentration of people, trade, and technical resources existed, Fitch and Rumsey are known for their novel inventions and unique experiments (Hunter 1993:5). Their competition erupted in pamphlet wars in 1788, and they were among the first to clash in federal patent battles over their creations with the passage of the United States Federal Patent Act in 1790. Fitch and Rumsey dabbled not only with modified engine types, but with methods of mechanical propulsion as well. Fitch devised boats equipped with racks of paddles and mechanical oars, and Rumsey tested mechanical pole boats and jet propulsion. In the late 1780s, both inventors were designing steamboats capable of traveling short distances during trial runs, which proved to be little more than promising demonstrations (Flexner 1978:367; Sutcliffe 2004:227-228). Despite the patronage of George Washington and other influential figures, Rumsey was unable to maintain the funding to continue his work. Fitch was marginally more successful, and in 1790 he had two commercial steamers operating between Philadelphia, Pennsylvania,

and Trenton, New Jersey. Despite this, he too was unable to raise the necessary funding to finance his work and, like Rumsey, could not continue his enterprise (Bauer 1988:68).

Wealthy businessman John Stevens supported both Fitch and Rumsey at different times during their careers. Dissatisfied with the progress of either, Stevens took it upon himself to produce a functional steamboat. Hiring mechanics and engineers to work under his supervision, Stevens was moderately successful in putting steam-driven vessels on the Hudson that traveled at a rate of 5 or 6 miles per hour (8 or 9.65 kilometers per hour). Their operation, however, was deemed impractical for common use (Preble 1883:25).

Independent of Fitch, Rumsey, and Stevens, Samuel Morey designed an experimental sternwheeler which steamed on the Connecticut River in 1793. His boat successfully traveled from Hartford to New York, and drew the attention of New York State's Chancellor Robert Livingston, who later approached him with a business proposition (Bellico 2001:261).

Meanwhile, mechanic Oliver Evans was working diligently on the design of a high-pressure engine for use in a steam carriage. Long a proponent of western river steam navigation, by 1802 Evans had produced a successful high-pressure engine which was lighter and more compact than its low-pressure counterparts. He was granted a patent for his design in 1804, but it was not until the late-1810s that this technology became more widely available to steamboat builders, particularly those built for the western rivers (Ward 1973:72; Hunter 1993:124).

Nicholas Roosevelt, a lawyer and engineer, was also drawn to steamboat design,

and built a foundry in New Jersey for producing steam engines in the early 1790s (Ward 1973:51). He would later become heavily involved in the construction and operation of western river steamboats on the Mississippi.

Livingston was able to obtain a steamboat monopoly from the state of New York in the early years of the 19th century, but despite collaborations with Roosevelt, Stevens, and Morey, was unable to produce a practical steamboat for operation on the Hudson. Stevens continued experimenting with his own designs, however, and in 1804 had a screw-propelled vessel operating on the river. As this boat required the use of a high-pressure steam engine, it was soon abandoned in favor of craft capable of operating with the low-pressure sort. Although Evans had developed a viable high-pressure engine by this time, it was still complicated to manufacture and not readily available (Fletcher 1910:29; Bauer 1988:69).

Livingston met American painter Robert Fulton in France in 1802 while serving as the minister to France. Fulton became intrigued with canal locks and steam vessels while studying in England, and eventually entered into a long-standing partnership with Livingston in the steamboat business. After spending time experimenting with a range of steam-propelled craft in France and England, Fulton obtained a Boulton and Watt steam engine and returned to the United States to begin construction of a vessel for Livingston, who had again secured a monopoly to operate steamboats in New York waters. Finally, in August of 1807, Fulton's side-wheeler *North River Steamboat of Clermont* was launched on the Hudson River. *Steamboat*, as she was known, was 140 ft. (42.67 m) long, 16 ft. (4.88 m) in beam, had a 7 ft. (2.13 m) depth of hold, a draft of 28 in. (71.12

cm), and was built with a flat bottom and a hard chine. Her paddlewheels were placed just forward of midships, and she carried two auxiliary masts for sails. *Steamboat* made the 150 mile (241.4 km) trip from New York to Albany in 32 hours at a time when swift Hudson River sloops were making the voyage in 48 hours. Fulton's steamer is almost universally considered to be the first successful commercially-operating steamboat in North America, and her design was a major milestone in the development of steam navigation (Figure 3-7; Bauer 1988:70; Simmons 1996:190; Bellico 2001:262; Sutcliffe 2004:165).

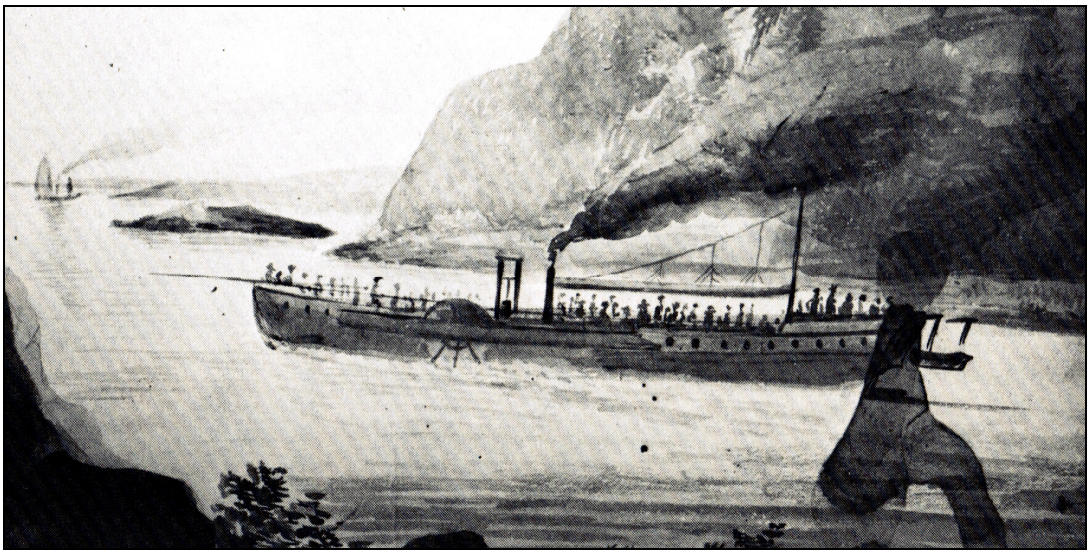


FIGURE 3-7. Fulton's own depiction of *Steamboat* on the Hudson River. (After a painting at the U.S. Naval Academy Museum.)

Early Steam Navigation on the Inland Seas and Northeastern Rivers of America

Transportation on the lakes and rivers was key to the successful establishment of economic life in many parts of northeastern North America. After the Revolution, there

was a steady and growing stream of settlers to the Champlain Valley. As suitable lands were cleared and homes built, there was a need to transport materials and people to their destinations, and to enable trade and cultural contact with inhabitants in the surrounding frontier. As towns developed populations boomed, and as trade increased there was a pronounced need for an economical mode of transportation. A combination of land and water travel was the most common method up until the mid-19th century. The land options in some areas, however, were not particularly reliable or accessible. For example, most of the existing roads along the western side of Lake Champlain were the remnants of old military roads largely in disrepair. Transporting merchandise by wagon was an arduous feat that required a number of horses and wagon drivers capable of the lengthy trek, and oftentimes a considerable portion of the goods had to be carried on pack horses (Kane 2004:6). The schooners and other sailing craft that operated on the inland seas and waterways in the 18th century were a far more efficient and effective alternative to overland travel along the often impassable sharp descents and abrupt ridges that existed in those regions, but it was the introduction of the steamboat that answered the call for increased shipping needs in the northern settlements in the early 19th century (Cone 1945:13).

From the Hudson River to Lake Champlain

John Stevens, continuing to work independently, completed the construction of his Hudson River steamboat *Phoenix* shortly after *Steamboat* was launched. Although Stevens' design was successful, he was compelled to move his operations to the

Delaware River as result of the Fulton-Livingston monopoly. Elihu Bunker, owner of a number of sloops on the Hudson, gained the support of investors from Albany and Troy and attempted to operate a pair of steamers on the river. He and his supporters, however, were brought to court by Fulton and Livingston for their illegal operation that infringed upon their monopoly (Bauer 1988:70). Charles Browne, a shipbuilder employed by Fulton and Livingston, testified that Bunker's vessels *Hope* and *Perseverance* were practically of the same design as Fulton's, resulting in a court order for Bunker to cease operations on the Hudson (Fletcher 1910:36; Davison 1981a:2-3).

Others involved in the shipbuilding trade also recognized the futility of operating a steamboat on the Hudson at this time. In 1808, shipwrights John and James Winans, previously employed by Fulton in the construction of *Steamboat*, moved to Burlington, Vermont. With the support of local businessmen they began construction of the 167-ton sidewheeler *Vermont*. The first steamboat to operate on Lake Champlain, this passenger vessel was 120 ft. (36.58 m) long with a flush deck, the passengers cabin below deck, and rigging for sails (Bellico 2001:264). The construction and use of *Vermont* represents an important achievement in early American steamboat history because her successful operation was the earliest attempt at adapting steam propulsion to the northern lakes. She operated on the lake and its tributaries for six years before her pitman became dislodged and drove a hole through the hull while traveling on the Richelieu River. Wrenched out of the lake in the 1950s during a salvage operation, *Vermont* was studied by historian A. Peter Barranco, Jr. before she completely deteriorated due to the lack of conservation efforts. She had a high length-to-beam ratio, side paddlewheels placed just aft of

midships, and was built with a hard chine (Bellico 2001:264). The Winans, who were hired to help with the construction of *Steamboat*, designed *Vermont* along lines that were similar to Fulton's early river steamers. *Vermont*'s construction and use is discussed in more detail in later chapters.

Bunker's Hudson River investors, largely from Albany, were able to secure a charter in 1812 from the state of New York for exclusive steamboat operation on Lake Champlain. Moving their business to Lake Champlain and naming it the Lake Champlain Steamboat Company, they set out, with additional support from Vermont businessmen, to construct a 120 ft. (36.58 m) long steamboat at their Vergennes, Vermont, shipyard (Ross 1997:30). At this time, however, Lake Champlain was considered a strategic waterway by both the British and United States during the War of 1812. Early in 1813, Commodore Thomas Macdonough arrived at Vergennes and spied the Lake Champlain Steamboat Company's hull under construction. Macdonough was seeking to augment his fleet in preparation for an impending British invasion of the lake. Lieutenant Steven Cassin wrote to Secretary of the Navy William Jones and described the unfinished boat, and, despite his initial hesitation, Macdonough decided to buy the uncompleted hull. At this time, the Lake Champlain Steamboat Company was more than willing to sell the hull at an inflated price, likely due to the effects of the war on commercial steamboat operations on Lake Champlain. Macdonough decided to have the ship, christened *Ticonderoga*, modified into a 17-gun schooner instead of a steam-propelled battery due to his concern about potential breakdowns and the inability to easily obtain replacement parts. Renowned New York shipwright Noah Brown altered

the hull, adding five pieces to the keel to add stability under sail, and he probably strengthened the upper portions of the hull to hold the guns she would need to carry. *Ticonderoga* served well during the Battle of Plattsburgh and, under Lieutenant Cassin's command, turned away a small flotilla of gunboats. The remains of *Ticonderoga*, currently on display in Whitehall, New York, contain elements of one of the earliest hull designs for a lake steamer. Her construction resembles that of a sea-going vessel adapted to steam rather than one of Fulton's early vessels modeled after canal boats with high length-to-beam ratios, hard chines, and lighter scantlings (Crisman 1983, 2009). *Ticonderoga* and *Phoenix*, Lake Champlain Steamboat Company's second vessel, were departures from this philosophy, as will be examined in later chapters.

The Lake Champlain passenger steamer *Phoenix*, built in 1814-1815, provided a regular service between Whitehall, New York, and St. Johns, Canada, for five seasons before burning and sinking off Colchester Shoal in Lake Champlain in September 1819. *Phoenix* represents a significant advancement in the development of the steamboat. She was 146 ft. (44.5 m) long with a 27 ft. (8.23 m) beam and 9 ft., 3 in. (2.82 m) depth of hold. Though she still had a fairly high length-to-beam ratio, her beam was increased from earlier steamboat designs to help prevent hogging as a result of the hull strains imparted from heavy steam machinery. Like *Ticonderoga*, she had lines more akin to a sailing vessel than earlier steamers, and carried a single mast stepped well forward in the hull. *Phoenix'*s 45-horsepower cross-head engine and paddlewheels were placed approximately three-eighths the overall length of the vessel abaft the stem (Ross 1997:31). She was sturdily built and appears to be the model upon which many of the

company's later vessels were designed. The remaining chapters of this study are dedicated to the analysis and interpretation of her documented history and archaeological remains, as she is the earliest surviving example of a steamboat in North America.

Following *Phoenix* were Lake Champlain Steamboat Company's steamers *Champlain*, *Congress*, and *Phoenix II*. *Champlain* operated alongside *Phoenix* until she burned in 1817. *Congress* was launched shortly thereafter and, upon *Phoenix*'s destruction in 1819, *Congress* was the only steam vessel operating on the lake until *Phoenix II* was built in 1820 (Ross 1997:31-41).

Steamboats were also being built in Canada at this time, and John Molson's 170 ft. (51.82 m) long *Lady Sherbrooke* is an example for which we have archaeological evidence. *Lady Sherbrooke* was built in 1817 and operated on the St. Lawrence River until she sank in 1824. She is said to have been modeled after Fulton's *Chancellor Livingston*, and was evidently well built and comfortably furnished. Designed to transport both passengers and cargo on the Canadian rivers, she was heavily constructed, double-framed, and had deck beams that extended past the hull to help support the paddlewheel assemblage. She was partially excavated in the 1980s and is the earliest surviving example of a steamboat in Canada (Bélisle and Lépine 1988). *Lady Sherbrooke* is another of the rare archaeological examples of early steamboat construction in North America, and the study of her remains has contributed to our understanding of early 19th-century steamboat design.

The Great Lakes

Steamboats were slower to gain a foothold on the Great Lakes, largely because sailing vessels were easier to handle and could take great advantage of the steady lake winds. In addition, limited settlement of the lakes prior to the War of 1812 restricted the demand for steam propelled vessels, and the earliest steamboat designs were not suited for open lake navigation. Among the earliest examples of Great Lakes steamers includes *Ontario*, built in 1817 for operation on Lake Ontario, and *Walk-in-the-Water*, designed in 1818 to navigate on Lake Erie (Simons 1996:192). Neither vessel, however, met with great success as pure freight vessels because they could not compete economically with the sailing ships in hauling cargo due to the large low-pressure engines and boilers that occupied cargo space (Still et al. 1993:69). Unfortunately, no archaeological evidence for the construction and use of early Great Lakes steamers has yet been discovered for analysis. Some data does exist from later vessels such as *Anthony Wayne*, which operated with moderate success during the 1830s and 1840s on Lake Erie until she blew up and sank in 1850, but her design represents a departure from the early steamers on which this study focuses (Krueger 2009:201-202). It was not until the advent of the screw propeller on the lakes in 1842 that steamboats on the Great Lakes were generally adopted, chiefly because screw-propelled vessels, with their submerged propellers and high gunwales, were better suited to the weather conditions of the lakes. Several screw propellers from the 1840s have been collected and studied (Cooper and Labadie 1997:178). One such example, the propeller from *Indiana* (1848), a steamer which sank

in Lake Superior in 1858, was recovered from the wreck site for interpretation and display in the Smithsonian Museum of American History.

Development of Western River Steamboats

Simultaneous with the development of lake steamers in the northeast was the introduction of steam navigation on America's western rivers. The advent of this technology was crucial to the development of the nation for it enabled the rapid unification of peoples on both sides of the Appalachians. As westward expansion took place, it was important to maintain the economic and cultural contact between the east and west. The existing roads that connected the eastern states with the agricultural regions in the west were little more than unreliable trails, and the carting of goods and people across the mountains was slow, arduous, expensive, and perilous (Sutcliffe 2004:xi). Keelboats and flatboats could journey downriver effectively enough, but traveling upriver was undertaken with great difficulty and at a glacial pace. Furthermore, sails were of little use on the winding, narrow, fast-flowing, and shallow rivers of the west (Hunter 1993:3-4).

In a situation that was analogous to the development of the lake steamer, a number of individuals contributed to the advancement of steam-propelled craft on the western rivers. Fulton and Livingston obtained exclusive rights in 1803 from the U.S. Government to steam navigation on the lower Mississippi. Roosevelt, who had become an associate of the Fulton-Livingston group, was largely responsible for the construction and operation of the steamer *New Orleans*, which on her maiden voyage in 1811 traveled

the 2,000 miles (3,218.69 km) from Pittsburgh to New Orleans. She continued to provide transportation in the New Orleans-Natchez trade until she struck a stump and sank in 1814. *New Orleans* was the first steamboat put into use on the western rivers, but was constructed more along the lines of a ship than a vessel designed to navigate the shallow, winding, snag-infested waters of the western rivers (Hunter 1993:12, 67). *New Orleans* was 116 ft. (35.36 m) long, had a beam of 20 ft. (6.1 m), a depth of 7 ft. (2.13 m), a somewhat rounded hull compared to later western river steamers, and was powered by a low-pressure condensing steam engine. She was equipped with side paddlewheels and two masts for auxiliary sails (Kane 2004:45). Although this steamboat design would be altered significantly in the coming years, *New Orleans* represents a vessel built with the considerations of the environmental conditions under which she would operate on the western rivers. Due to the unreliability and lack of sufficient power in their engines, *New Orleans* and her immediate successors were initially unsuccessful in gaining the nation's full attention. Over the next two decades, however, steamboats on the western rivers would become accepted as the chief mode of long-distance transportation.

By 1813 Fulton and Livingston had devised a plan to have a system of transportation that stretched from Canada to Charleston, West Virginia, and Pittsburgh to New Orleans, incorporating both steamboats and stagecoaches. This arrangement failed to materialize, however, due to hostilities arising from their monopoly, and throughout the next several years there were intense rivalries over navigation rights on the western rivers. Inventors and steamboat mechanics such as Daniel French and Henry Shreve openly repudiated Fulton and Livingston's rights on the lower Mississippi with the

operation of *Enterprise* and *Washington* in 1815 and 1816. A chain of lawsuits ensued and by 1824 the Supreme Court effectively annulled government grants of exclusive rights to navigation in *Gibbons* v. *Ogden* (Bauer 1988:70; Hunter 1993:13-14).

By 1820, most western river steamers were operating with a high-pressure steam engine, which was more easily obtainable than before and offered a significant increase in speed and power. With these advantages, however, came the deadly peril of boiler explosion. By this time, western river steamers were built with high length-to-beam ratios, which were more advantageous on the western rivers due to the decreased friction acting on longer hulls. After the successful development of a snag-removal system, which opened up previously impassable sections of the country and lowered the risk for steam navigation ventures, western river steamers were built with astonishingly light scantlings. The hulls were less-sturdily built than lake steamers in order to provide the shallower draft necessary to navigate the inland rivers. The hulls suffered chronic problems with hogging and sagging caused by the weight and distribution of the steam machinery; they were also susceptible to the menace of submerged logs. As a consequence of the extreme stresses and hazards imparted on these steamers, the average life span of a western river steamboat was four to five years. They were typically built with a boiler deck, hurricane deck, and sometimes a texas deck—the uppermost deck which sometimes incorporated the pilot house. Passenger steamers of this type were often lavishly decorated and appointed despite the light construction (Hunter 1993:87-102).

Heroine

Unfortunately no archaeological evidence exists for the first western river steamers. The earliest extant archaeological example of a western river steamboat to date is a sunken vessel in the Red River near Fort Towson, Oklahoma. The 160-ton *Heroine* represents an example of the riverboat design achieved after the many successes and failures of earlier steamboats. Lacking hogging trusses, *Heroine* was by no means of perfect construction. She was, nevertheless, built with the features that at the time were considered suitable for a vessel of her purpose. She was designed by a small-scale operation in the Midwest to carry both passengers and cargo on the western rivers (Crisman 2005:9).

Heroine was built in 1832 and worked as a transport vessel until she hit a snag in the Red River 1838, which punctured the hold and sunk the vessel. At this time, *Heroine* was six years old and had outlived the projected four to five years of service during which most western river steamers were expected to operate. She was transporting supplies, including barrels of pork and other provisions, to Fort Towson, Oklahoma, when she sank. Although some of the provisions were recovered shortly after the sinking, a large percentage was left on the steamer and quickly buried by the swift Red River current and sediment. This provided an ideal preservation environment, with examples of artifacts and hull structures surviving from a period of which little is known in the field of steamboat archaeology (Brown and Crisman 2005:3-4).

Heroine was 136 ft. 8 in. (41.66 m) long with a 20 ft. 4 in. (6.19 m) beam. In order to operate efficiently on the western rivers, she had to have a fairly high length-to-

beam ratio as well as a shallow draught. Key features uncovered during the archaeological and archival investigations of *Heroine* include relatively light scantlings, use of a high-pressure steam engine, side paddlewheels, use of a pair of fly-wheels to more efficiently cycle the engine, a fairly flat hull with heavy stringers installed for longitudinal support, a hard turn of the bilge, installation of a water resistant bulkhead at the bow, cross-braced support timbers placed beneath the steam machinery, bow and stern compartments for stowage of ship's equipment and crew possessions, and numerous access hatches. The hull was preserved in some parts to the main deck and was documented extensively (Figure 3-8; Crisman 2007:4).

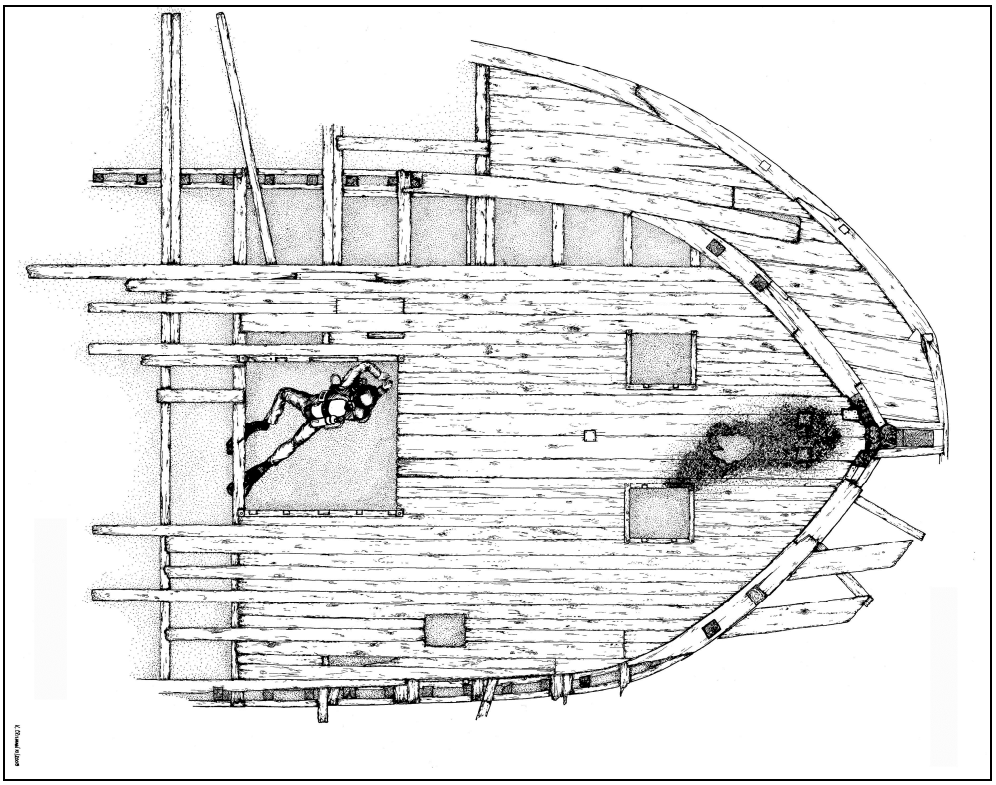


FIGURE 3-8. Plan view of the bow of *Heroine*. (Courtesy of Kevin Crisman.)

Steamboat Safety Concerns

The 221-ton *Washington*, built under the direction of French and Shreve and uniquely designed with a horizontally-placed high-pressure engine, made her maiden voyage from New Orleans to Pittsburgh in 1816 at record speed. Shortly thereafter she became the first vessel on the western river to blow a steam boiler, resulting in the death of a number of passengers and crew. Over the next thirty years a combination of steamboat races, incompetent steamboat operators, poorly trained engineers, lack of scientific knowledge, unreliable cast iron machinery, and the inability of Congress to legislate effective safety regulations for high-pressure steam resulted in the death of over 3,000 people. In the midst of the dissolution of the Fulton-Livingston monopoly in 1824, the steamboat *Aetna*'s steam boiler blew, killing 12 and wounding 9 others. Soon a bill was drafted which would require routine steam engine inspections and licensing, as well as the addition of tamper-proof safety valves to prevent racing, but Congress failed to act due to a lack of knowledge and general misconceptions about steamboats. Both Congress and the public at large were misled into believing that steamboat design followed a natural development and that advances in technology would correct present inadequacies. The truth about the available technology of the period, however, was that most steam engines were transferred from wreckage to new boats three to four times throughout their life spans (Morrison 1958:207; Brockmann 2002).

Throughout the 1830s a number of reports were generated by the Federal Government as well as private institutions, culminating in well-written compendia detailing the importance of a steamboat bill and providing guidance to the legislature. A

steamboat bill of 1838 was eventually passed but was ineffectual. Testimonies from steamboat inspectors of this era prove how cursory the inspections were, and the practice of modifying safety-valves allowed for continued racing. Eventually, a steamboat inspection law was passed in 1852, which required trained and licensed operators, pressure-tested boilers, fusible blow-out plugs, new gauges and indicators, and allowed a powerful group of independent steamboat inspectors to board vessels at any time and require repairs to faulty designs. This time the law proved effective, and in the eight years following the passage of the law, deaths caused by the explosion of steamboat boilers fell by 33% in America (Brockmann 2002:123-126).

The development of steam navigation during the 19th century in the west was instrumental for the growth of manufacturing, national economic stimulus, and maintaining cultural contact throughout the rapidly expanding United States. The western river steamer was viewed by the rest of the world as the typical American steamboat because of its unique, highly-recognizable design adapted to the environment in which it operated, as well as the heavy reliance placed upon it for general transportation within greater Mississippi watershed (Hunter 1993:3).

In Summary

The period between 1790 and 1840 was a progressive one for the development of steam-propelled vessels. This was, however, not a linear advancement. The advent of the double-acting steam engine of the 1780s allowed for more rapid improvements throughout the 19th century. The early efforts of Fitch, Rumsey, and others contributed

to the experiments of later developers such as Fulton, the Winans, and Shreve. The Fulton-Livingston monopoly only stoked the fires of competition, and many early challengers rose in defiance of government-granted exclusive rights to navigation, which eventually led to the nullification of steamboat monopolies in the United States. The early development of steam navigation on Lake Champlain and the St. Lawrence River in Canada led to increasing numbers of boats and widespread commercial successes of steamboat companies on these waterways. The Great Lakes saw the general acceptance of steam as well, initially with sidewheelers, a trend which expanded with the coming of the screw propeller in the 1840s. The accepted design of the western river steamboat developed in response to the shallow and rapid waters in which it operated, and differed significantly from the construction of northern lakes and rivers steamers. And finally, while slow to gain support, steamboat legislation eventually regulated the way steamboats would be designed in terms of safety and reliability, and set some of the standards for the continued advances of steam propulsion in America.

CHAPTER IV

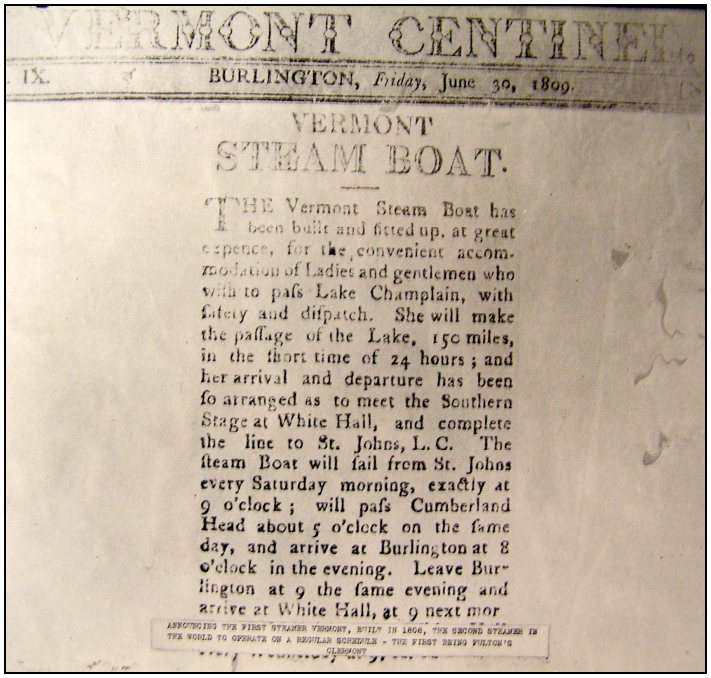
THE LAKE CHAMPLAIN STEAMBOAT COMPANY'S *PHOENIX*

> Truly, we know not what a day may bring forth. Human life is a vapour, that appeareth for a little time, and then vanisheth away. And yet, our eternal destiny is depending on the manner in which we spend this short and uncertain period. To neglect a preparation for death a single day, may be to loose [sic] our souls forever … (*Northern Sentinel*, 10 September 1819).

***Vermont*, the First Steamer on Lake Champlain**

In the summer of 1808, the Winans brothers completed the construction of *Vermont* and, while attempting to launch her into the lake, she got stuck halfway down the ways. This resulted in a significant delay of her operation as she became stuck in the mud of the lakeshore. With the assistance and determination of the Burlington townspeople, the steamer was forcibly maneuvered into deeper waters. Her regular trips from Whitehall, New York, to St. Johns, Quebec, finally began in June of the following year. This strategic route was designed to connect the existing Montreal-to-St. Johns stage coach line with the Whitehall-to-Troy line. Troy was across the Hudson River from Albany, where passengers could connect with *Steamboat* for passage to New York City. *Vermont* made one round trip per week, typically in 24 hours despite frequent breakdowns, and was advertised in newspapers such as the *Vermont Centinel* (Figure 4-1; Fowler 1974:30; Ross 1997:25).

Although no drawings or construction plans of *Vermont* are known to exist, surviving descriptions of the ship suggest that she resembled an elongated canal boat with a smokestack and paddlewheels (Figure 4-2). She was reportedly painted black, had



VERMONT CENTINEL

IX. BURLINGTON, *Friday*, June 30, 1809.

VERMONT
STEAM BOAT.

THE Vermont Steam Boat has been built and fitted up, at great expence, for the convenient accommodation of Ladies and gentlemen who wish to pass Lake Champlain, with safety and dispatch. She will make the passage of the Lake, 150 miles, in the short time of 24 hours; and her arrival and departure has been so arranged as to meet the Southern Stage at White Hall, and complete the line to St. Johns, L. C. The steam Boat will sail from St. Johns every Saturday morning, exactly at 9 o'clock; will pass Cumberland Head about 5 o'clock on the same day, and arrive at Burlington at 8 o'clock in the evening. Leave Burlington at 9 the same evening and arrive at White Hall, at 9 next mor

ANNOUNCING THE FIRST STEAMER VERMONT, BUILT IN 1806, THE SECOND STEAMER IN THE WORLD TO OPERATE ON A REGULAR SCHEDULE - THE FIRST BEING FULTON'S CLERMONT

FIGURE 4-1. Advertisement of *Vermont* in the *Vermont Centinel*. (From Champlain Transportation Company records at the Bailey Howe Library, University of Vermont.)

FIGURE 4-2. A modern-day artist's depiction of *Vermont* at Basin Harbor, Vermont. (After a painting by Ernest Haas.)

an open deck except for the presence of the chimney, a low deck house over the machinery and boilers amidships, two masts for ancillary sails, and possibly some shelter for the crew at the bow. The engine and boiler were located in the hold, and the largely unprotected paddlewheels were suspended over the side. Her deck had no pilot house as she was steered by a tiller positioned aft. A single 25 x 18 ft. (7.62 x 5.49 m) room below deck served as a dining saloon, stateroom, and sleeping quarters with berths on one side (Hemenway 1867:687; Hill 1977:195-196).

Vermont was 120 ft. (36.58 m) in length, 20 ft. (6.1 m) in beam, had an 8 ft. (2.44 m) depth of hold, and displaced 167 tons. She was powered by a 20-horsepower low-pressure engine equipped with a 20 in. (50.8 cm) diameter cylinder, a 36 in. (91.44 cm) stroke, and a balance wheel 10 ft. (3.05 m) in diameter. The engine was a second-hand Boulton and Watt type found by the Winans brothers on the Hudson, horizontal in design and complete with a side lever bell crank. *Vermont* was capable of making 4 to 6 miles per hour (6.44 to 9.66 kph), but was outdistanced by lake sloops in fair winds, much to the satisfaction of sailboat owners who felt threatened by the coming of steam navigation on Lake Champlain (Rushlow 1898:35; Hill 1977:195; Ross 1997:25).

During the War of 1812, *Vermont* was prohibited from entering Canada due to a British blockade of American ports. Unable to operate at her full commercial potential, she also supported the American war efforts by transporting troops and supplies, the first steamer in U.S. history to perform this duty. In one instance, upon being informed of a potential British ambush near Providence Island, Captain James Winans positioned kegs of powder in the hold in preparation to scuttle the steamer to prevent capture. In 1814,

Vermont further served by transporting Commodore Macdonough and General Macomb to a victory celebration in Burlington after the Battle of Plattsburgh Bay (Hill 1977:197).

Vermont operated for six years on Lake Chaplain until her frequently ailing engine finally caused a breach in the hull (Rushlow 1898:35). This staunch vessel was part of the competition that the fledgling Lake Champlain Steamboat Company faced upon the establishment of their shipyard in Vergennes.

Establishment of the Lake Champlain Steamboat Company

Next to the Great Lakes, Lake Champlain is the largest body of deep fresh water in the United States, encompassing approximately 490 square miles (788.58 square km). Lake Champlain's greatest width is 12 miles (19.31 km) and at its deepest point is 399 ft. (121.62 m). The lake is fed by a number of sources, including the Missisquoi, Lamoille, and Winooski Rivers and Otter Creek from the Green Mountains to the east; the Poultney and Mettowee Rivers, as well as Wood Creek and Lake George, from the south; and the Great and Little Chazy, Saranac, Ausable, Salmon, and Bouquet Rivers from the Adirondacks in the west. At its northern extent in Quebec, the lake becomes the Richelieu River, a tributary of the St. Lawrence River (Hill 1977:6-7).

Fully aware of the success of *Vermont* and grasping the potential for another commercial steamboat enterprise on Lake Champlain, Elihu Bunker's investors from Albany turned their eye toward the 118-mile (189.9-km) long lake following the Fulton-Livingston monopoly's lawsuit to prohibit their operation in New York waters. Although Bunker was pushed out of the Hudson River, the Albany investors were able to reach a

settlement with Fulton and Livingston by which the former would be permitted to sell their steamboats *Hope* and *Perseverance* in order to build steamboats for Lake Champlain. They would also be permitted to transfer the machinery from *Perseverance* to be used in the hull of a new vessel on the lake (Sherman 1977:26; Ross 1997:29).

Having solidified their legal position to operate on the New York side of Lake Champlain, the Albany investors successfully gained the interest of several influential and wealthy individuals in Vermont to supplement their existing capital. The Lake Champlain steamboat investors now included distinguished Vermonters Cornelius P. Van Ness, Moses and Guy Catlin of Burlington, and Amos W. Barnum of Vergennes. Along with Albany businessmen Teunis Van Vechten, Abram G. Lansing, Isaiah and John Townsend, J. Ellis Winne, Samuel T. Lansing, and Joseph Alexander, the group organized the Lake Champlain Steamboat Company. Among the company's directors was Captain Jahaziel Sherman, former captain of the Albany group's steamer *Perseverance* and future captain of *Phoenix* (Hemenway 1867:688; Rushlow 1898:35; Sherman 1977:26).

On 12 March 1813, a charter for the company was procured from the New York State Legislature, formally granting an exclusive right of steam navigation on Lake Champlain until 11 April 1838. In 1815, the state of Vermont granted a similar right to the steamboat company, a penalty of $500 being fixed for each violation of this act. The age of government-granted steamboat monopolies would not last, however, as judicial action was taken by would-be competitors in an increasing number of cases and culminated in *Gibbons vs Ogden* in 1824. Daniel Webster, arguing for lawyer and

steamboat operator Thomas Gibbons in the Supreme Court, successfully argued that in the Constitution commerce between states included navigation, and the federal government therefore had jurisdiction over common waterways. Conceding to this logic, Chief Justice John Marshal's ruling placed federal jurisdiction over that of the states, dissolving all previous steamboat monopolies and clearing the slate for open competition in steam navigation (New York 1813:36; Hill 1953:78; Bellico 2001:264-66).

The Lake Champlain Steamboat Company was the first major, multi-investor steamboat company established in America, and through the years survived in various forms until its absorption into the Champlain Transportation Company in 1835 (Rushlow 1898:35; Ross 1997:29). With an initial capital of $100,000 and multiple investors, the Lake Champlain Steamboat Company immediately set out to build vessels that could compete with *Vermont* and ply the long distance from Whitehall, New York to Canada on regularly scheduled trips.

The Conception of *Phoenix*

One stipulation of the New York charter of 1813 was that the Lake Champlain Steamboat Company had to have at least one steamboat operating on the lake within 18 months from the end of the present war—later known as the War of 1812 (Davison 1981a:3; Crisman 2009:4). Wasting no time, the steamboat company sent Jahaziel Sherman to oversee the construction of a new vessel to be built by a shipwright John Lacey in Vergennes, Vermont. When the keel of this vessel was laid in 1813, its designers were unaware that it was destined to become a warship. In the spring of 1814,

before the ship was finished, it was purchased by the U.S. Navy as part of an urgent and desperate effort to improve the squadron in preparation for the War of 1812. As described in Chapter II, due to the war's negative impact on commercial steamboat travel, the company was willing to sell the hull to the Navy and intended to charge the government for her use as a steamer, thereby meeting the requirements of the charter to have a steamboat in operation on the lake. Seeing little use for a steamship of war at this time, however, Commodore Macdonough instructed his carpenters to convert the would-be steamer to a 17-gun schooner instead, and as such *Ticonderoga* played an important role in the naval confrontation at the Battle of Lake Champlain in Plattsburgh Bay, New York on 11 September 1814 (Rushlow 1898:35; Sherman 1977:23; Crisman 2009).

Apparently undaunted by the loss of *Ticonderoga*, in 1814 the Lake Champlain Steamboat Company laid the keel of another steamboat at Vergennes, *Phoenix*, again under the supervision of Jahaziel Sherman. It was into this vessel that the engine and boiler from *Perseverance* was transferred and fitted. *Phoenix* was designed by a master-builder named Mr. Roberts as a passenger steamer for the purpose of making the round trip between Whitehall and St. Johns, the same route offered by *Vermont*. The construction of *Phoenix* was completed in 1815, and, because the war was over at this point, she was able to serve as intended. The total cost to build the Lake Champlain Steamboat Company's first vessel was $45,000 (*Commercial Advertiser*, 18 September 1815:1; Rushlow 1898:35; Sherman 1977:24; Ross 1997:30-31).

Characteristics and Operation of *Phoenix*

The Ship

Plans or drawings of *Phoenix* have never been found, if indeed they ever existed. Records from the Champlain Transportation Company, however, describe her as a wooden paddlewheeler 146 ft. (44.5 m) long, with a 27 ft. (8.23 m) beam and 9 ft. 3 in. (2.82 m) depth of hold (Ross 1997:31). She displaced 336 tons and was propelled by a low-pressure cross-head steam engine with a 24 in. (60.96-cm) cylinder and 36 in. (91.44-cm) stroke, built by Robert McQueen of New York City. Larger than *Vermont*'s power plant, *Phoenix*'s engine delivered 45 horsepower compared with her competitor's 20 horsepower, effectively doubling her speed. *Phoenix* combined the characteristics of both steam-propelled vessels and sailing craft, with a deep draft, mast stepped well forward in the hull, and a bowsprit. The hull of *Phoenix* was somewhat rounded, and her single mast was square-rigged to harness the wind when advantageous. The steamer had a canvas awning draped over the main deck aft of the smokestack for protection from the elements and the cinders and smoke issuing from the chimney. The paddlewheels of *Phoenix* were covered with wooden boxes to prevent drenching of the deck and to protect the machinery. Short guards extended from the bow to approximately 25 ft. (7.62 m) abaft the wheels. Just aft of the guards, which were positioned outboard of the hull to support the paddlewheels, small boats were suspended from davits for boarding and debarking passengers. These boats were reached by ladders leading to the deck (Hill 1977:198). A railing was fitted around *Phoenix*'s main deck to prevent people from going overboard, but the main deck did not have living quarters for passengers, a feature

that was starting to appear on steamboats (Figure 4-3; Hemenway 1867:688-689; Heyl 1956:199; Sherman 1977:25; Hill 1977:198-199).

A 6 ft. by 10 ft. (1.83 m by 3.05 m) housing sheltered the staircase, which led below deck to *Phoenix*'s elegant and stylishly-appointed ladies and gentlemen cabins. The steamer was also designed with a small state room, a lounge, a smoking room, a barber shop, a galley and pantry, a captain's office and separate stateroom, and luggage compartment. There was also an area to store stacks of cord wood which served as the steamer's fuel. These compartments all shared space with the boiler and engine, which were also located below deck (Hemenway 1867:688; Hill 1977:198-199).

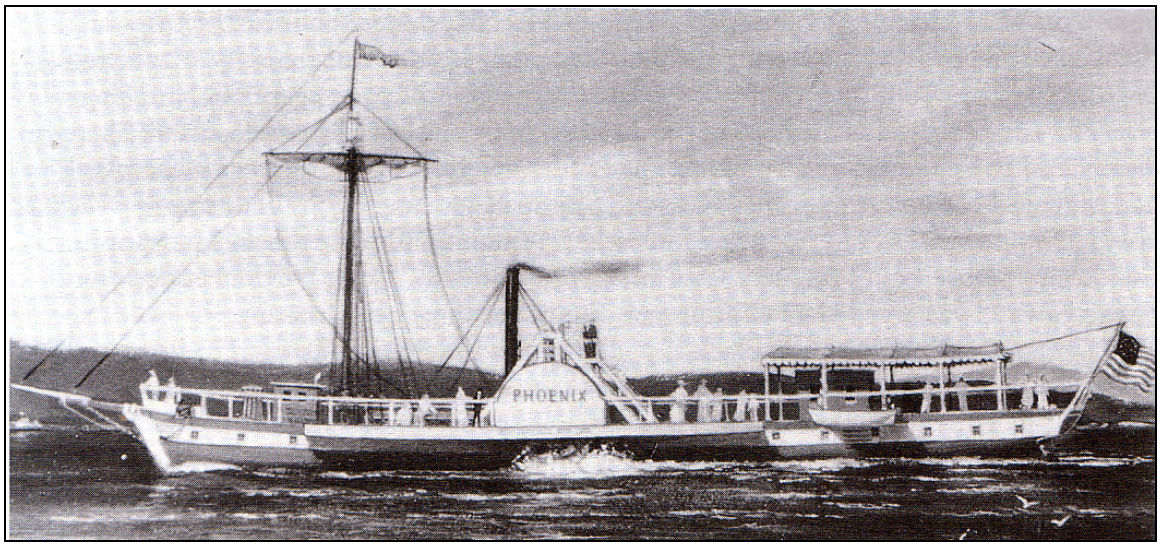


FIGURE 4-3. A modern-day artist's depiction of *Phoenix* under steam. (After a painting by Ernest Haas.)

As described in the fable "Witch of Lake Champlain," which recounts the story of the burning of *Phoenix*, "to the eye of superstition, the smoke that issued from her bowels, the wheels which appeared like immense feet to paw the deep, and the incessant noise of the machinery, would have pictured 'a dragon of the wave!' she presented to the intelligent observer one of the noblest triumphs of science" (Sedgwick 1826:109).

Operation

Captained by Jahaziel Sherman, *Phoenix* began steaming on Lake Champlain in September 1815, making the trip between Whitehall and St. Johns with an hour stop at Burlington in passing each way. She left the New York port every Wednesday morning at 9:00 A.M. and departed from Quebec on Sundays at 9:00 A.M. The cost of the trip was $10.00 for passengers, which included room and board, but the steamer also took on freight at various prices per barrel: pot and pearl ashes were $1.00, provisions were 75¢, flour was 50¢, firkins of butter were 25¢, tierces of seed or salt were $1.25, and tierces of rice were $2.00 (*Commercial Advertiser*, 18 September 1815:1; *Commercial Advertiser*, 20 September 1816:4).

A few months after *Phoenix* began plying the lake, misfortune befell *Vermont*. On the night of 21 October, on her way back from Quebec, *Vermont*'s connecting rod became detached from the crank and drove a hole through the bottom of the boat, sinking the vessel in 20 minutes a few miles south of Isle aux Noix. The pilot quickly steered her toward shore and the steamer grounded in shallow water with her quarterdeck exposed. The next day the passengers were rescued by *Phoenix*

(*Commercial Advertiser*, 6 November 1815:3). According to the *Commercial Advertiser*, which had copied an account published by the *Boston Centinel*, "she was one of the first boats that was built, and we are informed, that by the improvements in the machinery of the modern boats, they are not liable to the accident which occasioned the loss of *Vermont*" (*Commercial Advertiser*, 6 November 1815:3). To this text, however, the newspaper added "*Vermont* has been so much out of order during the whole Summer, that many persons, desirous of crossing the Lake, have considered her altogether unsafe, and have selected other modes of conveyance" (*Commercial Advertiser*, 6 November 1815:3).

To divert the Winans from building another potentially-competitive steamboat with the engine salvaged from *Vermont*, the Lake Champlain Steamboat Company contracted John Winans for the installation of the recovered engine and boilers in their newly-built 128-ton, 90 ft. (27.43 m) long steamer *Champlain*, launched on Otter Creek near Vergennes. *Champlain* was smaller, lighter, and less elegant than *Phoenix*; apparently built more as a dwelling for the recovered engine and boilers than to provide comfort for lake passengers (Ross 1997:31).

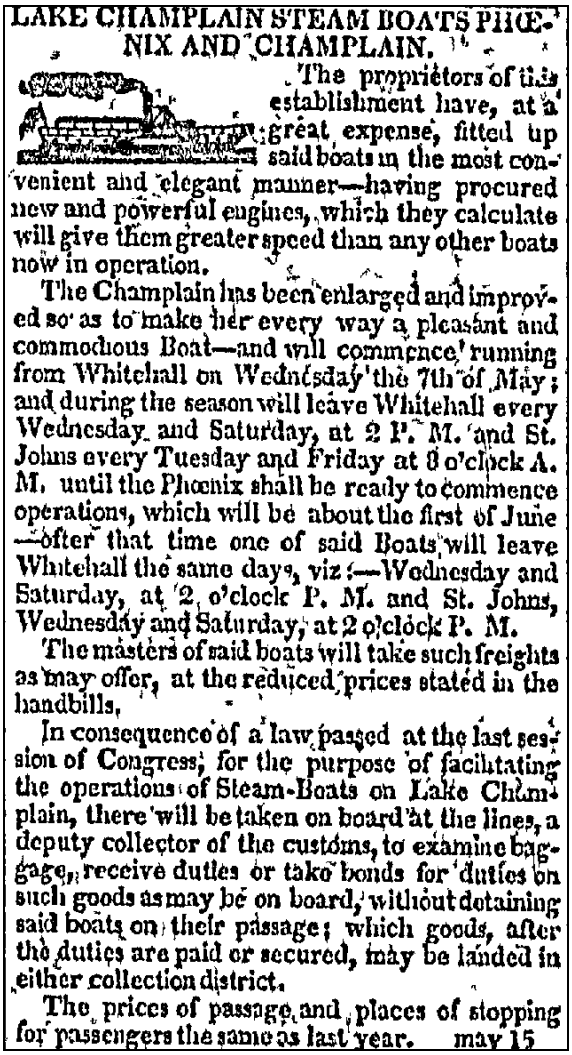
During the 1816 and 1817 seasons, *Phoenix* and *Champlain* ran a continuous service between Whitehall and St. Johns, departing from opposite ends of the lake. Every Wednesday *Phoenix* steamed out of Whitehall at 2:00 P.M. and on Saturdays left St. Johns at 8:00 A.M. Captained by George Brush, *Champlain* departed Whitehall at 2:00 P.M. on Saturdays and left from St. Johns at 8:00 A.M. on Wednesdays. Both routes continued to stop one hour in Burlington each way, but now also passed around

Cumberland Head to take on passengers from Plattsburgh, New York. In addition to people, they took freight at the same prices that *Phoenix* had quoted before. All other goods, except for fur and specie, were charged at the rate of "$5.00 per ton, weight, or measure, at the choice of the captain" (*The Albany Argus*, 27August 1816). Advertisements mentioned that freight could be landed at almost any place on the lake. In addition, goods ordered to the care of certain companies, such as Winnie & Fonda of Albany and Richard P. Hart & Co. of Troy, were "forwarded with the greatest possible care and dispatch, to Whitehall" (*The Albany Argus*, 27August 1816).

Equipped with the comparatively weak and troubled steam engine from the sunken *Vermont*, *Champlain* was plagued with engine troubles throughout her first year. Whatever her initial purpose as an expedient housing for the engine of a sunken rival enterprise, her situation was considerably improved when both *Phoenix* and *Champlain* received overhauls in the spring of 1817. In fact, the newly renovated *Champlain* would temporarily take over the duties of both boats while *Phoenix* underwent her own improvements. In April of that year, a newspaper article announced:

> LAKE CHAMPLAIN STEAMBOATS PHOENIX AND CHAMPLAIN. The proprietors of this establishment have, at great expense, fitted up said boats in the most convenient and elegant manner—having procured new and powerful engines, which they calculate will give them greater speed than any other boats now in operation. The Champlain has been enlarged and improved so as to make her every way a pleasant and commodious Boat –and will commence running from Whitehall on Wednesday the 7th of May … until the Phoenix shall be ready to commence operations, which will be about the first of June (Figure 4-4; *Commercial Advertiser*, 15 May 1817).

The cost to travel from Whitehall to St. Johns was lowered to $9.00, with rates varying from $2.00 to $5.00 for the landings in between. An advertising poster of the Lake Champlain Steamboat Company stated: “All other passengers to pay one dollar for every fifteen miles—no one can be taken aboard or put on shore, however short the distance, for less than one dollar … servants half price” (Ross 1997:31). Dogs and other



LAKE CHAMPLAIN STEAM BOATS PHŒNIX AND CHAMPLAIN.

The proprietors of this establishment have, at a great expense, fitted up said boats in the most convenient and elegant manner—having procured new and powerful engines, which they calculate will give them greater speed than any other boats now in operation.

The Champlain has been enlarged and improved so as to make her every way a pleasant and commodious Boat—and will commence running from Whitehall on Wednesday the 7th of May; and during the season will leave Whitehall every Wednesday and Saturday, at 2 P. M. and St. Johns every Tuesday and Friday at 8 o'clock A. M. until the Phœnix shall be ready to commence operations, which will be about the first of June —after that time one of said Boats will leave Whitehall the same days, viz:—Wednesday and Saturday, at 2 o'clock P. M. and St. Johns, Wednesday and Saturday, at 2 o'clock P. M.

The masters of said boats will take such freights as may offer, at the reduced prices stated in the handbills.

In consequence of a law passed at the last session of Congress, for the purpose of facilitating the operations of Steam-Boats on Lake Champlain, there will be taken on board at the lines, a deputy collector of the customs, to examine baggage, receive duties or take bonds for duties on such goods as may be on board, without detaining said boats on their passage; which goods, after the duties are paid or secured, may be landed in either collection district.

The prices of passage and places of stopping for passengers the same as last year. may 15

FIGURE 4-4. Advertisement from 1817 announcing the renovation of steamboats *Phoenix* and *Congress*. (From *Commercial Advertiser*, 15 May 1817.)

animals smaller than a sheep were also permitted to travel aboard the steamers, though it was stipulated that they be tied on deck forward of the capstan. Such animals cost as much as a person and twice as much as a servant (Ross 1997:33).

Champlain's "new" engine was actually the machinery which had served previously on *Perseverance* and *Phoenix,* while *Phoenix* was fitted with a brand new engine. Unfortunately for *Champlain*, these extensive modifications would be short-lived. On 6 September 1817, arsonists allegedly set the boat aflame while she lay at her Whitehall wharf. The fire started near the boiler and spread beyond control by the time it was discovered. Although attempts were made to extinguish the flames, the boat was consumed to the water's edge. The act resulted in *Champlain*'s total destruction except for her books, papers, and approximately half of the furniture; the loss was estimated to be between $30,000 and $40,000. Shortly after this event, Captain Sherman wrote a letter to be published by the newspapers, stating that *Phoenix*, on account of her uncommon speed, would be able to perform the service of both of the steamboats. This would continue for a few months, though she was temporarily laid up while an injured boiler was repaired in October (*Watch Tower*, September 1817; *Republican*, 13 September 1817:2; *Columbian*, October 1817).

Wasting little time after the combustion of *Champlain*, the steamboat company's shipbuilders began construction of another vessel at Vergennes; this one was 108 ft. (32.92 m) long, 27 ft. (8.23 m) in beam, 8 ft. (2.44 m) in depth, and displaced 209 tons. *Congress* was completed and launched during the winter of 1817-1818, and was fitted with the same veteran boiler and engine that had served on *Perseverance*, *Phoenix*, and

briefly *Champlain*. She was scheduled to make the Whitehall-to-St. Johns run along with *Phoenix*, and reportedly could steam at 8 miles per hour (12.87 kph). *Congress* was similar in appearance to her larger counterpart and cost the company approximately $30,000. Initially captained by Daniel Davis, she made three trips per week to Canada, alternating routes with *Phoenix*. After the loss of *Phoenix*, *Congress* was the only steamboat on the lake through the 1819 and 1820 seasons. She lasted for longer than her three predecessors on Lake Champlain, and plied those waters until retired in 1835 (Ross 1997:35; Bellico 2001:267).

In addition to running the regularly-scheduled New York to Quebec route, the steamboat proprietors occasionally took requests from organizations to transport passengers to and from specific events. For example, to accommodate a camp meeting arranged by the Society of Methodists at St. Albans in August of 1819, *Phoenix* and *Congress* took aboard passengers from a number of Vermont and New York towns between Whitehall and St. Albans, including Benson and Orwell, Ticonderoga, Larabee's Point, Chimney Point, Barber's Point, Basin Harbor, M'Neils, Charlotte, Essex, Burlington, and Plattsburgh. Cost of passage from any of these points to St. Albans was $1.00, and the passengers were accommodated with a deck passage only, with "such additional accommodations as the forward cabin will afford for the convenience of ladies and children" (*Christian Messenger*, 9 August 1819).

As steamboats were the only convenient connection between many cities and points of interest, *Phoenix* was twice able to serve the country during her career. The first instance was in July of 1817, when she carried President James Monroe from

Burlington to Vergennes to visit Macdonough's shipyard, then on to the village of Plattsburgh, where the President landed at the dock on the east side of Cumberland Head and was transferred at that point by barge. A year later, *Phoenix* had the honor of transporting the remains of General Richard Montgomery, the American Revolutionary War hero who had fallen during the siege of Quebec in 1775. The general's nephew escorted the remains to St. Johns, where they were placed aboard *Phoenix* and steamed the Lake Champlain portion of the journey to St. Paul's Churchyard in New York City. The steamer was draped in black and carried her flags at half mast for the voyage (Crockett 1921:146; Hill 1977:201; Ross 1997:30).

The Burning of *Phoenix*

On the clear moonlit evening of 4 September 1819, *Phoenix* was docked at the wharf in Burlington to pick up passengers before continuing on her way north to Quebec. That evening, illness confined Captain Jahaziel Sherman to his bed in Burlington, which left his 21-year-old son Richard in command of the steamer. Around 11:00 P.M., after all passengers had boarded the vessel—bringing the total on board to 46 persons—she steamed out of the waterfront toward Plattsburgh and St. Johns. According to Captain Richard Sherman's account of that night, he remained on deck with Custom House Officer George Burnham until the steamer passed the reefs of Colchester, while most of the passengers retired to their berths. At this point in the evening, having stayed up the previous night in preparation for his new duties, Sherman ordered his pilot to alert him when they approached Crab Island and went below to his

stateroom where he fell fast asleep. Per custom, a night watch was kept on deck at this time (Hemenway 1867:689).

The steward and barkeep, a gentleman named D.D. Howard, shared a cabin with the captain, which was in the forward end of the ship. The crew quarters were reached by a different flight of stairs than those which led to the passengers' cabins, which were toward the stern. Because the boiler was located amidships, there was no easy connection between those cabins and the captain's chambers. To one side of the boiler room was Captain Jahaziel Sherman's state room, and to the other side was the galley and pantry (Hemenway 1867:689).

Making for Plattsburgh, *Phoenix* encountered a violent northeast gale. Crawling slowly against the headwinds, the boat reached the broadest part of the lake by approximately 1:00 A.M. According to some accounts, members of the crew took a meal in the pantry about midnight. Upon leaving the pantry, a candle was allegedly left burning between two shelves. As *Phoenix* steamed north, now about midway between Burlington and Plattsburgh and about two miles (3.22 km) from Providence Island, the flame of the candle reached the shelf above and set the bulkhead and underside of the main deck near the boiler aflame (Figure 4-5; *National Standard,* 8 September 1819; Wright 1821:224). The events that followed vary according to the individual eyewitness and newspaper accounts of the tragedy.

The fire had made some progress before it was discovered by John Purple Howard, father of the steward and a hostler on his way to Montreal as a messenger for the Bank of Burlington (Figure 4-6). Mr. Howard was in charge of $8,000 that was

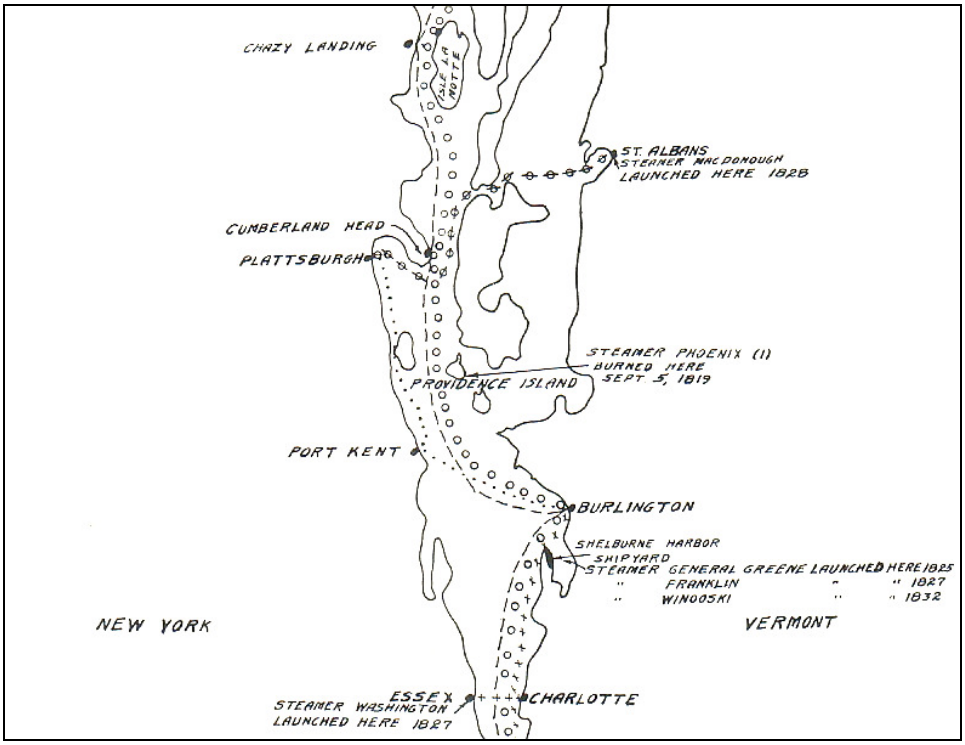


FIGURE 4-5. Map showing where *Phoenix* burned near Providence Island. (After Ross 1997:28.)

FIGURE 4-6. Mr. Howard's discovery of the fire. (After Davison 1981b.)

stowed away in a carpetbag in the bar, and had occupied the cabin next to the pantry. Upon detecting the flames, the elder Howard reportedly woke the passengers in the gentlemen's cabin before rushing to rouse those in the ladies' cabin. He directed everyone to the deck as quickly as possible, and most of the people, frightened and frantic, headed there in only their night clothes. The captain was alerted, and an alarm was sounded on deck (Wright 1821:225; Hemenway 1867:689). One popular account, published two years after the event, painted the scene vividly:

> The passengers were asleep or at least quiet in their births, when a man at the engine perceived, in some dark recess, of the vessel an unusual light. Approaching the spot, he heard the crackling of fire, and found the door of the pantry a glowing and tremulous wall of embers. He had scarcely time to turn himself, ere he was enveloped in flames; rushing past them, attempted to burst into the ladies' apartment by a small door which opened into the interior of the vessel: it was locked on the inside, and the noise of the storm seemed to drown all his cries and blows. Hurrying upon the deck, he gave the alarm to the captain, and flew to the women's cabin. Ere he leaped down the stairs, the flames had burst through the inner door, and had already seized upon the curtains of the bed next to it. You may conceive the scene which followed (Wright 1821:225).

One of the passengers later wrote that upon hearing the alarm he was unsure whether he had heard the cry of fire, but,

> as I approached the top of the cabin stairs an uncommon brilliancy at once dispelled all doubts. Instantly the flames and sparks began to meet my eyes, and the thought struck me that no other way of escape was left but to plunge half naked through the blaze into the water … a lurid light illuminated every object beyond the splendor of the noon-day sun; I fancied it was the torch of death, to point me and my fellow travelers to the tomb (Duncan 1834:462).

Before long, the fire began to rage and burst from the pantry. Being so close to the engine, the flames rapidly communicated to the oil splattered about the machinery.

As soon as the fire reached the oil, it grew in intensity and, being fanned by the north wind, quickly engulfed the center of the boat and nearly cut off all communication between the bow and stern. Captain Sherman and D.D. Howard had by this time made their way over the top of the wheelhouse and were trying unsuccessfully to save the $13,000 stowed away in an iron safe in the captain's cabin, but the fire had already reached through the skylight and surrounded the office (Allen 1819; Hemenway 1867:689).

Captain Sherman later recalled he "had not been absent a quarter of an hour, when I awoke. The engine was in motion. I found the boat was on fire; I immediately started for my office, in hopes of saving what property remained there, but was driven back by the flames" (*Northern Whig*, 14 September 1819).

It is written in the *Annual Register* for the year of 1819 that upon discovery of the fire, the captain tried to run *Phoenix* upon Stave Island, approximately three-quarters of a mile (1.21 km) distant. The informant for the register claimed that "the plunger-straps being consumed, and its fellow continuing to work, the boat veered round, and would not obey her helm" (Dodsley 1820).

One published account stated that the captain then rushed to the deck and assembled all hands. Stating that not everyone could be saved by the boats, he asked his men if they would assist in saving the passengers and stay behind with him, to which they unanimously agreed. While trying to lower the boats, flames burst through the deck planking and engulfed the mast and chimney. Bravely, the helmsman held fast to the wheel until his arms and legs were scorched and his shirt was half burned off his back.

The increased heat at the boilers gave the engine a renewed vigor (Figure 4-7). One passenger later recalled the chaos:

> … the boats were down, and the captain and his men held shrieking women and children in their arms, when the helm gave way, and the vessel, turning from the wind, flew backwards, whirling round and round from the shore. None could approach the engine; its fury, however, soon spent itself, and left the flaming wreck to the mercy of only the winds and waves (Wright 1821:225).

The pilot is said to have suggested the following course of action for saving the passengers:

> … he rushed into the throng of passengers proposing to the captain that all hands go ashore on two pieces of wood he had picked up and held in his hands and loudly insisting that they would make a sufficient raft to support and save everybody upon (Hill 1977:199-200).

This recommendation was, not surprisingly, dismissed; for, with the flames licking around them, the captain and crew reportedly helped the confused and barely-clothed passengers into the boats, refusing requests to join them in the escape (Wright 1821:225). One account stated that the captain brandished pistols in each hand to maintain order as the boats were loaded (Heyl 1953:200).

One passenger later recounted seeing one of the boats almost full and ready to detach from the steamer. He was determined to board the boat and leaped over the side into it, nearly capsizing the craft in the process. He remembered that the waves dashed the boat violently before the bow line could be cut free of the rampant steamboat. Many of the panic-stricken passengers, who were unfamiliar with small boats, were making the situation worse in their agitation (Duncan 1834:463).

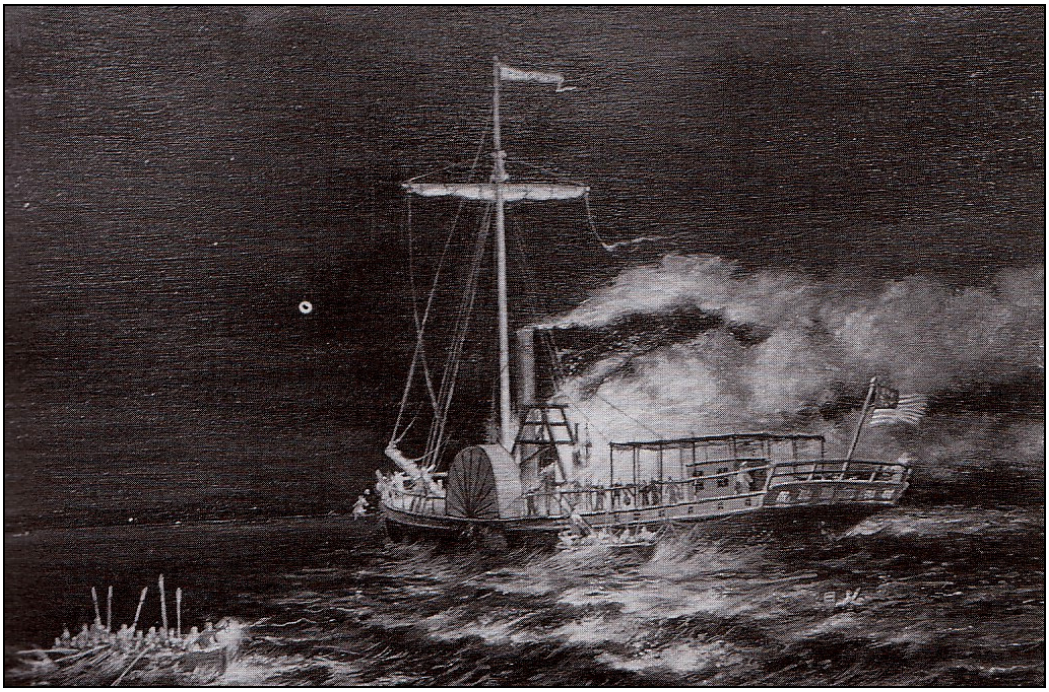


FIGURE 4-7. The passengers trying to escape the flames engulfing *Phoenix*. (After a painting from Ernest Haas.)

The starboard boat was filled with about 20 persons, including all the female passengers. The chambermaid, Mrs. Sarah Wilson, brought the women all of their belongings from the cabin, but did not join them in the first boat. Colonel Thomas and D.D. Howard took charge of this craft and started rowing for Providence Island. D.D. had his father's carpetbag with the $8,000 of the bank's money in the boat with him. The second boat, the larger of the two, was probably capable of carrying the rest of the passengers to safety. After 14 people had boarded it, however, someone cut the line prematurely and it dropped astern, leaving the captain and 10 others on board the burning vessel (Hemenway 1867:689).

Elias Hall, a survivor who later told of his experience on the lost steamer, wrote that it was a man named John Pierson who had cut the painters which secured the suspended boat:

> He was in the last boat, holding it to the vessel and watching the bow line, when John Pierson of Shelburne cut in [sic], which let the boat swing around, when there was a cry to "cut the stern-line or we shall go under," and Pierson then cut it off close to my side (Hemenway 1867:689).

Others accounts blame the engineer McVein, who reportedly abandoned the machinery while the ship was underway and forced his way into the boat (Hill 1977:199-200). McVein took charge of the port boat and, after rowing a few rods (16-1/2 yards; 15.09 m) from the fiery vessel, refused to return to rescue those who had been left, threatening to "knock the first man overboard with an oar" who attempted to change the course of the boat (Hemenway 1867:690).

As an oar from this larger boat dropped into the lake, the passengers noticed a man in the water who had already leapt from the floating inferno and hauled him aboard. Hall recalled that when they had made approximately forty rods (220 yd; 201.2 m) from *Phoenix*, they saw a figure of a man near the bow of the steamer with his arms outstretched making distress signals. Dr. Samuel Trevit, a naval surgeon on the larger bark "rose and said that the boat could and should rescue him" (Hall 1855). McVein ordered the doctor to sit back down. Trevit replied "that he was acquainted with boats

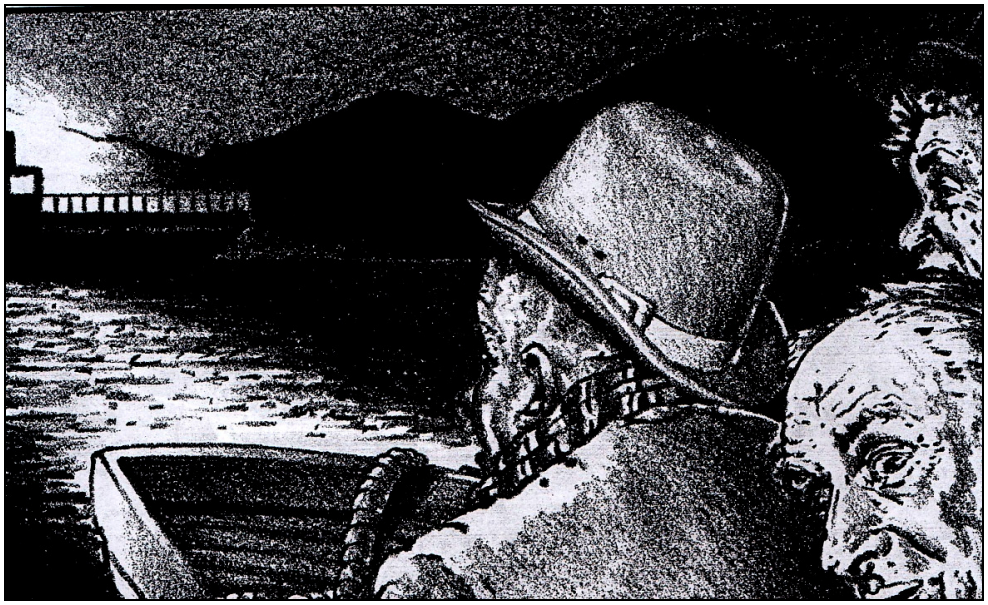


FIGURE 4-8. Survivors argue over returning to *Phoenix* to pick up more victims. (After Davison 1981b:9.)

sufficiently to know that the one they were in could carry a greater number of persons with perfect safety" (Figure 4-8; Tucker 1819). McVein demanded that he "sit down and keep so, or he would throw him overboard" (Hall 1855). The other passengers, perhaps not yet recovered from the trauma, did not support the doctor's request, and the boat went to shore leaving the remaining victims behind (Tucker 1819). Many years after the disaster, Hall would write that he believed it was Captain Sherman who was making the distress signals toward the boat (Hall 1855).

According to a number of accounts, Captain Sherman tended to the remaining passengers and crew on board the scorching *Phoenix*, and, with no other resort, instructed the stranded unfortunates to throw benches, boards, planks, and tables into the water. He reportedly strapped some of the passengers who could not swim to planks and

other objects so they would not sink (Platt 1819; *Northern Sentinel*, 10 September 1819). The following account describes the final actions of the captain while on board:

> … but shortly after the boats had left the second time, he discovered, under a settee, the chambermaid of the Phoenix, who, in her fright and confusion, had lost all consciousness. Lashing her to a plank which he had prepared for his own escape, this gallant captain launched her towards the shore; and was thus left alone with his vessel, now one burning pile (Barber and Howe 1841:107).

Another telling describes the captain holding the frantic chambermaid in his arms, and, finally, hurling with one hand a table into the lake he leapt into the water with the woman in tow. Despite his best efforts, she could not be saved and sunk below the water unable to remain buoyant (Wright 1821:225). Regardless of the true events that took place during those last minutes aboard *Phoenix*, of the 11 people left behind by the small boats six of them could not swim or locate a suitable object to cling to, and eventually succumbed to exhaustion. These victims include chambermaid Sarah Wilson, first pilot Aziba Manning—also the pilot on *Vermont*'s maiden voyage, sailor Harry Blash, steward Stephen Kellis, cook Andrew Harrison, and fourteen-year old Gilbert Painter from Quebec (*Northern Whig*, 14 September 1819). Hall later claimed that a Frenchman and two men from New York were also among the lost passengers (Hall 1855). One survivor hung by the rudder of *Phoenix* until a mass of wood burned free of the steamer and he clung to that. It was said that no more than five to ten minutes passed between the discovery of the fire and the abandonment of the ship by all passengers and crewmembers (Platt 1819; *Northern Sentinel*, 10 September 1819).

One of the steamboat proprietors later wrote of the incident:

> I cannot omit to mention, that many of the lives saved was owing to the uncommon presence of mind and cool deliberation of young Mr. Sherman, (the captain) and Mr. John Howard, of Burlington, who, regardless of their own personal safety, threatened with death those who attempted to cut the painters of the boats until they were loaded … (*Northern Whig*, 14 September 1819)

Hall's account of the tragic event, however, dismisses the heroic portrayal of the captain. In fact, he claims the captain never showed himself upon deck until both boats were lowered into the water. In a letter written 36 years after the incident, Hall states not one person among the 30 that had made it to Providence Island in the boats had seen either the pistols or the captain since the fire was noticed on *Phoenix* (Hall 1855).

Both of the boats were rowed to Providence Island, and, once the passengers disembarked, immediately returned to the site to pick up any survivors. Meanwhile, *Phoenix* continued to drift, before running aground in approximately three feet (0.91 m) of water at Colchester reef, burning to the waterline (*National Standard,* 8 September 1819).

Captain Sherman later wrote that after jumping into the water, he hailed a person close by who was also afloat, and told him that if one of the boats came to pick him up, let them know that he was headed for Stave Island. Two hours later, and nearly insensible, the captain was rescued by one of the boats. Once he regained his senses, he ordered his men to return to the wreck in hopes of finding other survivors.

> … we made for Colchester Point, where we landed and went up to a fisherman's hut, Mr. George Burnham carrying me in his arms. After remaining here an hour and recovering ourselves, we again went to the wreck, which had drifted some distance from where the boat took fire, and lodged upon Colchester reef, now known as the *outer reef*, and extinguished the fire, the vessel having burned to the water line (Hemenway 1867:690).

Amidst all the confusion, another drama was unfolding. John Howard had thrown the bag containing $8,000 into the boat under his son D.D.'s command during the chaos, and stayed aboard the steamer to assist the captain. Returning to *Phoenix* with the boat, D.D. entrusted the bag to the passengers on shore. At some point, an Irishman named Crooby discovered the bag and realized what it contained. As the boat reached the island in the early morning, he immediately made passage for Grand Isle in hopes of reaching Plattsburgh before the money was discovered missing. Sion E. Howard, another of John Howard's sons, learned of what had transpired and immediately pursued the culprit, overtaking him near Bell's Ferry on the west side of Grand Isle. Upon Sion's arrival, Crooby withdrew two knives, apparently prepared for combat. Sion offered two men near him his watch if they would assist him, but they refused. Sion armed himself with a nearby fence stake and advanced resolutely. He called for the other man to surrender, which, after a brief conversation, the Irishman agreed to do. Crooby was later sentenced to prison for his theft (Tucker 1819; Hemenway 1867:691).

Word of the disaster quickly reached the citizens of Burlington, and a number of boat captains promptly got their sloops underway and sailed toward the scene, carrying clothing and provisions the townspeople had gathered for the stranded passengers. Citizens of Grand Isle traveled to Providence Island to meet the survivors, providing them with food, clothing, and liquor. All of the passengers were then taken to Burlington where they were given shelter and other necessary items. Several Burlington residents returned to the wreck site in sailing craft in search of other survivors but to no avail. The

smoking hulk of the steamer had now run aground near Colchester reef, and would remain there until sliding to its present location on the lake bed (Hemenway 1867:691).

Causes of the Fire

The true reason for the outbreak of fire on *Phoenix* remains a mystery. There are a number of theories for how the steamer may have caught fire, but scant evidence exists for any particular one. The most commonly-attributed cause is the aforementioned candle carelessly left burning in the pantry near the boiler (*Commercial Advertiser*, 9 September 1819). This scenario was cited in most of the newspaper articles and other published accounts soon after the loss of the steamboat.

Elias Hall's recollection of the catastrophe, published as a letter to the *Rutland Herald* in 1855, points to two principal causes for the fire: rum and a lack of water to extinguish the flames. After the boat had steamed out of Burlington to a distance of approximately four miles, Hall, who was walking the deck, witnessed the peculiar activity of two crewmembers. Clinging erratically to the deck railing, the drunken individuals held up a black bottle to the steward who was passing by, indicating they wanted more rum. Hall made for the stern to converse with the Captain Sherman and George Burnham, who were commenting on "how like the devil the wind blows" (Hall 1855), then Hall went below for a nap. It was not long before he smelled smoke, and, along with a Mr. Allwyn of Quebec, headed to the cabin stairs to investigate. Someone told them there was a fire in the galley, but a cry of "Fire" had not been raised. Hall claimed he could see smoke rushing through a hatchway and immediately called for

buckets, but could not procure a single one. Apparently, the buckets had been locked up for fear of their being misplaced by the passengers in their attempts to obtain water. "Thus", Hall wrote, "when the buckets should have been full and in a convenient place, not a drop of water could be procured … I have never had the least doubt that with the timely aid of a bucket of water, I could have effectually stopped the fire …" (Hall 1855).

An alternative theory for the cause of the sudden conflagration is arson. As in the case of *Champlain*, newspapers speculated that an incendiary was the true cause of her destruction. On account of the fierce competition that existed between steamboat and sloop owners at this time, it is plausible that those with vested interests in the prosperity of sailboat companies hired arsonists to eradicate the opposition. In the case of *Phoenix*, this would likely have had to have been one of the passengers or crew, and no miscreants were identified in the newspapers or other published accounts.

Aside from the jealousy displayed by sailboat companies, other possible motives for incapacitating *Phoenix* may have been religious fanaticism. An article from *Christian Messenger* printed three days after the disaster is suggestive:

> … It has been a source of sincere regret to the Christian public, that the legislature of Vermont granted a *privilege* to a company to traverse the waters of Lake Champlain with steam-boats, on the Sabbath.
> … After the steamboat *Phoenix* was launched, and while fitting for operation, a request was made, that the arrangements for its sailing might be so fixed that it should not sail on the Sabbath. The reply was such that we had every reason to hope it would not. We were, however, disappointed.
> … The commencement of the next season was ushered in by advertisements, that these boats would still sail on the Lord's day. But GOD, who instituted this sacred day, and has given us His will respecting it, in the fourth commandment, saw fit to shew his displeasure of thus profaning it by destroying the steamboat Champlain by fire!

> … We hoped that this judgment of God (for it may be so considered) would have led the proprietors of the Steamboat Company to reflect on the subject but we soon heard that Phoenix would make two trips in a week, and thus continue to violate the day.
> … Before the boats commenced running the *present* season, a request was renewed to another of the directors, who appeared decidedly in favor of the arrangement that would not encroach upon the Sabbath, and engaged to use his influence to that effect. We believe he did. However, we regret to find that no such arrangements were made and that both boats have occupied the Sabbath through this season. But behold! A sad catastrophe has taken place, of which we have not heard the particulars. Report says, that on the morning of the last SABBATH, the steam boat Phoenix was destroyed by fire, while going from Burlington to Plattsburgh. Another judgment of God has been sent, if possible, to open the eyes of the Steamboat Company, that they may '*Remember the Sabbath day to keep it holy*'.
> We do hope, that in future, the Christian public will not be compelled to witness, or hear of the profanation of the Sabbath, by steamboats running on the waters of Lake Champlain … *(Christian Messenger*, 8 September 1819).

So devastating was the loss of *Phoenix* that its misfortune made its way into local lore. "The Witch of Champlain," written several years after the sinking, relates an incident taking place on *Phoenix* before her destruction, in which a curse was put on the steamer by a disgruntled water witch. After causing mischief aboard the vessel and refusing to pay her fare, an old hag was to be taken to shore to be dropped off. After being lowered into one of the ship's boats, she stretched "forth her withered limb, and raising her eyes, she pronounced some unintelligible words. Instantly a crash among the machinery was heard, and the motion of the vessel was evidently obstructed" (Sedgwick 1826:114). The engine was repaired shortly, and the small boat once again set out to deliver the witch to the shore. Upon leaving the steamboat, she rose again from her seat and exclaimed, "Tempt ye thus my power? Behold how I sign your destruction! How I

inscribe on the viewless air the reward of your folly!" (Sedgwick 1826:116). After tracing a sign in the air, the vessel once again stopped dead, accompanied by a shriek from the engine room. Apparently the engineer had broken his arm and dislocated his shoulder. There was much haste in sending the witch to shore this time and no further damage was done. According to the tale, however, that same year "the magnificent *Phoenix*, on board which this accident occurred, was destroyed by fire, the passengers scarcely escaping with their lives" (Sedgwick 1826:118).

As seen with the sinking of *Vermont*, those with vested interests in steam navigation were quick to point out that such accidents were caused by variables other than imperfect steam machinery. This was especially important in light of the graphic descriptions of steamboat boiler explosions, which were starting to become a staple headline in contemporary newspapers. Although rare at the time of the sinking of *Phoenix*, steamboat explosions had occurred on the western rivers, resulting in the horrendous deaths of passengers and crew members. The first to explode due to excessive boiler pressure was Henry Shreve's *Washington* near Marietta, Ohio, in June of 1816. Contemporary descriptions of the fate of the victims were horrific: "'…six or eight were nearly skinned from head to feet, and others slightly scalded to the number of 17. In stripping off their clothes the skin peeled with them'…" (*Weekly Aurora*, 18 June 1816; Hunter 1993:283). A few months later *Enterprise* exploded near Charleston, South Carolina, resulting in the loss of eight lives, followed by the destruction of *Constitution* eight months later on the lower Mississippi which killed 13 people (Hunter 1993:283-84).

Five days after the burning of *Phoenix*, *Northern Sentinel* (10 September 1819) published the following:

> Thomas W. Thomspon, Esq of Concord New Hampshire, one of the passengers in the Steam Boat *Phoenix*, assures us that, from the best information he could obtain at and since the time of her destruction, both from the surviving crew and passengers, the fire was occasioned by a candle or candles, left in the pantry of the kitchen, and not from the machinery.—The catastrophe was one of those events that might have happened to any vessel as well as a Steam Boat. He expressed a wish that this fact might be known, that the public mind might not be unreasonably prepossessed against Steam Boats; and being a perfectly disinterested witness, he supposed his testimony would have some weight.

Despite the trauma of having to evacuate a flame-engulfed vessel in the middle of the night, apparently not all of the *Phoenix* passengers were frightened to the point of avoiding these steam-propelled vessels. Nathaniel Platt's letter to his daughter, dated four days after the loss of *Phoenix*, mentions that the new steamer *Congress* provides the same service that the lost steamer did, and the accident taught a lesson that will "make them doubly watchfull [sic] in future. I should now feel perfectly safe to go in her— " (Platt 1819).

In the fall of 1819, Yale College professor Benjamin Silliman passed up and down Lake Champlain on *Congress* and made many observations of his travels. On the safety aboard the steamer he remarked:

> Before leaving the steamboat Congress, I will remark, that, under the auspices of her present commander, the younger Captain Sherman, who also commanded the Phoenix when she was destroyed, vigorous measures have been adopted to prevent a recurrence of a similar accident, and that we were much pleased with his management of the boat (Silliman 1820:380).

Continued Operations of the Lake Champlain Steamboat Company in the Aftermath of the Loss of *Phoenix*

Before *Phoenix* became dislodged from the reef and slipped below the water to come to rest along Colchester shoal, the Lake Champlain Steamboat Company had the opportunity to salvage the steam machinery for use on another vessel. Ten days after the wreck the *Christian Messenger* (15 September 1819) read:

> The engine was of course saved, though some injured; and some melted specie has been recovered.—the loss of property, by this disaster, is great. In addition to the destruction of this elegant and expensive boat, there were some thousands of dollars on board, belonging to her owners, most of which has probably been consumed. Many of the passengers lost considerable sums of money, and many valuable papers, and some other property. The mail on board was burned.

It seems the last direct reference to the location of *Phoenix* was made by P.C. Tucker, manager of the Monkton Iron Works in Vergennes. In a letter to iron works owner Benjamin Wells dated 29 September 1819, Tucker wrote, "A part of the steamboat's machinery arrived here by sloop some time ago and today her boiler arrived—the wreck is not yet removed from the Colchester reef" (Tucker 1819; Davison 1981:12-13). It is likely that *Phoenix* became trapped in the ice during the winter while grounded on the reef, and was dragged free when the ice melted the following spring, allowing it to drift and sink to its current location (Davison 1981a:12-13).

With the loss of *Phoenix*, the steamboat company had only *Congress* to provide the service between Whitehall and St. Johns. It was not long after the destruction of their first steamboat that the company began the construction of another vessel, which was even more elaborately designed than *Phoenix*. The keel of *Phoenix II* was laid before the

end of 1819. She was the last large steamboat to be built in the Vergennes shipyard. Problems with launching vessels in Otter Creek due to ice buildup caused the company to choose a site at Shelburne Harbor as their new shipyard (Ross 1997:39; Bellico 2001:267).

Approximately the same size as her predecessor, *Phoenix II* was 150 ft. (45.72 m) long, 26 ft. (7.92 m) in beam, 9 ft. 6 in. (2.9 m) in depth, and displaced 343 tons. She was equipped with the steam machinery recovered from *Phoenix*, and was capable of making 8 miles per hour (12.87 kph) (Ross 1997:39). Launched in July of 1820, *Phoenix II* was commanded by Captain Jahaziel Sherman and said to be the "fastest steamboat in the world" at the time (Hemenway 1867:693; Ross 1997:41).

Phoenix II was advertised by the Lake Champlain Steamboat Company as an elegant steamboat designed exclusively for passengers. Just before she commenced running on the lake, the following advertisement was published in the *Spectator* (1 May 1821):

> … in point of elegance and convenience, she is not exceeded by any boat in America…The Congress, R.W. Sherman, master, has the same accommodations for passengers as last year, but will run more particular for freight, and for the better accommodation of those who wish to ship by her from the usual landing places, she will run through principally in the day time.

Along with *Congress*, *Phoenix II* ran on the Whitehall-to-St. Johns route, and over the course of seventeen years of service was commanded by Masters Sherman, Dan Lyon, George Burnham, and George Lathrop. *Phoenix II* made three trips per week and for the first five years of service she and *Congress* were the only steamboats in operation

on Lake Champlain. The cost for passage from Whitehall, New York to Canada was $6.00 (Hemenway 1867:693).

Phoenix II and *Congress* were also hired for popular excursions. In 1821 an advertisement from the steamboat company read:

> For the better accommodation of Parties of Pleasure, and others, who may wish to view the remains of those ancient fortresses, Ticonderoga and Crown Point, and other more recently memorable places on the Lake, such as the Battle Ground of Macdonough's Naval Engagement—Plattsburgh, &c.—the *Congress* will leave Whitehall, as usual, every Thursday morning, at 5 o'clock, and if desired, will stop one hour at Ticonderoga…and will meet *Phoenix* , about half past 2 o'clock, at Cumberland Head, on her way from St. Johns…having, in two days only, performed this delightful excursion, and viewed the principle interesting scenery of the Lake. Lake-Champlain, July 24, 1821 (Ross 1997:36).

Once the Fulton-Livingston steamboat monopoly was effectively dissolved following the *Gibbons vs Ogden* case in 1824, it was not long before other steamboat companies were formed throughout the nation. In Lake Champlain, the second such company to be formed was the Champlain Ferry Company, who received a charter from the Legislature of the State of Vermont allowing it to operate steam-propelled vessels between Burlington and Port Kent, New York. The 75 ft. (22.86 m) steam ferry *General Greene* was launched in 1825 under the command of Captain Dan Lyon, which began the steamboat competition on Lake Champlain until the Champlain Transportation Company came to gradually absorb all existing lines between 1826 and 1835 (Ross 1997:41).

With the opening in 1823 of the Champlain Canal came direct water access between Lake Champlain and the Hudson River. The use of steamboats, which 15 years

earlier had been considered experimental creations, rapidly gained popularity as it was discovered that fleets of canal boats could be towed by steamers through the lake. Due to these and other factors during this period, such as the success of steam navigation on the western rivers, the pace of steamboat development on Lake Champlain accelerated quickly (Cone 1945:44-46).

Expansion and competition on the lake spread rapidly beginning in the second half of the 1820s. In the fall of 1826, both the Champlain Transportation Company and St. Albans Steam Boat Company were formed. The St. Albans operation launched *MacDonough*, similar in size to the Lake Champlain Steamboat Company's *Champlain*, in St. Albans Bay in 1827, which operated for eight years between St. Albans and Plattsburgh. Also that year Henry H. Ross and Charles McNeill, who had been operating horse ferries between Charlotte and Essex for six years, decided to enter the steamboat business and built *Washington*, similar in size to *MacDonough*. Three years later Jahaziel Sherman, who had a disagreement with the Lake Champlain Steamboat Company, established his own steamboat business and launched *Water Witch* in 1832. This proved to be too much competition on the lake, and between 1833 and 1835 the Champlain Transportation Company absorbed all of its rivals by purchasing all of the property of the Lake Champlain Steamboat Company for $47,000; the charter and all property of the Champlain Ferry Company—including their newest steamer *Winooski*—for $17,250; the charter and property of the St. Albans Steam Boat Company for $10,000; and, Jahaziel Sherman's *Water Witch* for $8,000. Upon selling his vessel, Sherman became a director of the Champlain Transportation Company, which now

owned seven steamers on the lake. *Franklin*, built by the company in 1827, *Phoenix II*, and *Winooski* continued to run as passenger vessels, while *MacDonough* and *Washington* were assigned to serve as freight and tow boats. *Congress* was relegated to being a fuel tender and *Water Witch* was eventually converted into a schooner and sold in 1837. The Champlain Transportation Company continued to build innovative and successful steam-driven vessels during their peak years between 1837 and 1875, at which point competition from railroads forced the company to transition into a tourist line which ran until the 1930s (Cone 1945:46-51; Ross: 1997:13).

CHAPTER V

ARCHAEOLOGICAL INVESTIGATIONS OF THE *PHOENIX* WRECK SITE

Shipwreck Discovery and Initial Studies

First Encounter with the Phoenix *Wreck Site*

When scuba instructor Don Mayland took two students on a deep dive off the outer reef of Lake Champlain's Colchester Point in August of 1978, he was unaware that he would happen across an unknown shipwreck that would become the focus of investigation of early steam navigation in America. The initial sighting revealed only a vague shape on the lake bed, and, despite a number of repeat dives, the divers failed to immediately relocate the wreck site. Three weeks later on 4 September—exactly 159 years since *Phoenix* left Burlington for the last time en route to St. Johns— Mayland, students Dick Hubbard and Don Mudgett, and diver Dick Sell rediscovered the vessel off Colchester Shoal (Figure 1-2). Although they succeeded in finding the wreck, they did not know the age or identity of the sunken vessel (Davison 1981a:ii; Davison 1981b:14).

Meanwhile, after learning of the steamer's fate from local Burlington historian Captain Merritt Carpenter, maritime researcher Art Cohn had begun independently searching for her remains (Davison 1981a:ii). In April of 1978, Cohn took out a permit for exploration from the Vermont Division for Historic Preservation. This permit granted Cohn the exclusive right to search for *Phoenix* in the vicinity of the Colchester Reef and Colchester Shoals, and also permitted limited artifact recovery to assist with wreck

identification (Vermont Division for Historic Preservation 1978). Upon discovery of the wreck, Mayland notified the Vermont Division for Historic Preservation, who in turn informed Mayland of Cohn's research goals. Teaming up to investigate the site, Mayland and Cohn were able to positively identify the wreck as the charred remains of *Phoenix* (Davison 1981a:ii).

Mayland and Cohn were not the only divers to discover the hull of *Phoenix* in the late 1970s. In search of Lake Champlain's ill-reputed serpentine monster Champ, first mentioned by Samuel de Champlain in the 17th century, Jim Kennard and Joe Zarzynski undertook a remote-sensing survey of the lake in 1979. Upon passing Colchester Shoal, the side-scan sonar insonified a grand shape along the reef. Kennard, a remote-sensing specialist, reported to Zarzynski that the image was not that of a monster but a shipwreck. Derek Grout, who had reportedly been searching for the wreck of *Phoenix* for three years, was told of the location of the shipwreck by Zarzynski and immediately replied that it was the remains of *Phoenix*. Grout dived the site and described his experience in an article written for *Skin Diver* in August of 1981. The article, entitled "The Phoenix Lives!," gave the location of the site, provided tips to sport divers on how to dive the wreck, and included a photograph of divers out of the water holding bottles found near or on *Phoenix* (Grout 1981).

Lack of public education on the significance of submerged cultural resources, combined with the increasing popularity of scuba diving on the lake in the 1970s, led to increased threats to the preservation of historic shipwrecks and their associated contents. In order to preserve *Phoenix* and other archaeological sites in Lake Champlain, Cohn

and R. Montgomery Fischer, the Vermont Chairman for the Lake Champlain Committee, with the assistance of Vermont state archaeologist Giovanna Peebles (then Neudorfer), formed the Champlain Maritime Society (Davison 1981a:iv). Due to the efforts of the newly-formed society and the Vermont Division for Historic Preservation, in 1985 *Phoenix* became the first Underwater Historic Preserve in the State of Vermont.

***Champlain Maritime Society Survey and Documentation of* Phoenix**

In 1980, Cohn submitted to the Vermont Division for Historic Preservation "A Pilot Study for the Evaluation and Management of a Significant Shipwreck in Lake Champlain" (Champlain Maritime Society 1980). In this document the society outlined specific goals for the study of *Phoenix*, including site documentation to determine its eligibility for listing on the National Register of Historic Places, data collection for analyzing the construction of early American steamboats, public education initiatives, and the generation of a database and a basic procedures manual for documenting the remains of submerged sites in the lake (Champlain Maritime Society 1980:5-6).

The first of two projects undertaken by the Champlain Maritime Society to document the *Phoenix* wreck site took place in the fall of 1980. This project consisted of a five-day field campaign to record the hull remains and construction features of the wreck. After obtaining another research permit from the State of Vermont, an eight-person team of divers, archaeologists, and photographers mapped the site and collected data in order to draft an archaeological site plan and create a conjectural reconstruction of the steamer. In 1981, the results of this survey, which included a historical

background of *Phoenix*, the logistical details of the diving operations, an archaeological site plan, and general observations on the data recovered from the wreck site, were made available by the Champlain Maritime Society in a publication entitled simply *The* Phoenix *Project* (Davison 1981a).

The assembled team, pictured in Figure 5-1, included Bill Brown and Jack Chase in the top row, Art Cohn, Roger Lambert, Don Mayland, and Scott McDonald in the second row, and Dean Russell, Kevin Crisman, and Mike Janson in the front row. The technical plan involved: numbering and labeling the frames; relating the frames to the baseline tape; measuring the length of the frames and futtocks; collecting measurements for the production of cross-sectional and bow profile views; obtaining data to determine the list of the wreck; and measuring the dimensions of the frames, futtocks, keelson, and other longitudinal timbers (Davison 1981a).

The divers worked in buddy teams and labeled the frames with a number and a "P" or "S" to indicate port or starboard. In order to obtain the curve of the frames and futtocks, the team employed a method of recording that involved the use of a float tied to the end of a line, which was fastened to the keelson. This served as a datum point and allowed for the vertical and lateral measurements required to reconstruct the curvature of the hull (Figure 5-2). The team took five section measurements in this manner, and provided these and the rest of the collected data to diver and draftsman Kevin Crisman, who produced the finished drawings of the site plan, which were subsequently published in the report (Figures 5-3 and 5-4; Davison 1981b:12-13).

FIGURE 5-1. 1980 *Phoenix* Project team members. (Courtesy of Lake Champlain Maritime Museum.)

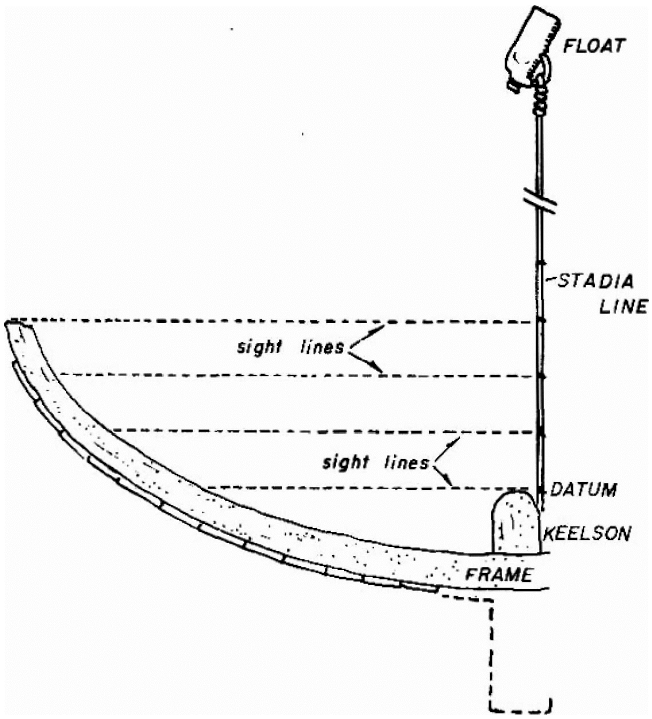


FIGURE 5-2. Method of recording frame curvature. (After Davison 1981:27.)

FIGURE 5-3. Kevin Crisman and Art Cohn reviewing the progress of the 1980 *Phoenix* site plan. (Courtesy of Lake Champlain Maritime Museum.)

Artifact Recovery and Initial Studies

The second survey conducted by the society took place under the direction of Jack Chase and Don Mayland in 1983. The objectives were to recover a limited number of artifacts from *Phoenix* for analysis and to provide training for volunteers in the proper procedures and techniques used for the systematic recovery of material culture from submerged sites. The chief purpose of the second goal was to assist the Vermont Division for Historic Preservation in future projects designed to protect and preserve Lake Champlain's underwater cultural heritage (Chase 1985:47).

The Champlain Maritime Society proposed to use a sampling method which would help determine the various compartments in the steamboat, using the

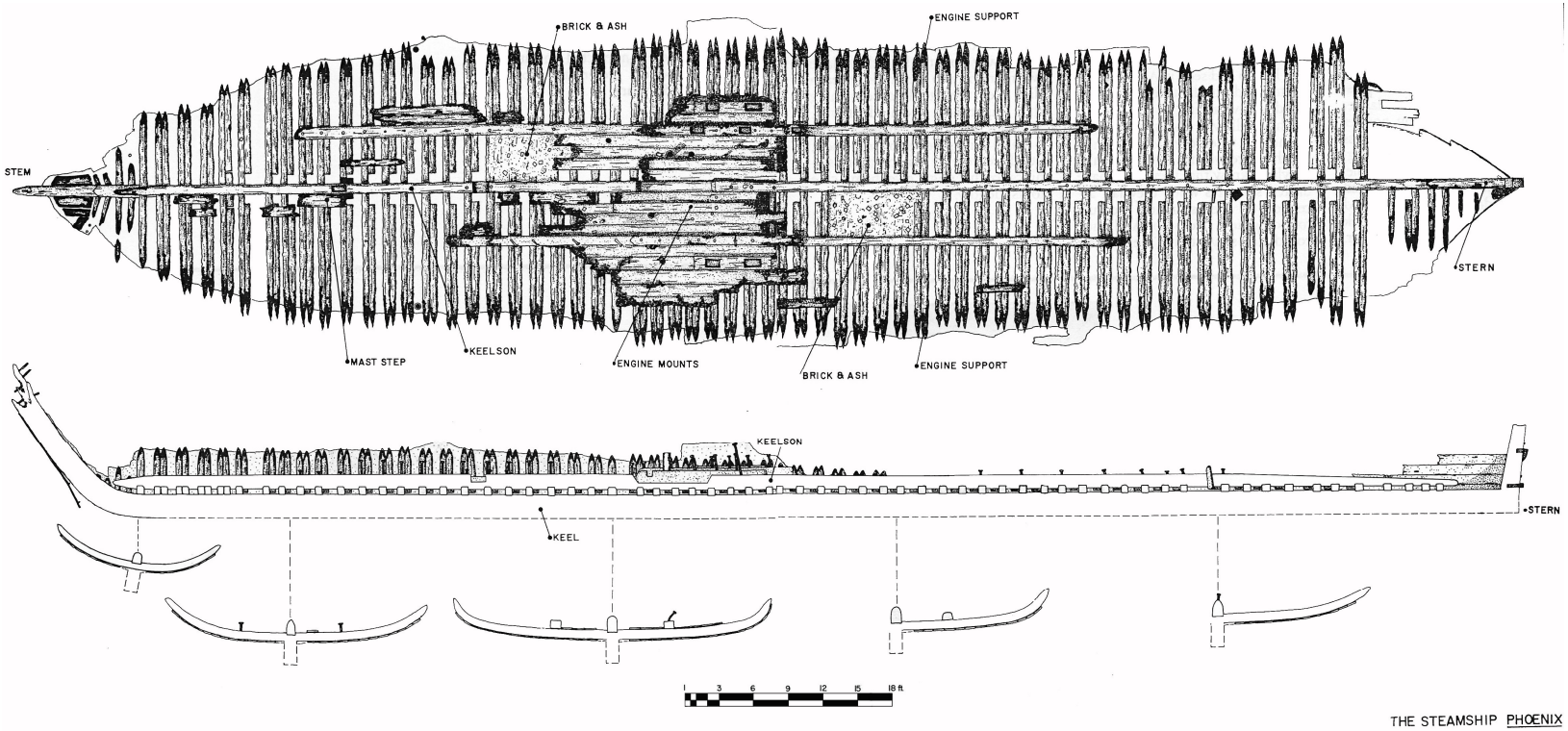


FIGURE 5-4. The 1980 *Phoenix* site plan by Kevin Crisman. (After Davidson 1981a.)

description of the interior layout of the vessel from Hemenway's *Vermont Historical Gazetteer* as a cross-reference. As Hemenway's description is the most detailed one known, a primary objective of the society was to assess the accuracy of that description to assist with an accurate reconstruction of the vessel. The recovered artifacts would also help with the interpretation of life aboard early passenger steamboats in America (Chase 1985:47).

Artifacts discovered in the hull were placed in ammunition boxes at depth and then raised to the surface by lift bags and buoyancy compensators. A trowel or knife was used in many cases to remove objects which had adhered to the hull. The artifacts were taken to the surface and transferred to water-filled re-sealable plastic bags, which were labeled according to the frame section from which they were removed. The artifacts were later cleaned and selected ceramic objects were treated with dilute hydrochloric acid for cleaning and documentation. According to the report, examples of artifacts discovered during the 1983 fieldwork include ceramic and glass fragments, keys, musket balls, and buttons (Chase 1985:51).

It is not clear whether additional provenience data was recorded, and a site plan plotting the location of the recovered artifacts was not included in the project report. The surviving artifact field notes do not contain precise positioning data for the discovered objects, and many were missing location information altogether. The lack of precise provenience data limits the contextual study of these objects and an artifact distribution plan cannot be created. Furthermore, despite what must have been good intentions, the

lack of project resources prohibited extensive conservation, cataloging, and analysis of the recovered objects (Haddan 1995:16).

Diving limitations restricted the artifact recovery to those areas of the hull that were shallower than 80 ft. (24.38 m), specifically in the vicinity of the mast step and an area amidships in the vicinity of the engine bedtimbers. The society hypothesized that due to the wave action on the lake bed and the probable destruction of bulkheads during the 1819 fire, currents swept the entire length of the vessel and scattered artifacts in a northwesterly direction. They concluded that the concentration of china and glass artifacts discovered on the port side of the hull, forward of the engine space, were likely objects originating from the port side of the ship immediately outboard of the engine space. This led the researchers to believe that this area was where the pantry was originally located, and helped them estimate the layout of other parts of the vessel. Through the initial analysis of recovered artifacts, such as the reported china pieces and upholstery tacks, the society also concluded that conditions aboard the early steamer were fairly opulent (Chase 1985:48). It is important to note, however, that these two classes of artifacts are not part of the collection housed at the Lake Champlain Maritime Museum, which limits the continued analysis of their use and distribution.

A methodical study of the artifacts was not conducted until Shelley Hight of the Vermont Division for Historic Preservation briefly examined the objects in July of 1985. Her report indicates that the 795 objects, which also included artifacts previously recovered by Don Mayland, were supposed to be returned to the *Phoenix* site on the lake bottom. This author examined and photographed 449 artifacts currently housed at the

Lake Champlain Maritime Museum. The location of the remaining 346 artifacts, which may include the aforementioned china pieces, is unknown. Hight's objective was to address the questions posed by Chase in the 1983 technical report, specifically to determine the location of the ship's various compartments and to gain insight into the living and traveling conditions aboard early steamboats (Hight 1985:1). James Haddan, a former Texas A&M University graduate student, conducted a more extensive study on the distribution and use of *Phoenix* artifacts. The results of his research, which incorporated Hight's findings, are described in Chapters VII of this dissertation.

Lake Champlain's Submerged Cultural Resources and Zebra Mussel Infestation

Lake Champlain contains an impressive array of historic and archaeological resources in and around the lake, spanning a period of 11,300 years of human occupation. In addition to such cultural resources as submerged prehistoric sites, historic dumpsites, naval battle sites, and harbor works, the lake contains one of North America's largest collections of historic shipwrecks. Researchers have estimated that several hundred wrecks, many still undiscovered, lie on the bottom of the lake. In order to learn more about the history of the lake and assist the state of Vermont with the development of management plans for these non-renewable resources, the Champlain Maritime Society began a long-term systematic survey of the lake shortly after its formation in the early 1980s, which continued with the founding of the Lake Champlain Maritime Museum in 1986 (Kane 2003:1-6).

In 1993, an invasive aquatic species known commonly as the zebra mussel (*Dreissena polymorpha*), which is native to the Black and Caspian Seas, was discovered in Lake Champlain. The mussels invaded the Great Lakes in the mid-1980s, possibly as larvae, or veligers, carried from Europe in the ballast tanks of seagoing ships. It was quickly realized that zebra mussels were colonizing wooden shipwrecks, posing a serious threat to their long-term preservation and inhibiting archaeological data recovery. In addition, studies conducted in Lake Champlain suggest that zebra mussels are accelerating the rate of iron deterioration in freshwater environments by altering the redox chemistry of the immediate environment. This occurs as feces and organic matter surrounding the mussels decompose and consume oxygen (Watzin et al. 2000:1-7). Due to the appearance of this invasive and potentially destructive species, a federally-funded program called the Lake Champlain Basin Program authorized the Lake Champlain Maritime Museum to conduct a survey of the lake to inventory all submerged cultural resources in order to prepare management plans for affected sites. This project ran from spring of 1996 through the summer of 2004 and resulted in an inventory of hundreds of submerged cultural resources including historic ships, aircraft, automobiles, and powerboats (Kane 2003:1).

Phoenix is one of the archaeological sites affected by the invasion of zebra mussels, and is covered with colonies which are concentrated mostly at the forward end of the vessel. The zebra mussels have clustered at the bow timbers in particular, and in many places obscure the true shape of the timbers in that section of the hull. The

noticeable spread of zebra mussels over the wreck site amplifies the urgency of this renewed archaeological site investigation.

Recent Archaeological Investigations

2009 Fieldwork

The 2009 fieldwork on Lake Champlain marked the first archaeological field season since the 1980 efforts described above for collecting archaeological data from the *Phoenix* site (designated VT-CH-587), and was executed under an archaeological research permit granted by the Vermont Division for Historic Preservation (Appendix A). The objective of the first field season was to record the offset measurements of the extant frames in order to draft a complete archaeological site plan. No artifact recovery was planned for the project, though permission for limited recovery was granted by the Vermont state archaeologist should the team encounter exposed or endangered objects during the recording process. With collaboration, funding, and resources from the Lake Champlain Maritime Museum and funding from National Geographic Society and Waitt Foundation, the first phase of this Institute of Nautical Archaeology project took place in late September and early October.

The author, an Institute of Nautical Archaeology Research Associate and Texas A&M University doctoral student, served as the Principal Investigator and archaeological research permit holder for the 2009 and 2010 *Phoenix* investigations. Texas A&M University graduate student Bradley Krueger and Texas A&M University alumnus Tiago Miguel Fraga participated in the project as archaeologists. Lake

Champlain Maritime Museum Maritime Research Institute staff members Art Cohn, Adam Kane, Chris Sabick, and Pierre LaRoque were integral members of the 2009 team. Frederick Fayette served as captain of the research vessel as well as dive tender and logistical specialist. Texas A&M University Nautical Archaeology Program Professor Dr. Kevin Crisman supported the project with funds from his academic chair and provided copies of previous site plans as well as measuring tools for hull recording.

The team was able to stage its operations from a headquarters at Stave Island, home of Lake Champlain Maritime Museum supporters Bill and Dawn Hazelett, who had great interest in the project. Approximately three miles (4.83 km) from the buoy marking the *Phoenix* wreck site, the island was an ideal base, with two large houses on either side of the island for staff members and the two caretakers (Figures 5-5 and 5-6). The small harbor also served as a shelter for the research vessel during foul weather days, and provided the team with a shallow area to test new approaches and equipment underwater. The Hazeletts graciously extended the use of their golf carts in order to transport gear from the house to the harbor and research vessel. The main island house served as the team's headquarters and was spacious enough to provide workspace to spread out maps, Mylar, computers, clipboards, notes, drawings, and other materials. Although there was no internet availability, electricity for laptops and battery chargers was provided by a generator and through solar panels. A weather monitor was available on the island, which was transmitted via a weather tower built in the early 20th century, in order to receive marine forecasts.

FIGURE 5-5. The main house on Stave Island, which served as headquarters for the 2009-2010 field seasons. (Photo by Chris White, 2010.)

FIGURE 5-6. View from the Stave Island weather tower looking north toward Providence Island, where the survivors of the burning steamboat rowed to safety. (Photo by author, 2009.)

The dive operations required extensive gear and numerous tanks (steel and aluminum) as well as a range of archaeological recording equipment. Nearly all members of the dive team used drysuits due to the water temperature at depth, which ranged between 40° and 46° F (4.44 and 7.78° C). Darkness at depths of 80 to 100 ft. (24.38 to 30.48 m) and beyond required the use of dive lights attached to the diver's mask or forehead. To maximize safety and provide more restful dive intervals, Nitrox enriched air was chosen as the breathing mixture. To record the hull measurements, each diver carried Mylar-clad clipboards, which were changed daily (Figure 5-7). Fifty and 100 ft. (15.24 and 30.48 m) measuring tapes, as well as plastic carpenter's rules, were used by the archaeologists to obtain hull measurements. As the ship was built in imperial units, all measurements were taken in feet and inches. Both digital video cameras and digital single-lens reflex cameras with underwater housings were used to document the hull and capture imagery in an effort to produce a site photomosaic. Computer software, including iPhotomeasure, AutoCAD, and Rhinoceros NURBS modeling, was also used to assist with hull documentation and site recording.

As part of one of the project grant studies, the team utilized a hand-held underwater multibeam imaging sonar donated by BlueView Technologies. This sonar tool, originally designed for submariners to detect enemy divers near submarines, was used as an experiment on the *Phoenix* site to test the value of the technology for documenting submerged cultural resources in the lake. Experiments conducted by the Lake Champlain Maritime Museum staff concluded that, for the purposes of

FIGURE 5-7. Diver entering the lake to record hull remains. (Photo by Chris White, 2010.)

FIGURE 5-8. Project work vessels *Neptune* and *Terri Anne* at Stave Island. (Photo by Chris White, 2010.)

documenting this particular archaeological site, the hand-held multibeam sonar was an ineffective tool due to lack of sufficient resolution required for accurate ship recording.

The research vessels for the project included *Neptune*, a 40 ft. (12.19 m) workboat captained by Fred Fayette, and *Terri Anne*, a 20 ft. (6.1 m) Mako powerboat operated by Pierre LaRocque (Figure 5-8). *Neptune* proved an ideal work platform that could be moored directly over *Phoenix*, allowing for safe and easy access to the wreck. Dive gear was assembled at the bow of *Neptune*, and divers conducted a giant stride into the lake that positioned them directly in front of the dive buoy. *Neptune*'s flat stern and access ladders allowed divers to climb aboard *Neptune* from the stern and exchange dive cylinders at that location. *Neptune* is a covered vessel and afforded protection to the team from rough seas and adverse weather conditions. In addition, this versatile boat provided warmth to the team after deep dives, was equipped with a refrigerator and microwave, and had a side-scan sonar and obstacle avoidance sonar for survey operations (Figure 5-9).

Dive operations and hull recording took place at the *Phoenix* site between 28 September and 7 October 2009. After discussing the day's plan over breakfast and loading gear onto *Neptune*, the crew typically left Stave Island at approximately 9:00 A.M., unless foul weather was predicted or present. Once *Neptune* was safely moored over the *Phoenix* buoy, the first team in the rotation prepared for diving (Figure 5-10). At all times, a fully-equipped safety diver was prepared for emergency action. In addition, a safety tank with regulators was tethered at the safety stop.

Depending on the number of divers at the site each day, there were either two or

FIGURE 5-9. Interior layout of project work vessel *Neptune*. (Photo by Chris White, 2010.)

FIGURE 5-10. The author and Tiago Miguel Fraga prepare for the first dive rotation on the deck of *Neptune*. (Photo by Chris White, 2010.)

three two-person dive teams that worked on the wreck site. Each dive rotation typically consisted of one dive team. Once this team surfaced, returned to *Neptune*, and related any noteworthy events or observations, the second dive team prepared to enter the water. Unless foul weather became an issue, there were two dive rotations per day, spending approximately 20-30 minutes at depth. Surface intervals were typically between 3 and 4 hours, during which time the divers transcribed notes, consumed refreshments, and rested.

Each diver was given a task and location on the wreck to work before descending to the site. The dive plan and objectives were discussed for each team prior to diving. Divers descended the mooring line, which led to the Underwater Historic Preserve plaque designed for *Phoenix*. Mesh bags were used to transport clipboards, rules, tags, goniometers, or other objects to the site. A bag of spare equipment was left down on the site in case of malfunction or loss of clipboards, pencils, or tape measures. At the end of the dive, the team members ascended the mooring line and made a three-minute safety stop at 15 ft. (4.57 m).

The first part of the project was spent recording the offsets of the extant hull timbers from the intact keelson to the outer extremities of the surviving frames. These data were obtained in order to draft a site plan and get an idea of the vertical and horizontal extent of the hull. First, plastic tags, numbered 1 to 76, were stapled to the frames. The low numbers started at the stern timbers, ending in 76, just before the bow cant frames. Depth gauges were used to get the heights of the measurements taken at the keelson and the extreme-most portion of each frame for which a measurement was

taken. In addition to measuring the offsets, the team recorded the frame curves. Digital goniometers in underwater housings were used to record the angles of the frames in order to reconstruct the section lines of the vessel. Some members of the team were also recording basic construction features during this portion of the fieldwork, such as variations in keelson thickness, plank thicknesses, and bow cant frame features.

The second week of the project was devoted to capturing high definition video footage of the wreck site in order to create a photomosaic of the remains of *Phoenix*. In addition to the plastic numbered tags on the frames, the team cut 6 x 6 in. (15.24 x 15.24 cm) squares out of colored paper, which were subsequently laminated so that they could be taken to the site. These squares were placed approximately every 3 ft. (91 cm) along one side of the wreck. The objective was to have one square visible in each frame of the video footage, to be used as a measuring guide when using the video as a visual aid for creating the site plan and construction drawings. With the use of computer software iPhotoMeasure, the dimensions of the reference squares could be entered into the software program and a digital measuring tool could be created. This was an experimental method meant to be used as a guide, supplementing the measurements obtained by the divers. After the tags were laid, a diver went down with the video camera and strobes and positioned himself approximately 4 to 6 ft. (1.22 to 1.83 m) above the wreck. He proceeded to record the site by swimming several laps over both the port and starboard sides, maintaining a consistent height above the timbers. Stills could then be taken from the video footage and stitched together to create a photomosaic in Adobe Photoshop.

In the evenings, the team members transferred their dive notes from Mylar to notebook or gridded paper, including any sketches or other observations that they noted on the original Mylar sheets. The original sheets were kept for future reference. The plan for the next day of data collection was based on the accomplishments of that day. Poor weather during the 2009 field operations prevented continuous days of uninterrupted diving, so there were several days during which members of the crew went to the mainland to purchase supplies and procure additional equipment that was needed for the field operations. Other team members remained on Stave Island to transcribe notes, process data, and transfer the hull measurements into AutoCAD and Rhinoceros 3D modeling software programs for the digital reconstruction.

As a consequence of the adverse weather conditions, hull offsets could only be obtained from frames 22 to 76. In addition, time constraints only permitted the recording of every other frame between 31 and 51. Despite these limitations, a preliminary draft of the wreck site from frames 22 to 76 was generated for purposes of illustrating the recorded features from 2009 (Figure 5-11). Between frames 31 and 51, only every other frame is shown in the drawing, as this section is where much of the surviving ceiling planking prevented full measurements to be obtained within the time available. The offsets, depth measurements, and frame curvatures for the remaining frames would be recorded at the beginning of the 2010 field season.

As evidenced in the previous archaeological investigation of *Phoenix*, the extant remains of the steamer were found to be in a tremendous state of preservation overall. The layer of exotic zebra mussels complicated hull documentation, but did not prohibit it

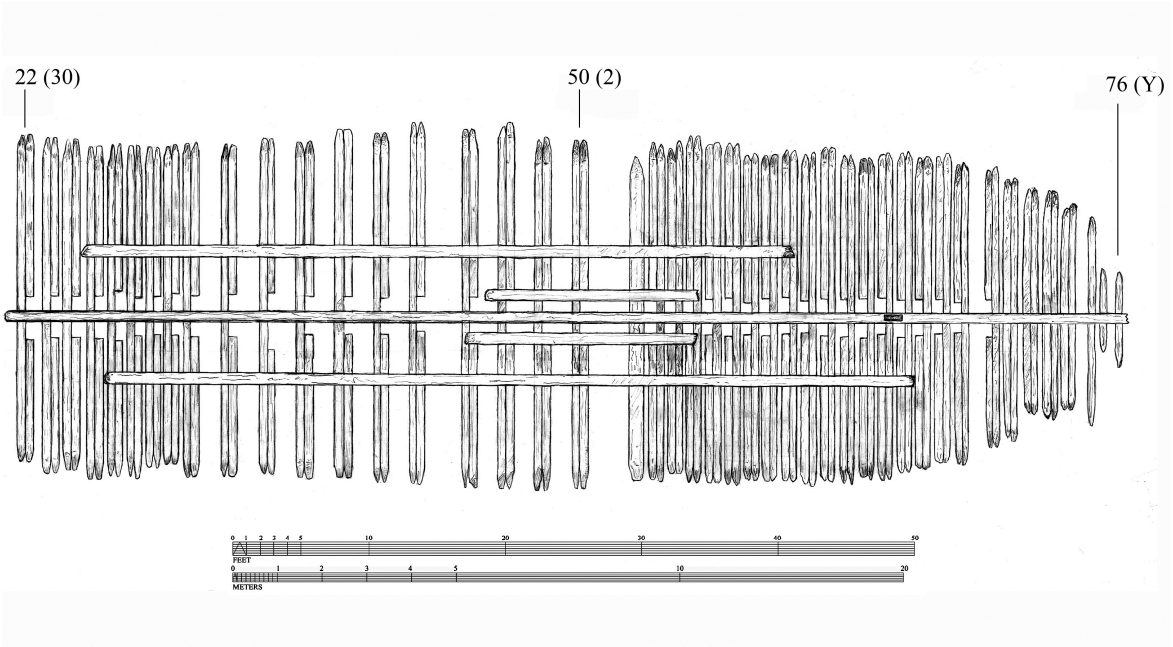


FIGURE 5-11. Draft of 2009 site plan including frames 22 to 76 (later renumbered 30 to Y), mast step, and elements of the longitudinal reinforcement and engine bedtimbers; omits odd frames between 31 and 51 (21 and 1). (Drawing by author, 2010.)

FIGURE 5-12. *Phoenix* frame extending beyond existing hull planking. (Digital still from video taken by Pierre LaRocque, 2010.)

on any section of the vessel. Despite the integrity of the hull, the extremities of the frames—in particular those at the aft end—are charred to the point of being extremely brittle (Figure 5-12). The existing length from stem to stern is 130 ft. 6 in. (39.78 m), and the maximum width of the site is approximately 29 ft. (8.84 m). Except for the extremities, the vast majority of the floors and frames are structurally sound and in many cases the frames curve up to a height of perhaps 9 to 11 ft. (2.74 to 3.35 m) above the lake bed. In addition to the well-preserved frames, the keel, keelson, ceiling planking, outer planking, stringers, stem, sternpost, deadwood, and bow cant frames are mostly exposed and intact for study. Although some of the basic construction features were recorded during the 2009 field season, the dimensions and structural details of the hull were chiefly the focus of the 2010 field season.

The use of iPhotoMeasure software for measurement of wreck site features was an experimental one. It proved to be a valuable exercise in archaeological site recording and much was learned in the few days that were spent capturing the imagery to improve future efforts. The program was designed to allow individuals to measure objects in a digital photo without having to take physical measurements. For example, this program can provide construction companies basic measurements of a client's roof in order to calculate a work estimate. By placing a rectangular object of known dimension somewhere on the roof and taking a digital photo, the client can send the image to the company, along with the dimensions of the rectangular object, and obtain a fairly accurate estimate without the company having to conduct an on-site assessment. While useful for this purpose, it was impractical for recording an underwater shipwreck site.

Complications arose because it was nearly impossible for the videographer to capture the imagery at an equal distance along the length of the hull. This was due, in part, to the fact that the wreck site is located on a slope between 60 and 110 ft. (18.23 and 33.53 m). Also, because of limited visibility and lack of sufficient lighting, it was necessary to video record the hull over several laps at close range to ensure that wreck features could be seen in each frame of the video. To be successful, this would call for hundreds of 6 x 6 in. (15.24 x 15.24 cm) squares to be placed over the hull timbers so that each video frame, which captured approximately a 3 x 3 ft. (91 x 91 cm) area, contains at least one reference square. These squares would have to be attached to the hull timbers so that they would remain stationary during the video recording, which presented another problem as penetration of timbers with fasteners was to be avoided as much as possible. The reference squares used during the 2009 season were limited in number and only placed every 3 ft. (91 cm) in one row along the length of the vessel, and weighted down with 4 in. (10.16 cm) bolts secured to the back of the squares with duct tape. The captured imagery allowed for a degree of photomosaic stitching in Adobe Photoshop, but was far from ideal as each frame had to be scaled in Photoshop individually to remain proportional (Figure 5-13). Although this recording method proved unsuccessful for this project, with the proper planning the technique has potential to work on a shipwreck in clearer waters on a level sea floor or lake bed. If a sufficient number of reference squares were placed on the hull timbers and the video or images could be captured at a consistent distance from the wreck, the method could potentially

be used to produce a limited site plan of relatively high accuracy in a reasonably short period of time.

2010 Fieldwork

Building on the previous year's accomplishments, the primary goals of the 2010 field season were to document construction features of the surviving hull timbers, record a number of the existing frame curvatures, collect data on fastening patterns and the steam engine bedtimbers, and record high-definition digital video of the shipwreck. In addition to traditional drafting methods, *Phoenix* project archaeologists continued to utilize computer software to create the two-dimensional and three-dimensional digital models of the *Phoenix* hull remains. This technology provides researchers with an additional visual aid with which to compare *Phoenix*'s hull construction with existing archaeological evidence recovered from other early lake steamers. In addition, these digital reconstructions are expected to facilitate public interaction with museum exhibits and serve as educational tools for demonstrating ship construction and operation during the early age of steam.

The 2010 field season team included the addition of Texas A&M University nautical archaeology graduate student Bryana Schwarz; former Lake Champlain Maritime Museum staff member Rob Wilczynski, who volunteered as an archaeological diver; and, local Vermont maple syrup candy manufacturer Chris White, who volunteered as project photographer. The team, pictured in Figure 5-14, included from left to right: Tiago Miguel Fraga, Adam Kane, Art Cohn, Pierre LaRocque, Bryana

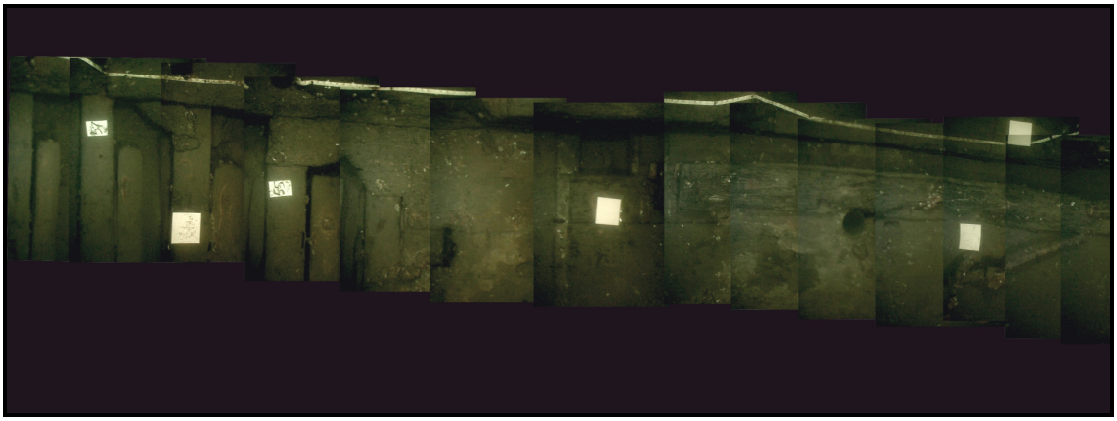


FIGURE 5-13. Photomosaic test using iPhotomeasure software and reference squares.

FIGURE 5-14. 2010 *Phoenix* Project team. (Photo by Chris White, 2010.)

Schwarz, and George Schwarz in the top row; and, Christopher Sabick, Chris White, and Frederick Fayette in the bottom row (Rob Wilcyznski is not pictured).

Due to the continued support of Lake Champlain Maritime Museum benefactors Dawn Hazelett and family, the project team was again able to stage out of Stave Island. The Hazeletts' historic house again served as headquarters for the team. Golf carts were again available to transport gear from *Neptune* to the house, and the island's harbor was a suitable shelter for the research vessels. Mallet's Bay was a 15-minute boat ride from Stave Island, and for the 2010 field season, groceries and supplies were usually transported to and from that location.

Tools and equipment were essentially the same as those used in 2009. As mentioned above, AutoCAD and Rhinoceros digital drafting and modeling software were used alongside traditional methods to generate site plans and reconstructions, but iPhotomeasure software was not used during the 2010 season, as the previous year's attempts at creating accurate visual documentation with this software were not effective.

The 2010 field season took place between 23 August and 2 September. Similar to the 2009 field season, the project members typically left Stave Island in *Neptune* at approximately 9:00 A.M. daily. Unlike the 2009 field season, there were virtually no adverse weather conditions, and only one day was considered unsuitable for dive operations due to high winds and heavy seas. This was largely a consequence of conducting the fieldwork one month earlier in the year than the previous field season. Once *Neptune* was safely moored over the *Phoenix* buoy, the first dive rotation prepared for diving. At all times, a safety diver was suited up with a scuba cylinder and set of dive

gear nearby in preparation for a rescue scenario. In addition, a 60 cubic foot aluminum pony bottle was hung 15 ft. (4.57 m) below the *Phoenix* buoy on the descent line for emergency use.

Using the tags and numbering system designed and placed on the site in 2009, the team continued measuring the extant frames of the steamboat. Obtaining the offset and depth measurements of the timbers between frames 31 and 51 that were left unrecorded in 2009 was one of the first priorities of the 2010 field season. Again, depth gauges were used to obtain the heights of the measurements taken at the keelson and the extreme-most portion of each frame for which a measurement was taken. This data was entered into the existing 3D Rhinoceros model, which was initiated during the 2009 field season. After the data were gathered in the field and the preliminary site plan was sketched, the frames and other structural timbers were renumbered for the final site plan to conform to the conventions used in ship hull recording and to ensure clarity in the description of the reconstruction. The midship frame, originally numbered 51b, was designated ¤. Frames forward of ¤ were labeled alphabetically while frames aft of ¤ were labeled numerically.

Another main objective of the 2010 field season was to obtain the curvature of a representative number of extant frame sections that might be used as a basis for reconstructing the shape of the hull. As the extent of survival of each timber varied, digital goniometer measurements were taken on selected frames along the length of the wreck site. Approximately every fifth frame along the keelson was recorded with the goniometer, and measurements were taken from the keelson to the outermost intact

portion of the highest futtock. Most of the frames that were measured were on the port side of the wreck as they were the best preserved timbers. Overall, 18 frames were recorded with the goniometers, in addition to the curvature of the stem and angle of the sternpost. This added to the number of frames recorded in the 1980s, and enabled researchers to get more detailed sections of the hull for the reconstruction.

The other primary objective of the 2010 field season was to document the steamer's hull construction details, which were numerous and mostly intact due to the excellent preservation conditions. Although blanketed in zebra mussels, structural features at the stem and stern were extensively recorded, as a number of the original timbers were still in place along with their fasteners (Figures 5-15 and 5-16). The apron,

FIGURE 5-15. Cluster of zebra mussels on *Phoenix* timbers. (Digital still from video taken by Pierre LaRocque, 2010.)

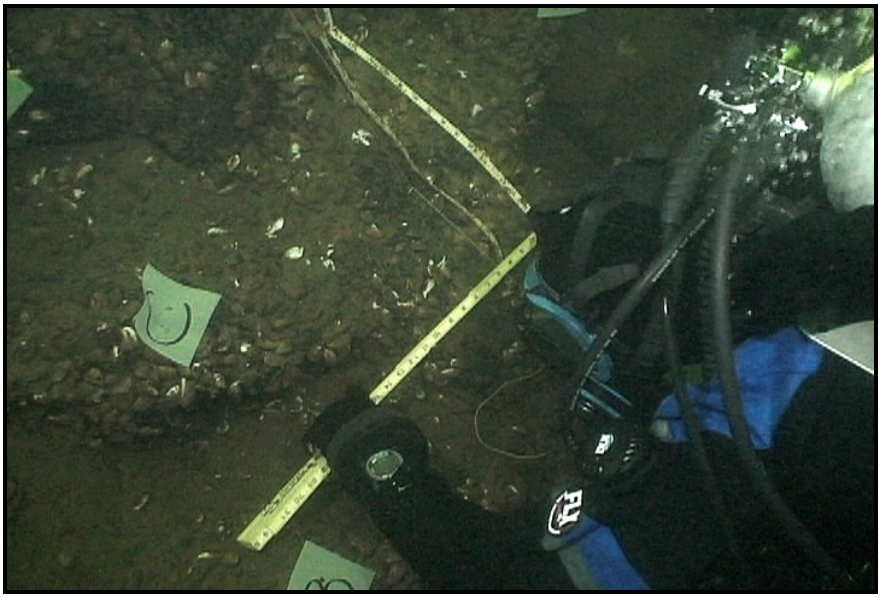


FIGURE 5-16. Measuring zebra mussel-infested timbers at the bow of *Phoenix*. (Digital still from video taken by Pierre LaRocque, 2010.)

inner stem, and cant frames were documented on the interior of the hull at the bow, while the stem and hull planking were recorded on the exterior of the bow section. At the stern, a number of intact timbers, which composed the sternpost as well as the supporting deadwood assembly, were recorded. Representative dimensions of all structural timbers were recorded along the length of the vessel, including the engine machinery support structures located near midships. Measurements of surviving hull planking and ceiling planking were recorded, and supplementary high-definition video was taken to assist with the site plan and reconstruction.

The excellent weather and lake conditions provided an ideal opportunity for data collection, which permitted the team to obtain all of the planned measurements for the hull reconstruction, making up for the previous season's weather impediments. The 2009

and 2010 field seasons yielded over 120 pages of notes and sketches, along with more than four hours of digital video, providing the required archaeological data for this particular study of early American steamboat construction. What follows is the analysis and interpretation of those data, and comparisons with information collected from the limited archaeological examples of other steam-propelled vessels from the first quarter of the 19th century.

CHAPTER VI

THE CONSTRUCTION OF *PHOENIX*

This chapter discusses the construction of *Phoenix* based on evidence recovered from the wreck's archaeological remains during the 2009 and 2010 field seasons. The documented timbers and other design features are presented in the probable order of construction at the Vergennes shipyard. Because the hull of *Phoenix* is partially buried in the soft sediment of the lake bed, not every feature was accessible for documentation. Particularly inaccessible were the majority of the keel and a considerable portion of the lower hull planking strakes. Near the stern on the starboard side of the wreck the frames, futtocks, and planking had fallen away from the rest of the hull, probably due to the list of the wreck and the mechanical stresses placed on those elements. In addition, as the steamboat was burned to the waterline, there are many features that remain charred in their submerged environment—particularly the upper ends of the floors and futtocks. Since the Lake Champlain Steamboat Company's shipwright, Mr. Roberts, designed *Phoenix* using the imperial system of measurement, timbers and other structural elements are described in feet and inches with the metric units in parentheses. For clarity, the archaeological site plan is included as a reference to the shipwreck features, as well as perspective views from the three-dimensional digital site plan model (Figures 6-1 and 6-2). Table 6-1 provides a summary of the principle scantling dimensions for ease of comparison, and Table 6-2 lists the various fasteners encountered during the recording of the wreck as well as their use in the construction of the steamboat.

Lake Champlain Passenger Steamboat

Phoenix

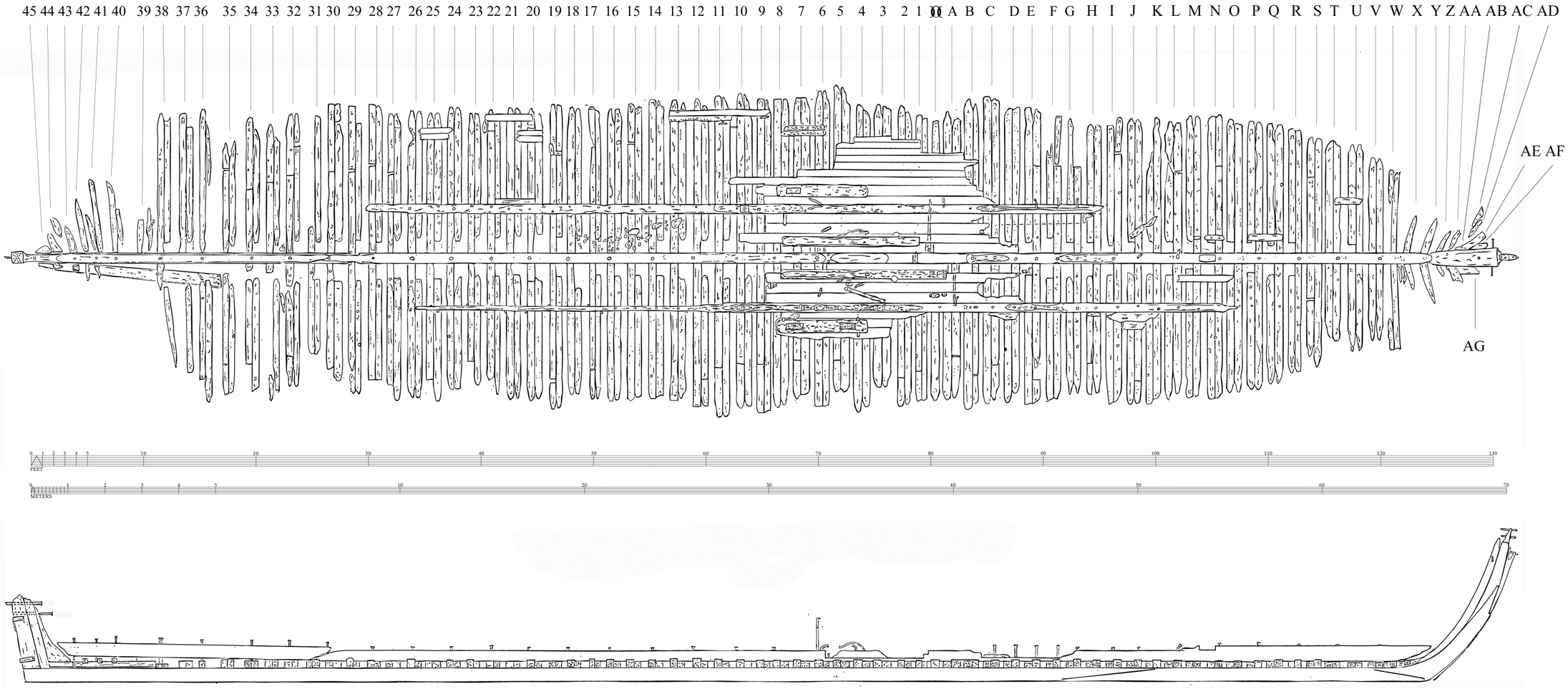
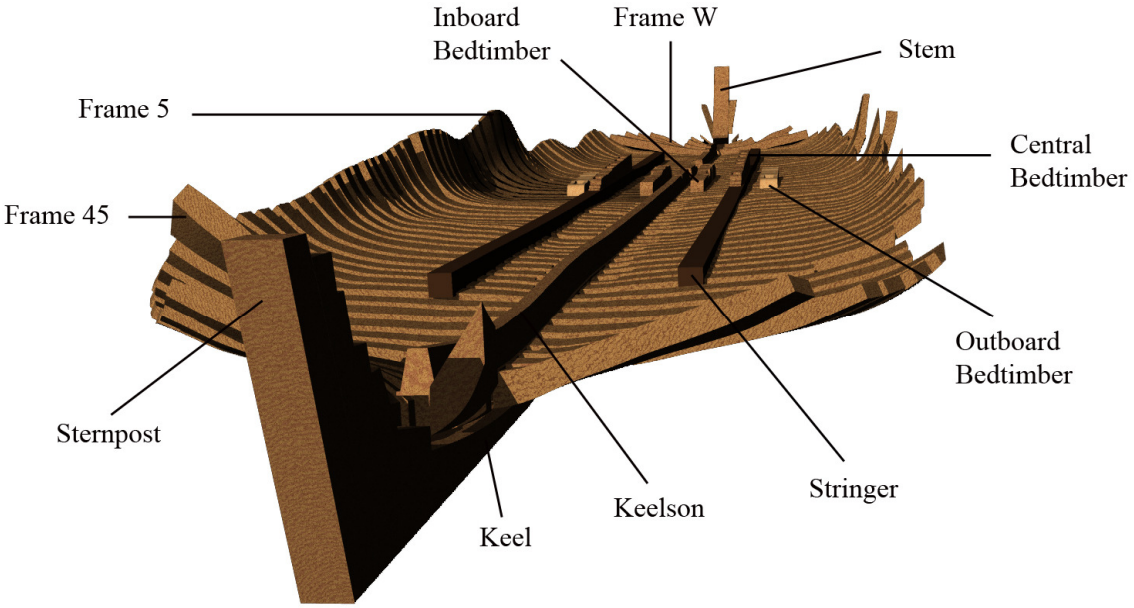


FIGURE 6-1. Archaeological site plan. (Drawing by author, 2011.)



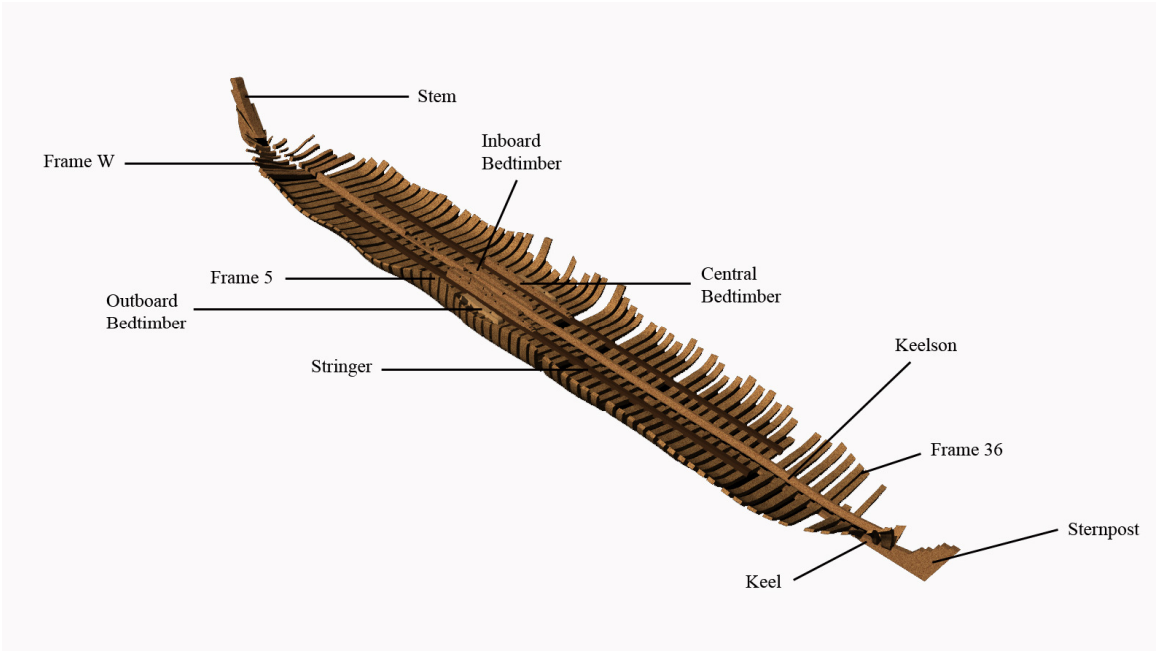


FIGURE 6-2. Perspective views of the site from the three-dimensional site plan model; reconstructed on a straight keel. (Digital model by Tiago Miguel Fraga and the author, 2012.)

TABLE 6-1. Principle scantlings of *Phoenix* as recorded on the wreck site.

	Keel	Stem	Sternpost	Frames	Keelson	Hull Planking	Garboard	Wale	Ceiling Planking	Inboard bedtimbers	Central bedtimbers	Stringers	Outboard bedtimbers
Total Length	124 ft. 6 in. (37.95 m)	14 ft. 4 in. (4.37 m)	6 ft. 6 in. (1.98 m) high	14 ft. 7 in. (4.45 m) longest preserved	125 ft. (38.1 m)	45 ft. 3 in. (13.79 m) longest preserved	unknown	unknown	8 ft. 8 in. (2.64 m longest preserved	14 ft. 4 in. (4.67 cm) longest preserved	17 ½ ft. (5.33 m)	67 ft. (20.42 m) longest preserved	7 ft. 11 in. (5.46 m)
Molded	*c.* 13 ½ in. (34.29 cm)	14 ½ in. (36.83 cm)	18 in. (45.72 cm) tapering to 12 in. (30.48 cm)	8 ¼ in. (20.96 cm) average	11 in. (27.94 cm) maximum	2 in. (5.08 cm) thick average	2 in. (5.08 cm) thick	4 in. (10.16 cm) thick average	1 ½ in. (3.81 cm) to 2 in. (5.08 cm)	6 ½ in. (16.51 cm)	Ranged from 2 in. (5.08 cm) to 14 in. (35.56 cm)	10 in. (25.4 cm)	12 in. (30.48 cm)
Sided	11 in. (27.94 cm)	6 ½ in. (16.51 cm)	7 in. (17.78 cm)	6 ½ in. (16.51 cm) average	11 in. (27.94 cm) maximum	Width ranged from 4 in. (10.16 cm) to 12 in. (30.48 cm)	12 in. (30.48 cm) to 17 in. (43.18 cm) wide	7 in. (17.78 cm) wide	6 in. (15.24 cm) to 11 in. (27.94 cm)	10 in. (25.4 cm)	Ranged from 2 in. (5.08 cm) to 8 ½ in. (21.59 cm)	10 in. (25.4 cm)	13 ½ in. (34.29 cm)
Components	3	3	2	Usually 2	3	unknown	unknown	unknown	unknown	2	2	1	1
Joinery	Flat scarf	Flat scarf	fasteners	Fastening of overlapping timbers	Flat scarf	Butt joint	Butt joint	Butt joint		N/A	Fe through bolt	N/A	N/A
Fasteners	Fe bolts	Fe bolts	Fe bolts	Fe bolts, Fe nails, treenails	Fe bolts	Fe spikes	Fe spikes		Fe nails, Fe straps	Fe bolt	Fe bolt	Fe bolt	Fe bolt
Wood types	unknown	Chestnut, white oak	unknown	Yellow pine, northern white cedar, unknown others	White oak	Chestnut, unknown others	unknown	unknown	Red pine	White oak	White oak	White oak	White oak

TABLE 6-2. List of fasteners recorded at the *Phoenix* wreck site.

	Iron bolt	**Iron nails**	**Treenails**	**Iron spikes**
Keel joinery	Yes, unknown dimensions			
Apron to stem	1 ½ in. (3.81 cm) diameter			
Stern hull planking to inner sternpost		¼ in. (0.64 cm) square		
Gudgeons to stern		¼ in. (0.64 cm) in diameter		
Inner stern post to outer post	2 in. (5.08 cm) in diameter			
Keelson and frames to keel	1 ½ in. (3.81 cm) in diameter and 3 ft. (91 cm) long			
First futtocks to frames		Yes, unknown dimensions	1 in. (2.54 cm) diameter	
First and second futtocks joinery			1 in. (2.54 cm) diameter	
Frames to keel	1 in. (2.54 cm) diameter			
Hull planking to frame				3/8 in (0.95 cm) square
Garboard to frame				3/8 in (0.95 cm) square
Ceiling planking to frame		3/8 in. (0.95 cm) square		
Bedtimber to frames	1 in. (2.54 cm) diameter			
Stringers to frame	1 in. (2.54 cm) diameter			

Keel

The keel of *Phoenix* was found to be intact over the entire length of the vessel. Due to the presence of the well-preserved frames, keelson, and planking, the backbone of the steamboat was largely inaccessible for documentation. Since the keel was partially buried, access when diving on the outside of the hull was restricted. Internally, the uppermost portion of the keel was partially visible beneath the keelson and deadwood timbers from the stern assembly to frame 26, 34 ft. 3 in. (10.44 m) forward of the sternpost (Figures 6-3 and 6-4). Despite the limited accessibility, numerous measurements and observations of the keel were recorded over the length of the wreck to provide adequate data for analysis and reconstruction.

The keel was preserved over a length of 124 ft. 6 in. (37.95 m), with two scarves observed. The first was a flat scarf located 87 ft. 6 in. (26.67 m) forward of the sternpost and extending over a length of 8 ft. (2.44 m). No evidence was found of another keel scarf between the stern and this point, but another is likely present and buried in the sand. If no other scarves exist, the overall length of the after keel timber would be 98 ft. 4 in. (29.97 m), an improbable length for a single piece.

The steamer-turned-schooner *Ticonderoga* had a keel length of 113 ft. 9 in. (34.67 m), originally composed of two overlapping timbers 59 ft. 6 in. (18.14 m) and 60 ft. (18.29 m) in length, flat-scarfed together and fastened with iron through bolts and fish plates. It was probably not until the U.S. Navy purchased the hull that a second layer of keel timbers was added to improve stability and lateral resistance for the converted sailing vessel (Crisman 1983:40-41). Although not verified, it is likely that *Phoenix* had

FIGURE 6-3. Exposed portion of *Phoenix* keel at frame 31. (Digital still from video taken by Pierre LaRocque, 2010.)

FIGURE 6-4. Exposed portion of *Phoenix* keel at frame 30. (Digital still from video taken by Pierre LaRocque, 2010.)

a keel constructed of three overlapping timbers, with this long section perhaps divided into two 57 ft. 2 in. (17.42 m) pieces joined together with an 8 ft. (2.44 m) flat scarf. The second observable scarf begins at 119 ft. 6 in. (36.42 m) forward of the sternpost. This flat scarf joins the forward keel timber with the stem and extends over a length of 4 ft. 5 in. (1.35 m), making the overall length of the forward keel member 32 ft. (9.75 m).

Although fasteners in the keel could not be seen, the scarves were probably secured with large wrought iron through bolts driven from above. There was no evidence for the presence of fish plates at the join of the keel and stern post; fish plates were widely used on a number of other early 19th-century vessels to reinforce the joining of timbers along the keel and at the stern assembly. Stopwaters, the term for wooden dowels inserted laterally into the seams of the keel scarves, were typically installed to prevent shifting of seams and water penetration in the hull. This feature, although probably present, was not visible on the exposed scarves and stern assembly seams. Neither was there evidence of a shoe, which would have been fitted beneath the keel to provide protection should the steamer run aground.

The exposed section of keel at the after end of the wreck measured 11 in. (27.94 cm) sided. The molded dimension could not be recorded due to inaccessibility. At this location on the hull, however, the keelson measured 13-1/2 in. (34.29 cm) molded, which may indicate the keel's minimum molded dimensions. Each side of the keel has a rabbet at the top of the keel 2-7/8 in. (7.3 cm) wide, defined by two oblique planes that run 3/4 in. (1.9 cm) deep. Two sections of the disarticulated garboard strake, measuring 2-1/2 in. (6.35 cm) thick and 12-1/2 in. (31.75 cm) wide, which would have fit into this

FIGURE 6-5. Disarticulated garboard strake at the stern. (Digital still from video taken by Pierre LaRocque, 2010.)

FIGURE 6-6. Forward face of the stem. (Digital still from video taken by Pierre LaRocque, 2010.)

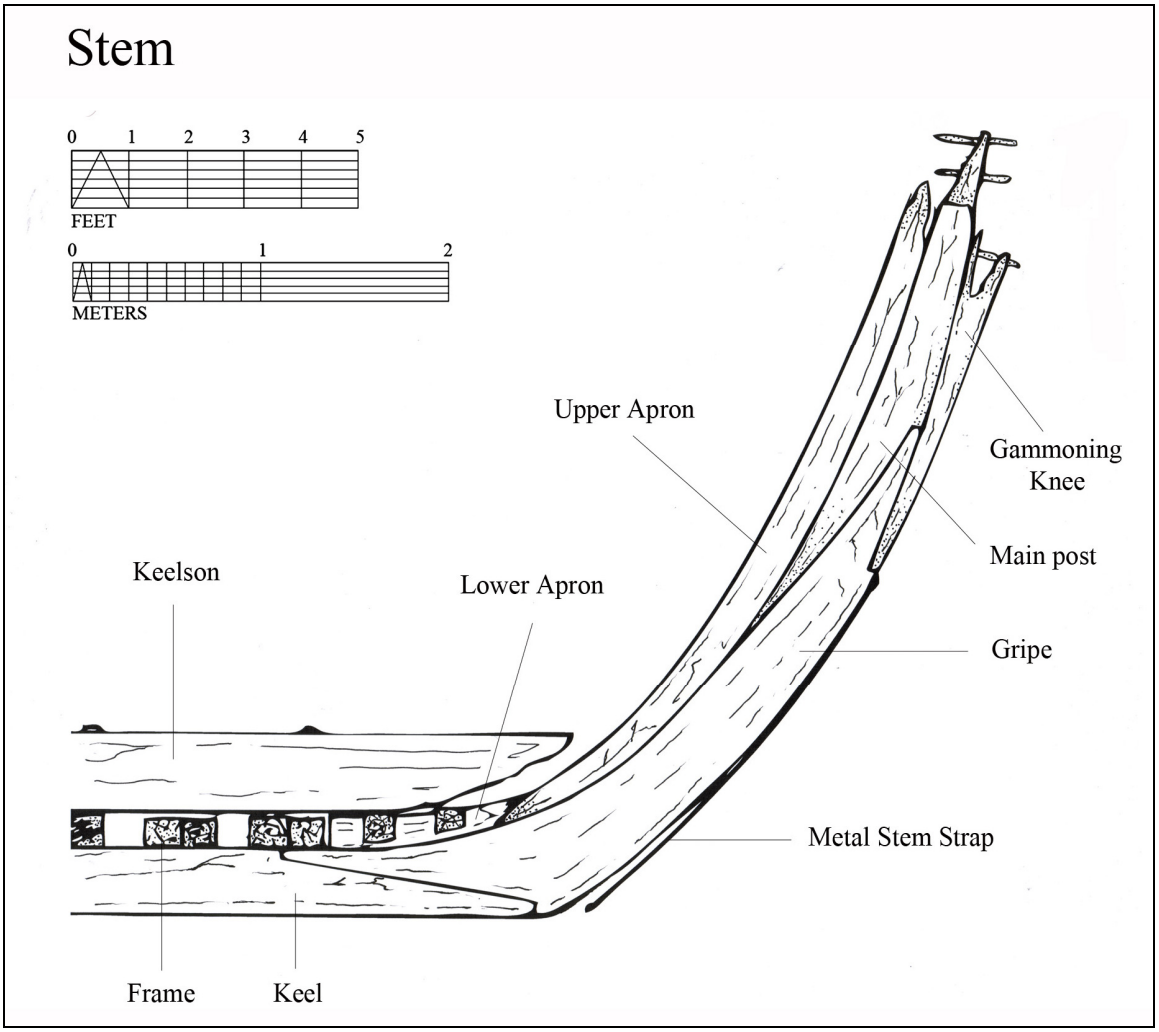


FIGURE 6-7. The stem of *Phoenix*. (Drawing by author, 2012.)

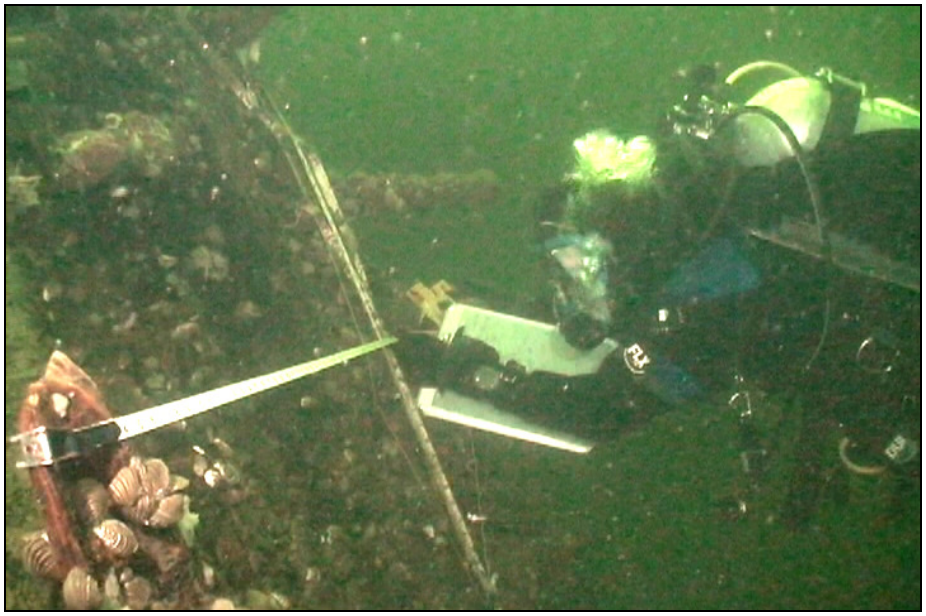


FIGURE 6-8. View of the inner stem. (Digital still from video taken by Pierre LaRocque, 2010.)

rabbet, lay next to the keel between frames 40 and 28 (Figure 6-5).

Stem

The stem was in excellent condition and preserved from the keel to the stem head (Figures 6-6 and 6-7). The assembly included the post, gammoning knee, and the intact apron. The entire observable stem assembly survived along a length of 14 ft. 4 in. (4.37 m).

Fashioned from white oak (*Quercus sp*.), the upper apron was positioned just forward of frame 76 and was preserved over a length of 12 ft. 10 in. (3.91 m). Although coated in zebra mussels, this curved timber was found to be in remarkable condition (Figures 6-8 and 6-9). At its lower end the piece measured 10 in. (25.4 cm) sided and approximately 8 in. (20.32 cm) molded. As the inner stem angled upward to form the

curvature of the bow, its sided dimensions grew to 16 in. (40.64 cm) halfway along its length to 18 in. (45.72 cm) at the stem head. Two mussel-encrusted iron bolts, 1-1/2 in. (3.81 cm) in diameter, were found exposed on the upper face of this timber, and were driven into pre-drilled holes from within to fasten the apron to the stem. This timber provided the surface for securing the hood ends of planking and strengthened the stem.

The stem was composed of multiple timbers, including the main stempost, the fore gripe, and a gammoning knee (Figures 6-10 and 6-11). The entire assembly was impressively preserved, and represents the entire curvature of the bow up to the stem head. Cut from chestnut (*Castanea sp.*), the stem was joined to the keel by a flat scarf. Although not detectable, this joinery was likely reinforced by two to three wrought iron bolts driven from above.

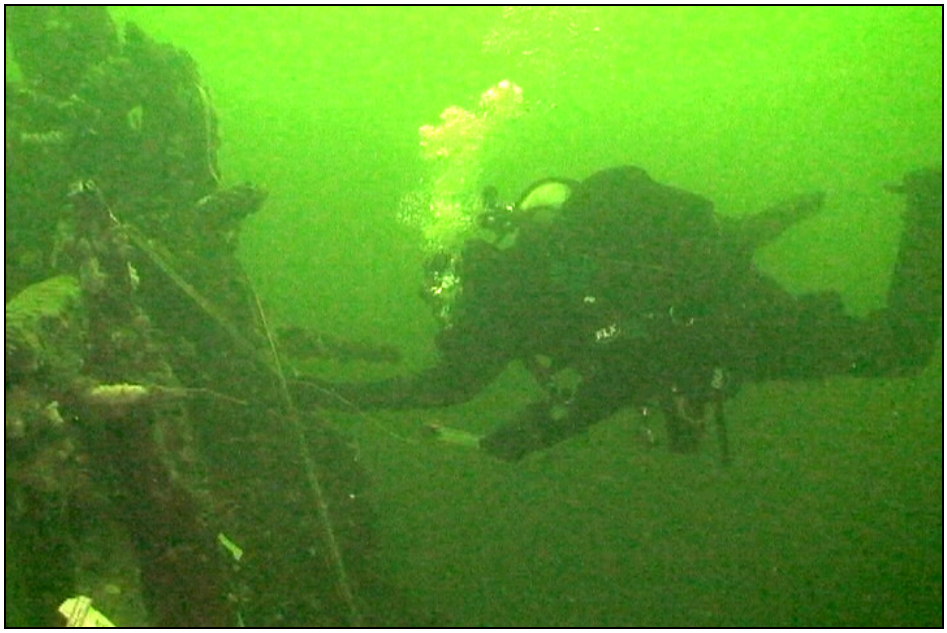


FIGURE 6-9. View of the apron. (Digital still from video taken by Pierre LaRocque, 2010.)

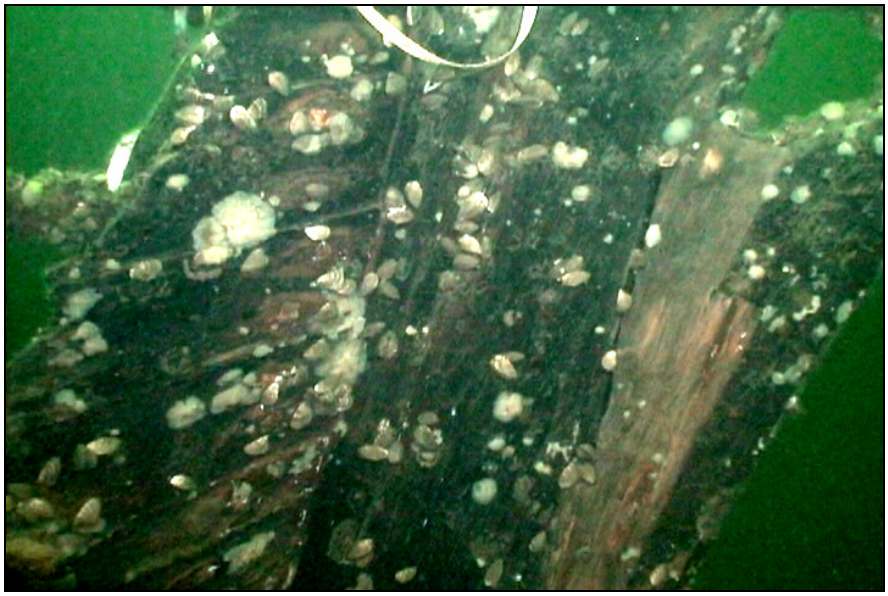


FIGURE 6-10. Components of the stem assembly. (Digital still from video taken by Pierre LaRocque, 2010.)

FIGURE 6-11. Detail of the components of the stem assembly. (Digital still from video taken by Pierre LaRocque, 2010.)

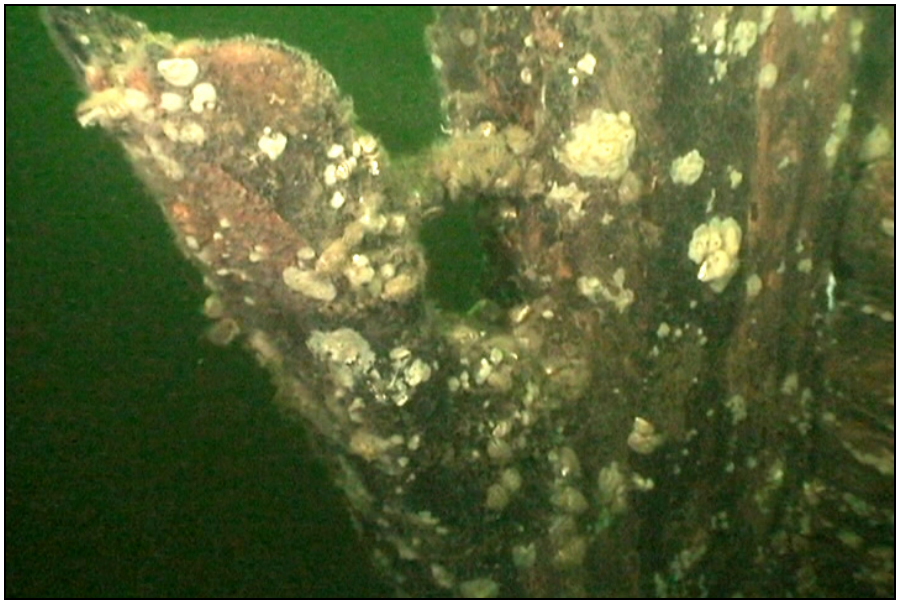


FIGURE 6-12. View of the gammoning knee. (Digital still from video taken by Pierre LaRocque, 2010.)

From the flat scarf to the stem head, the stem assembly was preserved over an approximate length of 15 ft. 10 in. (4.82 m). The rabbet along the keel would have widened to approximately 90° as it approached the stem to receive the hood ends of the hull planking in the bevels along the seam of the apron and stem and offer a watertight union.

The gripe constituted the lowest member of the stem assembly and widened chiefly to add dimension to the lower portion of the stem and to help the vessel hold her head better to windward under steam (Hedderwick 1830:154). The stem assembly's maximum molded dimension measured 14-1/2 in. (36.83 cm), while the sided dimensions were recorded at 6-1/2 in. (16.51 cm) at the forward face. Near the stem head a cutwater or gammoning knee was attached to the forward face of the stem, with the stem narrowing to 6 in. (15.24 cm) sided and the projecting knee narrowing to 5 in.

(12.7 cm) sided. This piece is a curved timber, which likely had a gammoning hole or notch through or around which *Phoenix*'s bowsprit was lashed (Figure 6-12).

On the forward face of the stem a metal strap, perhaps of wrought iron, was partially attached to the post (Figure 6-13). The strap was positioned just below the gammoning knee over a vertical distance of 8 ft. (2.44 m), and came loose from the stem at 2 ft. 6 in. (76.2 cm) from its bottom edge. It measured 4-1/2 in. (11.43 cm) wide and 1/4 in. (0.64 cm) thick. Although encrustations on the surface of the strap prevented the recording of the fastening method, it appeared to be secured to the stem via a series of small nails. The strap was likely installed to offer added protection to the stem in the event of a grounding or collision.

FIGURE 6-13. The metal strap used to prevent damage to the stem. (Digital still from video taken by Pierre LaRocque, 2010.

FIGURE 6-14. View of the sternpost. (Digital still from video taken by Pierre LaRocque, 2010.)

The lower apron was made of white oak, and although mussel-encrusted, was observable over a length of 2 ft. 6 in. (76.2 cm) until it was joined to the upper apron. The two pieces were presumably fayed and bolted together beneath the forwardmost terminus of the keelson. The sided dimensions of the lower apron averaged 12 in. (30.48 cm). The concentrated volume of mussels in this area prevented the acquisition of molded dimensions. The zebra mussels also obscured any evidence which may have indicated that the lower apron was notched to fit the cant or square frames at the bow. This technique, however, was customary and is seen in other archaeological examples from Lake Champlain shipwrecks of this era (Crisman 1983:46; Crisman 1987:139; Emery 2003:62).

Stern

The stern was among the most well-preserved sections of the wreck (Figures 6-14 and 6-15). For this reason, several of the timbers that composed the stern were inaccessible. While very few zebra mussels colonized this portion of the wreck, the intact framing and hull planking shielded some of the stern timbers so that precise measurements of the stern assembly were not obtainable without disassembly. The stern assembly consisted of the main and inner sternpost, deadwood timbers, stern knee, and iron rudder gudgeons.

The main post measured 6 ft. 6 in. (1.98 m) from its junction with the keel to its uppermost portion, which was somewhat eroded and damaged. The base of the main post measured 18 in. (45.72 cm) molded and tapered to 12 in. (30.48 cm). The sided dimension of the after face was 7 in. (17.78 cm). Iron fasteners used to attach this timber to the inner post were observed along the after face of the main post. Evidence of the bolts consisted of circular corrosion products recorded at approximately 2 ft. (60.96 cm) intervals along the after face of the main post. There was no evidence of the use of fishplates to secure the sternpost to the keel. Although expected, there was no proof of the use of stopwaters at any of the stern assembly junctions. As recorded *in situ*, the sternpost was inclined at an angle of 70.5° relative to the flat of the keel. As the base of the aftermost portion of the keel was buried in the sandy lake bottom, a determination could not be made on the existence of a skeg, or angular after end of the keel, which would have protected the rudder in the event of a grounding.

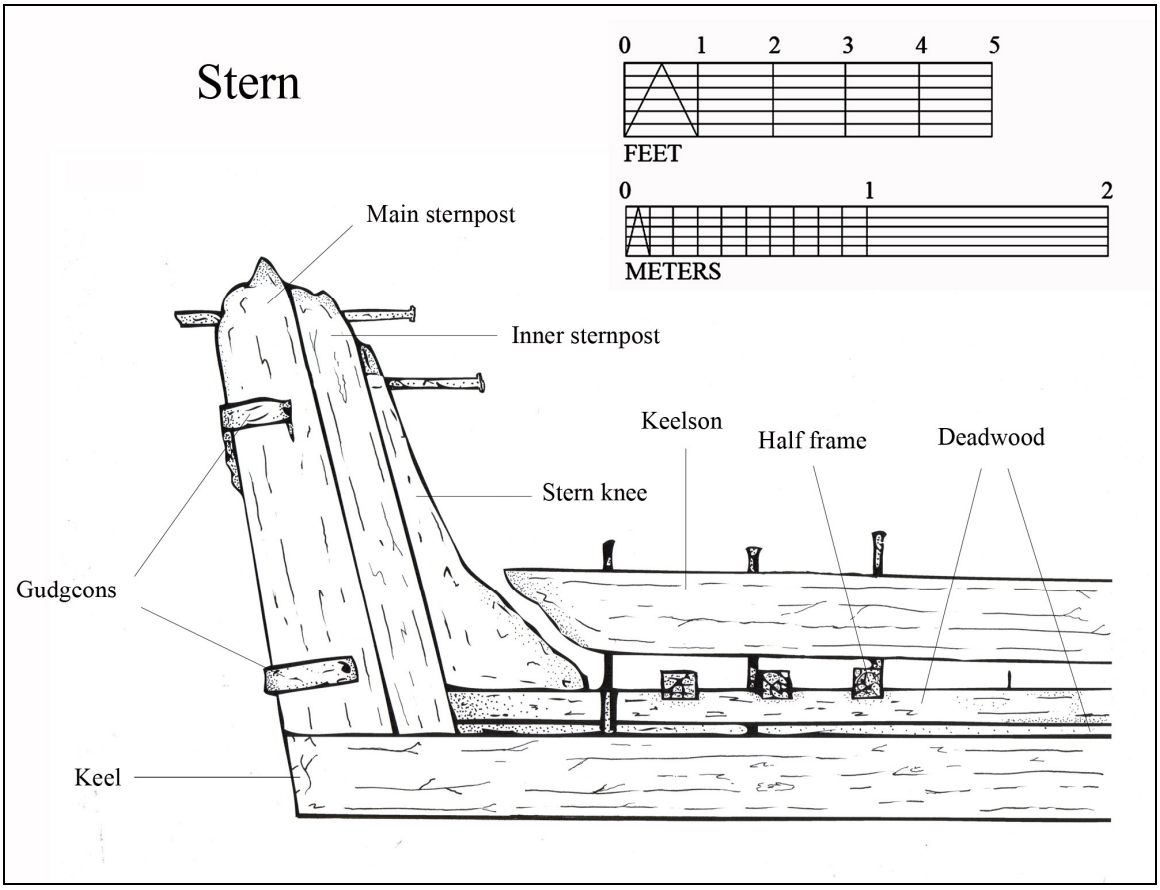


FIGURE 6-15. The stern of *Phoenix*. (Drawing by author, 2012.)

The garboard strake and four hull planking strakes survived on both sides of the vessel at the sternpost and were joined to the outer sternpost at the rabbet which had gradually widened from the keel as it approached the sternpost to approximately 90° to seat the hood ends of the planking. Four 1/4 in. (0.64 cm) square nails were used to fasten the planks to the inner sternpost.

Two intact but corroded iron gudgeons were documented on the sternpost. The gudgeons wrapped around the sternpost and the straps were fastened approximately 2 in. (5.08 cm) from the forward molded edge of the timber. The upper gudgeon was

positioned 2 ft. (60.96 cm) below the top of the extant sternpost and was connected to the side of the post with iron fasteners. Due to the corrosion products concreted to the surface of the strap and wood, the dimensions of the fasteners could not be measured. The heads of the fasteners are estimated to be 1/4 in. (0.64 cm) in diameter. The concreted gudgeon measured 3 in. (7.62 cm) wide and 12 in. (30.48 cm) long from the after edge of the sternpost to its distal end. Immediately below the upper gudgeon was an iron pintle stop, 2 in. (5.08 cm) wide and 11 in. (27.94 cm) long. The lower gudgeon, also concreted, was located 7 in. (17.78 cm) above the base of the sternpost and measured 4 in. (10.16 cm) wide and 16 in. (40.64 cm) long from the after edge of the sternpost to its distal end. The missing rudder would have included the other halves of the rudder hinge assembly and the pintles, which were bolted or spiked to the rudder and inserted through the gudgeons to hold the rudder in place and allow for it to swing as required for steering.

The inner post was attached to the outer post by iron drift bolts approximately 2 in. (5.08 cm) in diameter and of varying lengths. The inner post provided reinforcement for the outer post and rested on top of the second deadwood timber, which abutted the outer sternpost. It measured 10 in. (25.4 cm) molded by 6 in. (15.24 cm) sided and was approximately 5 ft. 3 in. (1.6 m) long. Two of the four iron bolts driven from the after end of the main post protruded from the forward face of the inner post and held wooden remnants of the transom timbers and additional deadwood pieces used to fill out this narrow section of the hull.

The lowest deadwood timber was a flat, 2 x 10 in. (5.08 x 25.4 cm) piece that sat directly on top of the keel and extended approximately 11 ft. (3.35 m) from the base of the inner sternpost to frame 38. The second deadwood piece was positioned on top of the first timber and was approximately the same length as the first. This timber measured 6 in. (15.24 cm) molded near the stern and grew in size to 8 in. (20.32 cm) molded as it extended forward. The sided dimension was recorded at 10 in. (25.4 cm). Notches were observed along the upper surface of the timber to receive frames 40 and 42.

The stern knee was positioned against the inner sternpost and atop the second deadwood timber. It was a compact, roughly hewn, robust knee that was fastened to the inner and outer sternposts with iron bolts. This timber served to support the junction of the sternposts, deadwood, and keel. Due to the presence of planking and frames at this section, the molded dimensions could not be recorded. Based on the dimensions of neighboring timbers, however, the molded measurements were estimated to be 6 in. (15.24 cm) at its minimum width near the top and 14 in. (35.56 cm) at its maximum width at the junction of the deadwood and second deadwood timber. The sided dimensions varied from 10 in. (25.4 cm) at the top of the knee to 14 in. (35.56 cm) at the expanded central portion to 11 in. (27.94 cm) where it flattened out beneath the keelson.

There was a 6 in. (15.24 cm) gap between the second deadwood piece and the keelson, which terminated in a beveled shape that matched the inner face of the knee. The gap between the timbers here indicates that upon settling to the bottom of the lake, the torsion and pressure placed on the backbone of the steamer resulted in some twisting of the hull. The keelson probably became disarticulated from the deadwood during this

event, exposing the underside of the keelson and upper face of the deadwood. The molded dimension of the keelson near the stern was 13-1/2 in. (34.29 cm). The timber was 11 in. (27.94 cm) sided at its base and reduced to 6 in. (15.24 cm) at the rounded upper surface. The keelson, first and second deadwood timbers, and frames were fastened to the keel by a series of large iron bolts driven from above. Several of these bolts, driven through the top of the keelson at the center of the frames, stood several inches proud of the keelson. They were 1-1/2 in. (3.81 cm) in diameter and approximately 3 ft. (91 cm) long.

Frames

A total of 72 surviving frames were recorded on the hull of *Phoenix* during the 2009 and 2010 field seasons. This included 60 square frames, 5 cant frames at the bow, and 7 half frames at the stern. These 72 frames represent the original number of frames installed on *Phoenix*, although one or two additional filling timbers may be missing from the forwardmost portion of the bow, and would have supported the cant frames that have survived. Although the vast majority of the surviving frames were in excellent shape, the list of the hull relative to the lakebed resulted in the better preservation of the port side elements (Figures 6-16 and 6-17). It was clear from the appearance of the best-preserved specimens that the shipwrights neglected to give the frames a finished look. Most of the framing timbers were roughly hewn, especially at the turn of the bilge and the extremities of the top timbers.

The hull's square frames each consisted of a single floor timber fastened across

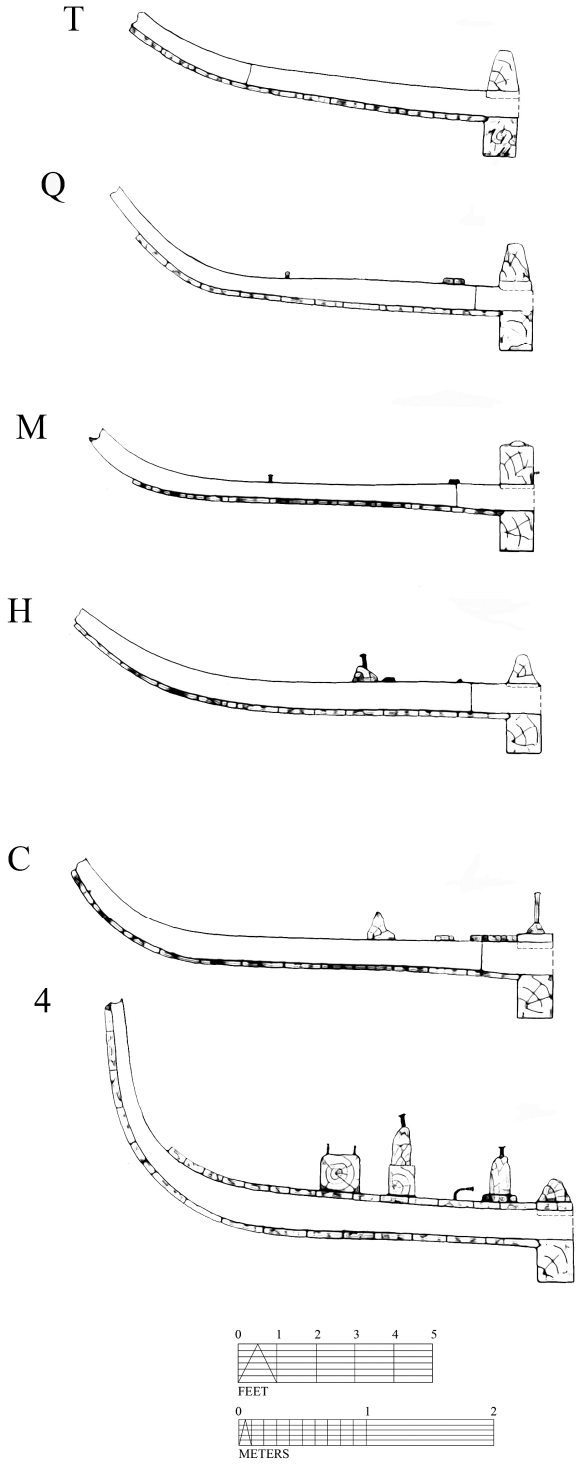


FIGURE 6-16. Cross-sectional drawing of *Phoenix* frames 4 to T, view forward. (Drawing by author, 2012.)

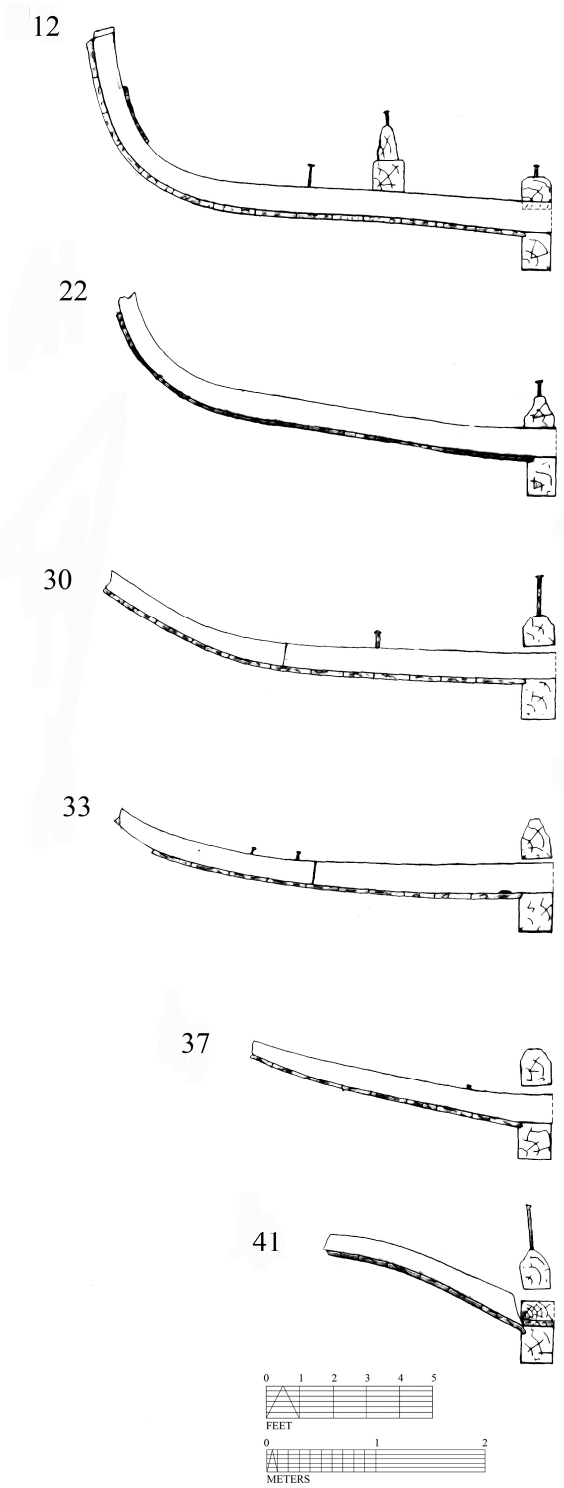


FIGURE 6-17. Cross-sectional drawing of *Phoenix* frames 41 to 12, view forward. (Drawing by author, 2012.)

the keel, a pair of first futtocks, and a pair of second futtocks, or top timbers. At 14 ft. 7 in. (4.45 m) in length, port frame 5 was the longest preserved frame. Wood samples from the port side of frame 4 revealed that the floor and first futtock were cut from yellow pine (*Pinus sp.*), while the second futtock was hewn from northern white cedar (*Thuja occidentalis*) (Appendix B). Additional samples are needed, however, to determine what species the majority of the frames were cut from.

The room and space, or distance between the centers of any two adjacent square frames, was between 22 and 24 in. (55.88 and 60.96 cm). A drift bolt driven through the center of each floor fastened it to the keel beneath. An exception was observed between frames B and E, which were each fastened with a drift bolt. The molded and sided dimensions of the frames varied widely. Molded measurements ranged from between 6 and 10-1/2 in. (15.24 and 26.67 cm) and averaged 8-1/4 in. (20.96 cm). The sided dimensions ranged from 5 to 9 in. (12.7 cm to 22.86 cm) and averaged 6-1/2 in. (16.51 cm). The distance between frames was between 4 and 6 in. (10.16 and 15.24 cm). Although the remaining floor timbers were found to be in various states of preservation, the approximate average length of each floor timber from the edge of the keelson to its head (the outermost extremity on either side of the hull) was 10 ft. (3.05 m). Watercourses, or limber holes, while difficult to observe on most floors due to the accumulation of sediment, were recorded on a number of floors, for which goniometer measurements were taken. These apertures cut by the shipbuilders in the bottom of the frames were designed to allow water to drain into the pump well.

The dimensions of the first futtocks averaged the same as those of the floors. The

gap between the keelson and the heel of the first futtocks varied from 5 to 26 in. (12.7 to 66.04 cm), and averaged 12-1/2 in. (31.75 cm). The first futtocks were attached to the frames via 1 in. (2.54 cm) diameter white oak treenails driven transversely. With the assistance of a hand-cranked auger, the shipwrights pre-drilled a hole into the molded dimension of the floors and futtocks and inserted the slightly compressed wooden fastener to join the timbers. While the treenails were difficult to detect, they were typically observed 9 to 10 ft. (2.74 to 3.05 m) from the keelson. At frame 17 there were two treenails recorded at 10 ft. 1 in. (3.07 m) and 12 ft. 3 in. (3.73 m) from the keelson, indicating the treenails were spaced approximately 2 ft. (60.96 cm) apart near the turn of the bilge. Frame 12 exhibited similar treenail placement and spacing. Iron fasteners of varying types and sizes were also recorded on the futtocks and held ceiling planking, engine bedtimbers, and longitudinal stringers. The longest-preserved futtock was on port frame 5, measuring 13 ft. 6 in. (4.11 m) in length.

The second futtocks were of approximately the same dimensions as the floors and first futtocks, although much shorter in length. As the steamboat burned to the waterline, the upper extremities of the second futtocks were charred. Treenails of 1 in. (2.54 cm) diameter were driven transversely to connect the first and second futtocks.

Frame 10 likely represents the midship frame. The forward edge of this single frame was located 76 ft. 8 in. (23.36 m) from the after end of the keelson and 42 ft. 6 in. (12.95 m) from the forward end of the keelson. The frame measured 9 in. (22.86 cm) molded and 7 in. (17.78 cm) sided. On the port side, the midship frame was preserved over a length of 12 ft. 9 in. (3.89 m). The midship frame represented the broadest frame

in the hull, was typically the first frame erected on the keel, and served as a guide for frames positioned both fore and aft of this location. The futtocks of frames A to U were located aft of each accompanying floor timber, while the futtocks of frames 1 to 40 were positioned forward of its respective floor.

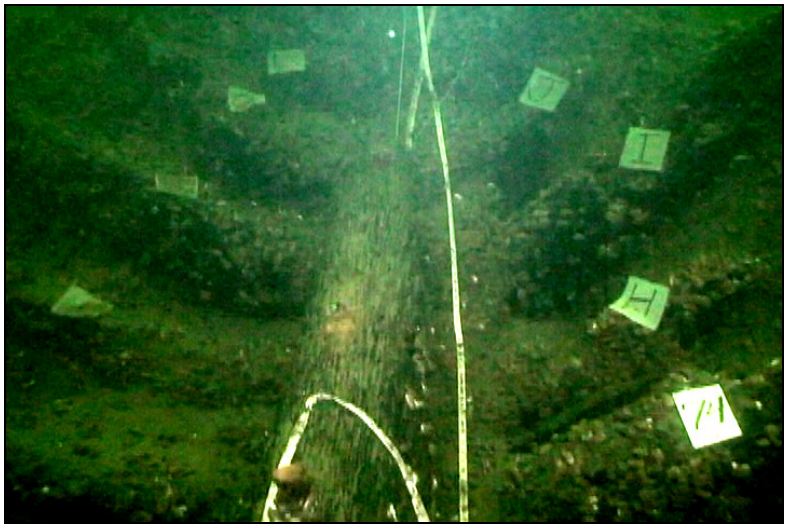


FIGURE 6-18. Zebra mussel-encrusted cant frames at the bow. (Digital still from video taken by Pierre LaRocque, 2010.)

At the bow, a number of cant frames existed to varying degrees along the apron and stem. Frames X and Y were located at the forwardmost extremity of the keelson and were fastened to the apron via a 1 in. (2.54 cm) diameter iron drift bolt driven through the top of the keelson. Forward of frame Y several cant frames were positioned on either side of the apron. Labeled AA through AG these timbers were largely eroded stumps, distributed along the apron to support and help form the shape of the bow (Figure 6-18). With the exception of timbers AC and AD, each of the cant frames abutted the upper

apron. Due to the varied state of preservation and their function of filling out irregular spaces in the bow, their recorded dimensions ranged from 4 to 10 in. (10.16 to 25.4 cm) molded and 5 to 8 in. (12.7 to 20.32 cm) sided. All of the cant frames were heavily encrusted with zebra mussels, obscuring the method of fastening to the stem.

At the stern, portions of five pairs of half frames survived. Their molded and sided dimensions were slightly smaller than the square frames, and the longest preserved timber was recorded at frame 41 at 6 ft. 5 in. (1.96 m). The deadwood was notched on top to receive these frames, and the same large iron drift bolts that were used to secure the frames to the keelson and keel also fastened these half frames to the hull. In addition to the half frames, there were two pairs of wedge-like filler timbers on either side of the stern assembly, just beyond the termination of the keelson. These remained in their original position and were presumably attached to the inner sternpost by transversely-driven iron fasteners.

Keelson

Cut from white oak, the keelson was found to be intact over the entire length of the steamer's hull. It was composed of three timbers flat-scarfed end-to-end. The aftermost timber, which overlapped the stern deadwood, measured 23 ft. 9 in. (7.24 m) long. The forward end of this timber and the after end of the middle piece, although originally flat-scarfed together, had separated at frames 30 and 29. The middle keelson timber stretch 48 ft. 9 in. (14.86 m) until it met the third and forwardmost timber, which measured 52 ft. 6 in. (16 m) long and overlapped the apron. The keelson was secured to

the frames and keel beneath by means of a 36 in. (91.44 cm) iron drift bolt, 1-1/2 in. (3.81 cm) in diameter, driven from above. Nearly every drift bolt stood 2 to 3 in. (5.08 to 7.62 cm) proud of the upper face of the keelson.

Due to the placement of the steam machinery, the effects of the fire, and the degradation which took place as the timbers were left exposed on the lake bed for nearly 200 years, the keelson's molded and sided dimensions varied along the length of the hull. The average molded and sided dimensions were 11 in. (27.94 cm). The keelson was not always square, however, and often tapered from 11 in. (27.94 cm) at its base to 4-1/2 in. (10.8 cm) at the upper face (Figure 6-19). Between frames 5 and 4, the keelson was notched from 2-1/2 in. (6.35 cm) to 4 in. (10.16 cm) to seat steam machinery components, and two fasteners stood proud of the keelson in this notch. Just aft of this notch a 1-1/2 in. (3.81 cm) diameter iron drift bolt with a 2 in. (5.08 cm) square head stood 34 in. (86.36 cm) proud of the keelson, presumably to secure engine support timbers below deck. Seven inches (17.78 cm) to either side of the keelson, beginning at frame 8, were longitudinal engine bedtimbers, described in more detail in a later section. Between frames 3 and 1, the keelson flattened to 3-3/4 in. (9.53 cm), then stepped back up to 11 in. (27.94 cm) molded just forward of frame 1. Between frames 1 and B, the keelson flattened completely and measured 10-1/2 in. (26.67 cm) sided until it stepped back down to 3 in. (7.62 cm) molded just aft of frame 53. Over this distance it was observed that a single rough notch was cut out of the base of the keelson to receive both frames A and B. Just aft of frame B, where the molded dimension was 3 in. (7.62 cm), the keelson again flattened all the way to frame F. Over this distance, a drift bolt was

driven through the keelson into each frame; each bolt stood 12 in. (30.48 cm) proud of the timber.

Forward of frame L, the molded dimension of the keelson grew to 12-3/4 in. (32.39 cm) and at frame M the molded dimension grew to 15 in. (38.1 cm). A notch 16 in. (40.6 cm) long by 6.5 in. (16.5 cm) wide was cut out of the keelson at frame N. This was the steamer's mast step, carved 4 in. (10.16 cm) deep and located 19 ft. 6 in. (5.94

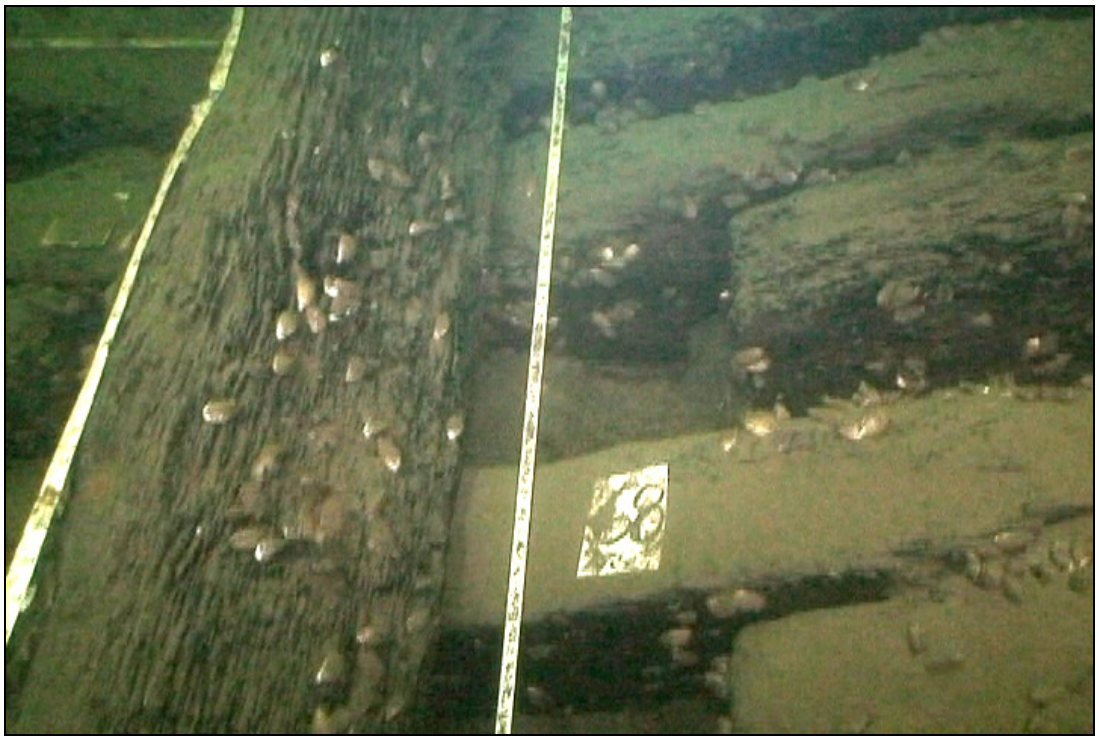


FIGURE 6-19. Example of the tapered keelson at frame Q. (Digital still from video taken by Pierre LaRocque, 2010.)

m) aft of the stem (Figure 6-20). From frame N to frame W the keelson maintained a 15 in. (38.1 cm) molded dimension until it began to taper toward frame Y, where it terminated over the apron at a molded dimension of 3 in. (7.62 cm) and a sided

FIGURE 6-20. The steamer's mast step carved into the keelson. (Digital still from video taken by Pierre LaRocque, 2010.)

dimension of 6 in. (15.24 cm). Between frames I and S, the keelson measured 11 in. (27.94 cm) sided at its base and tapered to between 4 and 5 in. (10.16 to 12.7 cm) on its upper surface.

The keelson was roughly notched 1-1/4 to 1-1/2 in. (3.18 to 3.81 cm) by the shipbuilders to fit over most of the square frames. Due to the twisting of the steamer's backbone during and after the wrecking, the keelson was offset from many of the frames and did not sit directly on top of them.

A wooden protrusion, 1-3/4 in. (4.45 cm) wide by 2-1/2 in. (5.72 cm) long by 2-1/2 in. (5.72 cm) tall, was observed just aft of frame I on the keelson. The function of this piece is unknown, although it appears to have been a tenon of some sort, perhaps to secure a member of the steam machinery or an associated support timber.

Hull Planking

With a few exceptions, the majority of the hull planking, which was at least partially cut from chestnut, was preserved over the length of the wreck up to the extremities of the surviving futtocks (Figure 6-21). As the starboard planking was the better preserved, the strakes on that side were recorded in detail from bow to stern. Most of the strakes at both the bow and stern were accessible for documentation from the garboard to the uppermost plank. As the hull flattened out towards midships, however, the strakes nearest the keel became inaccessible.

At the bow, fragments of up to 17 strakes were recorded where they were fitted into the stem rabbet. These likely represent the original number of starboard strakes that comprised the complete hull of *Phoenix*. Beginning at frame W, which marked the forwardmost square frame, 10 strakes including the garboard were preserved. Between 10 and 12 continuous strakes ran along the length of the starboard side of the hull up to frame 4, where three more strakes were found preserved over a length of 8 frames. At frame 12 the number of surviving strakes dropped to 11, which continued with little fluctuation until frame 30. As mentioned previously, at this location on the wreck site, the frames, futtocks, and planking had fallen away from the rest of the hull. These

FIGURE 6-21. Hull planking preserved up to the upper extremities of the frames. (Digital still from video taken by Pierre LaRocque, 2010.)

disarticulated sections were recorded lying flat on the lake bed with planking still attached to the separated frames and futtocks. At a point 18 ft. (5.49 m) forward of the stern (near frame 37), the frames, futtocks, and planking were again found to be intact and attached to the hull. Six strakes ran the rest of the length of the hull and into the stern assembly. The garboard at this section gradually twisted 90° from its upright position at the stern and separated from the keel rabbet near frame 42 to lay flat on the lake bed. This garboard plank ran 14 ft. 6 in. (4.42 m) and the hull plank above it became disconnected from the garboard at a distance of approximately 7 ft. (2.13 m) forward of the stern. The garboard plank forward of this was still attached to the keel and neighboring hull planking.

With a few exceptions, the same preservation pattern occurred on the port side of the wreck, with the planking mostly surviving over the length of the existing futtock members. The structural features in the stern section were more intact and there was limited collapse of frames and planking on the port side.

The garboard measured approximately 2 in. (5.08 cm) thick along the length of the hull. Its width varied, and it measured 12 in. (30.48 cm) wide near the stern and 17 in. (43.18 cm) wide near the bow (at frame V). The length of each garboard plank varied as well, and the first butt joint was recorded 31 ft. (9.45 m) aft of the stem. The inboard edge of the garboard was shaped to fit tightly into the V-shaped keel rabbet and ran the length of the hull until its hood ends ran into the stem, where it had twisted to a near 90° angle. The garboard and other strakes were fastened to the frames with 3/8 in. (0.95 cm) square iron spikes, usually four per frame.

The thickness of the surviving planking strakes averaged 2 in. (5.08 cm), although planking thicknesses of 1 in. (2.54 cm) were recorded at the bow, possibly due to the effects of the fire. Planking widths varied along the length of the hull, with starboard strake widths at the bow near frame Y measuring consecutively from top to bottom: 5 in. (12.7 cm), 4 in. (10.16 cm), 8-3/4 in. (22.23 cm), 7-1/2 in. (19.05 cm), 9-1/2 in. (24.13 cm), and 8 in. (20.32 cm). At midships, near frame 4, the strake widths measured from top to bottom: 7 in. (17.78 cm), 7 in. (17.78 cm), 8 in. (20.32 cm), 10 in. (25.4 cm), 10 in. (25.4 cm), 7 in. (17.78 cm), 11 in. (27.94 cm), 12 in. (30.48 cm), and 10 in (25.4 cm). The two uppermost strakes recorded near frame 4 were likely wales, and their thicknesses measured 4 in. (10.16 cm) compared to the 2 in. (5.08 cm)

thicknesses of the other strakes. An iron bolt was recorded at frame 4 protruding 22 in. (55.88 cm) inboard that may have secured a hanging or lodging knee in this area (Figure 6-22). The wales were 7 in. (17.78 cm) wide and may represent a location in the hull where the deck assembly was connected. The lengths of the strakes varied, with the longest strake recorded at 45 ft. 3 in. (13.79 m) long. The strakes were staggered, and no two planks were observed to end on the same frame.

Ceiling Planking

Although the majority of the ceiling planking on *Phoenix* was missing, a considerable amount had survived between frames 11 and D, particularly on the port side of the wreck (Figure 6-23). This is likely due to the presence of the engine

FIGURE 6-22. An iron bolt at frame 4 possibly used to fasten a hanging or lodging knee. (Digital still from video taken by Pierre LaRocque, 2010.)

FIGURE 6-23. Example of the surviving ceiling planking. (Digital still from video taken by Pierre LaRocque, 2010.)

bedtimbers which had pinned down large sections of internal planking and also probably protected the ceiling from the effects of the fire. Fragments of ceiling planking were also recorded on various port-side frames along the length of the extant hull, but survived in lengths no longer than 8 ft. 8 in. (2.64 m). Most of these planking fragments, fastened to the frames with 3/8 in. (0.95 cm) iron nails, were less than 5 ft. (1.52 m) long. Samples of both the lower and upper ceiling planking near frame 4 were identified as red pine (*Pinus sp.*).

Most of the existing ceiling planking was accessible for documentation, except for those portions positioned beneath the robust longitudinal stringers and engine bedtimbers. The ceiling planking between frames 11 and D, in fact, was so well-preserved that it prevented thorough documentation of the framing features below.

Because most of the ceiling planking was blanketed with layers of silt and zebra mussels, many fastening details could not be gathered without intrusive action. From the observable features, it was apparent that the internal planking was fastened to each frame with small iron nails driven at the upper and lower edges of each plank. A perpendicular row of iron straps measuring 2-1/2 in. (6.35 cm) wide was discovered on both port and starboard ceiling planking sections, providing additional transverse support to each plank.

Ceiling planking widths diminished as they ran outboard. On the port side of the wreck there were 14 consecutive strakes measuring 11 in. (27.94 cm) wide near the keelson and narrowing to 6 in. (15.24 cm) wide near the outboard end of the accompanying frame. Most of the planking thicknesses were between 1-1/2 in. (3.81 cm) and 2 in. (5.08 cm), although in some areas, such as frames 2 and M, the ceiling measured 3/4 in. (1.9 cm) to 1 in. (2.54 cm) thick.

Stringers and Steam Engine Bedtimbers

Three pairs of longitudinal timbers, positioned to support the vessel's heavy steam machinery, were documented along the length of the hull over a span of 43 frames. These pairs include the inboard bedtimbers, central stringers with bedtimbers, and outboard bedtimbers (Figure 6-24). These timbers and their associated hardware, including engine mount details, were largely intact and well-preserved for documentation. All wood samples gathered from the longitudinal timbers for analysis,

Engine Bedtimbers and Stringers

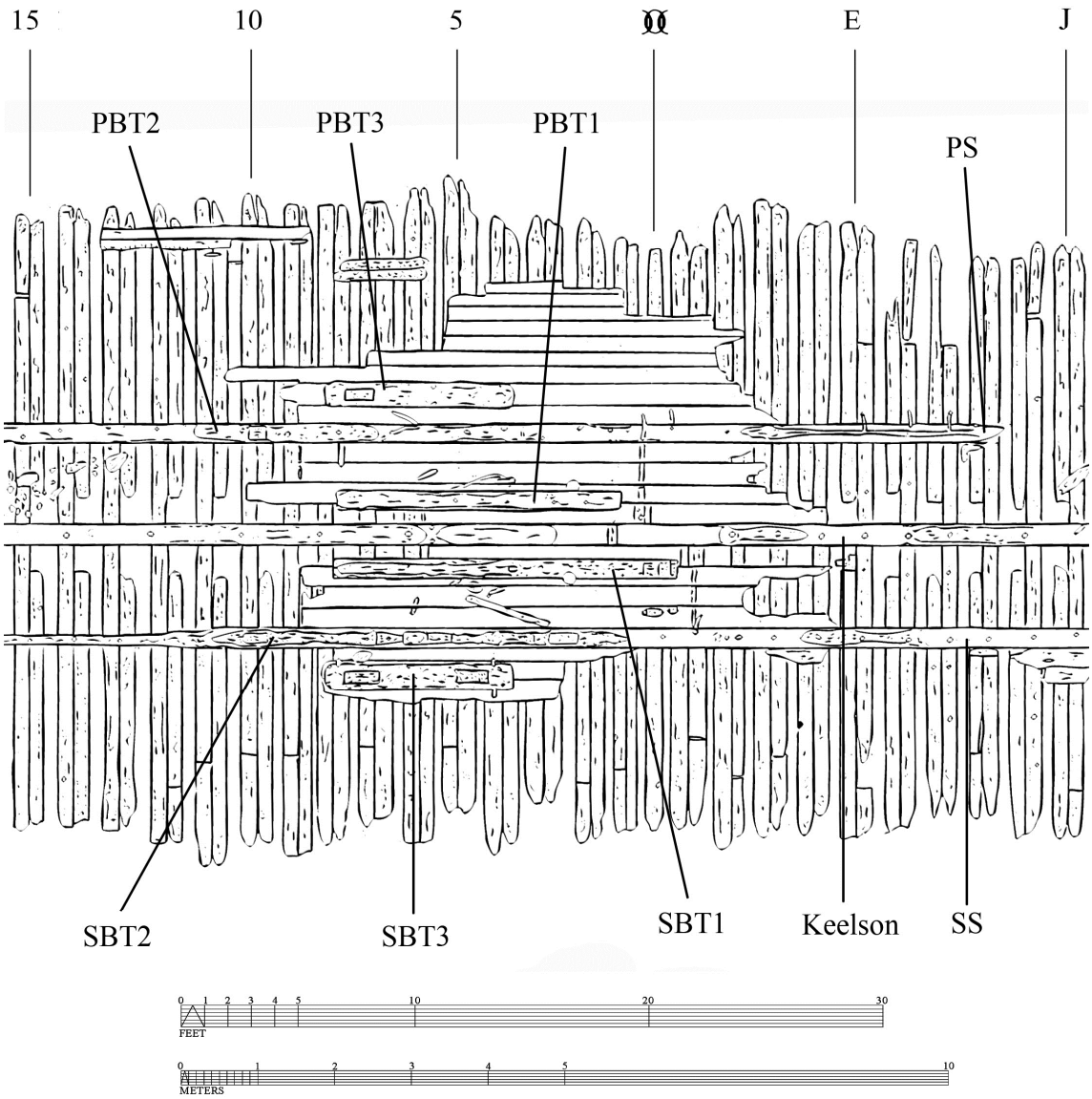


FIGURE 6-24. The engine bedtimbers and stringers between frames 15 and J. (Drawing by author, 2012.)

including both the upper and lower sections of the middle pair, were identified as white oak.

The inboard engine bedtimbers were located 7 in. (17.78 cm) to either side of the keelson and were stacked two pieces high, each measuring 6-1/2 in. (16.51 cm) molded (Figure 6-25). The bases measured 10 in. (25.4 cm) sided, while the upper members on either side were eroded and varied between 10 in. (25.4 cm) and 4 in. (10.16 cm) sided. The port timber (PBT1), which ran from frames 8 to 1, was 11 ft. 10 in. (3.61 m) long, and was fastened to frames 5, 4, 3, and 2 with 1 in. (2.54 cm) diameter iron bolts driven from above. The starboard bedtimber (SBT1) was positioned over frames 8 through A and measured 14 ft. 4 in. (4.67 m) long. As before, 1 in. (2.54 cm) diameter bolts fastened this timber to frames below, in this case 6, 4, 3, and 1. A series of six staggered 1 in. (2.54 cm) diameter empty bolt holes were recorded along the starboard edge of this timber between frames 3 and 𝔄. Although heavily eroded, some evidence of this was also apparent on PBT1. Three notches carved by the shipbuilders were also observed on SBT1 over frames 5 and 4. The first notch was located along the outboard edge of the structure, and measured 14 in. (35.56 cm) long, 2 in. (5.08 cm) wide, and 5 in. (12.7 cm) deep. The second notch was similarly positioned 8 in. (20.32 cm) aft of the first. It was 3-1/2 in. (8.89 cm) long, 3 in. (7.62 cm) wide, and 4 in. (10.16 cm) deep. The third notch was in the center of the bedtimber and measured 4-1/2 in. (11.43 cm) long, 2 in. (5.08 cm) wide, and 2 in. (5.08 cm) deep. Due to the significantly eroded port timber, these notches were not observable if present. In addition to providing support for the steam machinery, these inboard timbers acted, along with the ceiling planking, to clench the

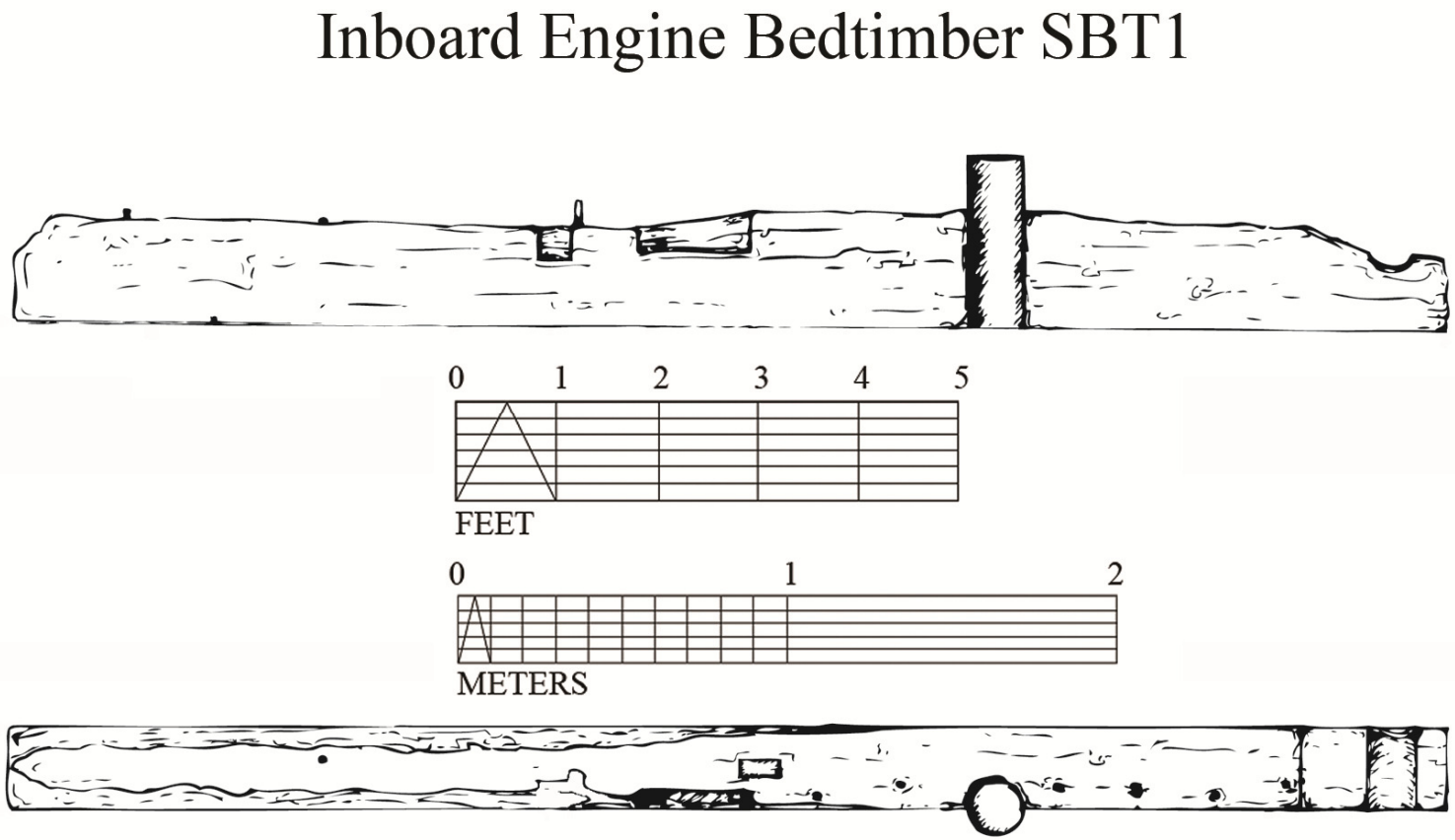


FIGURE 6-25. Drawing of inboard bedtimber SBT1. (Drawing by Chris Sabick, 2010).

floor timbers and first futtocks where they overlapped, additionally reinforcing the center of the hull where the bulk of the steam hardware was located.

Between frames 3 and 2, two 6 in. (15.24 cm) diameter copper pipes were discovered protruding from the ceiling planking, one each on the port and starboard sides of the hull. They were located at the forward ends of the inboard engine bedtimbers, and the shipbuilders had carved a circular notch in each timber to allow for half of the diameter of the pipe to be set into the face of the timber (Figure 6-25). Each pipe penetrated the ceiling planking down to the bottom edge of the frame below. The pipe on the port side stood approximately 8 in. (20.32 cm) proud of the ceiling and was otherwise freestanding. The starboard pipe stood 20-1/2 in. (52.07 cm) proud of the ceiling planking and was likewise freestanding.

To provide the longitudinal support required for the 146 ft. (44.5 m) long steamboat, the builders positioned two 10 in. (25.4 cm) square stringers 3 ft. 6 in. (1.07 m) to either side of the keelson. Due to nearly 200 years of erosion on the lake bed, the effects of the fire, and likely the damage caused from engine salvaging, the sided dimensions varied erratically over the length of the timbers, narrowing to 4 in. (10.16 cm) in some areas. The extant length of the port timber (PS) was 59 ft. (17.98 m), while its starboard counterpart (SS) measured 67 ft. (20.42 m). The stringers were secured with 1 in. (2.54 cm) diameter iron bolts to every frame along their lengths. The offset fastening pattern alternated between the inboard and outboard edges of the timber, possibly to avoid colliding with the iron spikes in the frames beneath. For both the port and starboard stringers, the fastening pattern continued beyond the extant remains of the

Components of Central Engine Bedtimber SBT2

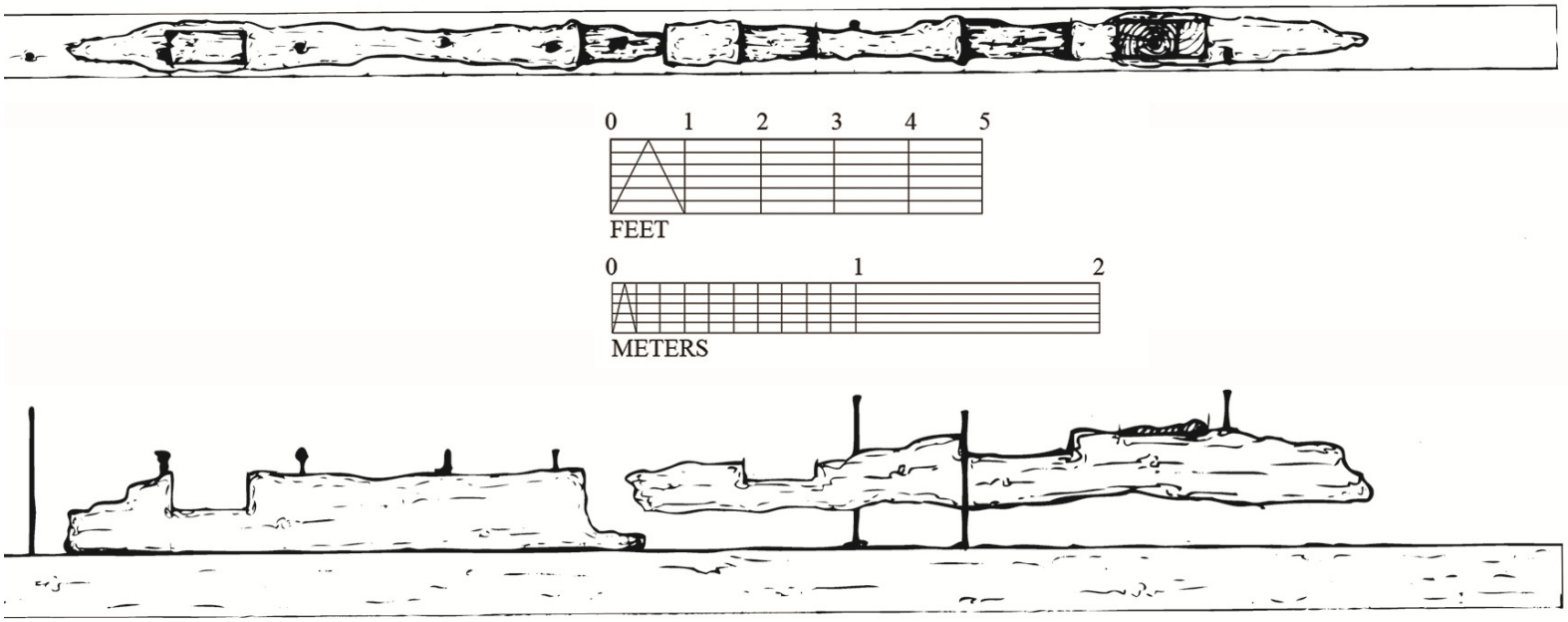


FIGURE 6-26. Drawing of central bedtimber SBT2. (Drawing by Chris Sabick, 2010.)

timbers, and bolts were observed standing several inches proud of the frames fore and aft of the stringers. This continuation of the fastening pattern indicated that the original length of each stringer was 84 ft. (25.6 m). To provide further support for the engine and boilers, the steamboat builders secured additional timbers on top of these central longitudinal stringers in the sections where the steam machinery was located. Damage from the burning and perhaps the subsequent salvage of the steam engine, combined with the effects of erosion, prevented the preservation of the full length of these central bedtimbers. The starboard member (SBT2), however, was found to be the most complete and a number of significant details were recorded (Figure 6-26). This upper timber survived over a length of 17-1/2 ft. (5.33 m), and was located between frames 11 and 1. It was discovered to be in two sections, the forwardmost piece having separated from the top of the stringer below.

The heavily-eroded forwardmost timber was originally secured to its base member with 1 in. (2.54 cm) diameter iron bolts, probably every frame. Only three remaining bolts were observed, however, emerging from the timber below. Two of the bolts no longer touched the side of the eroded wood, and the one that was driven into the center of the bedtimber stood several inches proud of its upper face. The molded dimensions varied between 5 in. (12.7 cm) and 12 in. (30.48 cm), while the sided dimensions ranged from 2 in. (5.08 cm) to 8-1/2 in. (21.59 cm). Three deep mortises were carved out of this timber, the forwardmost one filled with wooden wedges. It measured 14-1/2 in. (36.83 cm) long and 6 in. (15.24 cm) wide. The second notch was 17 in. (43.18 cm) long, 6 in. (15.24 cm) wide, and 4 in. (10.16 cm) deep, and the walls

had eroded away. Evidence of a white substance located at the bottom of this mortise was observed, possibly remnants of melted lead from the fire. The third notch was 11 in. (27.94 cm) long, 6 in. (15.24 cm) wide, 3 in. (7.62 cm) deep, and was more heavily eroded than the second.

The aftermost starboard bedtimber was still connected to the base stringer and was secured by 1 in. (2.54 cm) diameter iron bolts fastened to each underlying frame down the center of the timber. The dimensions of this timber also varied significantly, ranging between 2 and 14 in. (2.54 and 35.56 cm) molded and 2 and 8 in. (2.54 and 20.32 cm) sided. One large mortise was carved out of the aftermost end of this timber, measuring 13-1/2 in. (34.29 cm) long, 6 in. (15.24 cm) wide, and 6 in. (15.24 cm) deep. Similar to the other mortises, the walls had nearly eroded away. Although the port-side counterpart (PBT2) did not survive to the same degree, a similar notch was recorded in the same location on the other side of the keelson (Figure 6-27), indicating that the entire central bedtimber was originally duplicated on the port side.

The final set of engine bedtimbers was located 8 in. (20.32 cm) outboard of the central longitudinal stringers between frames 8 and 4, and each measured 7 ft. 11 in. (5.46 m) long (Figure 6-28). Compared to the inboard and central bedtimbers, these structures, consisting of only a single timber per side, were well-preserved. More robust than the other support timbers, they measured 12 in. (30.48 cm) molded and 13-1/2 in. (34.29 cm) sided. Four 1 in. (2.54 cm) iron bolts on both the inboard and outboard edges of the timbers fastened them to the planking and frames beneath, with several of these bolts standing 3 to 5 in. (7.62 to 12.7 cm) proud of the upper face of the outer bedtimber.

Two mortises were recorded on the starboard timber (SBT3), the first one beginning 1 ft. 0-1/2 in. (31.75 cm) aft of the forwardmost edge. It measured 1 ft. 4-1/2 in. (41.91 cm) long and 7 in. (17.78 cm) wide, and was filled with wooden wedges. Just forward of this mortise on either edge of the timber were 2 in. (5.08 cm) wide iron straps protruding 4 in. (10.16 cm) horizontally inboard and outboard. The second mortise was located 5 ft. 3 in. (1.6 m) aft of the first mortise, and measured 1 ft. 5-1/2 in. (44.45 cm) long and 7 in. (17.78 cm) wide. This mortise was empty and continued all the way through the timber. A single 2 in. (5.08 cm) iron strap was recorded just aft of the mortise protruding 3 in. (7.62 cm) horizontally inboard. The outboard strap had presumably fallen off either during or after the sinking. The port-side bedtimber counterpart (PBT3) was very similar in all aspects, except that no 2 in. (5.08 cm) iron straps were found.

FIGURE 6-27. A mortise carved into the outboard bedtimber SBT3. (Digital still from video taken by Pierre LaRocque, 2010.)

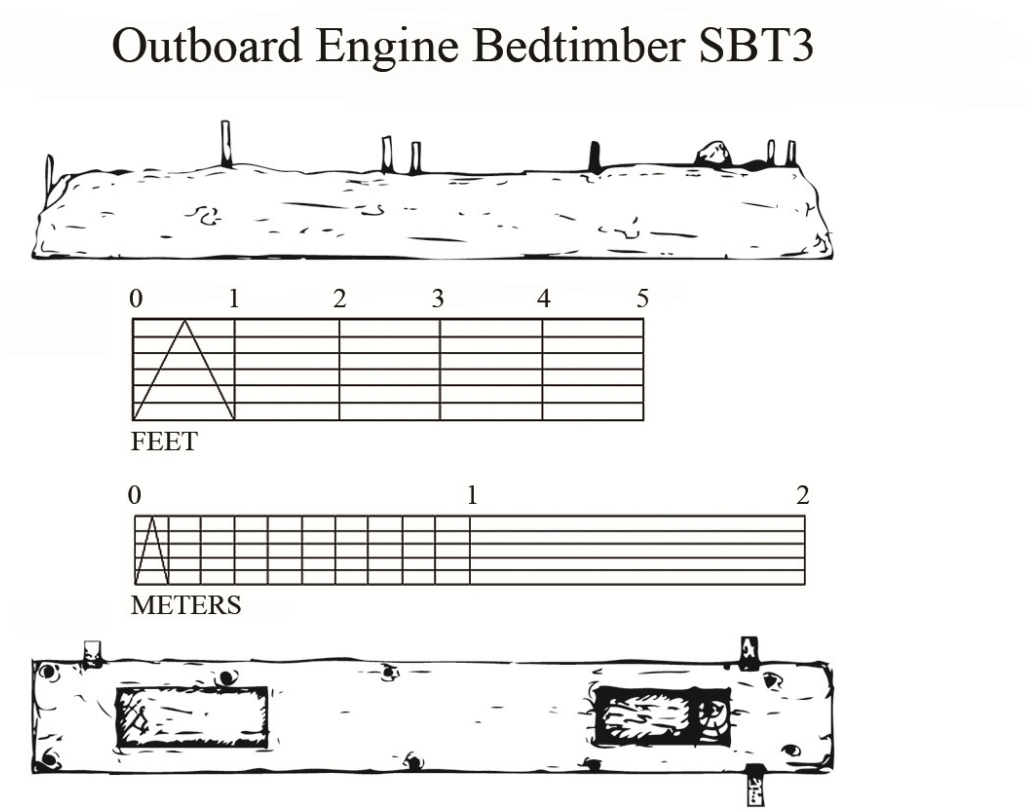


FIGURE 6-28. Drawing of outboard bedtimber SBT3. (Drawing by Chris Sabick, 2010.)

Overall, the surviving portions of the wreck, which consisted of the lower hull elements, were well preserved despite the effects of the fire and yielded a significant number of details for the analysis of the steamer's construction. As discussed in the following chapter, the missing components of the upper hull and superstructures had to be reconstructed based on information extrapolated from the remaining hull features discussed above. The chief missing hull elements for which we have little or no evidence likely include the uppermost portions of the top timbers, deck beams, paddle beams, deck clamp, waterway, hanging and lodging knees, beam stanchions, breast hooks, decking, and transom timbers. These structures are known to have existed based on the historical documentation as well as the archaeological data discussed in chapter VIII.

CHAPTER VII

ANALYSIS AND RECONSTRUCTION OF *PHOENIX*

Basis for Reconstruction

While a considerable percentage of *Phoenix*'s hull survives and is accessible for documentation, many of the details required for an entire reconstruction are absent from the archaeological remains. The previous chapter discussed the construction of the steamer based on the hull data collected in the field. As J. Richard Steffy wrote, "research and reconstruction are practically synonymous in the interpretation of shipwrecks" (Steffy 1998:214). This logic rightfully demands the examination of additional clues to early 19th-century steamboat design and assembly. Data derived from such studies can be used for reconstruction of missing sections of the hull. These areas include the uppermost portions of the stern and bow, the main deck and deck supports, paddlewheel guards, and the mast and bowsprit.

The first source of information comes from the wreck itself. The features recorded on *Phoenix* offer considerably more information than the principal dimensions of the scantlings and placement of structural elements such as engine bedtimbers, longitudinal stringers, ceiling planking, and mast step. Construction features, including fastening patterns, scarf joinery, positioning of top timbers, varied planking thicknesses, engine mount details, and the placement and size of iron bolts provide clues to the reconstruction of the upperworks and other absent elements. The recorded curvature of well-preserved floors and futtocks, for example, allows for the projection of the frames

up to the deck level. Likewise, the presence of a large iron bolt protruding inwards from a wale located near the top of frame 4 may indicate the former location of a hanging or lodging knee that supported a deck beam.

Beyond the wealth of archaeological data collected in 2009 and 2010, there are contemporary records, such as hull plans for similarly-sized steam vessels. We have few such plans from the 1810s and 1820s. The most useful collection of steamboat plans from these early years comes from Jean Baptiste Marestier's *Memoir on Steamboats of the United States of America*, originally published in 1824. Marestier's manuscript addresses the application of steam engines to navigation, provides an overview of the design and dimension of American steamboats, describes a number of steamboats he was able to observe, and examines some of the steam engine types installed in American steamers. Particularly useful is his description of the Hudson River passenger steamboat *Chancellor Livingston*, a vessel built in 1816, which is of similar dimensions to *Phoenix*. His review of the available data is somewhat cursory, but provides pertinent information on the dimensions and placement of steam machinery, which can be used as a guide for the reconstruction of *Phoenix*.

The historical accounts of the vessel's operation and sinking, as referenced in earlier chapters, are also an indispensable resource. Newspaper articles and advertisements, for example, provide sparse but often significant details on interior compartments and associated amenities of the steamboat. In addition, Hemenway's (1867) account of the sinking briefly describes the spatial arrangement below deck, and

can also be used as a guide for reconstruction in conjunction with studies conducted on artifact distribution from the *Phoenix* wreck site.

Archaeological parallels provide an additional source of information for reconstruction. Research conducted on the early 19th-century vessels *Vermont* (1809), *Ticonderoga* (1814), and *Lady Sherbrooke* (1824) provides comparative data to help fill the gaps in our understanding of *Phoenix*'s hull construction. Although each of these vessels was built with a distinct form and purpose, many of the same shipbuilding techniques exhibited on these vessels were employed in the construction of *Phoenix*.

Using the lines of evidence described above, the most relevant and informative details can be selected to help reconstruct *Phoenix*. A cautious approach should be taken, however, as historical records can portray details and events from a perspective skewed by the passage of time or propagation of misinformation. Furthermore, ship's plans provide comparative data, but may not accurately represent the true lines of the vessel as constructed. Another consideration is the use of contemporary plans, such as those from Marestier's manuscript. The French treatise can serve as a guide for drafting lines drawings but Marestier's experience was primarily with the early 19th-century steamers of the Hudson, St. Lawrence, Delaware, and other northeastern rivers versus the nascent lake steamers of the Champlain Valley. Moreover, structural elements documented in some vessels may not have been adequate, efficient, or otherwise practicable in the building of *Phoenix*, and must be considered with a dose of skepticism. Standing alone, these lines of evidence may not provide reliable or sufficient data for understanding the design and construction of *Phoenix*. The analysis, interpretation, and careful application

of the knowledge gained from the combination of sources, however, offer the best possible evidence for reconstruction.

Hull Lines

Hull lines describe a vessel's shape as seen through three views of the hull, the sheer, half-breadth, and body plans. The sheer represents a profile view of the vessel and depicts its geometry from the side. The half-breadth is a top-down view of the boat that portrays the contours of one-half of the hull as divided along its centerline. The body plan conveys the hull sections as seen from forward and aft. Contouring elements, including sheer lines, waterlines, section lines, and buttock lines, can be seen in all plans, and the measurements can be transposed from one perspective to another. Hull lines represent the molded dimensions of the vessel (the outsides of the frames), and do not incorporate the thickness of hull planking and other exterior components.

Hull lines are generated as ideal lines for the design of a ship or boat, and it is important to consider that the actual lines of the constructed vessel often deviate from the theoretical geometry. This could be due to the lack of appropriate materials, tools, or shipbuilding skill, or the shipwright's hull design might have been flawed, necessitating modification during the construction process. In addition, when basing reconstructed lines partially on archaeological evidence, it must be noted that the general deterioration, warping, and disarticulation of existing hull structures resulting from the burning and sinking of the steamboat may distort or misrepresent the original shape of the hull. This should be kept in mind, for example, when projecting the lines from recorded frame

curvatures.

The basic dimensions of *Phoenix* are known from the records of the Champlain Transportation Company, which state that the steamer was 146 ft. (44.5 m) in length, 27 ft. (8.23 m) in beam, and 9 ft. 3 in. (2.82 m) deep (Ross 1997:31). The archaeological evidence revealed a length of 133 ft. 9 in. (40.77 m) from stem to stern. Considering the missing transom and bow sections, however, an overall length of 146 ft. (44.5 m) is plausible. The maximum width of the hull remains was 29 ft. (8.53 m). Given the partial collapse and general degradation of the frames, a 27 ft. (8.23 m) maximum beam as listed by the steamboat company is also probable. Using the company's recorded hull dimensions in conjunction with the archaeological evidence, the sheer plan view of the lines drawings was begun (Figure 7-1). The data recovered from the wreck site provided the necessary information for keel length and location of diagonal scarfs used in joining the keel members, stem, and sternpost. Fortunately, the rake of the stem and stern were well-preserved and not subjected solely to conjectural guesswork.

As discussed in the previous chapter, the stem survived in an excellent state of preservation up to the level of the stem head. This allowed for a fairly accurate representation of the bow rake. The curvature of the apron was recorded along its length, but these measurements were hindered to some degree by the presence of colonies of zebra mussels. A second series of measurements was made on this structure to ensure accuracy, and the reconstruction is based on a fairing of the lines produced from these data sets.

Moreover, due to the varied dimensions of the multiple components that

Lake Champlain Passenger Steamboat *Phoenix*

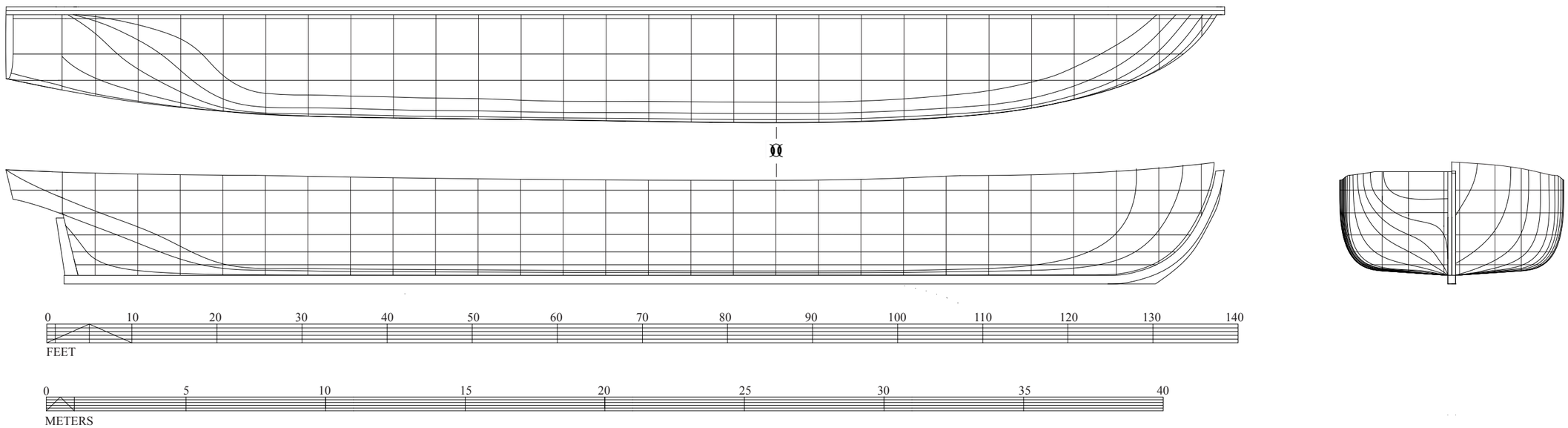


FIGURE 7-1. Conjectural lines drawings of *Phoenix* generated from 3D Rhino model.

comprised the stem, the curvature of this section could not be accurately captured with the goniometers as was performed on the apron. Instead, measurements were taken from the apron to the outside edge of the outer stempost along its length in order to reconstruct the shape of the bow assembly.

The sternpost was also in good condition, and the recorded angle of the rake measured at depth could be transferred to the lines drawings. The height of the sternpost was evident from the archaeological remains. The transom, which would have been at the level of the deck, unfortunately, did not survive for documentation. Details regarding the upperworks at the stern were derived principally from Marestier's hull plans for *Chancellor Livingston* (Figure 7-2; Marestier 1957:73) combined with the known depth of hold for *Phoenix*. With a depth of 9 ft. 3 in. (2.82 m) from the limber boards to the bottom of the main deck beams, the level of the deck at midships could be easily calculated at 11 ft. 7 in. (3.53 m) from the base of the keel. Based on the plans, *Chancellor Livingston*'s transom height measured approximately 7 ft. (1.22 m) from the top of the sternpost, which was 9 ft. (2.74 m) in height, making the transom height 78% of the height of the sternpost. If these proportions were applied to the hull of *Phoenix*, the transom height at the stern would measure approximately 5 ft. (1.52 m) from the top of the 6 ft. 6 in. (1.98 m) high sternpost. The transom extended aft of the sternpost, and its rake was typically steeper than that of the sternpost. As no information pertaining to the transom survived at the *Phoenix* wreck site, the shape of this structure was modeled after the vessel's shown in the plates in Marestier's treatise, principally *Chancellor Livingston*.

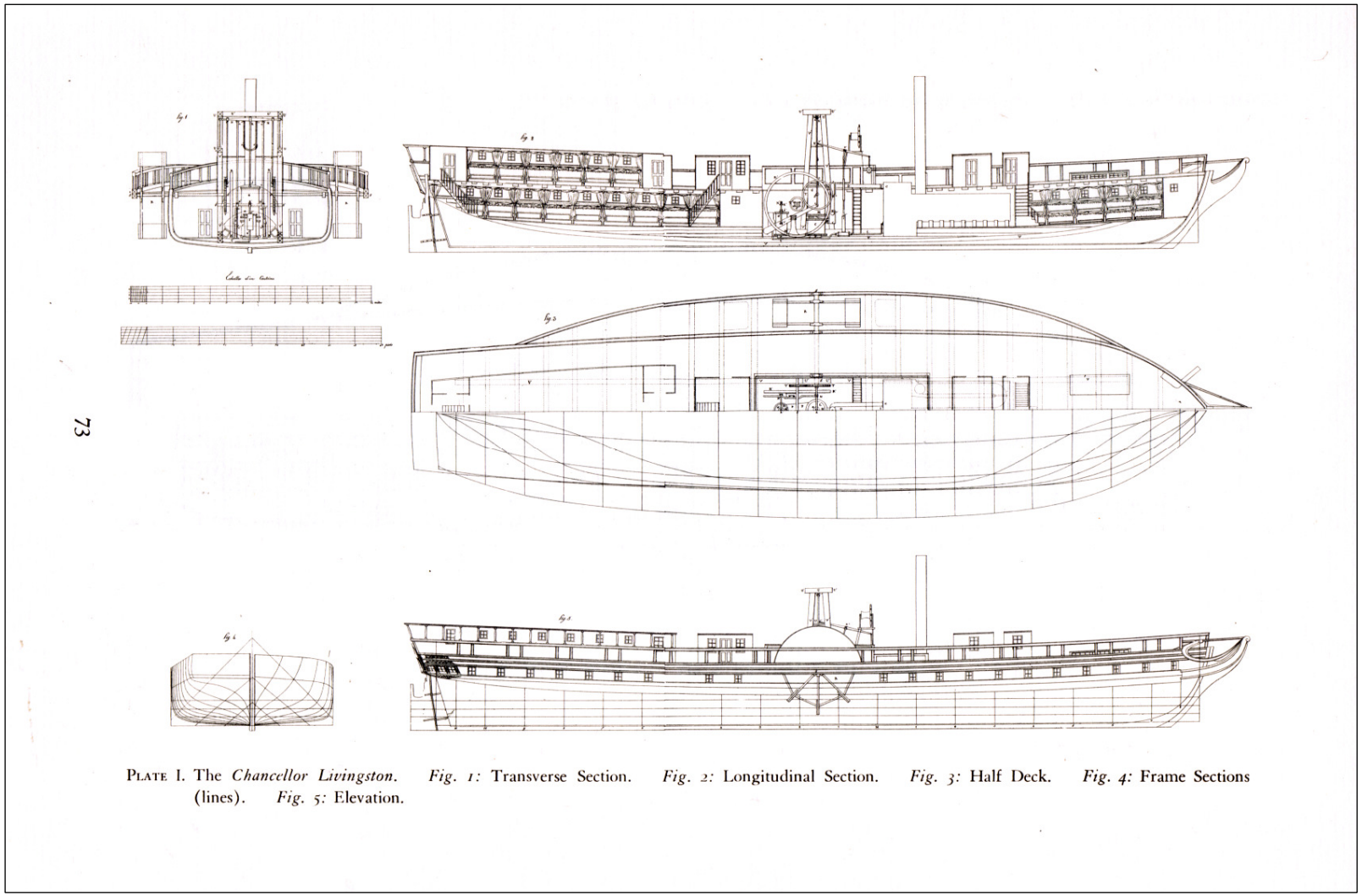


FIGURE 7-2. Marestier's plans for *Chancellor Livingston*. (From Marestier, 1957:73.)

A total of 18 frame curvatures were recorded during the 2009 and 2010 field seasons, including 14 square frames, 3 bow cant frames, and 1 stern half-frame. In order to represent the curvature of the hull as accurately as possible, the square frames curves were taken approximately every five frames along the length of the keelson. The best-preserved and intact cant frames were recorded to reconstruct the bow shape, and the single accessible and intact half-frame at the stern was selected to assist with recreating the stern contours. The recorded sections include port side frames 41, 37, 33, 30, 27, 22, 17, 12, 7, C, H, M, and S, and starboard side frames 4, Y, Z, and ZA.

The section lines for the body plan were created using the reconstructed curvature of the recorded frames up to their surviving height, and projecting this height up to the level of the sheer using the known depth of hold and maximum beam measurements (Figure 7-1). Once the section for each recorded frame was generated, the lines were mirrored for the frame on the opposite side of the vessel. It is likely, however, that *Phoenix*'s finished hull form was not as symmetrical as the theoretical hull design would suggest.

As no evidence for the curve of the main deck from bow to stern existed in the archaeological remains, the sheer line was based on inferences made from Marestier's hull plans and naval architect Peter Hedderwick's formula for setting off a flat curve from a straight line, or the sheer of a vessel from a straight line on the side. The curve of the line from the lowest point of the sheer at midships to either extremity on *Chancellor Livingston* was used as a guide. The rise was approximately 24 in. (60.96 cm) from the lowest part of the sheer to the extreme end of the bow and 32 in. (81.28 cm) from the

lowest part to the tangent line at the stern. The distances to either side were divided into equal parts, as instructed by Hedderwick (1830:15), and then divided by the square of the number of parts in order to reach the height of rise at the first division from the point of contact.

The waterlines were placed based on information taken from the plates of *Chancellor Livingston*, since that vessel was designed with similar dimensions and tonnage to *Phoenix*, and carried steam machinery of comparable size in her hull. Also included in the lines drawings were a series of buttock lines, placed to demonstrate the contours of the hull. From the reconstructed frame sections it was possible to determine the spacing of the waterlines and buttock lines. Two complete waterlines, one at 2 ft. 3 in. (69 cm) from the keel and another 3 ft. 1 in. (94 cm) above that line, were placed first. A partial waterline could also be reconstructed 5 ft. 9 in. (1.75 m) above the second line, which ran from the sternpost to midships. Forward of midships it was possible to create a probable continuation of this waterline using the reconstructed sections from frames H and Q due to their preserved curvature. From these waterlines and the projected arcs of the surviving sections, a fourth waterline 3 ft. 10 in. (1.17 m) above the third one could be placed. The final waterline was inferred based on the hull shape at that stage. Three buttock lines up to a height of 3 ft. 9 in. (1.14 m) at the bow and 8 ft. 1 in. (2.46 m) at the stern were also placed based on the reconstructed frame sections. The half-breadth plan was drafted from the contour lines depicted in the other two views, completing the set of hull lines.

As expected, these lines revealed a vessel with a broad midships section required

to support the heavy steam machinery and to offset the effects of hogging. The lines became sharp toward the extremities, however, and were more akin to a sailing vessel than the flat-bottomed steamboats of the western rivers. *Phoenix* was not designed with a hard-chine, as were the early steamers designed by Fulton and Livingston for use on the eastern rivers. The body plan shows a vessel with curves even sharper than those of *Chancellor Livingston* of the Hudson River, with a rounder turn-of-the bilge and more deadrise at the stern. This is no surprise considering the body of water in which *Phoenix* was designed to operate. The keel-to-beam ratio of the steamer was 4.88:1 compared with *Chancellor Livingston*'s 4.4:1, making it a little less beamy than the Hudson River vessel. According to Hedderwick (1830:383), seagoing vessels

> being narrow, or of a good length … allows them to be finely tapered toward the bow and stern, so that they may be the more easily propelled, and draw little water in proportion to their sharpness; they having at the same time sufficient breadth to carry engines of such power as will propel them with the required degree of velocity … also at this proportion of breadth they will be found to have sufficient stability to enable them to carry a moderate quantity of sail, when rigged on a low construction.

Marestier (1957:7) mentioned that the steamboats built after the successful design of the steamer *Fulton* in 1813, which had a relatively rounded hull, varied little from "an ordinary boat which has a very flat bottom and more or less sharp ends." The beam of early 19th-century steamboats gradually grew in order to reduce draft and increase stability. The beam of early boats was only about a tenth of the length, while the breadth of the boats at the time of Marestier's American sojourn reached one-fifth to

one-quarter of the length. This is also the approximate range of *Phoenix*'s overall length-to-beam ratio, which was 5.4:1.

Three-Dimensional Modeling

The data collected from the 2009 and 2010 fieldwork, in addition to the information gleaned from the other resources mentioned above, provided the framework for the digital reconstruction of *Phoenix*. The use of Rhinoceros Non-Uniform Rational B-Splines (NURBS) modeling software enabled the generation of three-dimensional (3D) computer models of the steamboat, which can be used both for study and virtual exhibition. The creation of a 3D model offers an accurate and easily-manipulated tool for comparative archaeological analysis and provides a better understanding of the construction and spatial layout of the ship.

There were a number of advantages to using the NURBS program to reconstruct the steamboat. The computer models afforded the opportunity to experiment effectively and efficiently with the use of space on board the steamboat. Using the few historical sources that address the interior compartments of the vessel, in conjunction with the known dimensions of the hull and the size of the steam machinery, it was possible to create hypothetical blueprints for the interior of the steamboat below deck with relative ease, and make adjustments as necessary based on new information. In the same manner, the vessel's steam machinery and associated components could be positioned in the hull and easily adjusted as desired in order to accommodate the theoretical locations of the other compartments below deck.

In addition to providing a tool for the interior design of the steamer, the software helped with the reconstruction of the vessel as a whole. Using the timber measurements gathered during the archaeological fieldwork, the software facilitated the recreation of the original scantlings and construction features. It was possible, for example, to calculate the curvature of the frames by entering the goniometer measurements into the NURBS program, fairing the lines, and projecting the curvature to the known height of the frame at that section of the steamboat. Subsequently, the frame dimensions and accompanying interior and exterior hull planking could be built from the known measurements taken in the field. The longitudinal reinforcement stringers, which had eroded to narrow stumps at either end of their approximately 40 frame span, could be reconstructed using known maximum molded and sided dimensions, and the length calculated based on the drift bolts protruding from the frames beyond the surviving portions of the timbers (Figure 7-3).

Through the Rhinoceros software it was also possible to calculate the tonnage of the three-dimensional model of *Phoenix*. It is known from the Champlain Transportation Company records that *Phoenix* was supposed to have displaced 336 tons. The ability to calculate the tonnage of the model enabled a cross-check of the reconstructed hull shape, and allowed for an adjustment of load waterline placement as necessary.

Although beyond the scope of this dissertation, the NURBS models created for this project can be tested in a number of other software applications to conduct hydrodynamic tests, which can assess hull stability and seaworthiness, and may provide insight into the steaming and sailing capabilities of the steamboat during future studies.

In addition to contributing to the comparative analysis for this project, three-dimensional models can facilitate public interaction as virtual museum exhibits and serve as educational tools for demonstrating ship construction and operation during the early age of steam. A virtual model is currently in preparation for the *Phoenix* shipwreck exhibit at the Lake Champlain Maritime Museum. Interactive digital models enable visitors to maneuver a reconstruction in any direction and examine specific features up close, providing different perspectives of the ship. A digital half model reconstruction has been included (Appendix C) as a 3D PDF in this dissertation to aid in the following description of the reconstruction, and can be manipulated to observe most of the features described in this chapter. Although currently incomplete, the half model can also serve as a resource for researchers who wish to compare with other early 19th-century hulls.

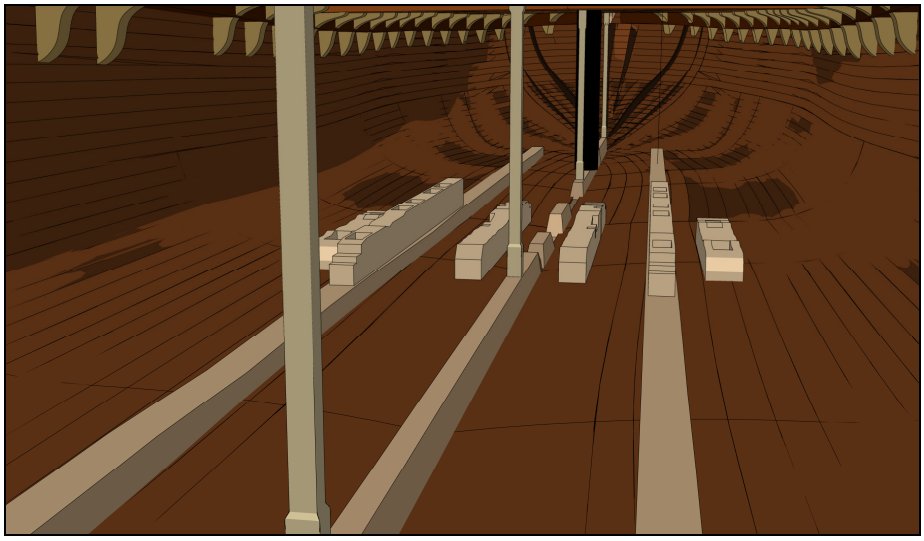


FIGURE 7-3. Perspective of reconstructed bedtimbers and stringers, looking forward. (Image from 3D model by Tiago Miguel Fraga and the author, 2012.)

Lake Champlain Passenger Steamboat *Phoenix*

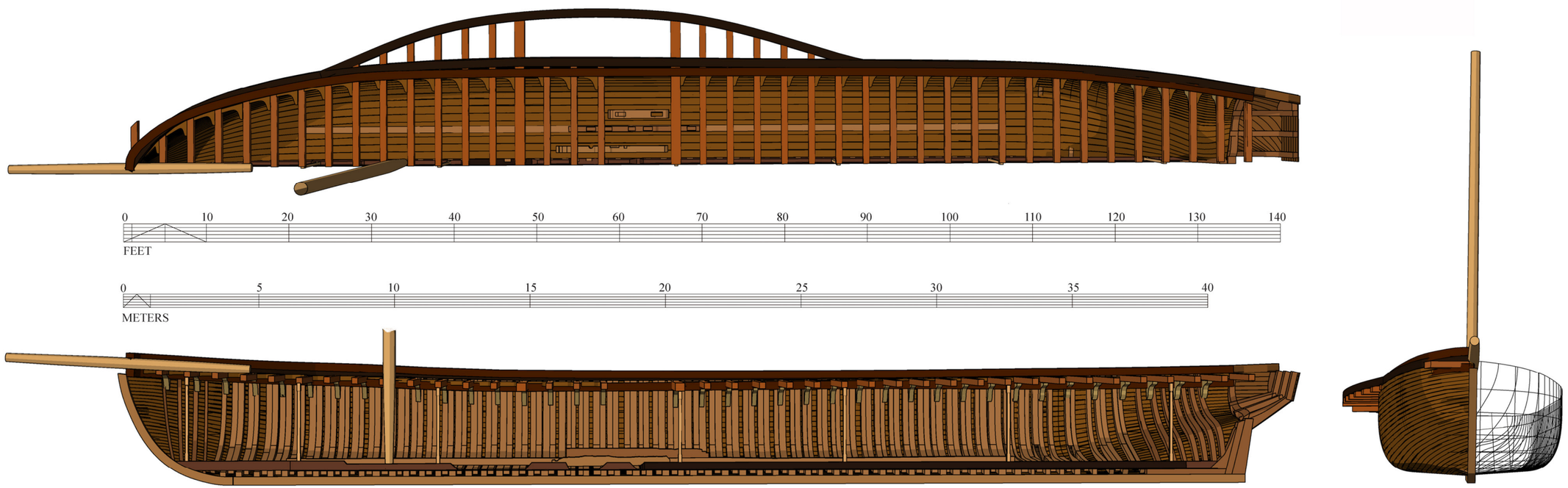


FIGURE 7-4. 3D conjectural reconstruction of *Phoenix* up to the main deck. (Model by Tiago Miguel Fraga and the author, 2012.)

Ship Reconstruction

As explained above, the conjectural reconstruction (Figure 7-4) was based on the analysis and interpretation of a variety of historical and archaeological sources. While most of the components of the lower hull could be placed with a fair degree of certainty using these resources, the upperworks required assumptions which conform to other available lines of evidence for steamboat construction, such as the study of *Lady Sherbrooke* and Marestier's hull plans. As such, the upperworks are more poorly attested, and reconstruction of these elements required a fair amount of speculation based on the known facts. An advantage to reconstructing the model digitally is that as new evidence presents itself during future studies, the model can be adjusted and improved as necessary.

Location of the Steam Engine and Boiler

Phoenix was originally propelled by the low-pressure steam engine removed from the Hudson River steamer *Perseverance.* The original cylinder's listed diameter is 24 in. (60.96 cm) and stroke is 36 in. (91.44 cm). In spring of 1817 this machinery was upgraded, but the specifics of the new engine are unknown. A newspaper advertisement from May of that year simply stated that the proprietors have "procured new and powerful engines, which they calculate will give them greater speed than any other boats now in operation" (*Commercial Advertiser*, 15 May 1817).

Of Marestier's six plates illustrating the various steam engines used on American steamboats during the first quarter of the 19th century, plate V (Marestier 1957:80)

probably most accurately resembles the steam machinery installed in the hull of *Phoenix* (Figure 7-5). This engine type was used in *Chancellor Livingston*, *Robert Fulton*, *Washington*, and *Olive Branch*. It is a low-pressure, double-acting condensing engine of the cross-head type. This meant that the paddlewheel shaft would be in line with the main cylinder, which was positioned vertically. The condenser was located directly below the main cylinder. Marestier wrote that most of the steamboats that he observed in America were propelled by machinery similar in design to this one (Marestier 1957:25).

As discussed in Louis Hunter's (1993) work on western river steamboats, the earliest detailed description of an engine of this type in operation comes from Montulé, a Frenchman who traveled on the 340-ton American steamer *Vesuvius* in 1817. An abbreviated version of Hunter's translated excerpt follows:

> The water is contained in a large boiler which is half filled. A fire is made underneath and the steam, which demands outlet, rushes into a cast-iron pipe eight inches in diameter which soon divides into two branches, one going to the top and the other to the bottom of the great cylinder. This cylinder is three feet in diameter and very strong, containing a piston which, always well oiled, fits it as exactly as that of a pump or pneumatic machine. It is made of iron and very heavy. It is this piston which the steam causes to rise and fall, thereby putting into play the paddlewheels … (Montulé 1821:170; Hunter 1993:135-136).

The placement of the steam machinery in the *Phoenix* reconstruction was based on a combination of archaeological data, steam engine plans from Marestier's manuscript, 19th-century treatises on steam navigation, contemporary steamboat woodcuts, Hemenway's (1867) description of *Phoenix*, and James Haddan's (1995) research on the artifact distribution across the wreck site. Naturally there was conflicting

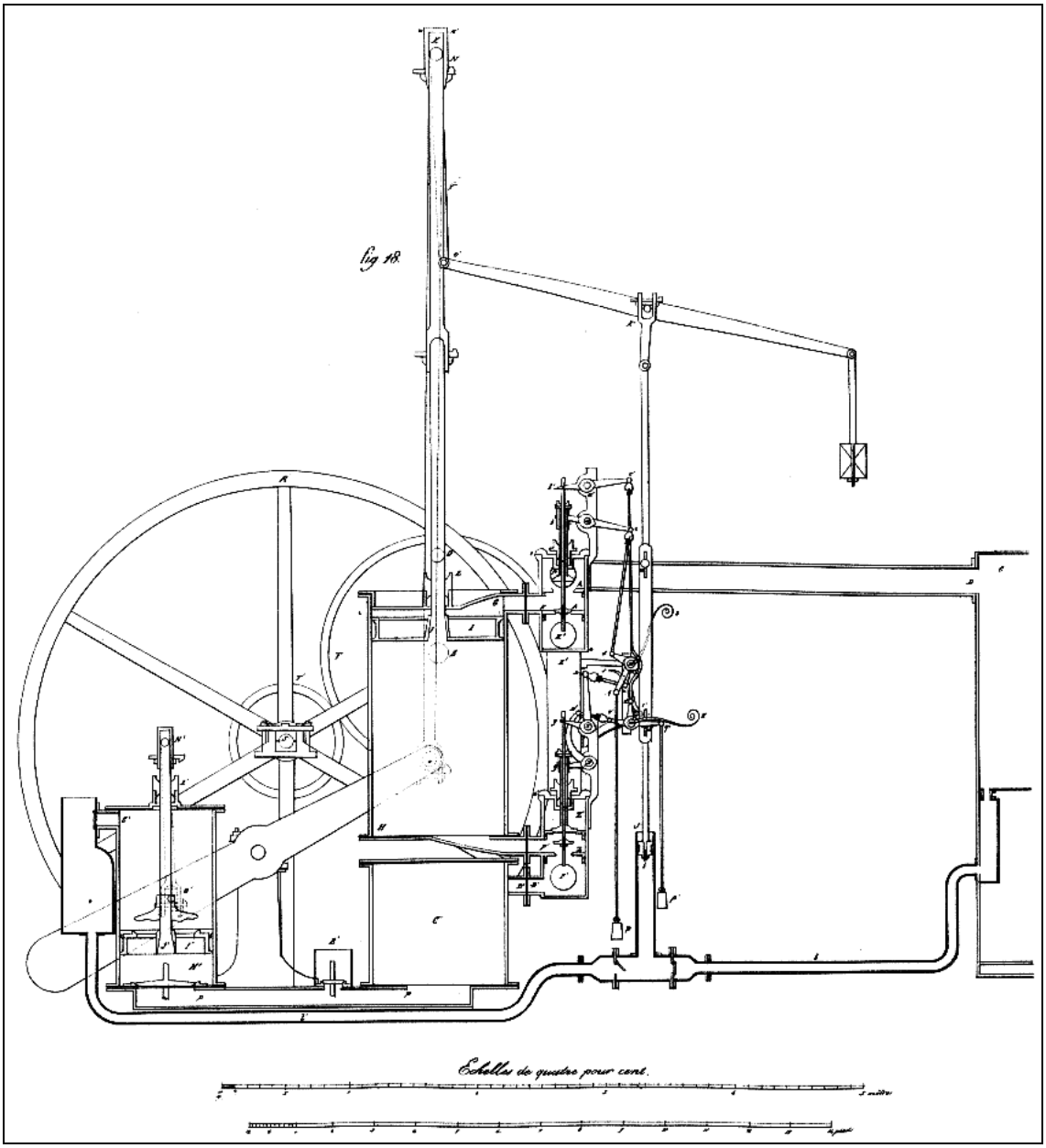


FIGURE 7-5. Marestier's plans of a low-pressure, double-acting condensing engine of the cross-head type. (From Marestier 1957:80.)

information found in these sources, and the following reconstruction represents a possible spatial layout of the steam machinery from *Phoenix* based on one interpretation of these lines of evidence.

Based on the available evidence, it is known that the interior of the ship was divided into three discrete areas; the engine room, approximately at the center of the hull, prevented access between the bow and stern living quarters (each was accessible only from the main deck level).

The chief engine components, including the main cylinder and piston, condenser, secondary cylinder, crank, connecting rod, beam, steeple, and flywheel assembly were located within the area of the engine bedtimbers. This engine room area stretched from frames 11 to A, and took up a minimum of 12 ft. (3.66 m) across the width of the hull (Figure 7-6). As described in the previous chapter, the engine bedtimbers exhibited a series of mortises in this area in order to receive the steam machinery and wooden support framework. In addition, several 1-1/2 in. (3.81 cm) iron bolts stood as high as 36 in. (91.44 cm) proud in this section of the hull, particularly between frames 38 and 36, to secure the machinery and framework to the bedding (Figure 7-7). Large bolts were also used to secure the bedtimbers to the framing. Although writing about slightly later merchant steamboats in use in Great Britain, Hedderwick's (1830:381) description of how these timbers were secured to the hull provides context:

> The engine stands on a large flat plate of metal, which is bedded solidly down on the top of two solid logs of timber running fore-and-aft the vessel parallel to the keelson; these are called engine-bearers, and must be very securely fitted and bolted to the floor timbers of the vessel, as all the framing parts of the engine and the cylinder are secured down to them.

Approximate Steam Engine and Boiler Placement

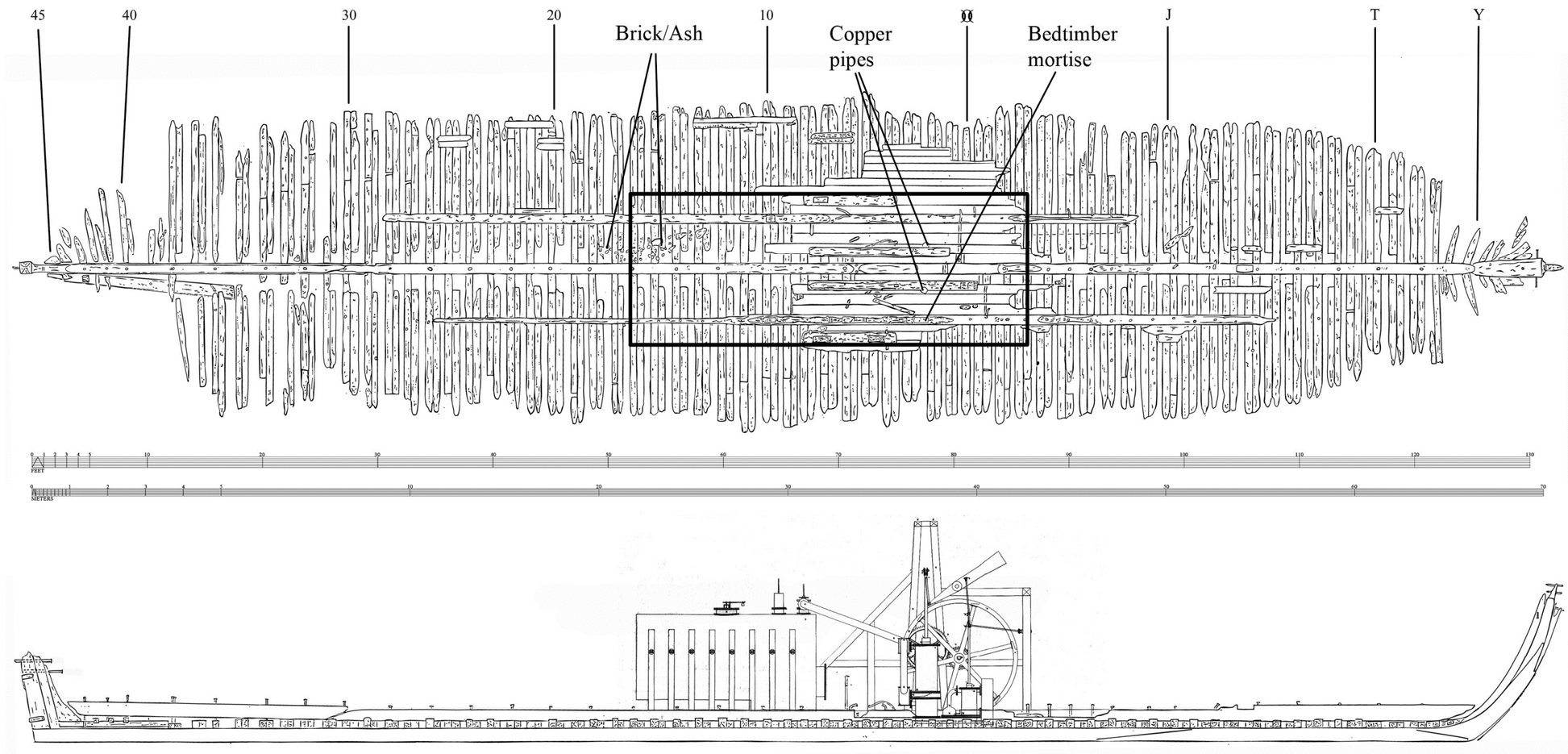


FIGURE 7-6. Approximate placement of steam engine and boiler on *Phoenix*. (Drawing by author, 2012.)

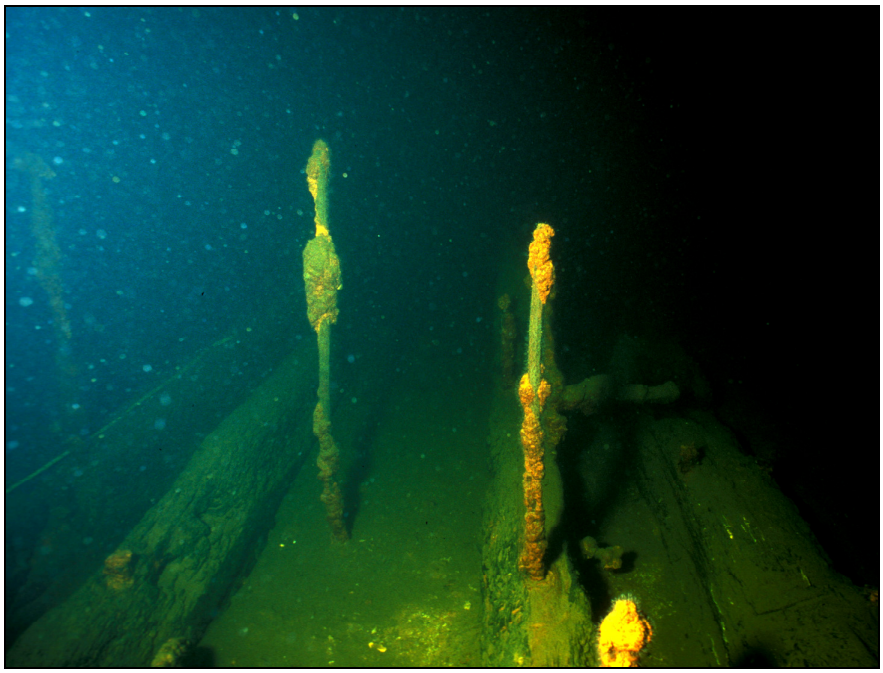


FIGURE 7-7. Large drift bolts used to secure the steam machinery. (Photo by Pierre LaRocque, 2000.)

The three sets of longitudinal support timbers on *Phoenix* were positioned strategically to secure the steam machinery as well as provide longitudinal support for the hull. Hedderwick (1830:384) wrote that the bedtimbers, which he termed engine-bearers, "should be as strong as the keelson, and extend past the engine room fore and aft at least equal to half the ship's breadth, and with the keelson should be completely bolted, so that the vessel may not bend or twist during the whole length of the engine room."

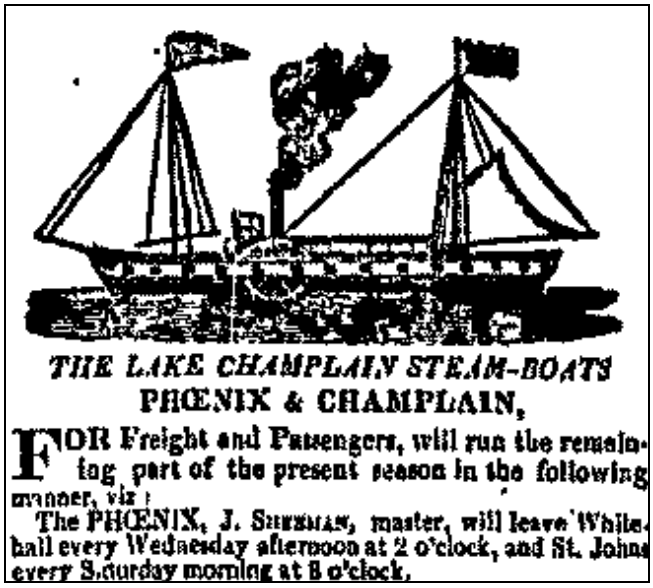
The main cylinder was probably installed at frame 2, in line with one series of mortises positioned athwartship on two sets of bedtimbers and between two copper pipes, which may have served as water intakes for cold water to cool the condensed steam within the cylinder. This would also place it just abaft the midship frame, a

probable position for the paddlewheel shaft, which would have been in line with the cylinder. Hedderwick (1830:386) describes the significance of this positioning:

> The position of the midship frame, or center of the paddle shaft, which should be in the same place, must next be determined. The center of the paddle wheel should, if possible, be placed near the center of gravity of the vessel, that the paddles may have little rising or falling with the pitching motion of the ship.

With regard to American steamers in the early 1820s, however, Marestier (1957:10-11) noted that "the most advantageous location of the paddle wheels, with respect to the length of the boat, does not appear to have been standardized. In some boats it is amidship, in others, about one-third of the distance from the bow."

Placing the cylinder and paddlewheel shaft slightly abaft *Phoenix*'s midship frame conforms to the representation of the paddlewheel position on one of the steamboat woodcuts used for the advertisement of *Phoenix*. Often the woodcuts were generic representations of steamboats used for advertisements (Figure 7-8), but occasionally a woodcut was produced which represented the vessel being advertised. One poster made by the Lake Champlain Steamboat Company featured a steamboat woodcut that appears to represent *Phoenix* (Figure 7-9). The image depicts a vessel with an awning positioned over a small deck house on the after deck, a chimney positioned abaft the paddlewheels, a single mast located just forward of the engine housing (in this depiction folded down), and a bowsprit jutting off the bow—most of the known characteristics of *Phoenix*. Heyl's drawing of *Phoenix* was based on this woodcut, but was altered to depict the mast positioned upright, the standing rigging in place, the

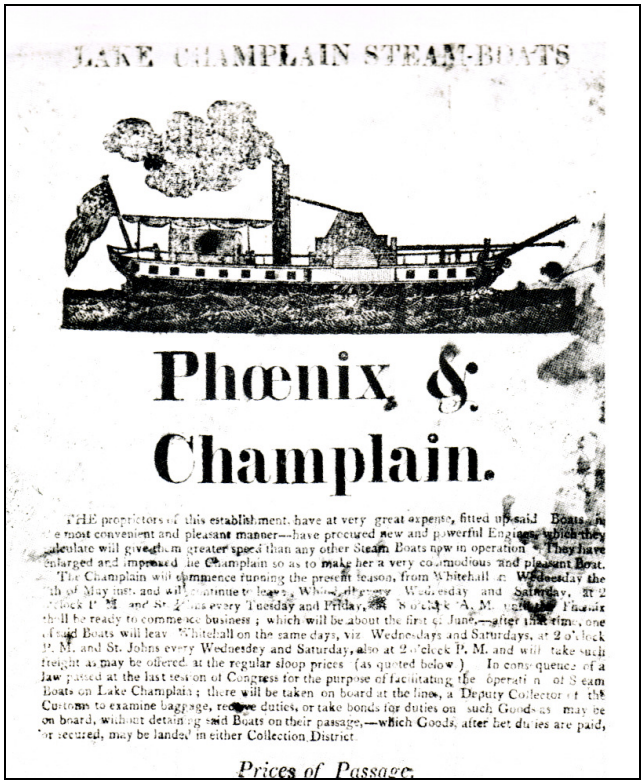


THE LAKE CHAMPLAIN STEAM-BOATS
PHŒNIX & CHAMPLAIN,

FOR Freight and Passengers, will run the remaining part of the present season in the following manner, viz:

The PHŒNIX, J. Sherman, master, will leave Whitehall every Wednesday afternoon at 2 o'clock, and St. Johns every Saturday morning at 8 o'clock.

FIGURE 7-8. Generic woodcut advertisement for *Phoenix*. (From *Commercial Advertiser*, 15 May 1817.)



LAKE CHAMPLAIN STEAM-BOATS

Phœnix &
Champlain.

THE proprietors of this establishment have at very great expense, fitted up said Boats in the most convenient and pleasant manner—have procured new and powerful Engines, which they calculate will give them greater speed than any other Steam Boats now in operation. They have enlarged and improved the Champlain so as to make her a very commodious and pleasant Boat.

The Champlain will commence running the present season, from Whitehall on Wednesday the [illegible]th of May inst. and will continue to leave Whitehall every Wednesday and Saturday, at 2 o'clock P. M. and St. Johns every Tuesday and Friday, at 8 o'clock A. M. until the Phœnix shall be ready to commence business; which will be about the first of June,—after that time, one of said Boats will leave Whitehall on the same days, viz. Wednesdays and Saturdays, at 2 o'clock P. M. and St. Johns every Wednesday and Saturday, also at 2 o'clock P. M. and will take such freight as may be offered, at the regular sloop prices (as quoted below). In consequence of a law passed at the last session of Congress for the purpose of facilitating the operation of Steam Boats on Lake Champlain; there will be taken on board at the line, a Deputy Collector of the Customs to examine baggage, receive duties, or take bonds for duties on such Goods as may be on board, without detaining said Boats on their passage,—which Goods, after the duties are paid, or secured, may be landed in either Collection District.

Prices of Passage.

FIGURE 7-9. Woodcut advertisement possibly representing *Phoenix* as she appeared. (After Ross 1996:32.)

engine crank frame extended beyond the housing, and a capstan placed well forward on deck (Figure 7-10).

The outboard bedtimbers each had two rectangular mortises, one of them at either end. There are at least two possible purposes for these notches. They may have been cut to mount the braces of the crank mechanism's frame, which would have been positioned over or adjacent to the main cylinder. Two slightly smaller and more closely spaced mortises on the middle bedtimber, however, exist just inboard of these outboard notches and may have served the same purpose. Another possibility for the outboard timber mortises is to seat the stanchions used to support the fore and aft stringers on which the inboard bearings for the paddle shaft rested. Similar timbers were discovered on the wreck of *Lady Sherbrooke*, although they were positioned closer to the turn of the bilge (Figure 7-11).

The positioning of the boilers is a matter of interpretation. In describing the typical steam engine he observed in America, Marestier (1957:16) wrote that the main cylinder is located amidship and the rest of the machinery is positioned aft of the cylinder, with the boiler placed 9 ft. 10 in. (3 m) to 13 ft. 1-1/2 in. (4 m) forward of the cylinder. The plates portraying the steamers *Fulton*, *Washington*, and *Paragon*, however, depict the chimney positioned aft of the steam engine and paddlewheels (Figure 7-12). In addition, every woodcut depicting a Champlain Steamboat Company vessel included in Ross's *The Steamboats of Lake Champlain 1809-1930* (including the one of *Phoenix* shown in Figure 7-9) shows the chimney abaft the steam machinery.

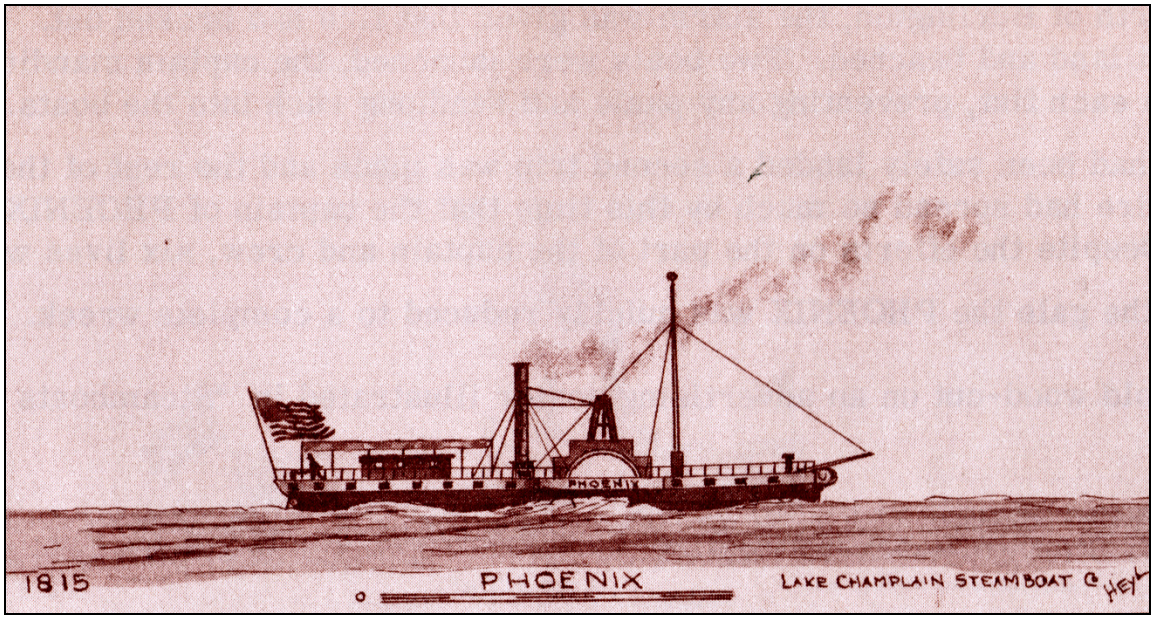


FIGURE 7-10. Heyl's embellished drawing of *Phoenix* based on woodcut. (After Heyl 1956:199.)

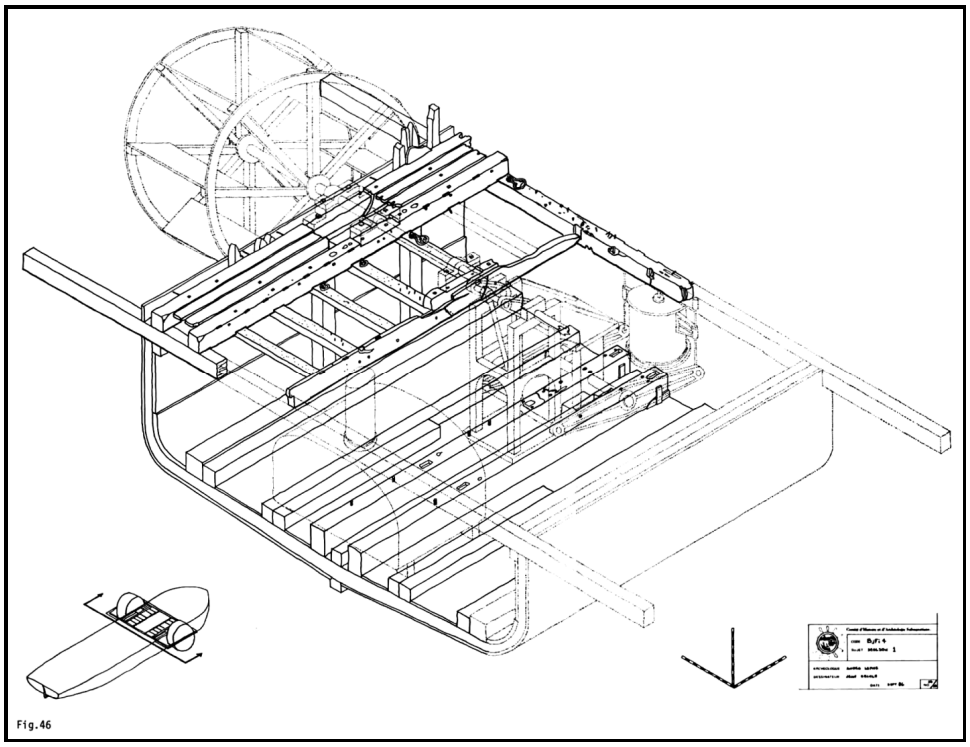


FIGURE 7-11. Reconstructed engine room assembly from *Lady Sherbrooke*. (After Bélisle and Lépine 1988:figure 48.)

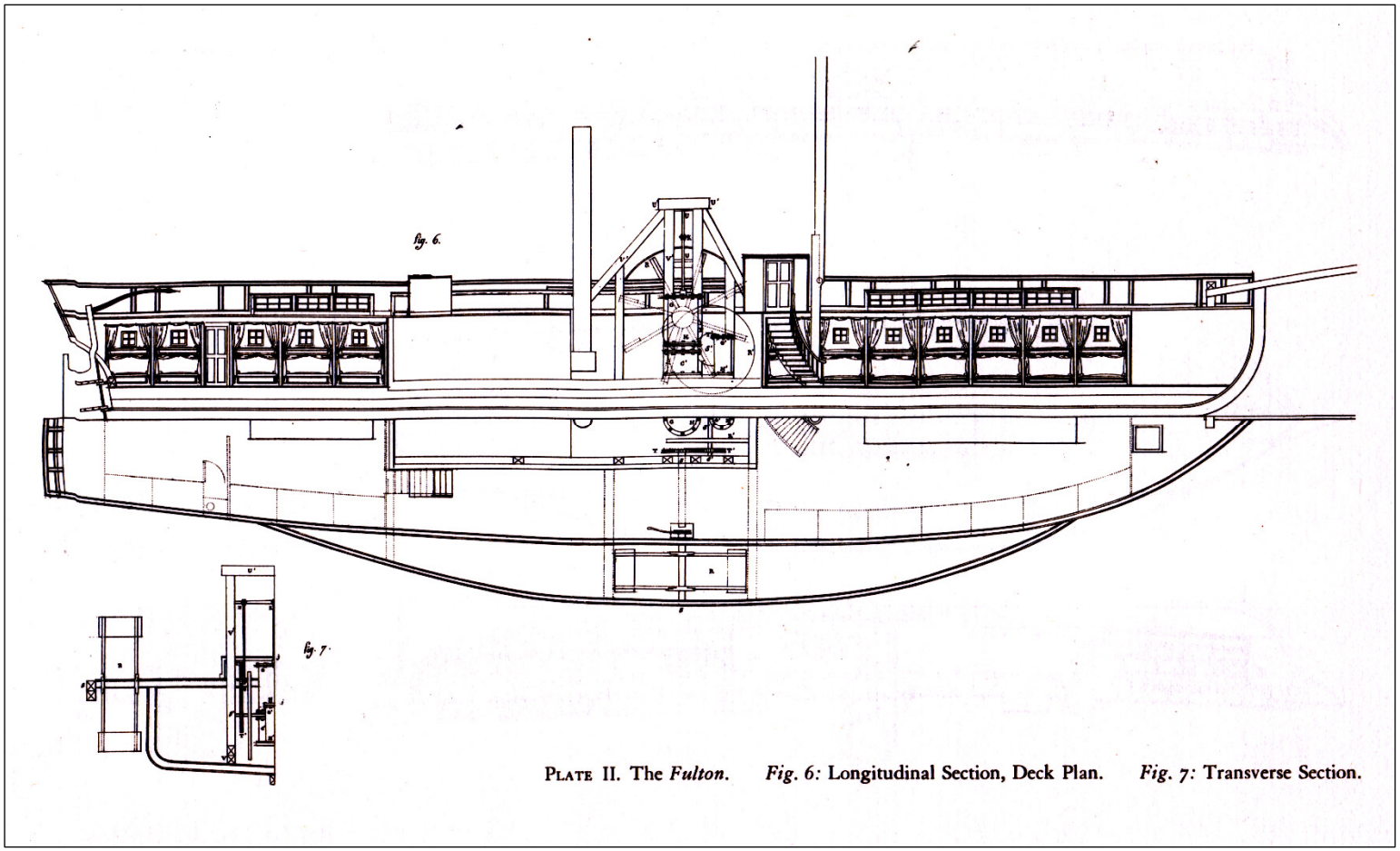


FIGURE 7-12. Marestier's hull plans for *Fulton* showing the position of the chimney. (From Marestier 1957:74.)

Evidence from the archaeological data, including the position of the engine mounts and possible frame assembly in relation to the cylinder location, suggest that the boiler might have been positioned forward on *Phoenix*. Accumulations of brick and ash were discovered on two areas of the hull remains, one fore and one aft of the engine bedtimbers. The first was located between frames 18 and 13, while the second mound was recorded near the keelson at frame E. Much of this evidence was obscured by the silt covering the lower portions of the wreck site. These are the same locations recorded by the Champlain Maritime Society in 1980 and subsequently published in *The* Phoenix *Project*. The Champlain Maritime Society concluded that the aft accumulation of bricks and ash represented the approximate location of the boiler and firebox, while the forward mound may have been remnants of a galley stove (Davison 1981a:52).

Hemenway's account of *Phoenix* provides additional insight into the arrangement of the steam machinery. In this description the boilers were located in the center of the ship, abaft the engine, with the captain's stateroom on one side and the galley and pantry located on the other. The pantry adjoined the gentlemen's cabin on the port side. Abaft the paddlewheels on either side, probably below deck, was an 8 ft. (2.44 m) area to store wood for the firebox. Additionally, the ladies' and gentlemen's cabins, a small stateroom, and a baggage room all competed for space abaft the boilers. The bar was also located beneath the stairs at the after end of the vessel. As mentioned earlier, the intervening location of the engine room and paddlewheels prevented these compartments from connecting to the forward spaces within the hull. According to Hemenway, the only compartments located forward of the engine room were the crew's quarters and the

small barber shop, which were accessible from a different flight of stairs than the one that led to the passengers' cabins. If the steam engine were located just aft of the midship frame with the boiler positioned aft of the engine, this would leave a disproportionately larger area in the forward end of the vessel compared with the after end which housed all of the passenger-related compartments listed above.

Haddan's master's research into the ceramics recovered from *Phoenix* in 1983 provides additional evidence for the placement of the steam machinery, and may have some bearing on the apparent abundance of space forward of the engine room. Haddan examined the recovered ceramics in detail, categorized each type, and interpreted the distribution across the wreck site (Haddan 1995:iii).

The results of Haddan's research into the distribution of ceramic artifact concentrations recorded on the wreck essentially show three food-related task areas present in the steamboat remains (Figures 7-13). It became apparent from the concentrations of stoneware, coarse earthenware, and glass in the forward end of the vessel, that a food storage compartment was located in that area (Haddan 1995:112). This could perhaps have been part of the crew's quarters, or another compartment forward of their quarters used for storage of tableware and provisions. This may help answer the question of why there was so much room forward of the engine room with the engine and boiler configuration suggested above.

A concentration of mixed ceramic types located amidships on the portside suggests a food preparation area outboard of the engine mounts (Haddan 1995:112). This supports the accounts stating that the pantry and galley were located on the port side of

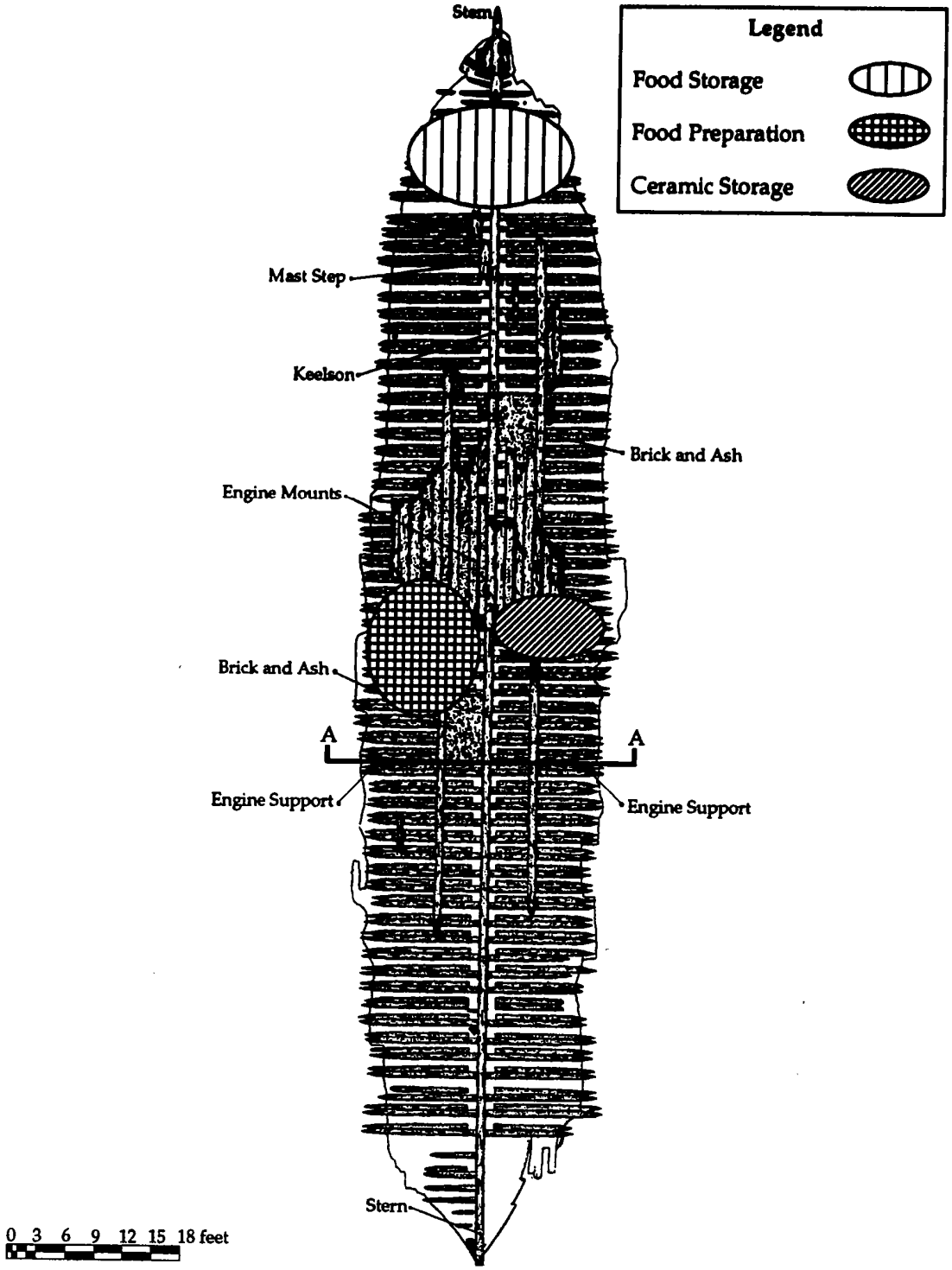


FIGURE 7-13. Distribution of recorded ceramic artifact concentrations on the *Phoenix* wreck site. (From Haddan 1995:113, figure 41.)

the vessel next to the engine room, where John Howard first discovered the fire aboard *Phoenix* before running into the adjacent gentlemen's cabin to arouse the passengers. On the starboard side of the vessel, at the same location amidships, was another ceramic concentration consisting of decorated pearlware and shell-edge plate fragments. These fragments, many of which were recovered fused together as if they had been stacked, indicate the probable location of the pantry within the gentlemen's cabin, which served as the passenger dining area as well as the crew eating area between watches (Hemenway 1867:689; Haddan 1995:112).

While none of the available sources mention stowage of cargo aboard *Phoenix*, there was very little room aft of the engine room for such material. There were spaces forward of the wood storage compartment and aft of the barbershop for cargo, however, and likely extra space in the crew cabins and provision storage area near the bow to stow goods brought on board by travelers. All animals, as stated in Lake Champlain Steamboat Company advertisements, were tied forward of the capstan. Additional cargo may also have been stowed on the deck of the steamboat, especially during fair weather conditions and on short voyages.

To provide protection for the crew and passengers, there was a structure built around the steam machinery, which constituted the engine room. Marestier described the housing covering the steam machinery as being 19-1/2 in. (50 cm) high above the boiler and 39 in. (1 m) high above the engine. The sides of the engine room were designed with louvers for both light and ventilation (Marestier 1957:10).

Although concrete evidence for the position of *Phoenix*'s boiler has not yet been discovered, it is likely that it was located aft of the engine (Figure 7-6) due to the combination of the ceramic distribution, Hemenway's interior description of the steamer, the characteristics of the existing bedtimbers, and iconographic representations of *Phoenix* and other Lake Champlain Steamboat Company vessels.

Paddlewheels and Guards

The paddles consisted of two wheels with arms radiating from the center (flange), to which the buckets were fastened. Except for perhaps the flange, the wheels were initially made entirely of wood due to its abundance, low cost, and ease with which it could be worked and repaired. Eventually cast and wrought iron wheels were made, though wood was still used, particularly on western river craft, for components such as the arms of the paddlewheels and the connecting rod, since wood was capable of absorbing shock and minimizing some of the damage inflicted on the steam machinery upon striking submerged obstructions (Hunter 1993:113).

In Hedderwick's (1830:394) slightly later-century treatise, he wrote that the diameter of the paddlewheels was a function of the diameter of the main cylinder. This may not have been a hard and fast rule in the first quarter of the 19th century, however, as Marestier's descriptions of the engines used on various steamboats do not conform to this formula. The dimensions of the paddlewheels on *Phoenix* were modeled after those from the similar-sized *Chancellor Livingston*, although *Phoenix* was equipped with a slightly smaller cylinder. *Chancellor Livingston*'s wheels measured 18 ft. (5.5 m) in

diameter, and had eight pairs of arms with buckets, 5 ft. 9 in. (1.75 m) long and 2 ft. 11 in. (90 cm) wide. This matches the diameter of the paddlewheels on the 139 ft. (42.37 m) steamer *Delaware* as well, which was powered by a 45 horsepower engine with a 2 ft. 8 in. (81 cm) diameter cylinder (Marestier 1957:39). This also corresponds to the diameter of *Phoenix*'s paddle wheels as described by Heyl (1956:199) in his volume on early American steamers, although his source for these dimensions is unknown. A 5 ft. (1.52 m) wide box was built around the wheels to offer them some protection and prevent water that was captured by the buckets from spraying the passengers and flooding the deck.

According to Marestier (1957:10), the paddle shaft is usually located above the deck, and can be more than 39 in. (1 m) above it when the wheels are of large proportions. Hedderwick (1830:394) mentions that the paddle shaft was usually positioned approximately one-third of the diameter of the wheel above the water. In the case of *Phoenix* this would equate to 6 ft. (1.83 m) above the waterline. The shaft was typically made of a pair of main shafts and a pair of paddle shafts connected by movable flanges to facilitate disconnection of the engine from either paddle wheel as necessary. There would also have been forward and aft of the paddlewheels, two through-hull paddle beams of somewhat larger scantlings than the other deck beams. These extended beyond the hull to support the ends of the paddle shaft and protect the wheels against collisions. These were placed about 1 ft. (30 cm) beyond the outer diameter of the wheel unless there was a very large wheel. In such cases it became common practice to place the paddle beams 4 to 6 ft. (1.22 to 1.83 m) wider than the diameter of the wheel to

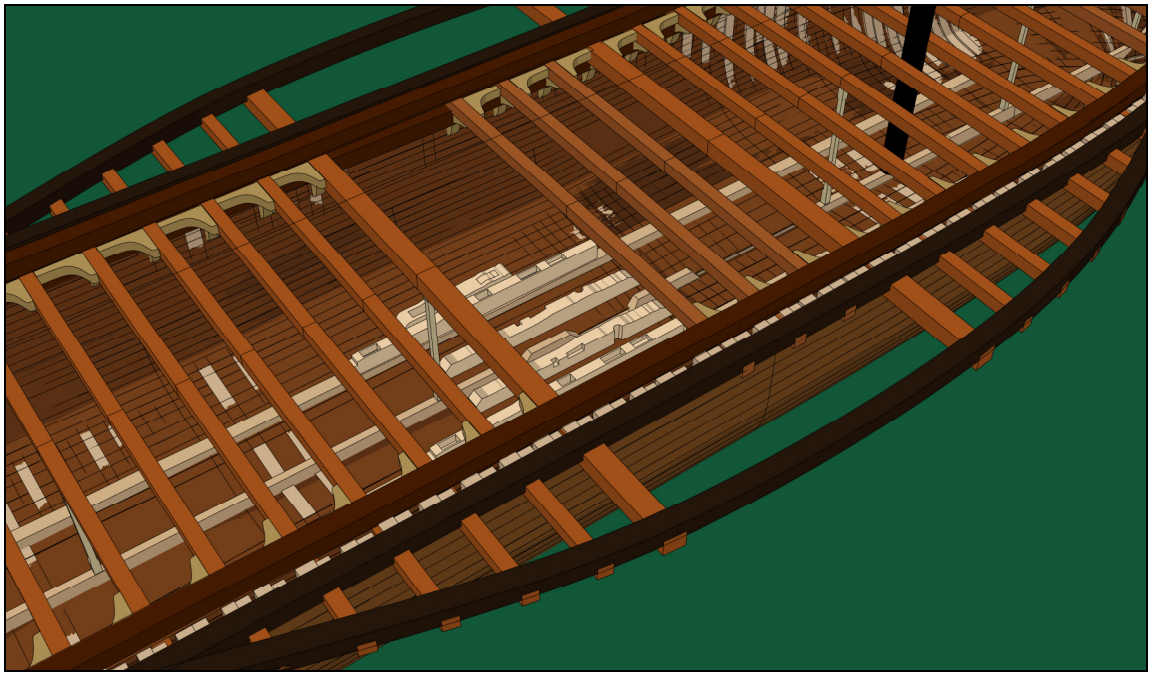


FIGURE 7-14. Paddlewheel guards and paddle beams on *Phoenix*. (Image from 3D model by Tiago Miguel Fraga and the author, 2012.)

allow water from the paddlewheel buckets to drain off more freely (Hedderwick 1830:394).

Phoenix is known from Hemenway's (1867:688) description to have had guards extending from the bow to approximately 25 ft. (7.62 m) abaft the paddlewheels (Figure 7-14). These were extensions of the main deck that protected the projecting paddlewheels and provided support for the ends of the paddle shaft (Hunter 1993:91). As mentioned previously, the robust paddle beams extended out past the lines of the steamboat's hull to support the guards at the wheels. Decking was fastened to these beams, which were supported from below by stanchions and shelf clamps (Kane 2004:111).

The deck fittings and arrangement were based in part by Marestier's reconstruction of the similarly-sized *Chancellor Livingston* and the recorded scantlings of *Lady Sherbrooke*, as well as comparisons with other early 19th-century vessels built on the northeastern lakes such as *Eagle* and *Jefferson*. The reconstructed *Phoenix* had deck beams 9 in. (23 cm) molded by 9 in. (23 cm) sided and paddle beams 12 in. (30.48 cm) molded by 14 in. (35.56 cm) sided. The beams were typically spaced on 40 in. (1.02 m) centers, except around the paddlewheels, and were secured with a clamp 4 in. (10.16 cm) molded by 12 in. (30.48 cm) sided and a waterway approximately 12 in. (30.48 cm) square. Hanging and lodging knees were added to provide reinforcement, and stanchions were placed every six frames along the keelson to further support the deck beams.

Mast, Yard, and Rigging

The archaeological evidence indicates that *Phoenix*'s single mast was stepped at the forward end of the vessel, 25 ft. 6 in. (7.77 m) abaft the stem. *Phoenix* likely carried a square sail and possibly a topsail supported by a crosstree, as seen on Marestier's depictions of *Paragon* (Figure 7-15). Sir John Ross's (1828:69) description of the mast, yards, and rigging required for sea-going naval steamboats of Great Britain stated that steamboat masts should be made to the same proportion of a schooner of similar size, and then reduced in length and diameter according to his suggested formula. He proposed that the length of the mast should be reduced by one-third, the thickness at the deck increased by 1 in. (2.54 cm) in 15 in. (38.1 cm), and the thickness at the head

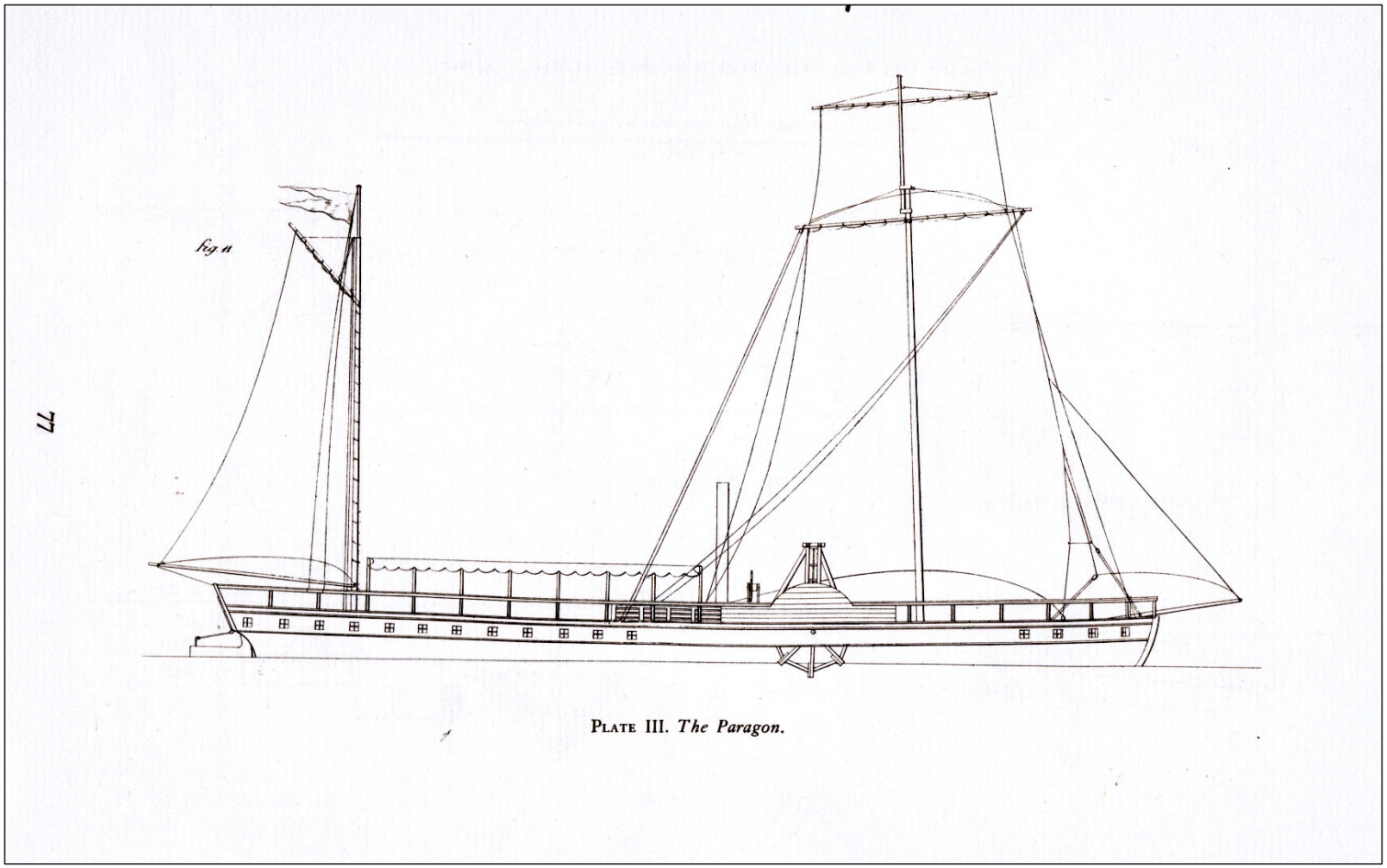


FIGURE 7-15. Marestier's plans for *Paragaon*. (From Marestier 1957:77.)

decreased by 1 in. (2.54 cm) in 15 in. (38.1 cm). Hedderwick's (1830:362) rules for finding the length of the main mast for a schooner can be applied to *Phoenix*. Multiplying the extreme breadth by three and adding one-third of the length of the estimated load water line and the depth of hold gives a sum of 133 ft. (40.54 m), two-thirds of which equal the length of the main mast. Ross's instructions for the length of steamboat masts, however, reduce this 88 ft. (26.82 m) by one-third, giving a total estimated length of 58 ft. (17.68 m) for *Phoenix*'s mast. The diameter of the mast should be 1 in. (2.54 cm) for every 3 ft. 6 in. (1.07 m) of its full length, which would equal 16-1/2 in. (41.91 cm). This would be increased by approximately 1 in. (2.54 cm) at the deck and reduced by the same at the mast head. According to Ross (1828:71-72), the yards were small in proportion to those of a schooner, and the main yard of the steamers were usually 8/9ths the length of the schooner's main yard. This would bring the length of *Phoenix*'s yard to 51 ft. 6 in. (15.7 m). The diameter was calculated at 1/4 in. (0.64 cm) for each foot of length, providing a center diameter of 12-3/4 in. (32.39 cm). The length of the bowsprit was calculated by taking one-third of the load waterline, adding the extreme breadth, and halving the sum (Hedderwick 1830:354). This resulted in a length of 35 ft. (10.67 m) forward of the stem. The diameter at the stem head was obtained by finding the diameter of the mainmast at the partners, or in the case of *Phoenix*, at the cross trees, which was approximately 15-1/2 in. (39.37 cm).

These calculations can only serve as a guide, however, as the naval sea-going steamboats for which these rules were written were outfitted with at least two masts to provide for seaworthiness in the open sea. In the early days of American steamboat

design, it is probable that the masts and yards were calculated as they would be for schooners of the same size. It is also unlikely that steamboat builders had access to treatises pertaining to the architecture and outfitting of steamboats during the first quarter of the 19th century in America, and were instead designing sailing steamboats based to their collective experience with sailboats and steamers.

The approximate length and diameter of the foremast from *Paragon* (as represented by Marestier) conforms to the calculations for a schooner of the same size as set forth by Hedderwick, without the reduction in length as proposed by Ross. This would suggest that the mast and yard dimensions for *Phoenix* would likewise be calculated based on a schooner of similar size.

Ross mentioned that the chief difference between the standing and running rigging of a sailing vessel and steamboat is the number of shrouds, which should be diminished by one-half if the mast is shortened by one-third for steamboats. In addition,

> The fore and after shroud of each mast should also be fitted on the plan of a pendant, which would admit of being removed at pleasure. The stays might be a little reduced: the blocks at the mast heads necessary for the running rigging, should be fitted with iron straps and hooks, or made to lash in their places, so that they could be sent down when not required for use (Ross 1828:73).

While Ross notes that the rigging might be a little reduced, it was important that the shrouds and stays be of sufficient strength for their application to auxiliary sails aboard steamboats. On board the St. Lawrence steamer *Malsham* during a squall, Benjamin Silliman (1819:319) remarked:

> I was on deck, and observed that our mast, with its feeble shrouds, was strained to the utmost, and felt some anxiety lest it should fail. Going below, I was scarcely seated, before a crash and an outcry brought me again on deck. The wind, it appears, suddenly flirted around, and a violent squall from an angry cloud, instantly threw the sail all aback upon the mast; there being no adequate stays or braces to sustain the solitary pine, it snapped, like a pipe's tail …

The rigging arrangement for *Phoenix*'s single mast would likely be similar to that seen in the depictions of *Paragon*'s sail configuration found in Marestier's representation. Regarding the securing of the bowsprit, Ross (1828:73) noted:

> The bowsprit should be well secured … and as it will, in propelling against the action of the waves, be often severely tried, the bobstays should be double, and also considerably stronger than those required for a sailing vessel of equal tonnage; the bowsprit should be double-gammoned, and, on the upper side, well supported by an oak fish.

That the mast should be stepped well-forward in the hull is supported by Ross, who wrote that the further the masts were placed from the extremities of the vessel, the more diminished the effectiveness of their power acting on the hull would be. He asserted that the mast should be placed as near the extremes of the steamer as possible to assist with the steerage of the vessel (Ross 1828:71). Another archaeological example of this forward-stepped single mast configuration can be seen from the remains of the Swedish canal paddlewheeler *Eric Nordewall*, launched in 1837 and in service until she sank after grounding on a shoal in the lake of Vättern in June of 1856 (Cederlund 1987:111). *Eric Nordewall* was rigged with a lugsail far forward in the hull.

Although there is no surviving evidence for the location of the ship's wheel, it is probable that it was raised above the engine housing, as on *Chancellor Livingston*, which

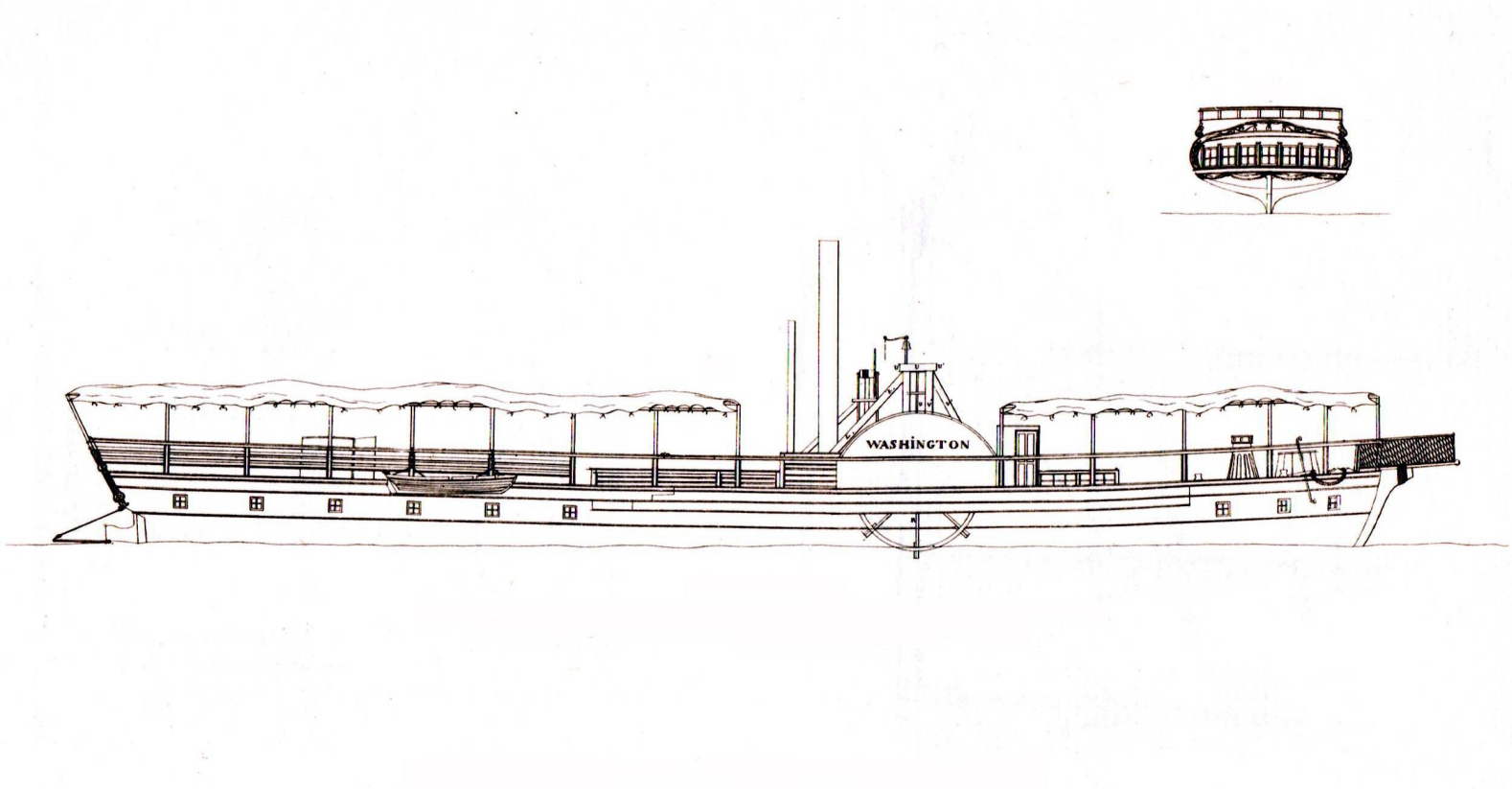


FIGURE 7-16. Marestier's plans for *Washington*. (After Marestier 1957:75.)

would have allowed the helmsman a clear view of objects ahead (Figure 7-2; Marestier 1957:17). Marestier's plates depicting *Washington* and *Paragon* also show the steering wheel above the engine housing, although in both cases, it is abaft the shaft crank frame, and *Paragon*'s wheel is positioned approximately at the level of the upper end of the paddlewheel. The wheel was placed aft of the crank frame on the reconstruction, at a level which would permit an unobstructed view forward of the steamboat.

The Lake Champlain Steamboat Company advertisement for *Phoenix* and *Champlain* mentioned that dogs and other animals not larger than a sheep were to be "tied on deck forward of the capstan" (Ross 1997:32). Marestier's (1957:75) plate II representing *Washington* (Figure 7-16) provided guidance for the location of *Phoenix*'s capstan, which was used to wind up or hoist heavy objects such as the mast, yards, anchors, and cargo. The principal components of the capstan include the spindle, barrel, drumhead, and whelps. The diameter of the drumhead was calculated by Hedderwick (1830:159) to be 12/10 of the ship's breadth, with inches exchanged for feet. Thus, *Phoenix*'s 27 ft. (8.23 m) breadth would give a 32-5/8 in. (82.87 cm) diameter for the drumhead.

Interior Arrangement of the Steamboat

The evidence for reconstruction of the interior compartments surrounding the engine room comes primarily from the Champlain Transportation Company's advertisements, newspaper accounts of the sinking, Hemenway's description of the vessel, and the interpretation of the artifact distribution discussed in Haddan's thesis.

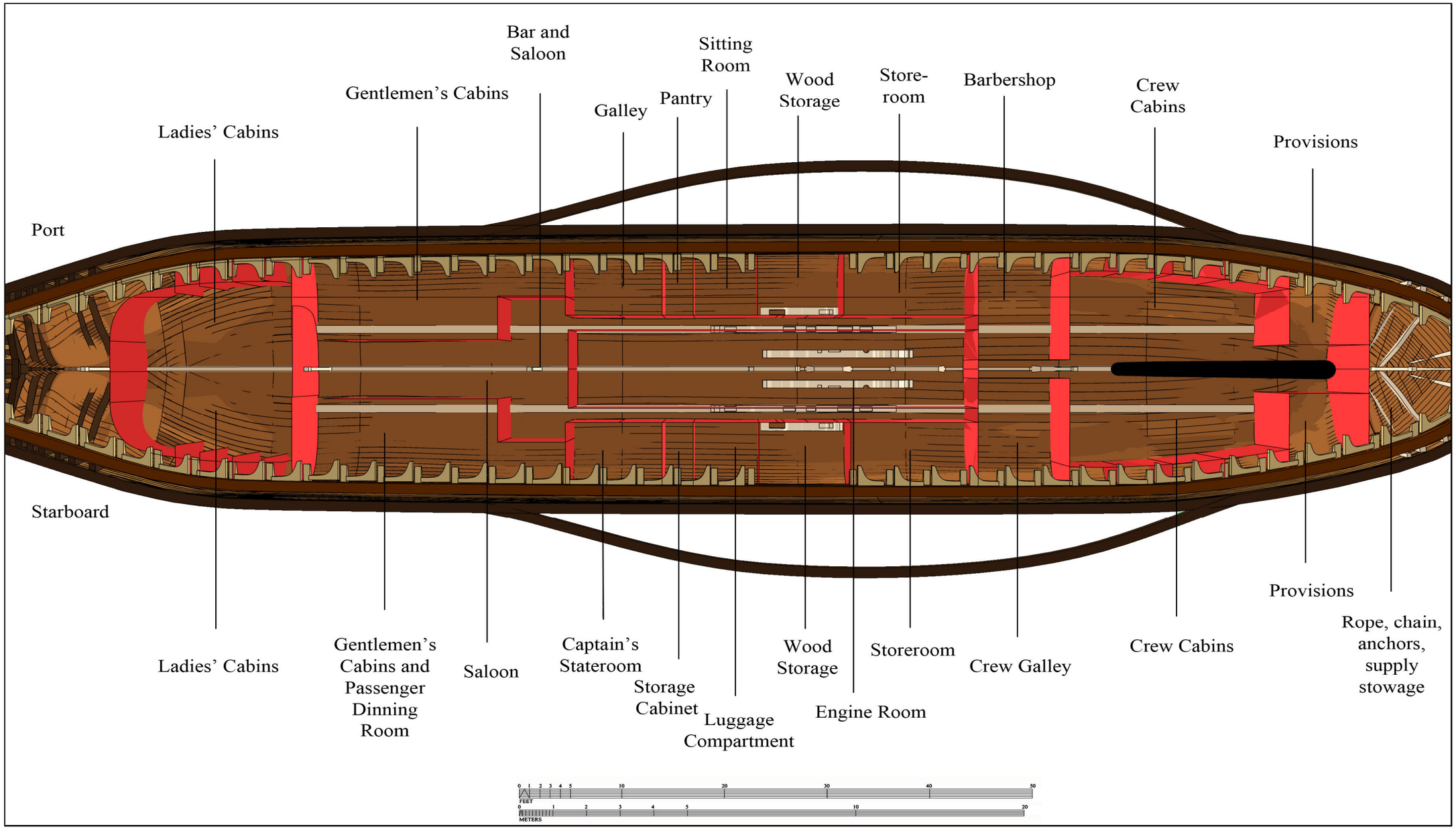


FIGURE 7-17. A conjectural reconstruction of the interior layout of *Phoenix*. (Image from 3D model by Tiago Miguel Fraga and the author, 2012.)

The conjectural arrangement of the compartments below deck shown in the reconstruction is one possible configuration based on the available data (Figure 7-17).

The probable location of the engine room has been discussed above. Historical descriptions of *Phoenix* indicate that forward of the engine room was a small barber shop and crew's quarters. This is supported by Marestier (1957:10), who, in his general observations on steamboat design and dimensions, noted that "the crew's living quarters are in the narrow part of the boat, forward." These quarters, which were likely divided into two or three separate cabins on either side of the ship, provided berthing for at least 11 crewmembers. The quarters were accessible via a companionway with a set of stairs on the main deck. In addition, as significant concentrations of ceramics mixed with broken wine bottle glass were discovered forward of the mast step, it is probable that at least one separate store-room forward of the crew's quarters was designated for storage of provisions and tableware. Another smaller hatch with a ladder was likely positioned forward of the capstan to provide access to ropes, chains, anchors, spare parts, and supplies stowed at the bow.

Based on the presence of brick and ash near starboard frame E it is possible that a crew galley with a stove was located near the crew quarters, as suggested by the Champlain Maritime Society (Davison 1981a:52). This galley is placed opposite the barber shop in the reconstruction, which is shown adjacent to the crew's quarters.

Marestier (1957:10) noted that the space on either side of the engine room was typically utilized as storerooms for provisions and the galley, while the bar was located alongside the engine (although, as noted earlier, historical accounts describe *Phoenix*'s

bar being under the aft cabin stairs). When describing *Chancellor Livingston*, he mentioned that there were bins for coal and wood fuel along the sides of the engine (Marestier 1957:16). Hemenway describes an 8 ft. (2.44 m) space abaft the paddlewheels on either side of *Phoenix*'s engine room for the storage of wood. Aft of this storage area on the starboard side was a luggage compartment, and on the opposite side of the engine room were a small state room and smoking room for passengers (Hemenway 1867:688). Captain Sherman's state room was located aft of the baggage compartment and entered into the starboard side of the gentlemen's cabin, which also served as a dining area for passengers. The galley and pantry were located opposite the captain's state room on the port side of the engine room, and were also adjacent to the gentlemen's cabin.

The ladies' and gentlemen's cabins on *Phoenix* were both located below the main deck, and were reached by a stairway which was protected at the main deck level by a small structure 6 ft. (1.83 m) by 10 ft. (3.05 m), located between the engine housing and the stern. The captain's office was located on the main deck at the head of the stairs within this structure. The bar was located alongside the engine room beneath the stairs (Hemenway 1867:688). The ladies' cabin was probably located in the stern area, and opened into the gentlemen's cabin and dining area. This was a fairly common arrangement for the cabins, for Marestier (1957:10) noted "women retire in a house built on the deck or in the saloon furthest aft." The ladies' cabins on the well-preserved *Erik Nordewall* shipwreck, on the *Lady Sherbrooke* wreck, and in Marestier's plans of *Chancellor Livingston* were likewise located in the stern (Marestier 1957:73; Cederlund

1987:114; Bélisle and Lépine 1988). As seen from these examples, a berth was typically located under each of the saloon windows.

The maximum number of passengers *Phoenix* could carry is unknown, but Marestier (1957:10) mentioned that the galley stove on a typical steamer was "large enough for 150 people because the preparation of food was very simple." This is not to assume, however, that there were 150 berths on the typical lake steamer of this period since there were many who traveled only on day trips between towns on the lake, which would not require a passenger berth. In addition, it was common to provide additional sleeping accommodations when necessary by converting floors and tables into beds. *Chancellor Livingston*, a boat familiar to Marestier and of similar size to *Phoenix* , had a ladies' cabin on deck which may have held up to 24 people based on the transverse section of Plate I (Figure 7-2; Marestier 1957:73). The lower cabin held up to 36 passengers, and the crew cabins forward of the engine room held up to 20 crewmembers, bringing the probable berthing capacity aboard *Chancellor Livingston* to 80. As *Phoenix* was not designed with this additional cabin space on the main deck, it may be estimated that she could have accommodated a maximum of approximately 56 people, including crewmembers. The actual number of berths, however, was probably much lower. If the night of 4 September 1819 represented an average night in the career of *Phoenix*, the 35 or so passengers that were aboard may indicate the typical number of passengers on board the vessel. As this was an overnight voyage, it may be assumed that all passengers would have needed berthing, bringing the minimum number of guest accommodations to 35.

Marestier (1957:10) mentioned there were typically 14 crewmembers, including the captain:

> There is a machinist, a cook, a clerk, and sometimes a pilot; sailors for the lookout, to steer and operate the craft; other men for taking care of the fire, cleaning the kitchen and tables, chambermaid, etc.

It is known from the accounts of the sinking that there were at least a first pilot, sailor, steward, cook, chambermaid, engineer, and barkeep, besides the captain. There was also likely a barber, at least another sailor, and probably a minimum of two firemen to feed the fires under the boilers, bringing the probable minimum crew count to 12. Historical accounts claimed that Captain Sherman requested his crewmembers to stay behind until all passengers had safely escaped the burning vessel, to which they agreed. It is known, however, that the engineer McVein abandoned his post and took control of one of the boats during the panic. If all other crewmembers had stayed on board the ship, this would bring the total to 11. Hemenway's account mentions that 11 people were left onboard the steamer after the second boat was prematurely cut loose. The list of victims includes a fourteen-year old boy from Quebec, Gilbert Painter, who was probably not one of the crewmembers. It is therefore plausible to assume that the minimum number of crew working aboard *Phoenix* was ordinarily 10 or 12.

A set of regulations published by the Lake Champlain Steamboat Company during the time of *Phoenix*'s operation refers to the "great cabin of 16 berths which will accommodate 24 persons, is for gentlemen," and the "back cabin of eight berths, but which will at a push, accommodate twelve persons, is exclusively for the ladies and their

children" (Ross 1997:37). Although it is not known whether the regulations refer to the cabins of *Phoenix*, *Champlain*, or *Congress*, the number of berths per cabin gives an idea of passenger accommodation for this company's steamboats. In this case, the ladies' and gentlemen's cabins combined would have contained a total of 24 berths.

The actual number of passenger berths for the ladies' and gentlemen's cabins is determined by the space that was available abaft the engine room of *Phoenix*. The area aft of this section measured approximately 35 ft. (10.67 m) long and 25 ft. (7.62 m) wide, narrowing as it moved toward the stern. This space also had to accommodate the stairs, bar, and open saloon area between cabins. The suggested layout of the passenger cabins which is depicted in the reconstruction accounts for 35 passenger berths, with 10 crewmember berths located in the crew cabins forward of the engine room in addition to the captain's private stateroom.

CHAPTER VIII

PHOENIX AND EARLY 19TH-CENTURY STEAMBOAT CONSTRUCTION

Introduction

There are no known contemporary plans or models of *Phoenix*, so to gain a better understanding of early 19th-century steamboat design it is imperative to examine the clues found in the archaeological record, written sources from the early 19th century, and parallels from studies conducted on other vessels built during this period.

As a number of works have been published on early 19th-century shipbuilding in America and Europe, this chapter is primarily dedicated to the construction and design of steamboats from the first quarter of the century in the northeastern region of North America. As discussed in Chapter I, a number of treatises on marine architecture from the early years of steam navigation have survived from this era. While these works tended to address general construction methods for wooden sailing vessels, occasionally the authors included sections dealing specifically with the design of steam-propelled vessels. Although most of these treatises were written a score or more years after *Phoenix* was built, many of the construction methods detailed in the manuscripts had already been in use for generations. Many of the treatises are from Great Britain, and only one was authored by an American shipwright (Goldenberg 1976:77).

It should be emphasized, however, that most early 19th-century American shipbuilders approached ship construction with a more practical point of view than their British counterparts, and were probably largely unaware of the numerous texts on

shipbuilding being published in Great Britain. Many of the shipbuilding methods employed in the American shipyard were the same as those used in the colonial era. Mid-19th-century shipbuilder John Griffiths mentioned that although there were a number of treatises on naval architecture printed in Europe in the early part of the century, there were rarely more than one or two copies available in the United States. The American style favored experimentation in the shipyard as opposed to memorization of mathematical formulae in order to obtain the most efficient hull shape, and the spreading of craft knowledge and skills through shipbuilding culture and apprenticeship versus classroom learning supported this practical approach (Thiesen 2006: 45-48).

To complement the written sources and flesh out construction details, reports documenting hull remains from other early 19th century vessels were gathered and studied. Comparisons of known construction features from *Vermont* (1809), *Ticonderoga* (1814), and *Lady Sherbrooke* (1817) demonstrate differences and similarities in steamboat design, fill in missing construction details, and contribute to a better understanding of early American steamboat design.

Construction of *Phoenix*

As was customary for the time, the shipwright carefully considered the shape of *Phoenix*'s hull prior to sawing a single piece of wood for her construction. *Phoenix*'s builder, Mr. Roberts, was instructed to assemble a steam vessel that was to operate on a narrow, but deep lake, which at times experienced heavy sea states, including frequent choppy seas, with waves not usually exceeding 4 ft. (1.22 m), and occasional sudden

squalls. He had to consider the vessel's primary purpose as a passenger steamer, take into account the heavy steam machinery that she would be carrying, and incorporate auxiliary sailing capabilities for use when the winds were fair. These factors had a bearing on the size and proportions of the steamboat as well as the curvature of the hull. For example, if a vessel was overloaded and submerged more than its structure could naturally bear, it could quickly suffer damage from the added strain placed on its hull (McKay 1839).

Roberts first needed to draw plans or drafts based on the dimensions specified in the Lake Champlain Steamboat Company contract and according to the requirements mentioned above. The drafts showed the sheer, half-breadth, and body plans for the steamer. In order to conceptualize the vessel in three dimensions, it was often practical for the shipwright to sculpt a half model of the ship—a skill which enabled American shipbuilders to produce ship's lines and determine its displacement. This was typically made on a 1/4 in. (0.64 cm) to 1 ft. (30 cm) scale and represented one-half of the vessel sliced fore and aft amidships. This model was also used by the builder to detect irregularities in the curves of the ship, determine carrying capacity, and evaluate steaming and sailing characteristics (Greenhill and Manning 1989:90; Thiesen 2006:55). Once *Phoenix*'s half-model was completed, the form of the vessel's hull was likely discussed at some length between Roberts and Jahaziel Sherman, who, as the first master of the steamboat, was sent by the Lake Champlain Steamboat Company to oversee the construction.

The construction of *Phoenix* began with the laying of the keel, which was likely composed of three pieces flat-scarfed together (see Chapter VI). These pieces were shaped and assembled on great blocks spread approximately 6 ft. (1.83 m) apart and temporarily fastened to the blocks with spikes or cleats while under construction (McKay 1839:47). Two or three bolt holes were drilled along the length of the scarfs with a hand auger, into which large iron bolts were driven to fasten the keel sections together.

Once the keel was laid and its pieces secured to one another, the next step was to erect the stem and sternpost. These large timbers were likely positioned with the use of shears, or spars lashed together for hoisting. The heel of the sternpost was probably carved into a tenon, and a mortise was notched out of the upper face of the keel's after end to seat the post. The stern knee and deadwood were sided the same dimensions as the keel, and were subsequently fayed and bolted to the keel. The stem was made of multiple components, but the bottom portion, or fore gripe (or foot of stem), was fastened to the main stem. This stem was then raised, flat-scarfed to the keel, and fastened in the manner of the assembled keel pieces. The apron pieces were bolted atop this assembly. Upon installation, each of these structural members were beveled, squared, and plumbed as appropriate using level lines, shores, and pure muscle (McKay 1839:51).

Once the end posts were raised and shored into position, the builders laid out and fastened together the floors and futtocks of each of the steamer's 60 square frames. The frames were assembled in an overlapping pattern with treenails and iron spikes driven

transversely through pre-drilled holes. Beginning at “dead flat”, or the midships frame, they were laid out along the length of the ship, numbered as they were during the lofting process, squared across the keel on approximately 24 in. (60.96 cm) centers, and shored as necessary with wedges until they were bolted down to the keel. Once this was completed, the limbers were cut and the heads of the top timbers were sawn off (McKay 1839:48-51). To form the bow and stern of the vessel without having to loft an inordinate number of frames, the shape of the extremities was probably created by the temporary bending of ribbands around the mold frames and into the rabbets of the stem and sternpost (Greenhill and Manning 1976:113). The 12 bow and stern cant frames were then positioned as needed to fill in the extremities of the hull.

Once the square frames were in position, the keelson, probably composed of three sections scarfed and fastened together, was bolted on top of them down through the keel. As mentioned previously, the keelson was roughly notched on the underside to fit over the frames.

The workers then built a stage around the vessel in order to plank both the interior and exterior of the steamboat. As the interior of the vessel was planked, or ceiled, longitudinal stringers and steam engine bedtimbers were installed and bolted to the frames beneath. Once the interior structure was nearly completed up to the level of the deck, clamps were fastened to the insides of frames to support the deck beams; the beams were further secured by a waterway on top and hanging and lodging knees below. The paddle beams, as well as the other deck beams located inboard of the guard structure, were designed to extend beyond the sheer strake, or uppermost hull strake, in

order to support the paddle shaft (Figure 8-1). Vertical posts were installed to support the heavy paddle beams from below. The deck beams were further supported by stanchions set into the keelson, probably about every six frames along its length.

Meanwhile, workmen were completing the construction of the transom and installing the steamboat's rudder. The shipbuilders planked the decks, framed ports and hatchways, fabricated gratings and cleats, and installed a capstan, pumps, and scuppers. A number of other tasks were assigned in order to complete the vessel. Joiners smoothed the hull planking and tended to interior cabin design, caulkers filled the seams with pitch and oakum, and the ship was fitted out with its mast and rigging. Roberts was likely able to obtain iron for fasteners, blocks, masts, and deckware from the nearby Monkton Iron Company in Vergennes, which may also have supplied the steamer's boiler. A mason installed the galley hearth, tinsmith lined the scuppers with lead, and a glazier installed the steamboat's glass ports. Additional craftsmen included painters, riggers, and boatmakers, among others (Goldenberg 1976:89). As a passenger steamboat, *Phoenix* was probably supplied with fine furniture, artwork, and elegant finishes to attract customers, as suggested in the Lake Champlain Steamboat Company's advertisements (Ross 1997:31).

This, of course, is a gross oversimplification of a much more complex process. There were many calculations and adjustments that had to be made along the way. Many of the structural components were also built "on the eye" based on experience and the practicality of the design. Numerous procedures went into the construction, which are

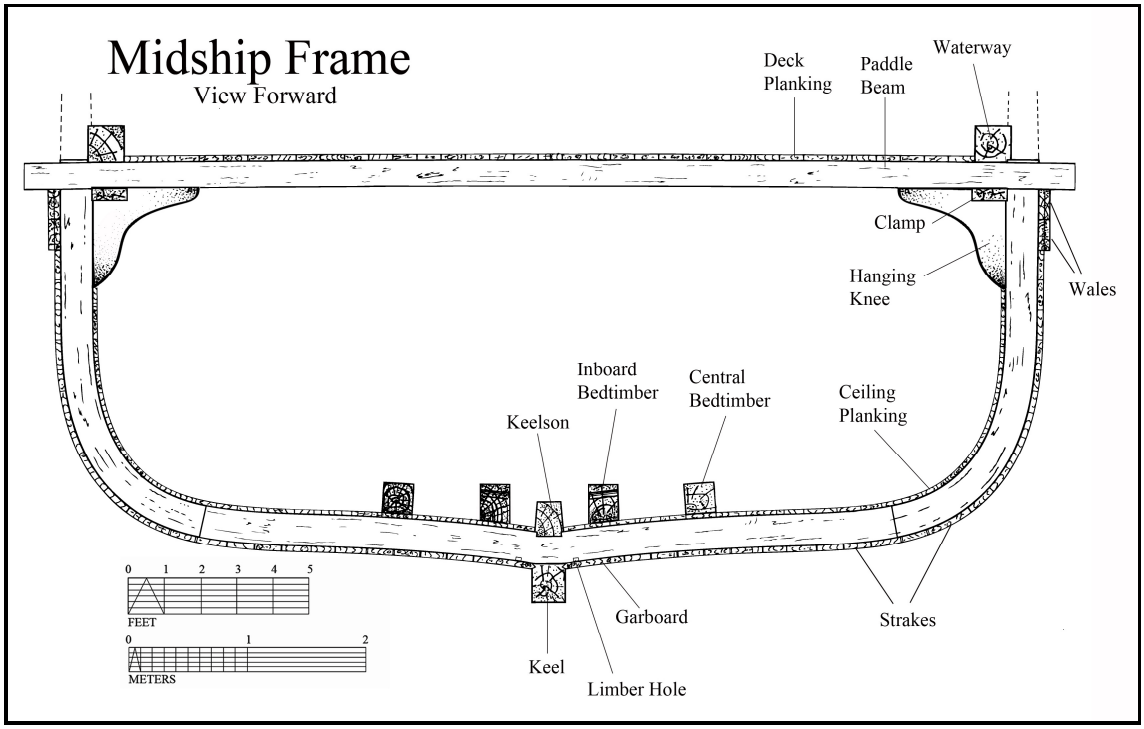


FIGURE 8-1. Reconstructed *Phoenix* midship frame. (Drawing by author, 2012.)

not discussed here, such as the method of seam caulking, the peening or clenching of fasteners to obtain secure grip, the plumbing of lines to ensure squareness and alignment of frames and posts, the carving of rabbets and bearding lines, the beveling of frames to allow for the installation of hull planking, the horning of the transom, the installation of the steam machinery, and the painting of the hull.

A Comparison of Early 19th-Century Steamboat Construction

Vermont

The first steamboat to operate on Lake Champlain did so successfully for six years until an engine malfunction caused a breach in the hull, which led to her sinking in

the Richelieu River in October of 1815. *Vermont* also became the first steam vessel to receive public attention as an historic shipwreck in the lake, and in 1953 her hull remains were raised with oil drums by Lake Champlain Associates, Inc. with the goal of putting the surviving timbers on display in a maritime museum in New York (Figure 8-2). One member of the company, salvor Lorenzo Hagglund, was responsible for the recovery of sunken Revolutionary War vessels *Royal Savage* and *Philadelphia* in the 1930s. When the wreck was first raised from the river, a portion of the vessel's sides were still attached. While under tow one night from Bloody Island to Port Douglas, however, the

FIGURE 8-2. Hauling the remains of *Vermont* to a clearing in New York in 1953. (After Fowler 1974:34.)

wreck ran aground and the sides were reportedly lost on a reef before the wreck was removed. The museum in which the hull was to be exhibited was never formed and *Vermont* was abandoned in dense foliage 100 ft. (30.48 m) from a road near Ausable Chasm, New York, where it remained for 20 years until the hull was destroyed to clear land for a campsite. A small number of the surviving timbers were donated to the Lake Champlain Maritime Museum in the 1990s by Edward Hatch, the son of one of the original salvors (Bellico 2001:291).

Before the remains of *Vermont* were cleared to make room for the campsite, maritime historian A. Peter Barranco, Jr. was able to record some of the hull features, make useful observations regarding her construction, and draft a plan of the wreck based on his notes (Figure 8-3). The information for the analysis of her construction is drawn from his unpublished notes (Barranco 1963). It is known from Lake Champlain Transportation Company records that the 167-ton *Vermont* was 120 ft. (36.58 m) in length and 20 ft. (6.1 m) in beam, making her length to beam ratio 6:1 compared to *Phoenix*'s ratio of 5.4:1. This long and narrow hull form was akin to Fulton's early steamboats on the Hudson River, and may have resembled a long canal boat with a chimney and paddlewheels (Ross 1997:24).

The keel was approximately 97 ft. (29.57 m) long and composed of at least three pieces as indicated by the presence of two scarfs. Unlike the keel of *Phoenix*, *Vermont*'s backbone consisted of multiple timbers stacked on top of one another, with dimensions varying along the length of the vessel (Figure 8-4). The sided dimensions ranged from 6 in. (15.24 cm) at the stern to 9 in. (22.86 cm) at frame 2 to 12 in. (5.08 to 30.48 cm) at

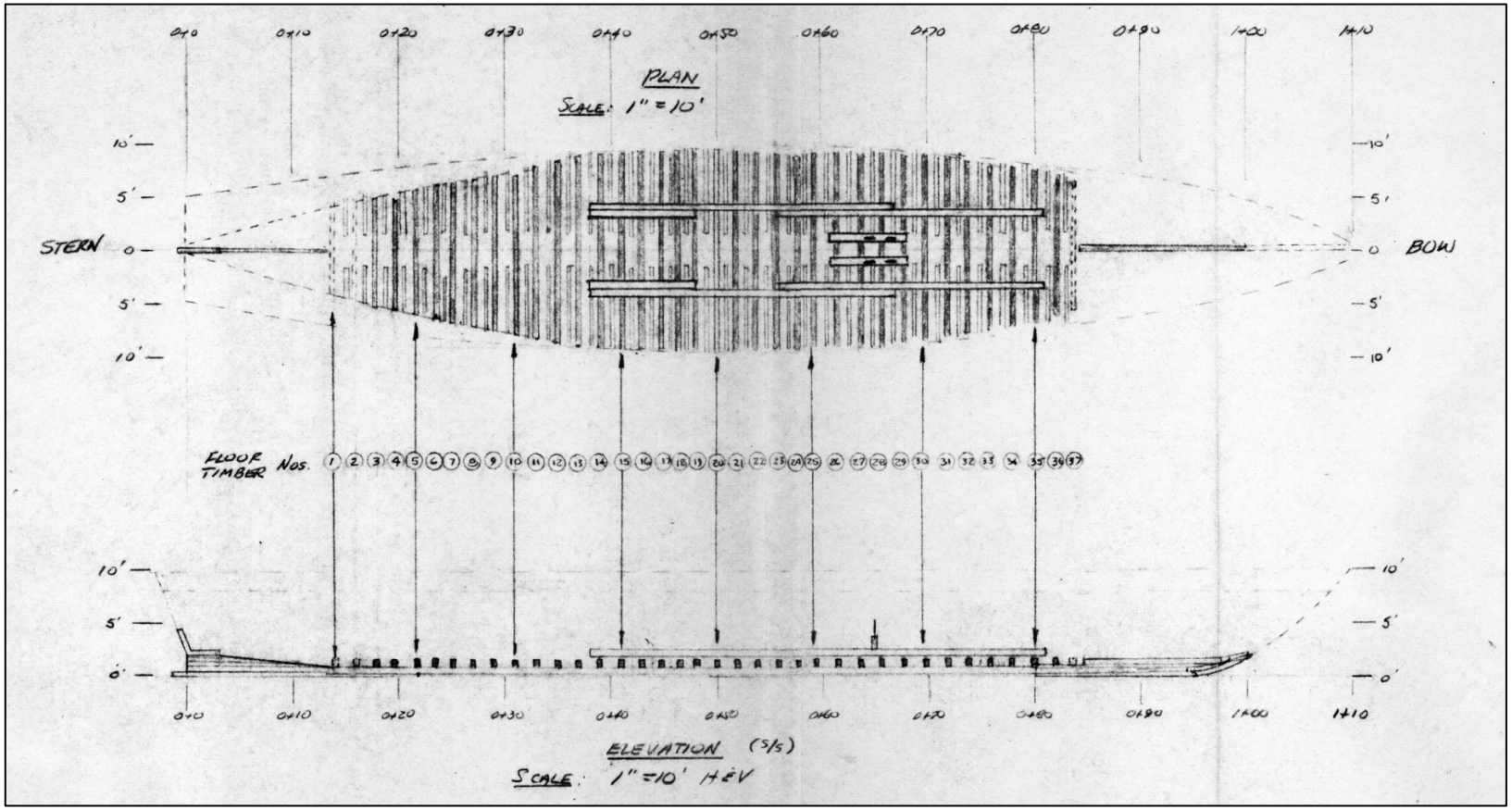


FIGURE 8-3. Plans of the hull of *Vermont* as recorded by A. Peter Barranco, Jr., in 1963. (Courtesy of A.P. Barranco.)

frame 30. At frame 36, the keel was composed of three stacked pieces molded 4 in. (10.16 cm) at the base, 7 in. (17.78 cm) in the middle, and 4 in. (10.16 cm) at the top. The aftermost heel of the keel was shaped into a skeg (Barranco 1963). Although comparable in some areas, the keel of *Vermont* was generally of slighter dimensions than that of *Phoenix*, which was at least 13-1/2 in. (34.29 cm) molded and 11 in. (27.94 cm) sided throughout.

There was a small scarf recorded on the keel 94 ft. 9 in. (28.88 m) from the stern where the heel of the stem was connected to the keel. This stem piece measured 7 ft. (2.13 m) long, and its dimensions at the scarf were 6 in. (15.24 cm) molded and 7 in. (17.78 cm) sided. As it curved upward it expanded to 10 in. (25.4 cm) molded while narrowing to 5 in. (12.7 cm) sided. At its forwardmost point, which was the forward extremity of the surviving hull, it measured 4 in. (10.16 cm) sided. Although not as large as its counterpart on *Phoenix*, the molded dimensions of the fore gripe appeared to be enlarged; perhaps to provide better handling capabilities when the vessel was steaming to windward.

Although the majority of the bow section did not survive, Barranco was able to estimate the approximate rake of the stem based on the existing fore gripe, which turned out to be much more gradual than that of *Phoenix*. As little evidence was available for the reconstruction of the bow, however, this remains a conjectural stem curvature. It is likely the stem projection was sharper and represented a hull form modeled after Fulton's early Hudson River steamers, which were more akin to canal boats.

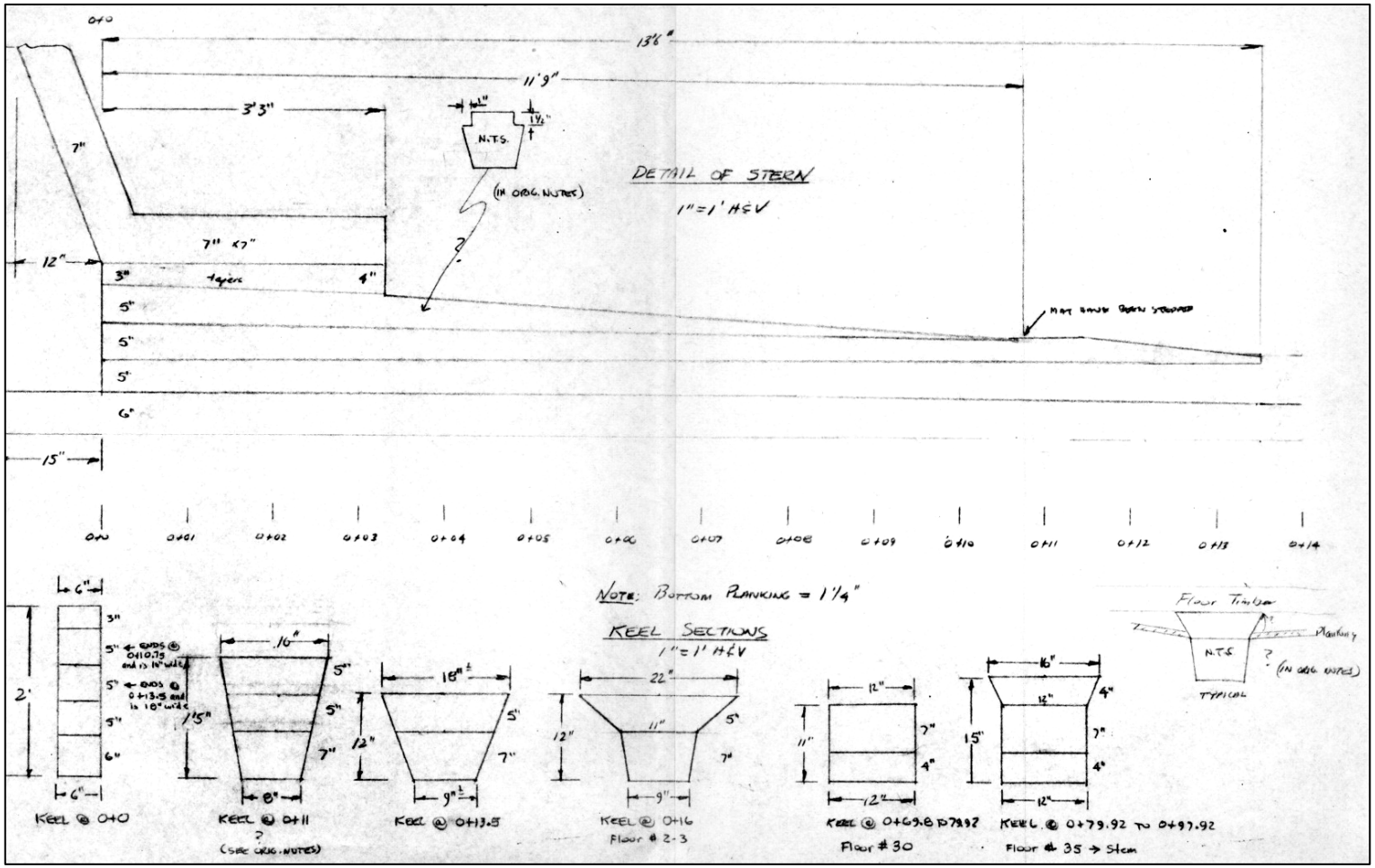


FIGURE 8-4. *Vermont*'s keel sections as recorded by Barranco in 1963. (Courtesy of A.P. Barranco.)

Although scale drawings were created, few notes detailing the shape and dimensions of *Vermont*'s stern were recorded. The keel extended 15 in. (38.1 cm) aft of the deadwood and stern knee, suggesting the molded dimension of the missing sternpost. A stern knee was positioned on top of four deadwood pieces at the aftermost structural remains. It sat approximately 4 ft. (1.22 m) high from the base of the keel, and, like the bow, was hypothetically extended along its rake 10 ft. (3.05 m) in Barranco's drawings. The deadwood in this section of the hull was built up four pieces high, totaling 18 in. (45.72 cm) above the keel. It began at frame 1 and tapered upward toward the stern over a length of 13 ft. 6 in. (4.11 m). Much like *Phoenix*'s deadwood, that of *Vermont* was notched to receive the cant frames near the stern. The stern knee measured 7 in. (17.78 cm) molded and 7 in. (17.78 cm) sided, and was approximately 4 ft. (1.22 m) long at its base. There appeared to be more deadrise at the stern of *Vermont* than in *Phoenix*, as the stern knee was positioned lower on two shallow pieces of deadwood on the latter steamboat.

There was no concrete proof for the existence of masts or rigging elements within the hull of *Vermont*. At 11 ft. (3.35 m) forward of the stern on the deadwood, however, were notches that Barranco noted "may have been stepped" (Barranco 1963). Whether or not this could have been a mast step is unknown.

Evidence for 37 surviving frames was recorded on the site plan, which may represent the steamer's original square frames. The floor timbers were bolted to the keel with 3/4 in. (1.9 cm) iron bolts, and between each, disconnected futtocks were attached to the planking with 1 in. (2.54 cm) treenails. All of the frames were broken off near the

turn of the bilge. The longest surviving frame was measured at 9 ft. (2.74 m) outboard of the keel. The floors were 8 in. (20.32 cm) molded by 5 to 7 in. (12.7 to 17.78 cm) sided, and the futtocks next to them were of similar dimensions. These were approximately the same size as the frames of *Phoenix*, which averaged 8-1/4 in. (20.96 cm) molded by 6-1/2 in. (16.51 cm) sided. The *Phoenix* frames, however, varied widely in their dimensions while the *Vermont* frames were fairly consistent in size throughout. The room and space of *Vermont*'s floor timbers was approximately 24 in. (60.96 cm), which was the same as that recorded on *Phoenix*.

There was no evidence for a keelson in Barranco's notes. Near the bow, just forward of frame 37, appeared a large timber, 8 in. (20.32 cm) molded by 12 in. (30.48 cm) sided. This timber ran 13 ft. 1 in. (3.99 m) to the point where it butted against the stem. This structure was positioned over the keel where the keelson should have been bolted, but being so far forward in the hull probably represents the steamer's apron instead.

Vermont's engine bedtimbers also survived for documentation. Between floors 26 and 29 were two 9 in. (22.86 cm) molded by 10 in. (25.4 cm) sided timbers, 7 ft. 3 in. (2.21 m) long and bolted to the frames beneath with 3/4 in. (1.9 cm) iron bolts placed 6 in. (15.24 cm) from the keel. Mortises were cut 3 ft. 2 in. (97 cm) from the aft end and 1 ft. (30 cm) from the forward end on each timber, each measuring 12 in. (30 cm) long by 4 in. (10.16 cm) wide. Two posts were found protruding from the after mortises on each bedtimber. They stood 18 in. (45.72 cm) tall, and a 1 in. (2.54 cm) square rod, threaded at the end, was found protruding another 18 in. (45.72 cm) proud of the posts.

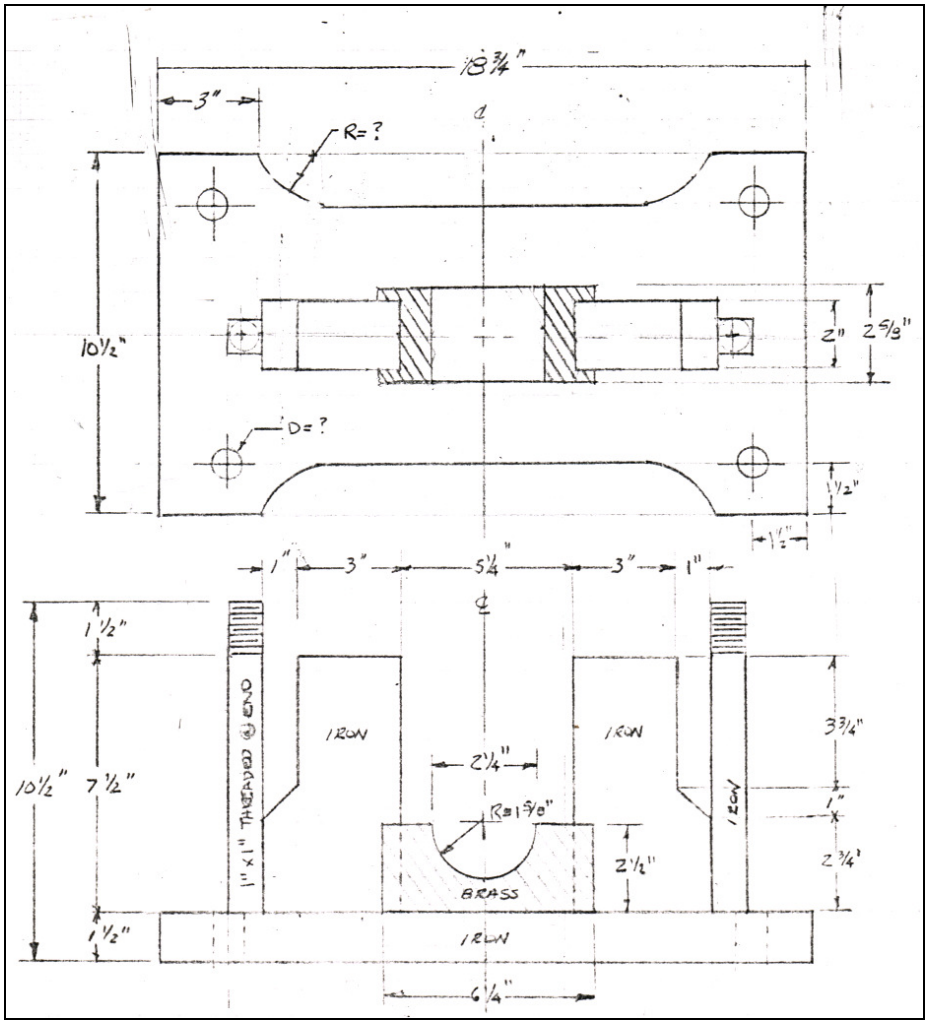


FIGURE 8-5. Cast iron and brass bearing from the hull remains of *Vermont*, as recorded by Barranco in 1963. (Courtesy of A.P. Barranco.)

Approximately 16 in. (40.64 cm) outboard of these timbers, starting at frame 14, ran another set of longitudinal stringers along the length of the hull to frame 36. There was a clean gap in this stringer, however, between frames 19 and 23, a distance of 7 ft. 9 in. (2.36 m). These timbers measured 9 in. (22.86 cm) molded by 10 in. (25.4 cm) sided. Outboard and adjacent to these stringers ran a third set of timbers beginning at frame 13

and stretching to frame 29. The molded and sided dimensions of these stringers measured the same as the other two sets.

In addition to the structural support described above, a brass bearing was discovered on top of one of the engine bedtimbers at frame 28 (Figure 8-5). The bearing was set into a plate 18-3/4 in. (47.63 cm) long, 10 in. (25.4 cm) wide, and 1-1/2 in. (3.81 cm) thick. The bearing itself was 6-1/4 in. (15.88 cm) wide, 2-1/2 in. (6.35 cm) tall, and 2-5/8 in. (6.67 cm) long. There was a 2-1/4 in. (5.72 cm) diameter opening for the shaft. There were 7-1/2 in. (19.05 cm) iron supports on either side of the bearing and two 1 in. (2.54 cm) diameter threaded iron bolts on either side of the supports. A 1 in. (2.54 cm) diameter bolt hole was found on each of the four corners of the plate.

Some of the steamer's planking also survived upon recovery from the river. At one unrecorded location at the bilge, the planking was observed to be 18 in. (45.72 cm) wide by 1-1/4 in. (3.18 cm) thick, while the next strake up measured 10 in. (25.4 cm) wide by 1-1/4 in. (3.18 cm) thick. At frame 16 the ceiling planking, which averaged 13 in. (33.02 cm) wide, had survived up to 9 ft. 6 in. (2.9 m) outboard of the keel.

Ticonderoga

In October of 1814, shortly after the Battle of Plattsburgh, Commodore Macdonough sent *Saratoga*, *Confiance*, *Linnet*, and *Ticonderoga* to winter quarters at Whitehall, New York. Following the signing of the peace treaty between Britain and the United States in December of that year, Secretary of the Navy Benjamin Crowninshield ordered the dismantling of the fleet at Whitehall. These vessels, in addition to the brig

Eagle and a number of gunboats, were moored in a line from stem to stern below the harbor of Whitehall, and periodically caulked and payed from the waterline up to keep them serviceable in case of need. In 1820 *Ticonderoga*, *Eagle*, and *Linnet* were moved to the inside mouth of the Poultney River. A report from 1821 describes *Ticonderoga* with her "hull unsound and in rotten condition." By 1825 her hull appeared to have settled to the bottom, where she remained for over 130 years (Crisman 1983:26-33).

In preparation for a bicentennial celebration of the town of Whitehall in 1958, the residents decided to raise *Ticonderoga* for public display. She was pulled forcibly from the bottom of the river by a bulldozer with cables attached to the bow until she breached the water several feet and part of the keel became separated. The next few days were spent sawing the hull in half and dynamiting the wreck to dislodge it from the mud. The ship was thus successfully raised and transported to downtown Whitehall in pieces, where she was reassembled and supported by railroad ties beneath a tin roof behind the Skenesboro Museum (Figure 8-6). Unfortunately no comprehensive conservation plan was in place at the time of the recovery, and the already degrading timbers continued to deteriorate until the museum started coating the timbers with creosote or anti-rot compounds (Crisman 1983:35-39).

In 1981, Kevin Crisman led an archaeological study of *Ticonderoga*'s hull remains, and with a team of four researchers recorded her construction features in detail over a two-day period. The results of this study were published in a work entitled *The History and Construction of the United States Schooner* Ticonderoga (Crisman 1983), which includes technical drawings of the vessel's hull remains (Figure 8-7). As an

analysis of the vessel's construction is presented in detail in Crisman's book, this section focuses specifically on the differences and similarities in the construction of *Ticonderoga* and *Phoenix*.

Originally intended as a lake steamer by the Lake Champlain Steamboat Company, the lower portion of *Ticonderoga*'s hull has the most interpretive value in a comparative analysis with *Phoenix* because this was probably left largely unaltered when bought by the U.S. Navy. *Ticonderoga* was 120 ft. (36.58 m) long, had an approximate 25 ft. (7.62 m) beam, and probably displaced between 325 and 350 tons. Her length-to-beam ratio was 4.8:1, which made her slightly beamier than *Phoenix*. These proportions

FIGURE 8-6. *Ticonderoga* housed at the Skenesboro Museum, Whitehall, New York. (Photo by author, 2008).

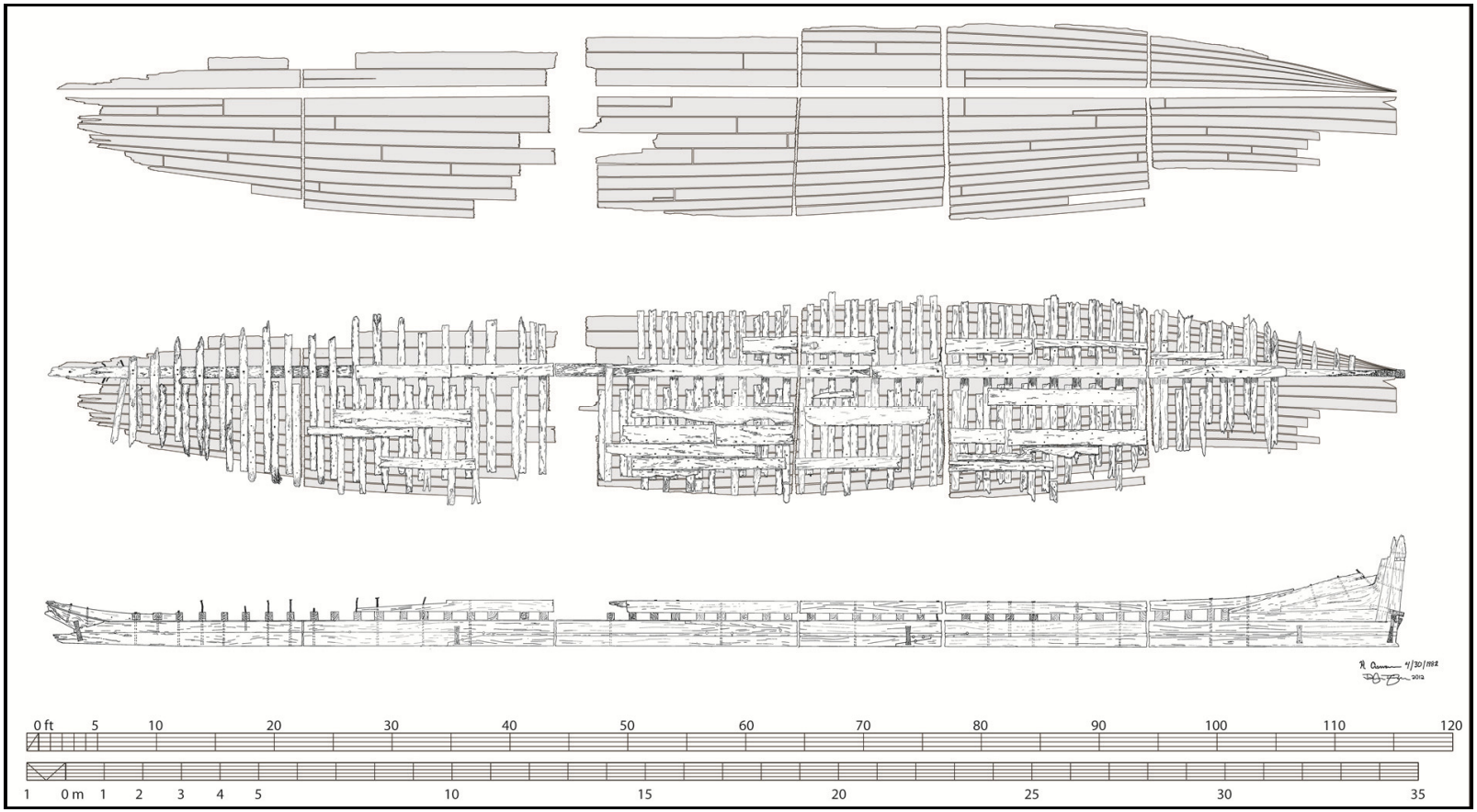


FIGURE 8-7. Drawings of *Ticonderoga*'s remains at Whitehall, New York, by Kevin Crisman and Douglas Inglis. (Courtesy of Kevin Crisman.)

probably also made her a more competent sailor, although she was still longer and narrow than the other sailing vessels in her fleet such as *Saratoga* and *Eagle*, which had ratios of 3.91:1 and 3.75:1 respectively (Crisman 1983:60).

The 113 ft. 9 in. (34.67 m) long keel of *Ticonderoga* was composed of seven pieces of white oak flat-scarfed together, and averaged 13 in. (33.02 cm) sided by 24 in. (60.96 cm) molded. It narrowed to 8 in. (20.32 cm) sided at the stern. The keel timbers were stacked on top of one another, the top layer consisting of two overlapping timbers, 59 ft. 6 in. (18.14 m) and 60 ft. (18.29 m) in length, flat-scarfed together and fastened with iron bolts and fish plates. Stopwaters were inserted to prevent the seams from shifting and to keep water from penetrating the hull. Unlike *Phoenix*, the schooner was completed with a false keel, probably added by the U.S. Navy's shipwright, Noah Brown, to improve stability under sail. The five bottom-layer timbers represent this false keel, and are joined by 3 ft. (91.44 cm) long flat scarves. The upper layer, which represents the original keel, was 10 in. (25.4 cm) molded and 13 in. (33.02 cm) sided. The rabbets cut into the top face of the keel measured 3 in. (7.62 cm) wide and 1-1/4 in. (3.16 cm) deep (Crisman 1983:40-43). These dimensions differed somewhat from the keel of *Phoenix*, which was molded at least 3 in. (7.62 cm) more and sided 2 in. (5.08 cm) less. The rabbets were as wide, but approximately 3/4 in. (1.9 cm) shallower. As mentioned previously, no evidence for the use of fish plates was found on the hull of *Phoenix*.

Unlike the bow of *Phoenix*, only the base of *Ticonderoga*'s stem survived upon being wrenched from the river. This included sections of the stem and apron, as well as a

portion of the disarticulated outer stem. Unfortunately, due to the deteriorated state of the bow, it was not possible to accurately ascertain the rake of the stem. The remaining 4 ft. (1.22 m) section of stem was connected to the top of the keel via a hook scarf and fish plates, with stopwaters installed across the seam of the scarf (Figure 8-8; Crisman 1983:44). The lower section of the outer stem fit between the false keel below and the stem above. It appears to have been fayed and bolted to the keel timbers and main stem, completing the assembly. As *Phoenix* was not built with a false keel, the stem assembly was simply flat-scarfed to the keel and the apron fastened directly to the stem.

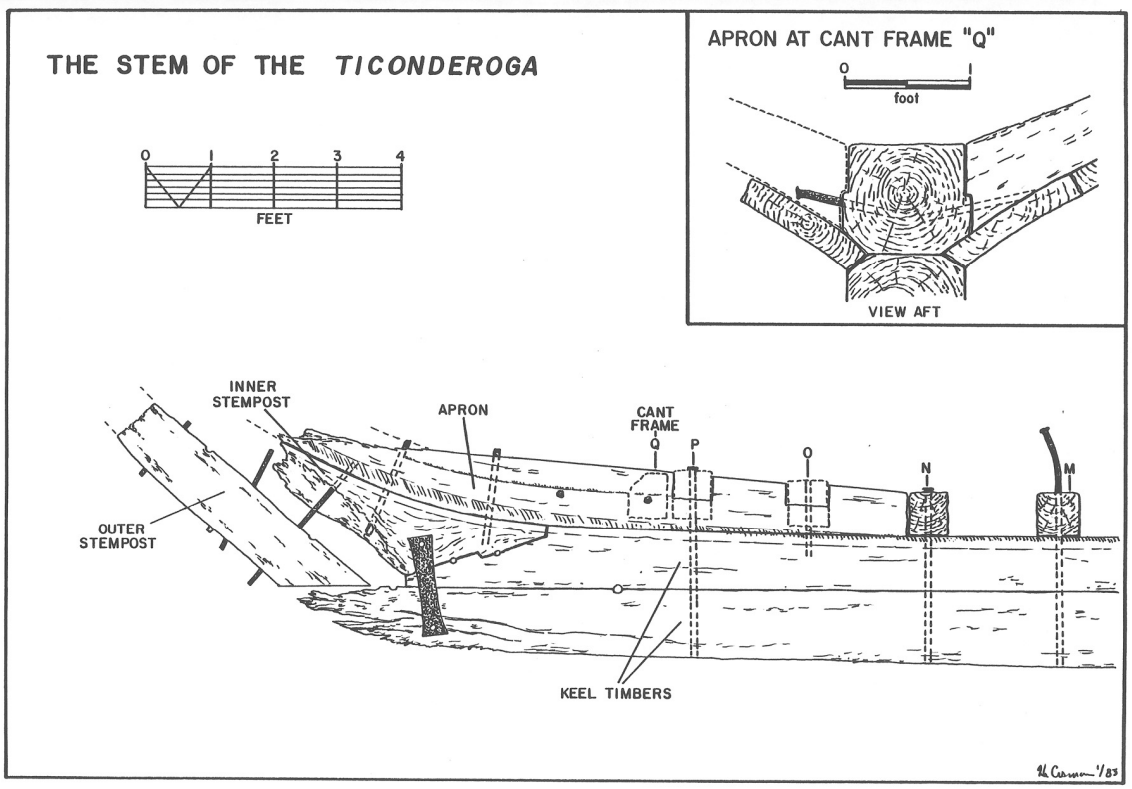


FIGURE 8-8. The stem of *Ticonderoga*. (Courtesy of Kevin Crisman.)

Ticonderoga's remaining 4 ft. 6 in. (1.37 m) piece of outer stem was molded 11-1/2 in. (29.21 cm) and sided 5 in. (12.7 cm) at its forward surface. This section of *Phoenix*'s fore gripe was molded approximately 4 in. (10.16 cm) greater, but was sided the same. This increased molded dimension may have been Roberts's answer to improving *Phoenix*'s handling abilities under steam, although an expanded fore gripe was deemed appropriate for sailing vessels as well in Hedderwick's (1830:154) treatise.

The 10 ft. (3.05 m) section of *Ticonderoga*'s apron ran along the forward end of the keel and inner stempost. It was fastened to these members with bolts driven from above, and was notched on top to receive the two forwardmost square frames and one cant frame. The positioning of the apron differed slightly on *Phoenix*, where it ran along the keel until it met the upper apron, to which it was fayed and bolted directly beneath the keelson. The presence of zebra mussels prevented the thorough documentation of this structure, but it is believed that *Phoenix*'s apron was likewise notched to seat at least two floors. The corners of *Ticonderoga*'s apron were also chamfered to form a rabbet into which the vessel's garboard strakes were fitted (Crisman 1983:46). Although unobservable, it is suspected that the lower corners of *Phoenix*'s apron were likewise chamfered to receive the garboard strake. The rabbet continued along the seam between the stem and apron. While the molded dimensions of the *Phoenix* apron could not be recorded, the sided dimensions were found to be similar to those of *Ticonderoga*'s apron.

The stern of *Ticonderoga* was well-preserved and composed of essentially the same elements, as seen on *Phoenix*, including the sternpost, inner sternpost, deadwood,

and one gudgeon (Figures 8-9 and 8-10). The surviving sternpost length was 11 in. (27.94 cm) higher than that of *Phoenix*, and its sided dimensions were the same. The molded dimensions, however, differed significantly. The uppermost section measured 12 in. (30.48 cm) molded on both sternposts. The base of the *Phoenix* sternpost grew to 18 in. (45.72 cm) molded, however, while the *Ticonderoga* sternpost retained the same dimensions at the base. Both assemblies also incorporated an inner post, which, along with the roughly cut stern knee positioned immediately forward, was bolted to the main post with large iron bolts. The similarities, however, stop there. The bottom of the schooner's sternpost was additionally secured to the keel with a fish plate, and stopwaters were observed at the union of the sternpost and keel. The one surviving

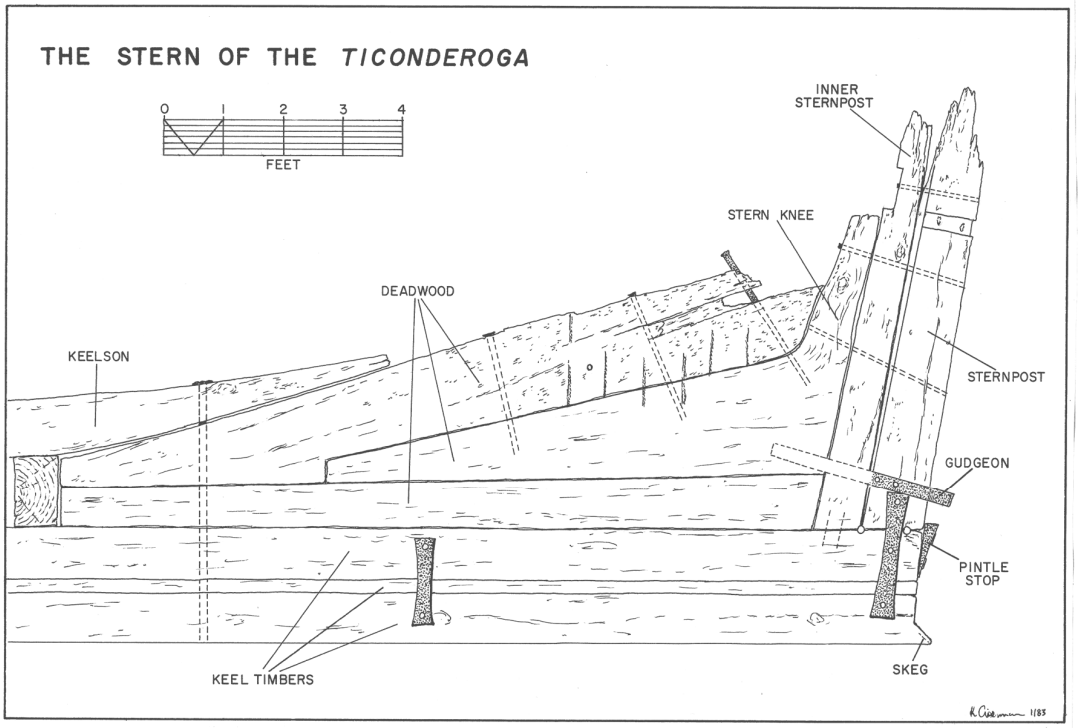


FIGURE 8-9. The stern of *Ticondergoga*. (Courtesy of Kevin Crisman.)

FIGURE 8-10. Stern of *Ticonderoga* as it appears at the Skenesboro Museum. (Photo by author, 2008.)

gudgeon was fastened to the sternpost, inner sternpost, and deadwood, while on *Phoenix* they were attached only to the sternpost. There was a pintle stop beneath the lower gudgeon of the schooner, while on the steamer the sole pintle stop was found beneath the upper gudgeon.

The deadwood assemblies were constructed in a different manner. *Ticonderoga*'s lowest deadwood piece consisted of a flat section seated on the keel, 12 ft. 6 in. (3.81 m) in length with a molded dimension that tapered from 12 in. (30.48 cm) against the base of the inner sternpost to 8 in. (20.32 cm) at its forward end. Above that piece was the stern knee, which was much longer than the stump knee found on *Phoenix*. The angular knee extended 8 ft. 9 in. (2.67 m) forward until it connected to the upper deadwood section, which ran diagonally along the upper surface of the knee and was bolted to the

knee with three bolts. It was into the sides of this piece that the stern half frames were seated. The after end of the keelson tapered to overlap the upper face of this third deadwood piece (Crisman 1983:49-50). The stern of *Phoenix* appears to have been built in a simpler manner, with two relatively flat pieces of stacked deadwood, which ran from the base of the inner sternpost forward 11 ft. (3.35 m). It was into these deadwood pieces that the stern half frames were seated. The keelson ran all the way to the stern knee, onto which it was originally fayed and bolted.

As a vessel with a shorter overall length, *Ticonderoga* had a total of 59 frames compared to the 72 frames on *Phoenix*. There were originally three cant frames at the bow, 50 square frames, and 6 half frames at the stern. The framing patterns of the schooner and steamer were the same, and, like *Phoenix* and *Vermont*, the floors of *Ticonderoga* were bolted to the keel on 2 ft. (61 cm) centers. Although the dimension of the frames varied, they averaged 8 in. (20.32 cm) molded and 7 in. (17.78 cm) sided. These average dimensions were the same as those recorded for the floors of *Phoenix*. Limber holes were cut into most of the floors about 9 in. (22.86 cm) from the keel on either side (Crisman 1983:51).

On every fourth frame, the mold frames, the first futtocks were attached to the floors by 3/4 in. (1.9 cm) square iron bolts driven laterally. Unlike *Phoenix*, the use of treenails to connect frame timbers was not observed. The average distance from the heel of the first futtocks to the keel measured 12 in. (30.48 cm), which matched the average distance on *Phoenix*, though this varied significantly on the steamer. Crisman noted that

the turn of the bilge appeared to be very sharp, with the first futtocks cut to fit the curve, creating a weak point on each side of the hull (Crisman 1983:52).

Akin to the hull of *Phoenix*, the midship frame consisted of a single timber that represented the maximum breadth of the hull. The midship frame on *Ticonderoga* was located approximately one-third of the distance from the bow to the stern, while the midship frame on *Phoenix* was located approximately 3/8 that distance. On both vessels the frames forward of the midship frame had their first futtocks placed on the after face of the floors, while frames aft of the midship frame had their first futtocks placed on the forward face of each floor.

Both vessels had keelsons composed of three timbers flat-scarfed together and bolted through the frame floors to the keel. The schooner's forwardmost member was missing when the hull was recorded, but the bolts used to fasten it to the keel were still present. This is also where the foremast step would have been located. Evidence of the mainmast step was scant, and was in the form of bolt holes and square iron bolts in the top surface of the keelson over frames 14-16. *Ticonderoga* clearly had a separate mortise block for a step, rather than the carved rectangular notch that was present on *Phoenix*. *Ticonderoga*'s keelson was molded and sided 13 in. (33.02 cm), a full 2 in. (5.08 cm) larger in both dimensions than the average recorded size of the steamboat's keelson. As with *Phoenix*, the bolts that fastened the keelson to the frames and keel were off center, possibly to avoid striking the bolts that attached the frames to the keel below (Crisman 1983:55-56).

Ticonderoga's hull and ceiling planking survived to varying degrees for documentation. The garboard strake measured 18 in. (45.72 cm) wide and 3 in. (7.62 cm) thick, which was larger than the garboard from *Phoenix*, which measured between 12 and 17 in. (30.48 and 43.18 cm) wide and 2 in. (5.08 cm) thick. The hull strakes above the garboard gradually reduced in width to about 9 in. (22.86 cm) but remained 3 in. (7.62 cm) thick on average. The *Phoenix* hull strakes, in contrast, averaged only 2 in. (5.08 cm) and were as thin as 1 in. (2.54 cm) near the bow. The two uppermost strakes recorded on *Phoenix* were probably wales due to their increased thickness of 4 in. (10.16 cm). Such enlarged strakes were not encountered on the surviving hull remains of *Ticonderoga*. Fibrous material, perhaps oakum, was found in the seam between the schooner's garboard strake and keel rabbet as well as between the hull strakes (Crisman 1983:56). Although not detected on the submerged hull of *Phoenix*, it is very likely this material is present in the seams of the steamer's planking as well.

Ceiling planks recorded on the interior hull of *Ticonderoga* measured between 12 and 18 in. (30.48 and 47.72 cm) wide and averaged 1-1/2 to 2 in. (3.81 and 5.08 cm) thick. These planking widths were a few inches larger than those found on *Phoenix*, but the average thicknesses were the same. They were both fastened to the hull with 3/8 in. (0.95 cm) iron nails (Crisman 1983:57-58).

Lady Sherbrooke

As the fourth in a line of steamboats built for John Molson's successful Montreal shipping company, *Lady Sherbrooke* had a prosperous career operating as a passenger

and cargo vessel between Quebec and Montreal on the St. Lawrence River. After nine years of service, the steamer was retired and her steam engine was transferred to the newest of Molson's line, *John Molson*. In December of 1826, her hull was towed to the shallow waters off the bank of Ile Charon in a side channel of the St. Lawrence and abandoned (Johnson et al.). Unlike the two previous wrecks, the hull of *Lady Sherbrooke* was studied archaeologically *in situ*, and has provided a wealth of information on early steamboat design in addition to details of passenger amenities and experiences traveling aboard.

With support from the David M. Stewart Museum and Molson Family Foundation, in 1983 the Comité d'Histoire et d'Archéologie Subaquatique du Québec (CHASQ) began its search for *Lady Sherbrooke*'s hull remains. The wreck was discovered during a side-scan sonar survey of a section of the St. Lawrence River around the Boucherville Islands. Investigation of physical anomalies detected during the survey revealed a wreck buried in some sections under 6 ft. 7 in. (2 m) of mud in the shallow waters off of Ile Sainte-Marguerite. Over 60% of the steamer's hull was found to be in an excellent state of preservation for archaeological investigation (Lépine and Bélisle 1991).

From 1984 to 1991 the site was excavated under the direction of archaeologist André Lépine of the David Stewart Museum and historian Dr. Jean Bélisle of Concordia University. The hull, listing to port at a 35° inclination, was excavated in 6 ft. 7 in. (2 m) square grids, which aligned with the engine room amidships, passenger cabins in the stern, and crew's quarters in the bow. The surviving portion of the wreck was 133 ft. 6

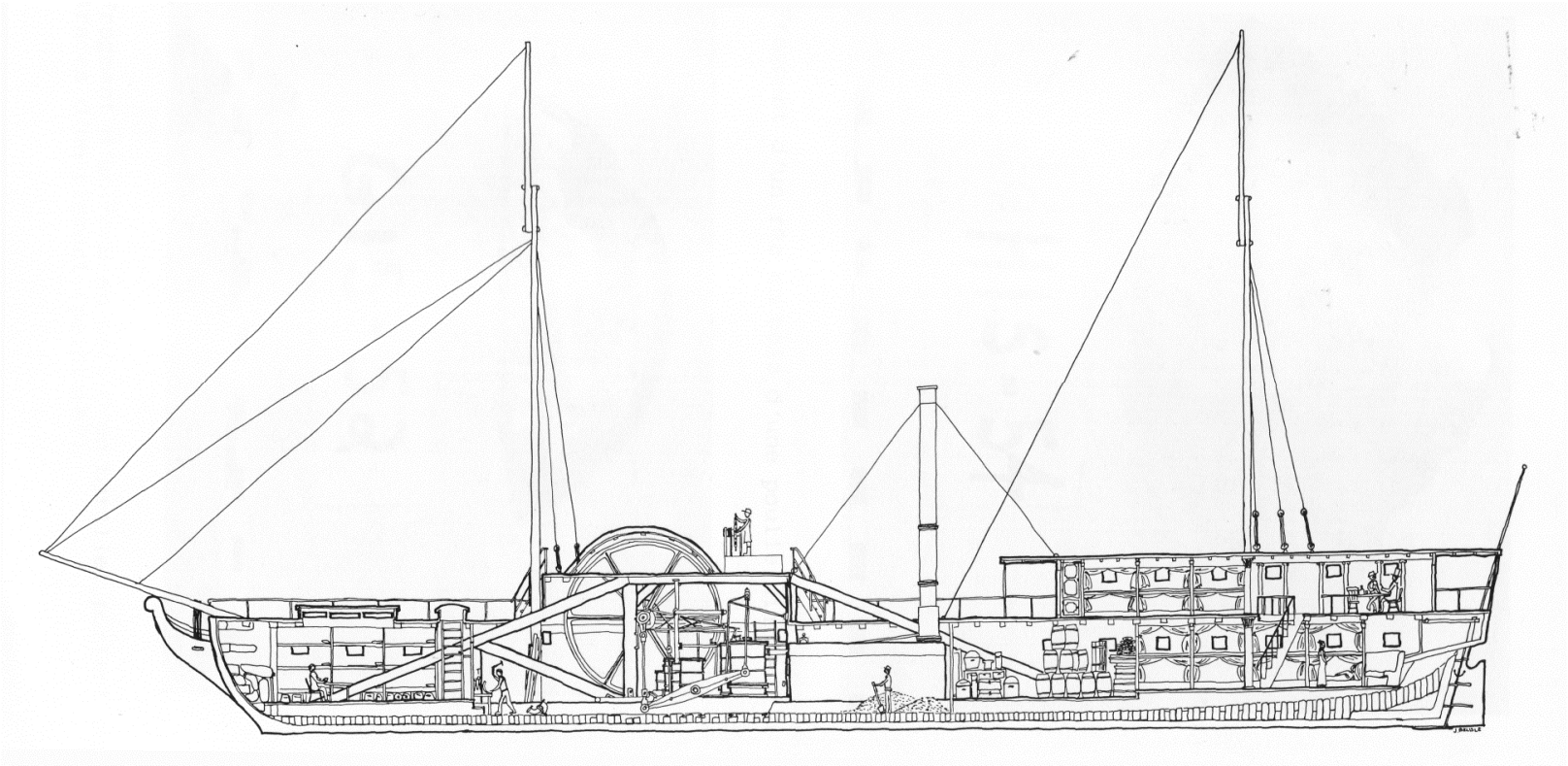


FIGURE 8-11. Reconstruction of *Lady Sherbrooke*. (After Bélisle and Lépine 1986.)

in. (40.7 m) long, 31 ft. 2 in. (9.5 m) wide at midships, with a 9 ft. 10 in. (3 m) depth of the hold (Lépine and Bélisle 1991). Her original dimensions measured 147 ft. 8 in. (45 m) in length, 32 ft. 10 in. (10 m) in breadth, and a 9 ft. 2 in. (2.8 m) depth of hold. Although *Lady Sherbrooke* was just slightly longer than *Phoenix*, her breadth was nearly 6 ft. (1.83 m) broader, making her length-to-beam ratio 4.5:1 (compared to the Lake Champlain steamer's ratio of 5.4:1). This beamier design was, perhaps, intended to accommodate her capacity to carry freight in addition to passengers.

The preserved hull structures consisted of the keel, keelson, stem, sternpost, a number of frames, hull planking, ceiling planking, engine bedtimbers, diagonal bracing, and other steam machinery support timbers. She was a single-decked vessel with a stern cabin on the main deck for gentlemen passengers. *Lady Sherbrooke* was propelled by an imported Boulton and Watt engine and was equipped with two masts for use in favorable winds. The heavily-built hull was found to be of a flat-bottomed design with hard bilges and steam machinery placed nearly amidships (Figure 8-11; Lépine and Bélisle 1991).

Although the keel could not be reached except for its junction with the stern, the presence of the stem and stern permitted the archaeologists to determine its length of approximately 133 ft. 6 in. (40.7 m) (Bélisle and Lépine 1986:39), 9 ft. (2.74 m) longer than the preserved keel of *Phoenix*.

The stem of *Lady Sherbrooke* was constructed largely of white oak, and, like the bow of *Phoenix*, consisted of several components including the inner and outer posts, the forefoot, and a cutwater. Large breast hooks shaped from spruce helped reinforce the bluff bow, which resembles the shape of cargo vessels found in the canals at that time.

Although the figurehead was not preserved, the investigators believe that elements present on the stem indicate the former presence of a figurehead (Lépine and Bélisle 1991).

The measurable section of fore gripe was 12 ft. 4 in. (3.75 m) long. The stem survived to a height of 12 ft. 4 in. (3.75 m), and its rake was approximately 47° with respect to the keelson. The first breasthook measured between 7-3/4 and 9-1/2 in. (20 and 24 cm) thick, and its observable starboard arm was 6 ft. 6 in. (2 m) long. The second breasthook, positioned above the first, was of the same approximate dimensions, and both were beveled at 47° to match the rake of the stem. They were fastened to the inner stempost with iron bolts, and the presence of bolts above these timbers indicated the probable location of at least two more breasthooks. The bow appeared very round and robust, probably designed to absorb the shock of docking the vessel, which was performed bow-first to avoid damage to the steamer's paddlewheels (Bélisle and Lépine 1986:80-83). The stem of *Phoenix* was likewise stoutly built, and although no concrete evidence of breasthooks survived, it is plausible that her bow was also reinforced with these robust horizontal timbers.

Lady Sherbrooke's stern was made from white oak, and the entire assembly consisted of the inner and outer posts, deadwood, keel, keelson, and floor timbers (Lépine and Bélisle 1991). The exposed portion of the sternpost was 8 ft. 6 in. (2.6 m) long, 8-5/8 in. (22 cm) thick, and 16-1/2 in. (42 cm) wide. The recorded rake aft from the keel was 10°, close to the 8° inclination of *Phoenix*'s stern. Like the stern of the Lake Champlain steamboat, a number of twisted iron bolts were recorded protruding from the

upper section of the sternpost, indicating that the transoms were torn off. In addition to these observations, the investigators discovered the Roman numeral IV carved into the starboard side of the sternpost, probably representing the steamer's water line (Bélisle and Lépine 1986:83-85).

Also preserved along the sternpost were the rudder and three intact gudgeons. At the union of the keel and sternpost was an iron plate that served as a skeg to protect the paddlewheeler's rudder when beaching. The observable section of rudder was considerably worn on the bottom and suggested frequent contact with the river bed. The steamboat's rudder was small compared to other river boats, but its use for steering was secondary since the independently controlled paddlewheels were the chief means of maneuvering the vessel (Lépine and Bélisle 1991). Three gudgeons were discovered on the sternpost, and measured 3-1/8 in. (8 cm) high by 1-1/2 in. (4 cm) wide. The first gudgeon's arms measured 11-3/4 in. (30 cm) and wrapped around the sternpost. The second gudgeon, located 37 in. (94 cm) below the first, had arms that extended 4 ft. 3-1/4 in. (1.3 m) where it was fastened to the stern hull planking. The last gudgeon was positioned 2 ft. 11-1/2 in. (90 cm) below the second one with arms of comparable length, which were also fastened directly to the hull planking (Bélisle and Lépine 1986:83-85). The rudder assembly differed from that of *Phoenix* in a few ways. First, there were three gudgeons into which the pintles were inserted versus the two found on the Lake Champlain vessel. Second, the arms of the St. Lawrence steamer's gudgeons were significantly longer than those of *Phoenix*, and were fastened directly to the hull planking as observed on the stern of *Ticonderoga*. The intact gudgeons of *Phoenix* had

short arms, which were fastened to the outer post instead of the planking. Third, the well-preserved gudgeons on *Lady Sherbrooke* were made of copper or copper alloy while those from *Phoenix* appear to be wrought iron.

Lady Sherbrooke's frames consisted of an assembly of floors and futtocks similar to those of *Phoenix*. The floors and futtocks were hewn from a combination of white oak and spruce, with the wood type alternating along the length of the keel. The researchers suggested two possibilities for this species variation, including a reduction in cost due to the scarcity of oak in the early 19th century, and to provide flexibility in the hull to counter the vibrations caused by the machinery. Similar to *Phoenix*, the framing pattern was found to be of a typical style, no different from that of a sailing vessel (Bélisle and Lépine 1986:40-41).

The floors measured 11-3/4 in. (30 cm) molded and 11-3/4 to 15-3/4 in. (30 to 40 cm) sided, and the futtocks were attached to the floors snugly. Although the dimensions of the futtocks were not given, cross-sectional drawings of the frames indicate they were of slightly smaller molded dimensions (Figure 8-12; Bélisle and Lépine 1988:43). The researchers were able to conclude from the study of the frames that the bottom of the hull was extremely flat, the steamer had hard curves at the bilges, and the sides of the vessel were nearly vertical (Lépine and Bélisle 1991).

The keelson was cut of white oak and measured 14 in. (35 cm) molded by 10 in. (25 cm) sided. It was preserved over an estimated length of 133 ft. 6-1/2 in. (40.7 m), although the number of timbers of which it was composed could not be ascertained due to inaccessibility. Over the 32 ft. 9-3/4 in. (10 m) section of exposed keelson, the

researchers were only able to record a few iron bolts fixing the keelson to the floors (Bélisle and Lépine 1986:42).

As it approached the stem, the keelson did not blend into the apron or fore gripe, but instead stopped abruptly. A mortise was recorded atop the keelson near the bow which measured 11 in. (28 cm) long, 4-1/4 in. (11 cm) wide, and 5-1/8 in. (13 cm) deep. The project members suspected that a stanchion was placed there, which supported the first deck beam forward of the crew cabins. The longitudinal stringers do not flank the keelson in this section of the hull (Bélisle and Lépine 1986:79-80).

A valuable portion of the wreck, in terms of steamboat comparison, is *Lady Sherbrooke*'s engine room, a feature not often preserved in early steamboat wrecks. This section of the wreck provided a number of architectural clues for the interpretation of

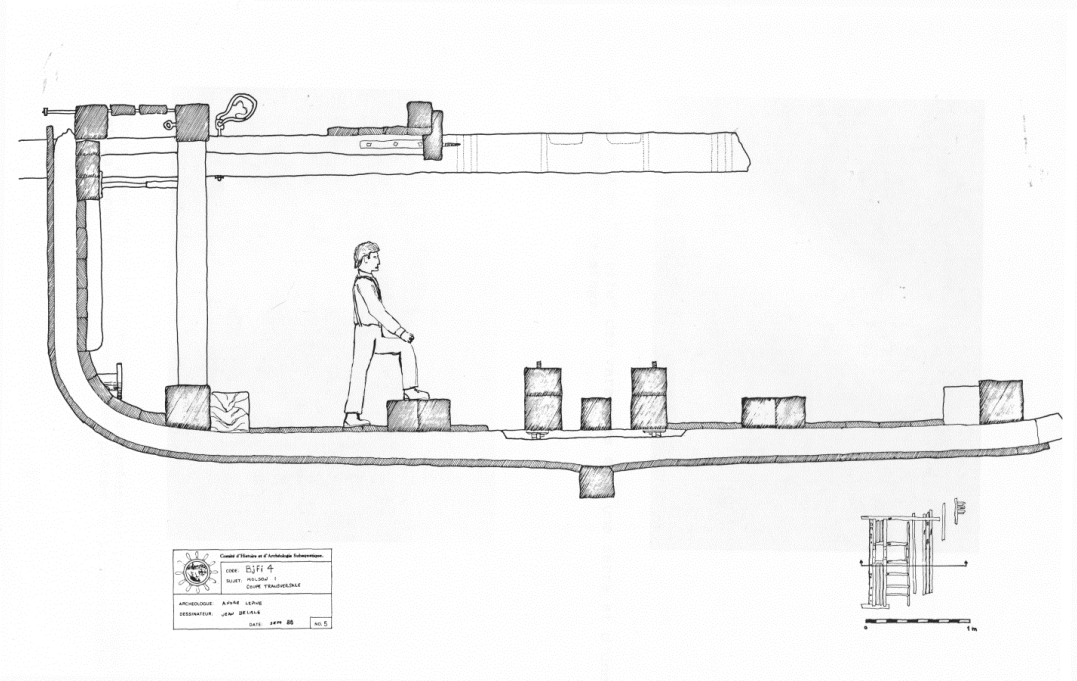


FIGURE 8-12. Cross-sectional reconstruction of *Lady Sherbrooke*. (After Bélisle and Lépine 1986.)

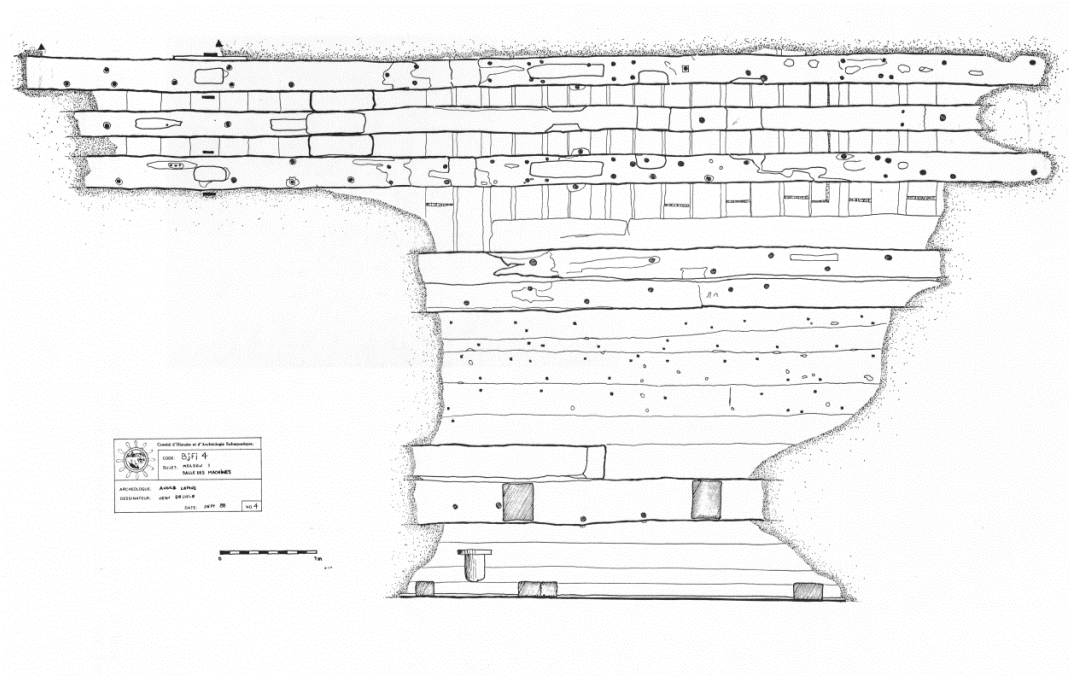


FIGURE 8-13. Engine bedtimbers from the extant hull of *Lady Sherbrooke*. (After Bélisle and Lépine 1986.)

early steamboat hull design, and is described in detail in the researchers' 1986 report. Although the starboard side of the wreck disintegrated over the years due to exposure, the port side was preserved up to an estimated 90% in this area and consisted of the keel, frames, ceiling planking, keelson, engine bedtimbers, paddle beams and associated bracing, and external hull planking. This section of the steamer contains the bottom of the hull as well as main deck level structures that supported the paddle beam. The researchers also encountered a collared cast iron pipe in this section of the hull near the boat's bilge, probably used to feed water into the boiler (Lépine and Bélisle 1991).

Akin to the design of *Phoenix*, the keelson was accompanied by two robust longitudinal stringers positioned less than 9-1/2 in. (24 cm) outboard on either side

(Figure 8-13). These bedtimbers, which exhibited a series of mortises to seat the steam machinery, were shaped from white oak and measured 1 ft. 11-5/8 in. (60 cm) molded by 13-7/8 in. (35 cm) sided. Although the keelson appears to have been shaped from one timber, the stringers were composed of two timbers fastened together with a metal plate over the length of one meter. Approximately 2 ft. 7-1/2 in. (80 cm) outboard of these timbers was another set of smaller stringers, measuring 10 in. (25 cm) molded by 1 ft.-1/4 in. (31 cm) sided and bolted to the frames beneath. These bedtimbers helped distribute the weight of the 70-ton steam engine and associated machinery over the length of the hull and provided longitudinal reinforcement of the engine room (Bélisle and Lépine 1986:53; Lepine and Belisle 1991).

Approximately 4 ft. 3-1/4 in. (1.3 m) outboard of these timbers was a third set of large stringers bolted to the frames, with a stacked measurement of 2 ft. 8-1/3 in. (82 cm) sided and 1 ft. 5 in. (43 cm) molded. Two mortises measuring 1 ft. 2-1/4 in. by 1 ft. 3 in. (36 cm by 38 cm) were found on either side of the timbers, and wrought iron bands were observed on the surface of the stringers, presumably to connect them to each other. A second set of mortises were found that measured 11 in. (28 cm) long by 4 in. (10 cm) wide. The exact function of these mortises was not determined (Bélisle and Lépine 1986:43).

Robust pillars, approximately 11-3/4 in. (30 cm) squared and 7 ft. 8-1/2 in. (2.35 m) high, were inserted into the mortises of the outboard stringers to provide support for the paddle beams, which extended outboard of the deck and supported the paddlewheel shaft (Bélisle and Lépine 1986:20; Lépine and Bélisle 1991). There was a marked

difference in hull design between the northeastern lake and river steamers where the paddle beams and paddle shaft were installed. The interior planking in this section of the vessel was much stauncher than in *Phoenix*, and was probably enlarged to provide longitudinal reinforcement to the hull. The planking at the vertical sides consisted of boards, approximately 10-5/8 to 1 ft. 0-1/2 in. (27 to 32 cm) wide and 4 in. (10 cm) thick, which were nailed to the frames. For added support, a series of diagonal braces and vertical beams provided strength for the weight of the paddle shaft, which was installed on this section of the hull (Bélisle and Lépine 1986:11; Lépine and Bélisle 1991). Although some form of this bracing may have existed on the lake steamer, there was no indication of this in the archaeological record other than the likelihood of the large stanchions mentioned previously.

The forward paddle beam was preserved over a length of 21 ft. 8 in. (6.6 m) inside the hull, and probing conducted on the outside of the hull indicated that it continued for more than 10 ft. 10 in. (3.3 m) outboard. The investigators determined that when they were intact, the paddle beams were approximately 55 ft. 9-1/4 in. (17 m) long overall. The paddle beam measured 1 ft. 1-3/4 in. (35 cm) molded by 1 ft. 3-3/4 in. (40 cm) sided, and had a slight curvature or crown, which corresponded to the curve of the main deck. A number of nails were still in place on the upper surface of the beam, and at 4 ft. 7-1/8 in. (1.4 m) inboard of the hull sat a longitudinal timber which housed the bearing that supported the outboard end of the paddle shaft. Interestingly, a deadeye was discovered bolted just inboard from this longitudinal timber, which the researchers speculate may have been used to secure the stays of the chimneys. The second paddle

beam, which measured 1 ft. 2-1/8 in. (36 cm) square, was located approximately 25 ft. 7 in. (7.8 m) aft of the first and was only preserved over a length of 6 ft. 6-3/4 in. (2 m) inboard of the hull (Figure 7-11; Bélisle and Lépine 1986:59-63).

Also recorded in this section of the hull was a coaming which ran longitudinally above the second set of stringers in the hull. This was a large L-shaped timber measuring 25 ft. 10-5/8 in. (7.89 m) long and 1 ft. 6-1/8 in. (46 cm) high. It measured 7-7/8 in. (20 cm) wide at its base and 3-15/16 in. (10 cm) at its top. The coaming was set into a notch in the paddle beam down to the top of the L-curve, with the top 8-3/4 in. (22 cm) left exposed to receive a short 6 ft. 3 in. (1.9 m) timber which seated one of the bearings that supported the inboard end of the paddle shaft. A series of smaller beams were positioned at regular intervals of approximately 1 ft. 9-3/4 in. (55 cm) to support the other large longitudinal timbers responsible for bearing the weight of the paddle shaft (Figure 7-11). The main axis of the paddlewheel was located approximately 1 ft. 7-3/4 in. (50 cm) above the level of the deck, and paddlewheel boxes were built around the moving parts to protect the passengers (Johnson et al.).

Elements of both the interior and exterior planking were recorded in various sections of the wreck. Several strakes were found to be in excellent condition at the stern, and the widths of the planking in this section were 1 ft. 3-3/4 in. (40 cm) (Bélisle and Lépine 1986:83-85). The ceiling planking recorded in the hull of the engine room was made from pine and measured over 1 ft. 1-3/4 in. (35 cm) wide and 1-3/8 in. (3.5 cm) thick (Bélisle and Lépine 1986:55-56).

The team discovered three staterooms 42 ft. 7 in. (13 m) aft of the engine room. These were part of the ladies' cabins, and the tight confines of each cabin measured only 5 ft. 10-7/8 in. by 6 ft. 2-7/8 in. (1.8 m by 1.9 m). Each was furnished with two beds, one installed above the other. Archaeological evidence suggested the cabin walls were painted white, while the tongue and groove cabin floor was painted yellow (Lépine and Bélisle 1991).

Conclusions

Since no ship plans exist to assist researchers with the interpretation of *Phoenix*'s hull design, archaeological parallels must be used in conjunction with shipbuilding treatises from the first half of the 19th century, as these are the primary sources for understanding the trends used in early American steamboat construction. All four ships examined in this chapter, *Phoenix*, *Vermont*, *Ticonderoga*, and *Lady Sherbrooke* exhibited similar features unique to steam-propelled vessels, though individually tailored for a particular use and body of water.

Although the principal scantlings of each vessel were found to be comparable, the chief difference in size among the steamers was the length-to-beam ratios. *Vermont* had the highest ratio, and represented the earliest river steamer design, which resembled a canal boats *Phoenix* and *Ticonderoga* represent a departure from this hull form, and were built with a wider breadth to increase stability and accommodate steam machinery, passenger cabins, and moderate cargo holds. They were more ship-like in appearance, and, considering their intended use on Lake Champlain, were not designed with the flat

bottom and hard chine as exhibited in *Lady Sherbrooke*. While beamy amidships and along the majority of the ship fore and aft, both *Phoenix* and *Ticonderoga* appear to have had a fairly sharp entry at the bow and a finely tapered run at the stern. As mentioned in the treatises from the second quarter of the century, shipwrights considered there to be little distinction in hull form between sailing vessels and steam-propelled vessels in these areas of the ship. Beamier than all three vessels, the lines of *Lady Sherbrooke* did not follow this design concept. Although she also operated as a passenger vessel, the St. Lawrence River steamer was built chiefly to transport freight from Quebec to Montreal. For this reason, her hull was shaped like a box in which to house the steam machinery, passenger cabins, and as much cargo as possible. Probably to accommodate this and to operate safely in her riverine environment, she was more powerfully-built than the other vessels, as exhibited in her substantial longitudinal reinforcement, ceiling planking, and bluff bow.

A number of peculiarities were discovered during the investigation of each of these vessels, which revealed clues to the ways in which early 19th-century shipwrights approached problems encountered in steamboat design. As chronicled in the history of the development of the marine steam engine, much of this involved experimentation when transferring knowledge borne from sailboat design to vessels meant for steam navigation. A few examples of such vagaries include *Vermont*'s framing pattern, which, due to the disconnected frame members, does not appear to have strengthened the hull as much as the other vessels studied. The shipwright hired by the U.S. Navy to complete *Ticonderoga* added a false keel to improve stability under sail, which altered the way the

fore gripe was connected to the forwardmost section of the keel. The gudgeons found on *Phoenix* were fastened directly to the sternpost, while those from both *Ticonderoga* and *Lady Sherbrooke* were fabricated with long arms that permitted them to be fastened to the stern hull planking. Although a common practice in shipbuilding on the lake, no fish plates appear to have been used as joinery reinforcement in the stem and stern construction of *Phoenix*. The bow of *Lady Sherbrooke* was heavily built to withstand the force of landing the vessel stem-first in order to prevent damage to the paddlewheels; and a deadeye was found on the St. Lawrence steamer's bridge assembly, which was presumably used to secure the stays of the boiler chimneys.

Phoenix emerges from this study as a vessel with a boxy hull capable of carrying the ship's engine, boiler, and passengers. This design, however, did not significantly compromise her sailing and steaming abilities on the open seas. *Phoenix* maintained a somewhat tubby, though still ship-like hull amidships with finer lines at the bow and stern. Although her hull form was probably still experimental, her proportions seem to have been acceptable and were virtually replicated in her replacement, *Phoenix II*. The hull design and layout of *Phoenix* appears to have been a success, as she was complimented in a number of newspaper advertisements and by passengers who had the opportunity to travel aboard the lake's second steam-propelled vessel. If not for the unfortunate catastrophe in the early morning hours of 5 September 1819, it is probable that *Phoenix* would have had a long and successful career on Lake Champlain as steamboats became a more acceptable, speedy, affordable, and popular form of transportation in the Champlain Valley.

CHAPTER IX

STEAMBOAT LIFE IN THE EARLY 19TH CENTURY

"It seems as if the people were mad after these steam-boats!" (Sedgwick 1826: 107).

Living conditions aboard early American steamboats varied significantly depending on geographic location and the organization of the particular steamboat enterprise. A good portion of what is known about life aboard steamboats of the western and eastern rivers, as well as the inlands seas and waterways, comes from contemporary accounts, travel journals, and late 19th- and early 20th-century studies on steamboat operation in America. While certain parallels can be drawn between life aboard western river steamers and those of the inland seas and waterways of the East, there were also vast differences in traveling and working conditions derived largely from the distances traveled, conditions on the western rivers, and the transient lifestyle of the western river steamboatmen. This chapter offers a glimpse into life aboard the country's early lake steamers based on historical accounts and material culture recovered from *Phoenix*.

General Living Conditions aboard Early American Passenger Steamers

Passenger steamboats from this era were typically designed to attract well-off passengers. For her time, *Phoenix* was a fashionable and well-equipped steamboat. As a passenger noted in one newspaper, "I noticed a neat and convenient Barber's shop, for

the accommodation of passengers" (*Commercial Advertiser*, 16 May 1816: 3). A sense of the daily routines and living conditions aboard *Phoenix* can be gleaned from a set of passenger rules and regulations published by the Lake Champlain Steamboat Company. The rules were established to maintain "order and neatness in the boat", and would be judged "according to the letter of the law" (Ross 1997:39). In these regulations, which served as passenger guidelines, customers were advised to have breakfast before they embarked, but that dinner, which consisted of tea and meats, was to be served exactly at 2:00 P.M. Supper, which was the same fare, was to be served at 8:00 P.M. and breakfast the following morning at 7:00 A.M. No one was permitted to ask the steward for additional provisions during any other hours. Dogs and other animals, except for horses, could be taken on board for one dollar each. The back cabin was for the exclusive use of women and their children, and servants were to sleep on the floor (Ross 1997:37). The following excerpts describe the gentlemen's cabin and the penalties incurred for various offenses:

> The great cabin of sixteen berths which will accommodate twenty-four persons, is for gentlemen. The first who apply and pay their passage money, will have their choice of the sixteen berths. Any greater number of persons will be accommodated with cross-lockers. According to the order in which passengers pay their fare, they will be entitled to entry into the wash-room. Gentlemen are not permitted to soil or dirty unnecessarily any article used in the wash-room, and not to remain in longer than ten minutes each, washing themselves.
>
> As the comfort of all persons must be considered, cleanliness, neatness and order are necessary; it is therefore not permitted that any person shall smoke in the ladies cabin, or in the great cabin, under the penalty, first, of one dollar and a half, and a half a dollar for each half hour they offend against the rule; the money to be spent in wine for the company. It is not permitted for any person to lie down in a berth with their boots or shoes on, under penalty of one dollar and half for every half hour they may offend against the rule. A shelf has been lately

> added to each berth, on which gentlemen will please put their boots, shoes and clothes. Hitherto the cabin table has been much encumbered from gentlemen throwing their small garments upon it. This will not be permitted for the future. On deck it is allowed to smoke. In the ladies cabin, and in the great cabin, cards and all other games are to cease at 10 o'clock at night, that those persons who wish to sleep may not be disturbed.
>
> Gentlemen are not permitted to sing or whistle the tunes of "Clinton's March" or "Burgoyne's Defeat" as it may prove offensive to some of the company.
>
> As the steamboat has been fitted up in elegant style, order is necessary to keep it so … and every breakage of table, chairs, sofas or windows, tearing of curtains or injury of any kind will be visited with the severest penalty of the law (Ross 1997:37-39).

These rules were similar to the regulations for the conduct of passengers on board the western river steamer *New Orleans* in 1817:

> 1. No gentleman passenger shall descend the stairs leading to, or enter the lady's cabin unless with the permission of all the ladies, to be obtained through the Captain under the penalty of two dollars for each offense.
> 2. Smoking is absolutely prohibited in any of the cabins…
> 3. No gentleman shall lie down in a berth with his shoes or boots on under a penalty of one dollar…
> 5. Cards and games of every description are prohibited in the cabin after ten o'clock at night...
> 8. All damages done to the furniture or boat by any of the passengers, it is expected, will be paid before leaving the boat (Flugel 1924:436).

Though many passengers were from the upper levels of society, the privilege to travel was offered to anyone who could pay the fare. A wide variety of people, therefore, might have been found on *Phoenix*. As described in "Witch of Champlain," "… yet a liberal and benevolent mind must delight in the spectacle of a whole people going forth in quest of knowledge and happiness; unrestrained by any monopolies, either of wealth, rank, or steam-boat navigation" (Sedgwick 1826:110).

As steamboat chronicler Louis Hunter wrote, "to the general public the steamboat was not so much a humble instrument of commerce as a marvelously swift and comfortable means of locomotion—a 'floating palace' and a 'moving hotel' (Hunter 1993:390)"—offering a degree of luxury not previously obtainable for the common traveler. These boats represented a world where representatives from all ranks and classes of society labored, ate, slept, leisured, suffered illness, and sometimes perished (Hunter 1993:391). Although applicable to passenger steamers of the East, this was especially the case for the western river steamboats, whose passengers and workers traveled extremely long distances for days and weeks on end from one destination to another. Some aspects of the living conditions aboard western river vessels were certainly different from those on the eastern lakes, if for no other reason than the length of passage. One American riverboat traveler opined that the western river folk were:

> … usually well dressed, but were a rough, coarse style of people, drinking a great deal, and most of the time under a little alcoholic excitement. Not sociable, except with the topics of cotton, land, and negroes, were started; interested, however, in talk about theatres and the turf; very profane; often showing the handles of concealed weapons about their persons, but not quarrelsome, avoiding disputes and altercations … (Ward 1973:113).

Although life travelling on the western rivers was undoubtedly harsher, the passage above provides context for the Lake Champlain Steamboat Company's published rules and regulations for its steamboat passengers, and helps explain why penalties were listed for the various offenses, which had likely been committed numerous times before the company's rules were published for public benefit.

From their inception, passenger steamers were handsomely designed, and no space on the vessel was more finely decorated than the saloon. This large room served as a lounge for the passengers, and was the main attraction which lured customers. Even in the early years, steamboat owners outfitted the saloons with rich carpets, paintings, draperies, mirrors, chandeliers, and mahogany furniture upholstered with velvet (Hunter 1993:396). This was especially the case with the larger western river steamers, whose proprietors splendidly designed the saloon—which also served as the main dining hall—with extravagant furnishings. To a lesser degree this could also be seen on eastern steamboats, as a western traveler's account from 1826 attests:

> The steam-boats in these waters, are elegantly furnished with every article of convenience, particularly the articles of meat and drink yet they are greatly inferior in size, to the steam-boats of the western rivers: the ballroom in *General Green* is fully as long as most of the boats in these rivers. Nor is the furniture equal to ours; I have seen no satin spreads, or gold fringe in any of them as yet, which are common in our boats, although we are looked upon as little more than savages, by many of the people in these large cities … (Ward 1973:95).

The passenger accommodations were generally well-decorated and neatly organized, if somewhat confined. The beds were usually on two tiers—bunks—on either side of the cabin separated by curtains, which provided some privacy during the daytime. There was often a small window at each bunk to admit light and ventilation into the cabin. When the beds within the cabins proved to be insufficient, sofas, boxes, dining room tables, and even the floor were converted into additional beds (Marestier 1957:10; Hunter 1993:393).

Excerpts from the published journal of an American traveler entitled *Pages from a Journal of a Voyage Down the Mississippi in 1817* describes the elegance of the cabins of *New Orleans*, of the same length and breadth as *Phoenix*:

> The ladies' cabin is below deck, it being the most retired place. It is elegantly fitted up. The windows are ornamented with white curtains and the beds, twenty in number, with red bombazette curtains and fringes and mosquito bars, besides sofas, chairs, looking glasses, etc., and an elegant carpet ornaments the floor (Flugel 1924:432).

Despite the opulent accommodations, not all passengers considered the steamers to be 'floating palaces'. American and European travelers alike were critical of the living conditions and social dynamics aboard American steamboats. Frances Trollope, an English dry goods dealer living for a time in Cincinnati, Ohio, had this to say about steamboat travel:

> The total want of all the usual courtesies of the table, the voracious rapidity with which the viands were seized and devoured … the frightful manner of feeding with their knives … and the still more frightful manner of cleaning the teeth afterwards with a pocket knife soon forced us to feel that we were not surrounded by the generals, colonels, and majors of the old world; and that the dinner hour was to be anything rather than an hour of enjoyment (Ward 1973:113).

Another amenity to be desired aboard early passenger steamers was the toilet. For many years the toilets consisted of crude washrooms adjacent to the ladies' and gentlemen's cabins, which contained tin basins installed on a bench with common roller towels and a supply of river or lake water. One report from a traveler aboard a western river steamer mentioned that two basins and two towels had to serve the needs of seventy men (Hunter 1993:398).

Lighting was achieved through the use of whale-oil lamps and candles, though an attempt was made to confine their use to the public areas (Hunter 1993:399). The devastation of what might happen should a candle or lamp be left unattended was clearly demonstrated by the total destruction of such steamers as *Phoenix* and *Champlain*. In Benjamin Silliman's *Remarks Made on a Short Tour between Hartford and Quebec in the Autumn of 1819* (1820), he commented on the lack of safety on steamboats on the northern waters, and specifically mentioned *Phoenix* as an example of negligence aboard steam vessels.

> The Phoenix, as I have before observed, was, without doubt, destroyed by a candle; still candles are negligently left on board of most of the boats in the northern waters; fires and candles are not adequately watched on the St. Lawrence, and we have seen in one of the Canadian boats, a fire made in an open stove, standing without a chimney, on the naked deck, while the coals were every moment blowing against pine spars … (Silliman 1820:318).

Although the dangers aboard steamers were plentiful, the most frightening and loathsome was the boiler explosion, which always made grisly headlines. These accidents were often the result of pushing the limits of high-pressure engines during the steamboat races mentioned in Chapter III. Explosions could also happen randomly, however, often while starting a steam engine after a pause in operation. One early example of an unfortunate steamboat accident comes from Lloyd's description of an explosion aboard *Washington* in 1816 on the Ohio River. While all hands were on deck hauling in a kedge anchor at the stern, the end of a cylinder blew off, unleashing a column of scalding water on the crew and nearby passengers (Figure 9-1). The scene described by Lloyd is graphic: "… but no language can describe the scene of misery and

torture which then presented itself to the view of the spectators. The deck was strewn with mangled and writhing human beings, uttering screams and groans of intense suffering" (Lloyd 1856:56). The explosion was caused when a safety-valve was improperly arranged, becoming immovable as weight was applied accidentally to the end of the lever.

There are dozens of similar examples throughout *Lloyd's Steamboat Directory*, with the recurring themes of mayhem, consternation, and gore. The author's rendition of the events, mostly taken from first-hand accounts, reveals the horror associated with the

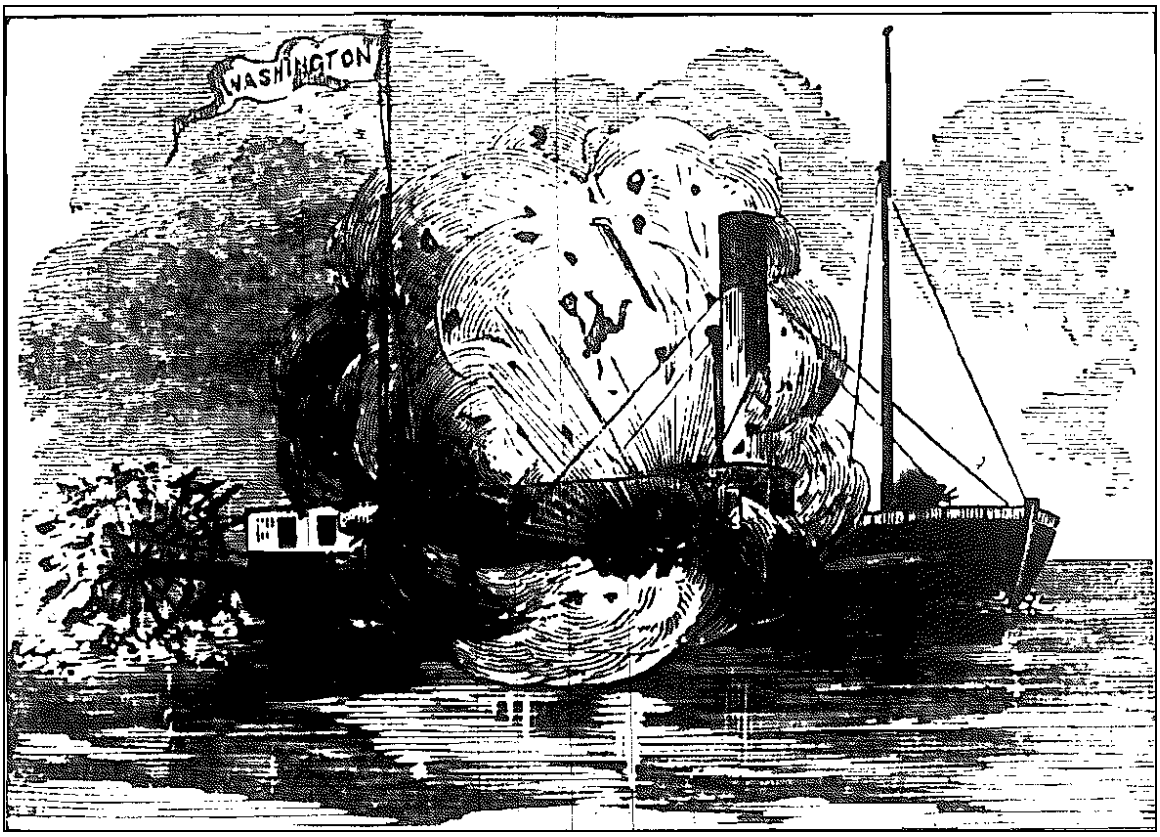


FIGURE 9-1. Explosion of the steamer *Washington* in 1816. (From Lloyd 1856:56.)

somewhat frequent disasters that occurred during the early years of steamboat travel in the United States, particularly on the western rivers.

The booklet entitled *Explosion of the* Moselle*: Cincinnati, 1838* (Flash 1838), is essentially a response from the public regarding the disaster that befell the steamer *Moselle*. It is an investigation into the explosion of the vessel and the safety issues associated with early western river steamboats and an attempt to address these problems in steam navigation. Excerpts from the lengthy but telling narrative below are from the pen of Judge Hall:

> *Moselle* was a new boat, intended to ply regularly between Cincinnati and St. Louis. She had made but 2 or 3 trips, but already established a high reputation for speed …
>
> Wednesday, 25 April 1838, the shocking catastrophe occurred…the boat was crowded with passengers…the largest portion were poor German emigrants, ignorant of any language but their own, and the larger portion consisting of families…making in all about 260 souls.
>
> The crowd was thus attracted (in Fulton) and certain vague rumors began to circulate, that the captain had determined, at every risk, to beat another boat which had just departed.
>
> The landing completed, the bow of the boat was shoved from the shore, when an explosion took place, by which the whole of the forepart of the vessel was literally blown up. The passengers were unhappily in the most exposed positions—on the deck, and particularly on the forward part, sharing the excitement of the spectators on shore, and anticipating the pleasure of darting rapidly past the city in the swift Moselle. The power of the explosion was unprecedented in the history of steam: its effect was like that of a mine of gunpowder. All the boilers, four in number, were simultaneously burst, the deck was blown in to the air, and the human beings who crowded it hurried into instant destruction. Fragments of the boilers, and of human bodies, were thrown both to the Kentucky and the Ohio shore, and as the boat lay near the latter, some of these helpless victims must have been thrown a quarter of a mile. The body of Captain Perrin, the master, was found dreadfully mangled, on the nearest shore. A

> man was hurled with such great force, that his head with half his body, penetrated the roof of a house, distant more than a hundred yards from the boat. Of the number who had crowded this beautiful boat, a few minutes before, nearly all were hurled into the air, or plunged into the water. A few, in the after part of the vessel, who were uninjured by the explosion, jumped overboard. An eye witness says, that he saw sixty or seventy in the water at one time, of whom not a dozen reached the shore.
>
> … On the shore lay twenty or thirty mangled and still bleeding corpses, while others were in the act of being dragged from the wreck or the water. There were men carrying away the wounded, and others gathering the trunks, and the articles of wearing apparel, that strewed the beach.
>
> The survivors of this awful tragedy, presented the most touching objects of distress. Death had torn asunder the most tender ties; but the rupture had been so sudden and violent, that as yet none knew certainly who had been taken, nor who had been spared. Fathers were inquiring for children, children for parents, husbands and wives for each other. One man had saved a son, but lost a wife and five children. A father, partially deranged, lay with a wounded child on one side, a dead daughter on the other, and his wife, wounded, at his feet. One gentleman sought his wife and children, who were as eagerly seeking him in the same crowd—they met, and were re-united (Flash 1838:18-21).

If passage aboard the early steam-propelled vessels was so unappealing and fraught with danger such as boiler explosions, why did so many tourists sail to their destinations aboard passenger steamboats? The best explanation probably lies in the conditions of contemporary stagecoach travel. A Frenchman traveling from New York to New Orleans in 1816 wrote, "I must repeat again and again that the American stagecoaches are untrustworthy … It is impossible to conceive of these vehicles … to pass from the steamboat to the stage, especially in bad weather, is to descend from paradise to hell" (Ward 1973:113). This passage, described further by Ward, goes on to say that travelers get "soaked, crushed, shaken, thrown about and bumped every foot of

the way: coaches are shattered, horses killed, [and] passengers crippled by the many stagecoach accidents" (Ward 1973:113).

While certain of the rough attributes characteristic of western river steamers could undoubtedly be found on lake steamers from the East, journal entries from eastern travelers suggest there were fewer unpleasant aspects of steamboat travel there. John Duncan's memoirs on his travels in the United States and Canada in 1818 and 1819 describe the steamboat excursions with interest, perhaps due in part to the shorter travel duration. Duncan, who sailed on both *Phoenix* and *Chancellor Livingston*, described the former as "a very fine vessel" and his voyage aboard the latter as "comfortable" (Duncan 1823:228-235). His journal entries regarding these two vessels focused mostly on the scenery and historical background of Lake Champlain and the Hudson River rather than disagreeable living conditions which were the focus of many of the western river travel accounts. He even implied that his custom house experience aboard *Phoenix* was relatively easy. Duncan mentioned the inspection "was a mere matter of form; the trunks and portmanteaus could scarcely be said to be more than opened and shut again. The boat was not delayed by this ceremony …" (Duncan 1823:230).

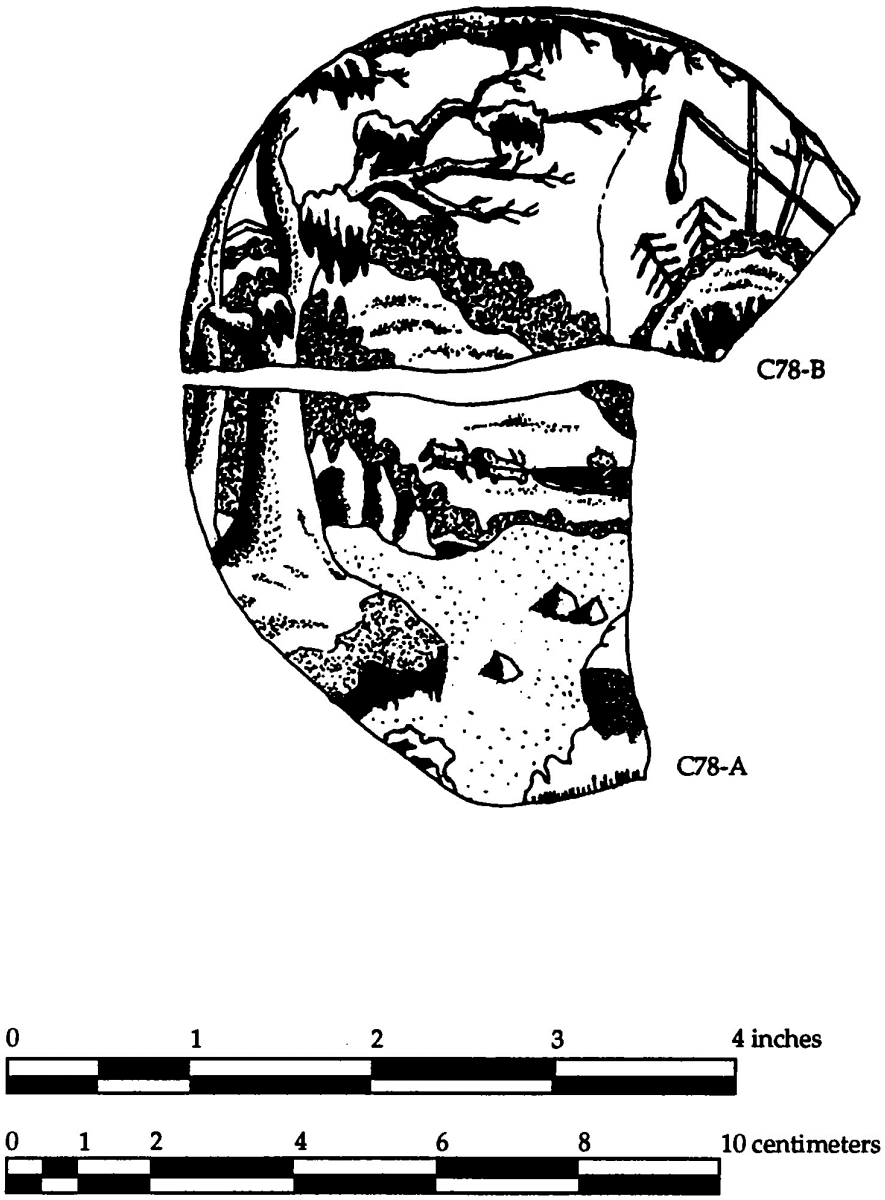
Likewise, Silliman's (1820) travel journal described the steamboats on which he traveled in the northern lakes and rivers of North America. He wrote that "the accommodations are good, and the provision for the table ample—for dinner it is luxurious—there is a lunch at noon, for dinner is at four o'clock, and tea at eight; breakfast also at eight o'clock" (Silliman 1820:316). He described the captains as congenial and courteous to their passengers, who they make comfortable aboard their

vessels. While on board the St. Lawrence River steamer *Malsham*, Silliman mentioned that since no women were present, he and another passenger were allowed in the ladies cabin located aft. He described a "very pretty room, where with a comfortable fire, we enjoyed even domestic retirement, and were allowed to occupy our time as we pleased" (Silliman 1820:317). Although he was not able to board *Lady Sherbrooke*, Silliman was told she was the finest boat in the Canadian line (Silliman 1820:317).

As discussed in Chapter VII, James Haddan examined the ceramics recovered from *Phoenix* in order to interpret the foodways aboard the steamer. One of his goals was to determine whether the surroundings of the passengers were luxurious or simple in nature, and how they compared to contemporary foodways in terrestrial settings. For this investigation he examined the ceramic assemblage from *Phoenix* and compared them to similar ceramic vessel types found in the early 19th-century ceramic markets (Haddan 1995:iii). The study was complicated by the fact that the ceramic artifacts from the wrecked steamboat consisted mostly of fragmented and often severely burned sherds, which were at times difficult to identify.

Haddan found that mass-produced refined earthenware, consisting of creamware, pearlware, and whiteware, constituted 65% of the assemblage. Decorated transfer-print and hand-painted examples were limited to teaware—such as tea bowls, saucers, and a teapot—and shell-edged dinner and serving plates (Figures 9-2 and 9-3; Haddan 1995:27-45).

The fragments of coarse earthenware from the wreck were the remains of simple vessels used primarily for shipboard food preparation and storage, and were found to be



PH C-78A and C-78B. Blue transfer-print plate fragments.

FIGURE 9-2. Drawing of shell-edged dinner plate by James Haddan. (After Haddan 1995:49.)

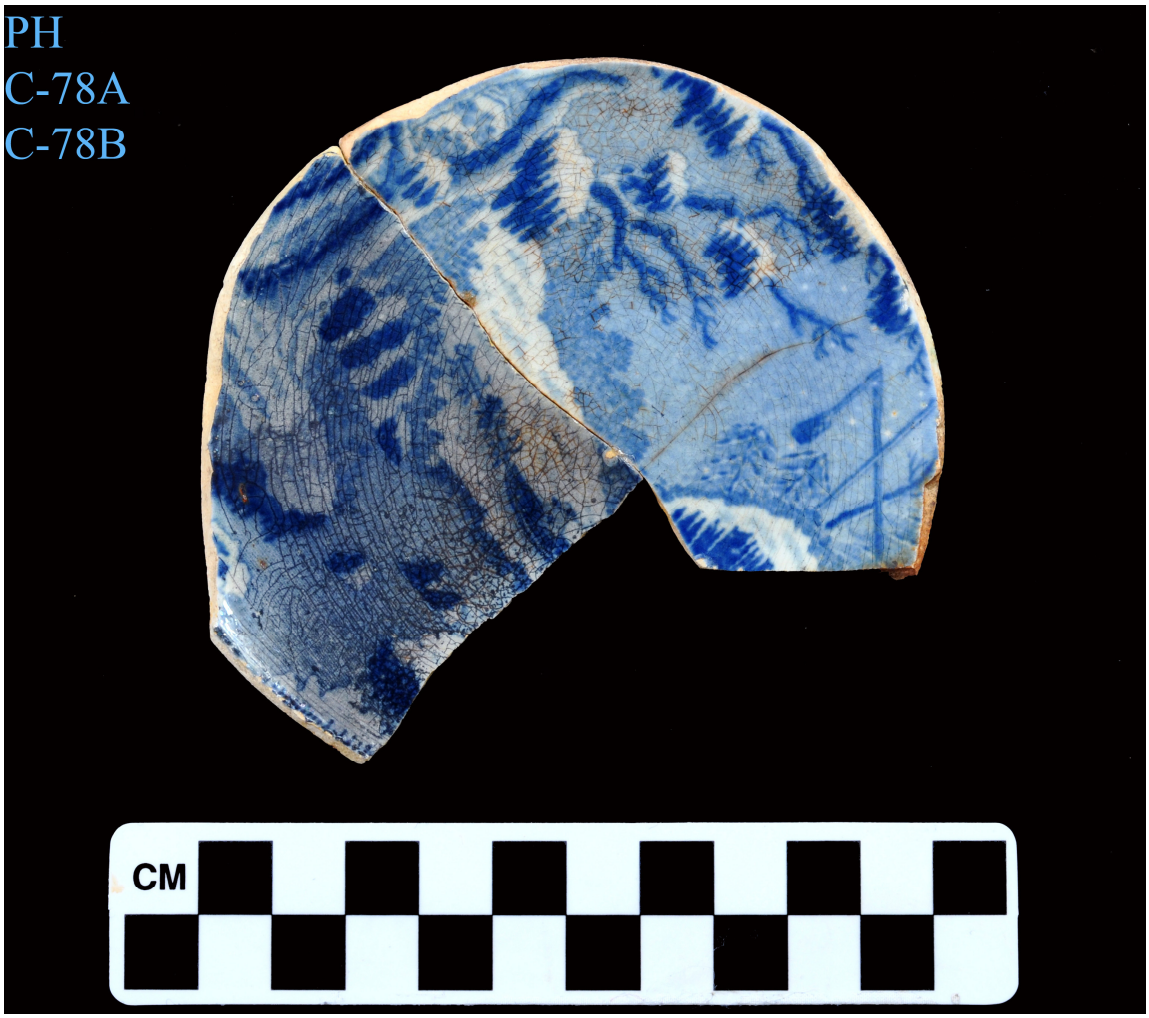


FIGURE 9-3. Shell-edged dinner plate from *Phoenix* ceramic collection at Lake Champlain Maritime Museum. (Photo by author, 2012.)

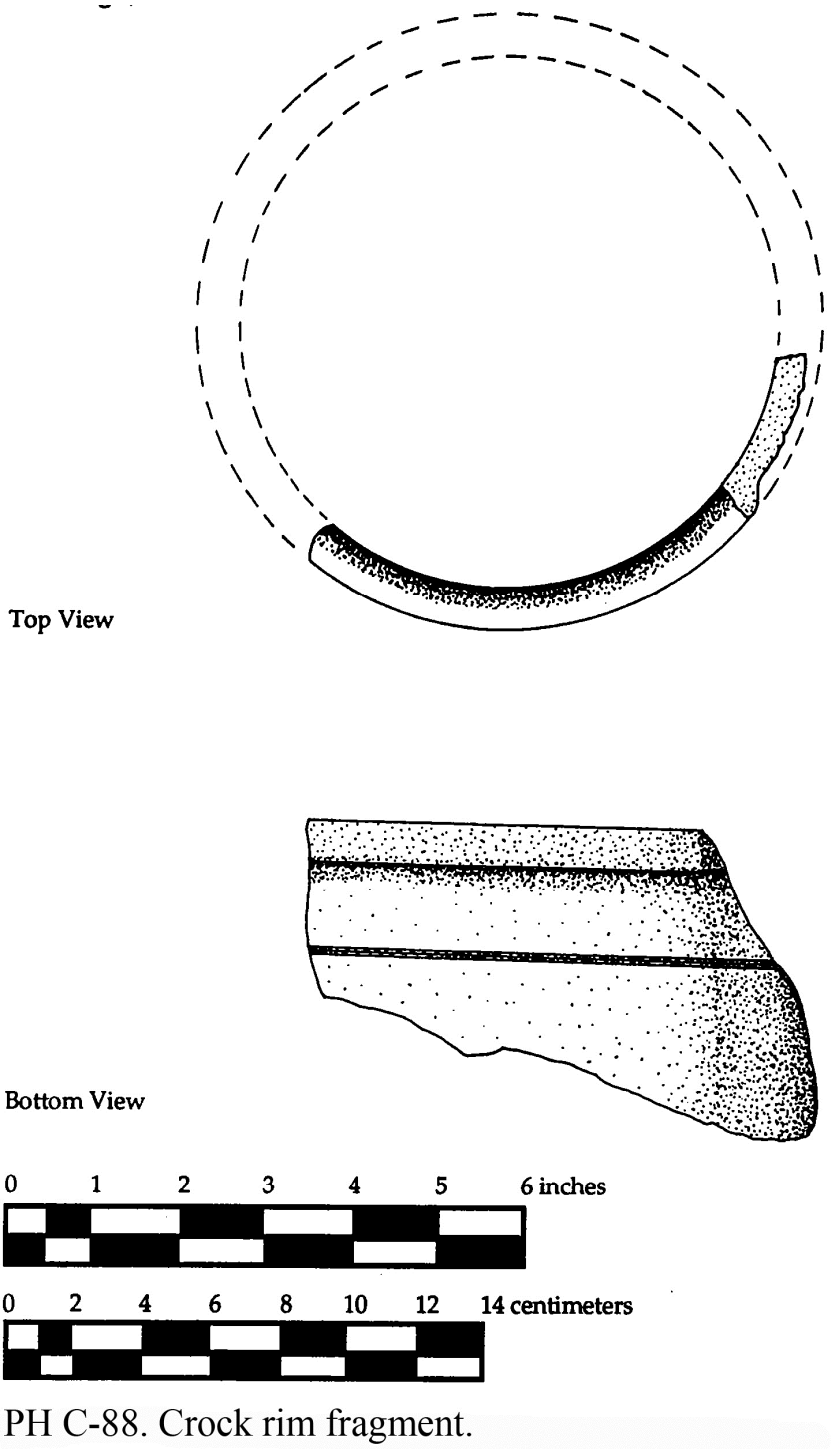


FIGURE 9-4. Drawing of coarse earthenware crock fragment by James Haddan. (After Haddan 1995:79.)

FIGURE 9-5. Crock rim fragment from *Phoenix* ceramic collection at Lake Champlain Maritime Museum. (Photo by author, 2012.)

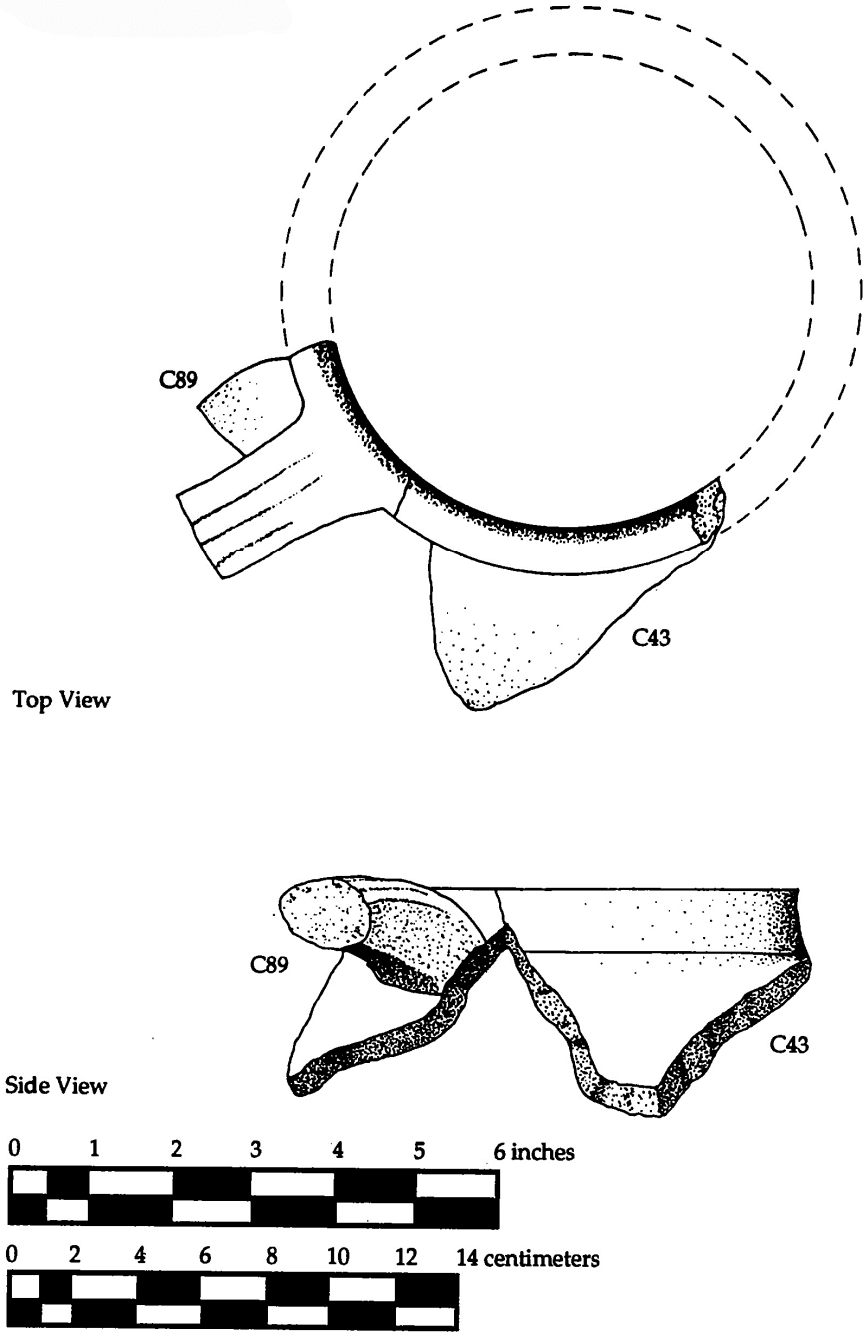
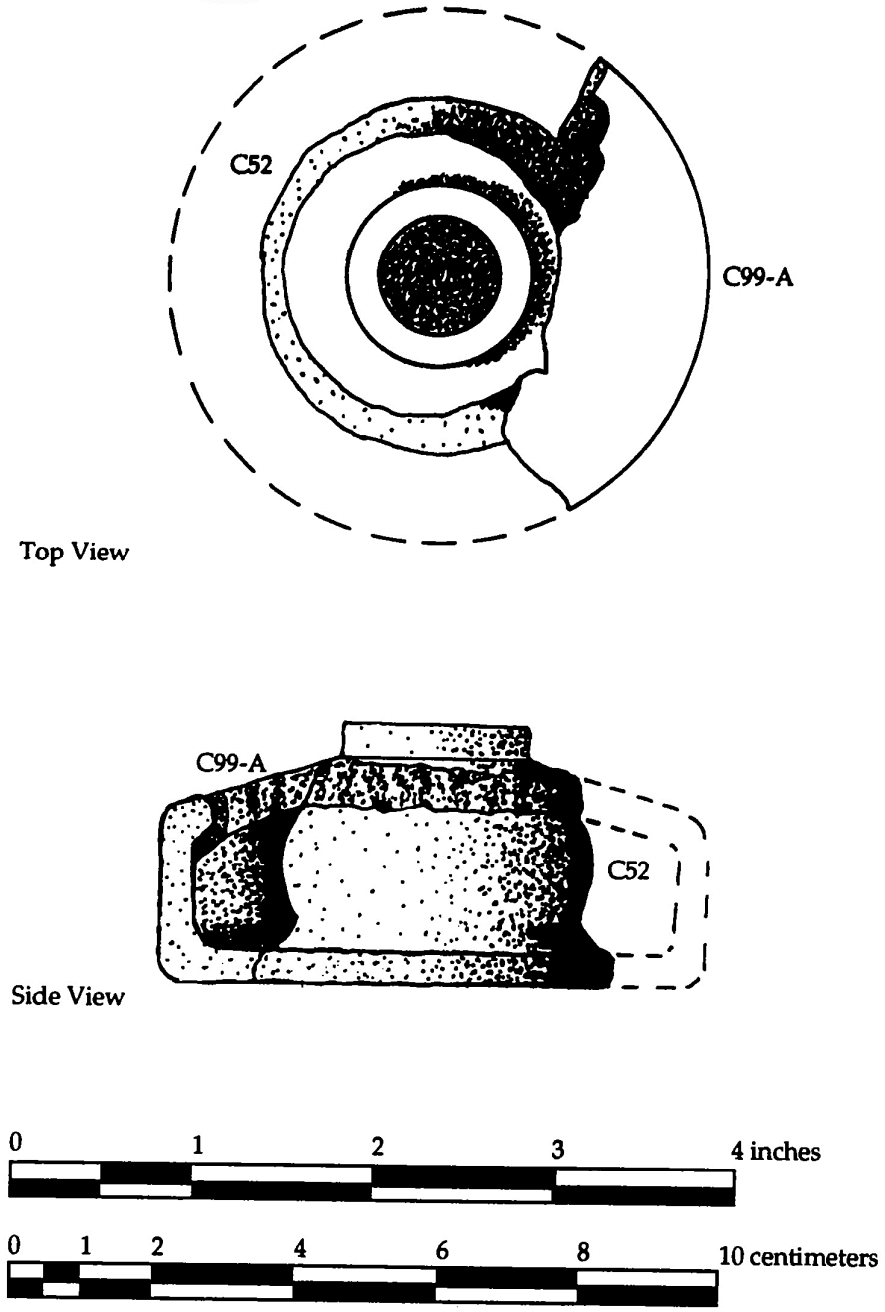


FIGURE 9-6. Drawing of stoneware jug rim by James Haddan. (After Haddan 1995:90.)

FIGURE 9-7. Stoneware jug rim fragments from *Phoenix* ceramic collection at Lake Champlain Maritime Museum. (Photo by author, 2012.)



PH C-52 and C-99A. Inkwell with quill holder fragments.

FIGURE 9-8. Drawing of stoneware inkwell by James Haddan. (After Haddan 1995:93.)

FIGURE 9-9. Stoneware inkwell from *Phoenix* ceramic collection at Lake Champlain Maritime Museum. (Photo by author, 2012.)

mostly undecorated and with a glazed interior. Produced for a wide range of utilitarian purposes, examples of regional coarse earthenware include flower pots, stove-pipe collars, drain pipes, tobacco pipes, applebutter crocks, milk cups, mixing bowls, cheese-pots, pie plates, bottles, jars, jugs, pitchers, basins, bowls, and shaving cups. Ten percent of the ceramic assemblage recovered from *Phoenix* consisted of coarse earthenware sherds, and appeared to represent wide-mouthed crocks (Figures 9-4 and 9-5) or small body sherds that could not be positively identified (Haddan 1995:66-77).

By 1735, stoneware was being manufactured in the Northeast for a variety of purposes, including jars or crocks, water coolers, churns, pitchers, beer bottles, cups, ink wells, and drainpipes (Ramsey 1947:138-140; Haddan 1995:84). The stoneware pieces from the wreck made up 25% of the ceramic assemblage, and, like the coarse earthenware sherds, exhibited features representing food storage and preparation vessels (Figures 9-6 and 9-7). A stoneware inkwell was the sole variant, and was found to be relatively intact (Figures 9-8 and 9-9; Haddan 1995:84).

Haddan's study revealed that the dining styles of *Phoenix* appeared to be similar to contemporary rural homes, inns, and taverns (Haddan 1995:iii). The comforts aboard the steamboat appear to have been akin to those associated with land travel, but not with the homes of wealthy individuals. Evidence for true luxury items from this period, such as porcelain, silver, and cut glass, was not discovered on the *Phoenix* wreck. Instead, earthenware and stoneware utilitarian vessels used for food storage, preparation, and service constituted the bulk of the ceramic assemblage. As the dishware was found to be of the same general types, no direct evidence for various passenger classes was

discovered. Haddan concluded from his findings that, while well-furnished and tastefully-decorated, *Phoenix* would not have been considered a luxury vessel based on the ceramics she carried (Haddan 1995:137-138). *Phoenix* probably paled in comparison to the slightly later western river steamers, which prided themselves on interior extravagance almost to the point of structural negligence. By virtue of the Lake Champlain Steamboat Company's enticing advertisements as well as the comments from passengers found in contemporary newspapers, however, there is no doubt that *Phoenix* was an impressively-outfitted pioneer of steam navigation.

To Summarize

As seen in this brief glance at early 19th-century steamboat living conditions, the comforts, amenities, dangers, and social dynamics differed depending on location and vessel type. Early steamboats of the northern lakes may not have been the lavishly-decorated 'floating palaces' of the western rivers, but were nonetheless impressive passenger vessels with a number of amenities not found in other contemporary forms of travel. Not everyone was ecstatic about the steamboat revolution, however. As mentioned earlier, owners and operators of sailboats on the lake felt threatened by the success of the steamboats. Although the early steamers were slow and cumbersome compared to the agile sailing vessels, a feeling of contempt was certainly present. Dialogue from a contemporary story out of the book *Hints to My Countrymen* portrays this sentiment:

> ‘There they go,’ cried one, ‘as fine a boat full as the lake ever bore! I am sure the captain’s pockets must be well lined if he very often makes such trips as this.’ ‘Yes,’ replied another, with a countenance and tone expressive of no friendly feeling to the individual who was the subject of the remark; ‘yes, you may say so—our schooners had no such good luck. It seems as if the people were mad after these steam-boats! If they only took their share, it would do; but we lads don’t get enough to keep us in tobacco; and on the waters of our own lake too! sink ‘em!’ (Sedgwick 1826: 107).

Although *Phoenix* was neither remarkably fast nor the epitome of splendor in the late 1810s, she was a comfortable and appealing vessel that drew many tourists, local travelers, and even government officials to her decks, and was certainly considered spacious and luxurious compared to the confines of the dreaded stagecoach of her day. As an early American steamboat, the construction and operation of *Phoenix* proved to be a successful endeavor, which encouraged the Lake Champlain Steamboat Company to model her namesake replacement along the same design. *Phoenix II* enjoyed a successful career of 17 years on the lake before being retired; a luxury *Phoenix* never had, but her loss was our gain, offering us insight into our collective maritime past.

CHAPTER X

CONCLUSIONS

Steam-propelled vessels were a novelty at the turn of the 19th century, and the shipwrights designing these ships were still testing the viability of various hull forms to determine an ideal shape for river and lake environments. The first three decades of the 19th century represent this era of experimentation, and *Phoenix*, among only a handful of other early hull remains from this period, is a good example of the adaptation of steam navigation in America.

There are a number of archaeologically-investigated steamboats that have been discovered in the lakes, rivers, and coastal waters of North America, and the information gained from each contributes to our knowledge of steamboat development in different ways. The three known extant hulls from the first quarter of the 19th century that have been studied archaeologically and can be compared with *Phoenix* are *Vermont* (1809), *Ticonderoga* (1814), and *Lady Sherbrooke* (1817). Each provides evidence for early advancements in steam technology, steamboat design, and navigational characteristics. The remains of these vessels exhibited informative details about the designs of early steamboats in North America not found in historical documents. Table 10-1 provides a list of the principle dimensions of these hulls for ease of comparison.

TABLE 10-1. Principle dimensions of *Vermont*, *Ticonderoga*, *Phoenix*, and *Lady Sherbrooke*.

	Vermont	***Ticonderoga***	***Phoenix***	***Lady Sherbrooke***
Keel	97 ft. (29.57 m)	113 ft. 9 in. (34.67 m)	124 ft. 6 in. (37.95 m)	*c*. 133 ft. 6 in. (40.7 m)
Length	120 ft. (36.58 m)	120 ft. (36.58 m)	146 ft. (44.5 m)	147 ft. 8 in. (45 m)
Breadth	20 ft. (6.1 m)	25 ft. (7.62 m)	27 ft. (8.23 m)	32 ft. 10 in. (10 m)
Depth of Hold	8 ft. (2.44 m)	*c.* 10 ft. (2.54 m)	9 ft. 3 in. (2.82 m)	9 ft. 2 in. (2.8 m)
L:B	6:1	4.8:1	5.4:1	4.5:1
Displacement	167 tons	325-350 tons	336 tons	unknown

Summary of Hull Comparisons

Hull Form

The overall hull shape of the vessels appears to have been influenced by the conditions in which they operated and the -capacity required for the steam machinery, cargo, passengers, crew space, and fuel storage areas. The earliest steamboat designs for the country's northeastern lakes and rivers were modeled after Fulton's work on the Hudson, as is seen in the long and narrow hull of *Vermont*. These vessels exhibited flat floors and hard chines, perhaps more suitable to the relatively shallow rivers with their strong currents than the open sea conditions of the lakes. As a lake steamer, *Phoenix* was one of the first to successfully combine steam and sail, and, like *Ticonderoga*, was built with a fairly deep draught and rounded hull in comparison with *Vermont*; perhaps an indication that the shipwrights were becoming more familiar with the needs of steamboat hulls on the lakes. *Lady Sherbrooke* of the Hudson River retained the river prototype design with regard to a flat-bottom and hard chines, but was capaciously built with robust timbers and marked bow reinforcement. This combination of features is

another indicator that by the end of the 1810s the shipbuilders were incorporating the desired hull features based on environment and vessel purpose.

Departing from the construction of the earlier Hudson River steamboats, *Ticonderoga*, *Phoenix*, and *Lady Sherbrooke* were given a wider breadth to prevent sagging due to the constraints of the engine and to provide for a more capacious hold. This change in hull form, perhaps, represents a shift in steamboat conceptualization to one which is more akin to a sailing vessel versus a canal or barge. Further research on steamers from the first quarter of the century may help determine whether these adaptations developed into distinct regional traits in the middle of the century.

Paddlewheel Placement

Although many features of a hull can be useful indicators of the location of the paddlewheels, the presence of *Lady Sherbrooke*'s robust paddle beams that extended across the breadth of the vessel and protruded outside of the hull to support the paddlewheel was a clear sign. While the hull remains of *Phoenix* and *Vermont* did not include evidence of these beams, their approximate placement is known from the suspected location of the cross-head steam engine based on the position of the engine bedtimbers.

Phoenix's engines and paddlewheels were located approximately 3/8 the distance from the stem to the sternpost; those of *Lady Sherbrooke* 1/3 the distance from the bow to the stern; and, those of *Vermont* 1/2 this distance. This variation suggests that the placement of the paddlewheels had perhaps not been standardized, and varied from

vessel to vessel and region to region. Marestier (1957:10) wrote that several Mississippi steamboats were designed as sternwheelers so the paddlewheels were less exposed to the shock of striking trees. While this approach seems logical for the relatively shallow western rivers, the placement of the paddlewheels at the stern did not appear necessary or fashionable on the early steamboats of Lake Champlain. Of the dozens of steamboat illustrations from Ross's (1997) publication on Champlain Transportation Company steamboats, none were designed as sternwheelers. The location of the paddlewheels varied, and there appeared to be no chronological standardization. The placement of the paddlewheels ranged from 1/3 the length of the vessel abaft the stem, to midships, to 2/3 the length of the vessel abaft the stem. This suggests, at least for the Lake Champlain vessels, that the location had little to do with the lake environment and more to do with the desires of the marine architect. Additional research on the placement of paddlewheels in different regions may answer whether it was based chiefly on regional style, marine environment, accommodation for the interior design, engine type and location, or another factor.

Scantling Size

Each of the hulls examined in this study varied in construction technique and form, as did their scantlings. *Lady Sherbrooke* was marginally more robust than *Phoenix* and *Ticonderoga*, while *Vermont* was of a somewhat slighter build than the others. This was at a time when, by now, western river steamers had largely conformed to flat-hulled vessels with scrawny scantlings and extremely shallow draughts. According to

Marestier, the steamboats he observed in the Northeast were carefully, but lightly built. A steamer of 20 or 23 ft. (6 or 7 m) beam had a keel of 7-3/4 in. (20 cm) molded, floor timbers 7 in. (18 cm) molded, and bedtimbers 11-3/4 in. (30 cm) molded (Marestier 1957:11). While these dimensions are comparable to *Vermont*, the beamier *Lady Sherbrooke* was double framed with a keel and bedtimbers almost twice that size. These heavier scantlings had to do with her intended purpose of carrying cargo and passengers long distances in the currents of the St. Lawrence River.

Although the schooner was not as long as the steamboat, *Ticonderoga* and *Phoenix* had similar scantlings; these were typically in between those of the two vessels described above. It is not known exactly how much *Ticonderoga* was altered after she was purchased by the Navy, other than the addition of the false keel, but the surviving hull remains do prove that, with a few exceptions, the stem, sternpost, frames, and keelson were of approximately the same dimensions. As a great number of factors could have affected the determination of scantling size per vessel, future archaeological studies of similar hull remains and further research on early 19th-century shipbuilding enterprises may reveal how sea and river conditions, rapidity of construction, and access to resources might have influenced the actual scantling sizes.

Observations on the Shipbuilding Techniques Found on Phoenix

Based on the archaeological evidence, *Phoenix* was a well-built vessel. While a great number of shipbuilding shortcuts were not observed, a few possible time-saving methods may have been used in her construction. As the steamboat company was under

pressure to have an operating steamer on the lake within 18 months of the end of the War, there may have been some haste in getting *Phoenix* in the water. The use of treenails, while observed in the joining of futtocks, appeared to be limited on *Phoenix*. The majority of the timbers were fastened with iron spikes, nails, and drift pins. This may have been a combination of two factors: the proximity of the Monkton Iron Company, which could have easily and quickly supplied Mr. Roberts with the necessary fastenings; and the desire to save time by not having to shape an inordinate number of treenails for the hull. The use of treenails seems to have been the preferred method of fastening the planking to frames in sailing vessels. At this time, Navy contracts were specifying that treenails were to be used for this purpose in ocean-going sloops of war. Probably to save time in building ships for the War of 1812, however, treenails were not used in the construction of either of the navy brigs *Jefferson* or *Eagle* (Crisman 1987:117, 1989:304). These vessels, built for a war that was not expected to last very long, were not built to endure as long as the commercial passenger steamboat. More archaeological research is necessary to determine if the combination of iron fasteners and treenails was a common practice for steamboat construction at this time or was a time-saving method to more quickly deliver the steamboat company's financial need for a steamboat on the lake.

Another possible example of a time-saving effort was the rough shaping of particular hull structures that were hidden from public view. While the skill of the shipwrights was evident in the observation of many well-shaped timbers, a number of the frames were irregularly hewn and indicate haste in chopping out the floors and

futtocks near the turn of the bilge. These elements would have been hidden by the ceiling planking and unnoticed by the passengers. Likewise, the stern knee appeared to be rugged and unsmooth. It was well-fashioned to suit its purpose, but not carefully cut like the knee from *Ticonderoga*. This may not represent poor craftsmanship on the part of the shipbuilders, but rather an effort to speed the construction in order to prepare the steamboat for launching. Future investigation of hull remains from similar vessels may help answer this question.

To Conclude

It is apparent from the archaeological evidence and historical documentation that the living conditions aboard lake steamers from the days of *Phoenix* were elegant and comfortable, although not as opulent as those found in the saloons of the western river craft. This could be a reflection of regional cultural tastes, and the difference between life on the western rivers versus that on the northeastern rivers and inland seas. Contemporary accounts suggest that steamboat culture aboard the lake steamers, which traveled relatively short distances compared to the lengthy sojourns of the western river steamboats, was perhaps more refined. It could also be a consequence of a less competitive steamboat environment, as western river craft needed to be more elaborate to attract customers in order to compete with neighboring steamboat enterprises. *Phoenix*'s successors, *Congress* and *Phoenix II*, were among the first vessels to offer excursions to tourist destinations on the lake. These voyages, however, were usually

only a few hours long and the conditions aboard the lake steamers, cramped as they may have been, were comfortable for day trips.

The archaeological analysis and interpretation of the *Phoenix* hull remains and the resulting site plans have provided a basis from which to investigate other North American steamboats as they are discovered. *Phoenix* and her contemporary archaeological comparanda provide a good starting point for broader regional, economic, and social research questions. The interpretation of *Phoenix*'s hull remains offers a look not only at the shipbuilding technology and social views of the period, but the adaptation within marine architecture in the face of a new and advanced form of transportation that would effectively change the way humans traveled, traded, communicated, and otherwise interacted into the middle of the 20th century.

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APPENDIX A

RESEARCH PERMIT

PERMIT NO. 2009-01
Page 1 of 2

VERMONT

STATE OF VERMONT
DIVISION FOR HISTORIC PRESERVATION
Montpelier, VT

PERMIT

FOR
FIELD INVESTIGATION
AND/OR
DATA RECOVERY

In accordance with Title 22 of Vermont Statutes Annotated, Subchapter 9, Section 782, permission is hereby granted to the **Institute of Nautical Archaeology, Dept of Anthropology, Texas A & M University, College Station, TX**, to carry out a Field Investigation and/or Data Recovery project, as described in the Application, dated **August 13, 2009**, on the following property: **Phoenix underwater site** - **VT-CH-587 (also a VT Underwater Historic Preserve Site)** in the area mapped on the attached map in the Town of Colchester, Vermont.

This permit is subject to the General Conditions and Special Conditions attached hereto.

Effective Date: **September 16, 2009**
Expiration Date: **June 1, 2010.**

STATE OF VERMONT
DIVISION FOR HISTORIC PRESERVATION

By: Nancy E. Boone
Nancy Boone
Acting State Historic Preservation Officer

Date: 9/15/09

I have read and understand and agree to the attached permit conditions.

George Schwarz 9/23/09

George Robert Schwarz, on behalf of Texas A&M, Permit Holder **Date**

APPENDIX B

PHOENIX WOOD SAMPLE IDENTIFICATION

Alden Identification Service

3/20/12 Invoice #: 4260

Mr. George Schwarz
2100 Greenwich Street
Falls Church, VA 22043

Dear George,

Thank you for sending the 15 samples (Phoenix) to us for identification. They are as follows:

1 – F48P Hull Planking	Chestnut	*Castanea sp.*
2 – F48P Stringer 1	White Oak Group	*Quercus sp.*
3 – F48P Stringer 2 Upper	White Oak Group	*Quercus sp.*
4 – F48P Futtock 2 Aft	Northern White Cedar	*Thuja occidentalis*
5 – F48P Futtock 1 Forward	Yellow Pine Group	*Pinus sp.*
6 – F48P Floor	Yellow Pine Group	*Pinus sp.*
7 – F48P Keelson	White Oak Group	*Quercus sp.*
8 – F48P Stringer 3	White Oak Group	*Quercus sp.*
9 – F48P Stringer 2 Lower	White Oak Group	*Quercus sp.*
10 – F48P Ceiling Lower	Red Pine Group	*Pinus sp.*
11 – F48P Ceiling Upper	Red Pine Group	*Pinus sp.*
12 – Stem (Inner)	White Oak Group	*Quercus sp.*
13 – Stem (Contra Roda)	White Oak Group	*Quercus sp.*
14 – Stem (Outer)	Chestnut	*Castanea sp.*
15 – Treenail	White Oak Group	*Quercus sp.*

Oak (*Quercus* spp./Fagaceae) contains 275 to 500 species and can be separated into three groups based on their microanatomy; the Live or Evergreen Oak Group, the Red Oak Group and the White Oak Group. Species within each group look alike microscopically.

White Oak Group (*Leucobalanus***)**

Eastern North America		Europe	
Common Name	Scientific Name	Common Name	Scientific Name
Chestnut Oak	*Q. prinus*	Algerian Oak	*Q. canariensis*
Chinkapin Oak	*Q. muehlenbergii*	Cork Oak	*Q. suber*
Overcup Oak	*Q. lyrata*	Downy Oak	*Q. pubescens*
Post Oak	*Q. stellata*	Durmast Oak	*Q. petrea*
Swamp Chestnut Oak	*Q. michauxii*	Holm Oak	*Q. ilex*
Swamp White Oak	*Q. bicolor*	Hungarian Oak	*Q. frainetta*
White Oak	*Q. alba*	Pedunculate Oak	*Q. robur*
		Portuguese Oak	*Q. faginea*
		Pyrenean Oak	*Q. pyrenaica*
		Round-Leaved Oak	*Q. rotundifolia*
		White Oak	*Q. polycarpa*

APPENDIX C

THREE-DIMENSIONAL CONJECTURAL RECONSTRUCTION OF *PHOENIX*

The three-dimensional reconstruction of *Phoenix* was generated using Rhino NURBS software and was subsequently converted to a 3D PDF for viewing and user manipulation. It can be accessed on the following page, and a user toolbar has been included to assist with examining the half model. This is a working model and is meant to aid in visualizing the reconstructed hull elements as described in Chapter VII. (Model by Tiago Miguel Fraga and the author, 2012.)