THE SLOOP BOSCAWEN:

HULL CONSTRUCTION AND DESIGN DURING THE MID-EIGHTEENTH CENTURY IN THE CHAMPLAIN VALLEY

A Dissertation

by

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ABSTRACT

In 1983, the British sloop *Boscawen* and two other vessels were discovered in the shallow waters near Fort Ticonderoga, New York. The vessels located at the site are believed to be some of the oldest sailing vessels in Lake Champlain and among the handful of naval vessels from the mid-eighteenth century that have been excavated in North America. Using *Boscawen* as the focal point, this dissertation explores how colonial shipwrights designed, built, and rigged early sailing vessels for use on Lake Champlain and considers *Boscawen*'s hull construction in context with other eighteenth-century watercraft. Some of these vessels include those built by the British and French for use on the lake during the same conflict, while others were built for use on different inland and coastal waterways in northeastern North America. These cross-vessel comparisons reveal how multiple factors contributed to ship design and construction of the period and identify certain shipbuilding trends among these northeastern North American-built vessels.

DEDICATION

To my grandfather, David Houston, who taught me to love the woods and appreciate the beauty in hull lines. To my parents, Linda and Fred, who filled my childhood with water and adventure.

ACKNOWLEDGEMENTS

This dissertation and my graduate work would not have been possible without the help of many people. First and foremost, I would like to thank my committee chair, Dr. Kevin Crisman, for encouraging me to take up this project and for sharing all of the original 1980s excavation notes. I have cherished his friendship, guidance, and support over the years.

I would like to express my gratitude to committee member Dr. Donny Hamilton. Dr. Hamilton kindly allowed me to use the Conservation Research Laboratory and its resources to conserve artifacts from *Duke of Cumberland* and other vessels from the King's Shipyard site. More important to me, however, were the years I spent as his teaching assistant. I learned much about conservation from him, but I am most grateful for his friendship and mentorship during my time in the program.

I wish to also thank committee member Dr. Filipe Castro. Ever since I entered the Nautical Archaeology Program, Dr. Castro has showed his support and enthusiasm for my research. He has been one of the biggest advocates of my recent photogrammetric research projects and I value his unwavering support.

The winter geophysical project at the King's Shipyard would not have been possible without the support and generosity of Dr. Mark Everett. Dr. Everett invited me to join his geophysical field methods course as soon as I expressed interest in learning more about the operation of geophysical equipment. He also did not hesitate to allow me to borrow his department's gradiometer for use on my project. I am deeply grateful for his eagerness to help me and his willingness to join my doctoral committee.

I also would like to thank Christopher Sabick and Cherilyn Gilligan of the Lake Champlain Maritime Museum. Chris is one of my closest colleagues and I could not have conducted the 2019 archaeological investigations at the King's Shipyard without him. I have been fortunate to learn from him throughout my graduate student career and hope to continue working with him in the years to come. Cher was paramount to the success of the King's Shipyard projects: not only did she help with the in-water surveying but she was invaluable to the project by helping to organize all the artifacts, conducting important analysis of the faunal and botanical remains, and generating the artifact database. I am so appreciative of her dedication to the project.

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I am fortunate to have a wonderful relationship with the Waterfront Diving Center (WDC) in Burlington, Vermont. I received my initial SCUBA training from WDC and worked as one of their retail associates during college. Since then, they have continually supported my diving career and are a positive force for stewardship of the lake's cultural resources. My thanks go to Jonathan Eddy and the rest of the WDC staff.

I would not have been able to complete the fieldwork and lab work without the assistance of many archaeologists, conservators, and volunteers who contributed to the projects. Many thanks go to Olivia Brill, Stephen Campbell, Dr. William Chadwick, Nicole Deere, John Hamilton, Julia Herbst, Benjamin Ioset, Karen Martindale, Mason Parody, Dave Potter, Patricia

Reid, Edwin Scollon, Sophie Stuart, and Ryan Theis. Special thanks go to Ryan Theis and Julia Herbst who were constant voices of reason during the summer project and were leading factors in that project's success. In addition, I am eternally grateful to Edwin Scollon. Ed was a tireless contributor during the summer field season and went above and beyond in helping me wrap up the project.

I cannot thank the Institute of Nautical Archaeology (INA) enough for their support of my project. The equipment and funding they provided were invaluable to the project. In addition, I am also appreciative of INA president, Dr. Deborah Carlson. She has continuously advocated for my research and teaching aspirations. I am fortunate to have her friendship.

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My deepest gratitude goes to my parents, Linda and Fred, for their love, encouragement, and support they have always provided me. I am especially grateful to them as I was wrapping up my doctoral work and for their help to that end—from my mother, who graciously looked over this dissertation, and my father, who was a much-appreciated sounding board for ideas. I could not have done any of this without them.

CONTRIBUTORS AND FUNDING SOURCES

Contributors

This work was supervised by a dissertation committee consisting of Professor Kevin Crisman, committee chair; Professors Donny Hamilton and Luis Filipe Vieira de Castro of the Department of Anthropology; and Professor Mark Everett of the Department of Geology and Geophysics.

The 1983–1985 fieldwork on *Boscawen* was completed by Kevin Crisman and Arthur Cohn, leading a team including Anne Erwin, Scott Cooper, William Bayreuther, David Andrews, Terry Stone, Peggy Zak, Heidi Miksch. The fieldwork and lab work for the 2019 King's Shipyard projects were conducted and directed by the student, in collaboration with Christopher Sabick of the Lake Champlain Maritime Museum. The archaeologists, conservators, volunteers, and site coordinators who contributed to the projects include Olivia Brill, Stephen Campbell, Dr. William Chadwick, Nicole Deere, Cherilyn Gilligan, John Hamilton, Julia Herbst, Benjamin Ioset, Matthew Keagle, Karen Martindale, Mason Parody, Miranda Peters, Dave Potter, Patricia Reid, Edwin Scollon, Margaret Staudter, Sophie Stuart, and Ryan Theis. All other work for the dissertation was completed independently by the student.

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All of the artifact conservation efforts were facilitated by Center for Maritime Archaeology and Conservation (CMAC) and the Conservation Research Laboratory (CRL) at Texas A&M University. CRL provided equipment, chemicals, and other resources to complete all of the conservation treatments.

Permission for archaeological work in 2019 in New York's Lake Champlain waters was granted by the New York State Museum, the New York State Department of Environmental Conservation, and the Adirondack Park Agency.

The contents of this dissertation are solely the responsibility of the author and do not necessarily represent the official views of any of the above awarding offices.

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CHAPTER I

INTRODUCTION

Boscawen was built during the Seven Years' War (1754–1763)[1] as part of a British campaign to counter the French presence in the Champlain Valley. In an incredible feat of ship construction, the 78-foot-long (23.8 m) sloop was assembled, launched, and ready for action in less than three weeks. Soon after, Royal Navy Captain Joshua Loring led the 16-gun *Boscawen* and its 18-gun brig consort *Duke of Cumberland* in the 1759 naval campaign and captured three of the four French warships on Lake Champlain. After the war, the responsibility for maintenance and upkeep of the vessel was given to a private contractor. *Boscawen* was seemingly abandoned soon after and allowed to sink at its moorings.

Between 1983 and 1985, *Boscawen* was discovered and excavated by Kevin Crisman and Arthur Cohn in the shallow waters near Fort Ticonderoga, New York. The wreck's remains were documented and over 5,000 artifacts were recovered and conserved. These artifacts were the subjects of four master's theses from Texas A&M University's Nautical Archaeology Program, but no further study of the hull's design and construction was undertaken. Crisman and Cohn also located the remains of two other colonial vessels and two adjacent rock piles thought to be part of the mid-eighteenth-century dock from the "King's Shipyard" at Ticonderoga. No in-depth survey was conducted on these additional sites, and the vessels were not positively identified.

For definitions of terms related to nautical archaeology and ship construction, refer to Catsambis, Ford, and Hamilton, "Illustrated Glossary of Ship and Boat Terms," https://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780199336005.001.0001/oxfordhb-9780199336005-e-48/; adapted from Steffy, J. R. "Illustrated Glossary of Ship and Boat Terms." In *Wooden Ship Building and the Interpretation of Shipwrecks*, 266–298. College Station, TX: Texas A&M University Press, 1994.

[1] There are different names for the interconnected global military campaigns during this time span, each with their own start and end dates. This dissertation applies a single label ("The Seven Years' War") to the entire conflict to reduce confusion and maintain consistency.

Boscawen and the other vessels located at the site are believed to be some of the oldest sailing vessels in Lake Champlain and are among the handful of military vessels from the mid-eighteenth century that have been excavated in North America. This dissertation documents how colonial shipwrights designed, built, and rigged these early sailing vessels for use on Lake Champlain. Using *Boscawen* as the focal point, I consider its hull construction in context with other eighteenth-century watercraft built in northeastern North America. Some of these vessels include those built by the British and possibly the French for use on the lake during the same conflict, while others were built later in the eighteenth century for use on different inland and coastal waterways in northeastern North America.

Research into eighteenth-century shipbuilding in northeastern North America led me to primary sources such as the Thomas Gage Papers at the William L. Clements Library (Ann Arbor, Michigan),[2] the Amherst Papers at the Public Records Office (London, UK),[3] and *The Journal of Jeffery Amherst*[4] for important correspondence regarding the local military organization and operations on Lake Champlain and the construction of vessels examined in my dissertation. I also reviewed treatises such as William Sutherland's *The Ship-builder's Assistant* (1711) and Mungo Murray's *A Treatise on Ship-Building* (1754). Although these works provide theoretical information surrounding ship design and construction in England, it is the tangible evidence of colonial shipbuilding recorded during archaeological investigations which reveals many of the actual techniques used by colonial shipwrights to design and build vessels. Several archaeological studies have been published on eighteenth-century vessels built in northeastern North America, including the Terence Bay Wreck,[5] the colonial vessels from Lake George (CV-

[2] Thomas Gage Papers and Naval Documents from the Gage Papers.
[3] PRO, W.O.R.
[4] Webster, *The Journal of Jeffery Amherst*.
[5] Carter and Kenchington, "The Terence Bay Wreck."

1 and CV-2),[6] the Readers Point Vessel,[7] the New Bedford Harbor Superfund Site Unanticipated Discovery Shipwrecks (NBHSS UAD SW),[8] the Phinney Site (*Diligent*),[9] the Devereaux Cove Vessel,[10] the Revolutionary War privateer *Defence*,[11] the World Trade Center (WTC) Wreck,[12] and the transport schooner *Nancy*.[13]

Part of this dissertation covers the findings from my own archaeological investigations at the King's Shipyard in 2019 (Chapters III and VI). In February 2019, I led a team of archaeologists in a through-ice geophysical survey over *Boscawen* and the surrounding area. Using ground-penetrating radar and a gradiometer, we were able to locate *Boscawen*, the two unknown colonial vessels, and other archaeological features from the nineteenth and early twentieth centuries. In the summer of 2019, I led a crew of student colleagues, professional archeologists, volunteers from the lake's diving community, and staff from the Lake Champlain Maritime Museum in the survey of the other two vessels near *Boscawen*, and "ground-truthed" the other geophysical targets observed in the winter survey data.

The original goal for my summer field research was to re-excavate *Boscawen* and redocument components of its hull construction. However, the legal owners of the site, the British Ministry of Defence, did not issue permits to redocument this already-disturbed wreck. The summer fieldwork instead focused on a survey of the submerged material around *Boscawen*, including the possible French colonial vessels.

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[6] Kane and Sabick, "Lake Champlain Underwater Cultural Resources Survey."
[7] Cook, "The Readers Point Vessel."
[8] Robinson, "Marine Archaeological Investigation"; Robinson, "Marine Archaeological Documentation and Assesment."
[9] Hunter, "The Penobscot Expedition Archaeological Project."
[10] Green, "The Devereaux Cove Vessel."
[11] Switzer, "The Excavation of the Privateer *Defence*"; Feldman, "Hull Construction in Revolutionary War America."
[12] Pappalardo et al., "World Trade Center"; Dostal, "Laser Scanning as a Methodology."
[13] Sabick, "His Majesty's Hired Transport Schooner *Nancy*."

Although the proposed re-examination of *Boscawen*'s hull remains was not completed, the archaeological notes from the 1980s excavation were sufficient to serve as the foundation for my comparative analysis. Using those notes, I created a hypothetical set of lines for *Boscawen* (i.e., a two-dimensional representation of the vessel's three-dimensional [3D] geometry). In addition, in Chapter IV, I use archaeological remains, archival evidence, and historical paintings to generate a hypothetical rigging plan of the vessel. Construction plans of *Boscawen*'s hull as it was found in 1984 and 1985 and as it was assembled in 1759 are included in Chapter V. These graphical reconstructions are used to aid comparisons made with the other vessels from this period and region.

I also examined two British-built vessels constructed in and around the Champlain Valley. Archaeological study of these vessels had yet to be pursued because they were raised in the early twentieth century and were subsequently destroyed. The 18-gun brig *Duke of Cumberland* was built by the same carpenters at the same time and place as *Boscawen*. The two vessels sank side-by-side. Although the remains of *Duke of Cumberland* no longer exist, several historical photographs taken of the wreck at various stages of its decomposition throughout the twentieth century have survived. After creating a methodology that applies photogrammetric techniques to historical photographs to recover 3D structural geometry, I was able to retrieve hull information from this vessel to generate a hypothetical set of hull lines. The methodology and the generated results are discussed in Chapter III.

The Tuttle Sloop was the second British-built vessel I similarly reconstructed, a small mid-eighteenth-century sloop from Lake George (just south of Lake Champlain). Now, we can compare both sets of lines to *Boscawen*'s and other vessels' to better understand ship design and construction practices during the eighteenth century in northeastern North America. This novel photogrammetry methodology also has the potential to be useful to many areas of study, such as architecture, historic preservation, and other subfields of archaeology.

To gain insight into the shipbuilding traditions of this period and region, I performed a comparative analysis of twelve vessels built in northeastern North America during the eighteenth century to specifically examine their framing construction. In Chapter VI, I present an original standardized equation to better evaluate a vessel's "framing robustness" in relation to its hull size. By incorporating several aspects of frame construction into an equation, a single value is generated that can quantify a vessel's framing robustness, allowing scholars to more easily and objectively compare vessels.

A table presenting the main scantlings of fifteen vessels examined in this study can be found in Appendix A (Table 1). Before the archaeological data can be interpreted, however, the historical background of *Boscawen* and the other vessels from Lakes Champlain and George must be considered; this information will help to establish a framework for subsequent analyses in later chapters.

CHAPTER II

HISTORICAL BACKGROUND

Colonial Conflict in North America and the Naval Contest for Lake Champlain

During the late seventeenth and early eighteenth centuries, British and European policy makers and military strategists understood the importance of the waterways throughout northeastern North America. Lakes and rivers served as "highways" that offered vital access to the early northern colonies. These highways were the stage for many conflicts among native and foreign powers. In the mid-1750s, sources of tension in European countries, such as securing geographic, military, and economic control over the Americas and anti-Prussian sentiment, contributed to the outbreak of the Seven Years' War. This war consisted of continental campaigns in central Europe and North America, as well as naval campaigns around the globe.[14] In the continental campaigns in northeastern North America, British and French military strategists focused largely on establishing control of (and around) waterways, including the Eastern Great Lakes, the St. Lawrence River, and Lakes George and Champlain (see Figure 1 for a map of the region).

[14] More information on the specifics of this conflict (in North America and abroad) as well as the previous Anglo-French conflicts of the eighteenth century can be found in Michael Laramie's *The European Invasion of North America*; Daniel Baugh's *The Global Seven Years War, 1754–1763*; and Karl Schweizer's *England, Prussia and the Seven Years War*.

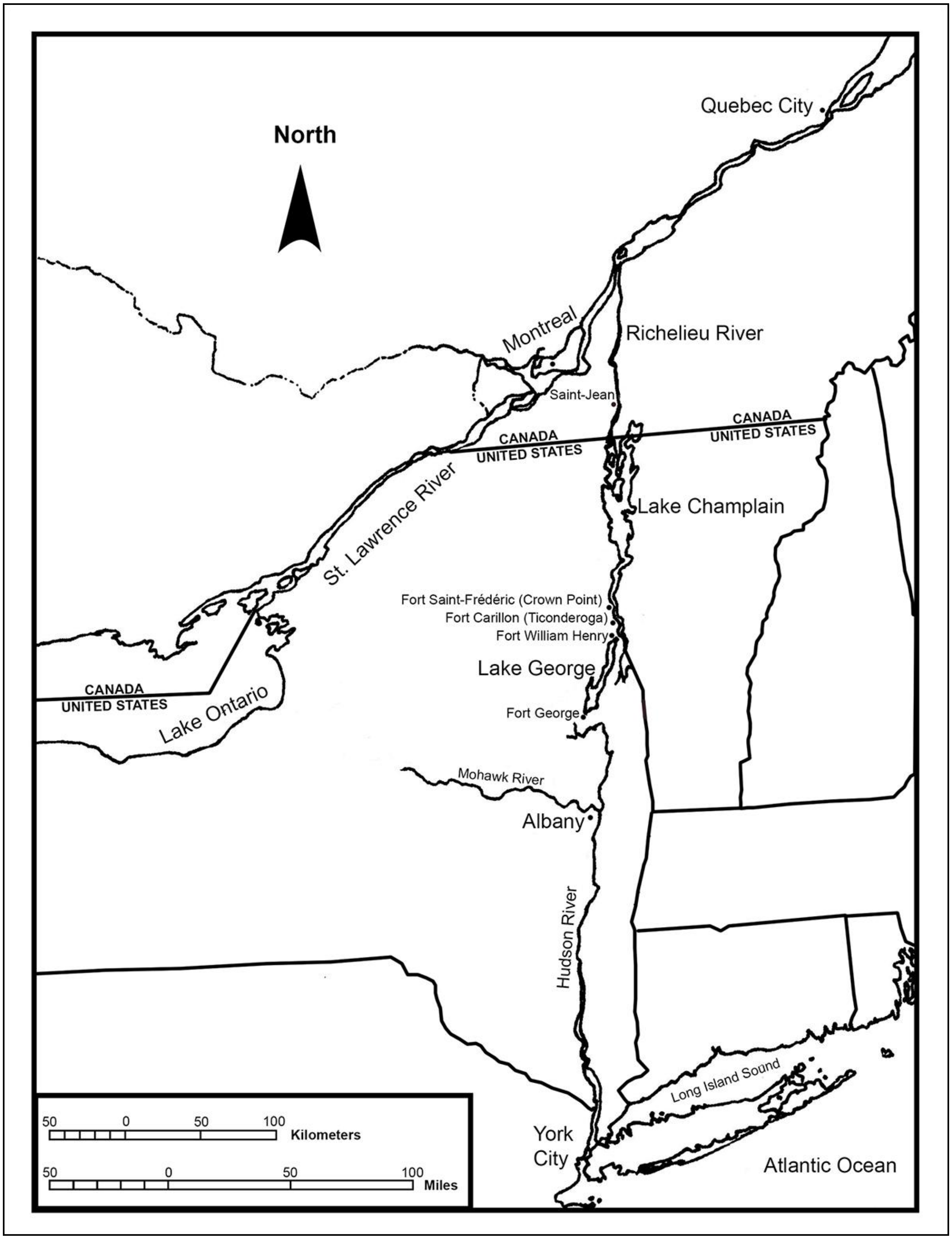

Figure 1 Map of the inland waterways of northeastern North America.

Since the early eighteenth century, the French had maintained a strong foothold in the Lake Champlain region. By the 1750s, they had already constructed Forts Saint-Frédéric and Carillon at the southern end of the lake. The British, upon learning of the construction of the French Fort Duquesne in the Ohio Valley in 1754, launched a campaign to drive the French from that region. These series of aggressions would lead to full-scale war in North America the following year. From 1756 to 1758, British forces led unsuccessful campaigns against the two French forts (Forts Saint-Frédéric and Carillon) at the southern end of Lake Champlain.[15] However, in 1758, the siege of Louisbourg on Cape Breton Island under the command of General Jeffery Amherst proved successful. After this momentous victory, Amherst was appointed commander-in-chief of the British forces in North America and soon devised a three-pronged attack to complete the conquest of New France in 1759. His plans began with capturing four French strongholds along the borders of the British and French colonies: Fort Niagara on western Lake Ontario, Quebec, and Forts Saint-Frédéric and Carillon.[16]

The attack upon the French positions on southern Lake Champlain were intended to weaken the French and divide their attention and forces as British General James Wolfe attacked Quebec with 9,000 troops transported up the St. Lawrence River. Wolfe laid siege to the fort for ten weeks before making a surprise landing above Quebec City. This allowed the main British army to move onto the Plains of Abraham and achieve a decisive victory over the French garrison in only fifteen minutes. Both Wolfe and Louis-Joseph de Montcalm (the commander of all French forces in North America) died in this engagement.[17]

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[15] More information on the specifics of these unsuccessful British campaigns can be found in Laramie, "The French Lake Champlain Fleet and the Contest for the Control of the Lake, 1742-1760" and in Bellico, *Sails and Steam in the Mountains*.
[16] Burke et al., *The Annual Register or a View of the History, Politics, and Literature for the Year 1759*, 29.
[17] Anderson, *A People's Army. Massachusetts Solders and Society in the Seven Years War*, 18; Jennings, *Empire of Fortune*, 423; Knox, *Journal of Captain John Knox*, 133–135.

As Quebec was falling to British forces, Brigadier General John Prideaux and Sir William Johnson laid siege to Fort Niagara with 2,200 regulars and provincials and 700 Iroquois. The siege lasted three weeks before the French contingent at the fort surrendered.[18] This was a strategic British victory, as it forced French forces in the west to retreat down the St. Lawrence to Montreal and Quebec and halted all French communication to the interior.

Before his defeat and death at Quebec, Montcalm was preparing for a staged retreat from the French forts in the Champlain Valley. Because he knew that British forces were planning to assault Quebec and other outposts, he wanted to consolidate a main force in New France, slow the British advance, as well as retain control of the waters of Lake Champlain and the Richelieu River. To achieve these goals, Montcalm ordered that a small naval force consisting of a topsail schooner, several sloops, and smaller boats be constructed between 1757 and 1759. These vessels were hurriedly built and fitted with sails, masts, and tackle taken from merchant vessels at Quebec and from the Saint Lawrence River.[19] In the spring of 1759, Montcalm appointed naval officer Monsieur de Laubaras to command the topsail schooner *Vigilante*[20] and the sloops on Lake Champlain to provide support for the French army when it began to withdraw from Forts Saint-Frédéric and Carillon.[21]

Amherst received reports in July 1759 that the French forts at the southern end of the lake were being abandoned and that two sloops and *Vigilante* were aiding in the retreat.[22] In fact, only a four-hundred-man garrison was left to defend Fort Carillon against the British. The siege lasted just four days. Before withdrawing to nearby Fort Saint-Frédéric, the French garrison exploded

[18] Marshall, "Fort Niagara: Under the French, English and the United States," 6.
[19] Casgrain, *Journal du marquis de Montcalm*, 44.
[20] Built in 1757 at Saint-Jean, Quebec, by Nicolas-René Lavasseur. Lavasseur's skill as a shipwright was utilized to build a number of vessels at Quebec for the northern lakes. Casgrain, *Journal du marquis de Montcalm*, 174, 444.
[21] In total (including Laubaras), six officers and ninety seamen were sent to man the vessels. Lewis, "The Naval Campaign of 1759 on Lake Champlain," 203; Casgrain, *Journal du marquis de Montcalm*, 525, 535.
[22] Webster, *The Journal of Jeffery Amherst*, 143, 148.

the fort's magazine. On July 31, the French forces destroyed Fort Saint-Frédéric's citadel and joined the rest of the army at Île-aux-Noix at the northern end of the lake.[23]

The French abandoned their southern forts on Lake Champlain but maintained their small and dangerous naval presence. Anticipating this obstacle, Amherst began preparations to establish his own small squadron in May 1759. He first wrote to Captain Joshua Loring of the Royal Navy and dispatched him to oversee the building and command of a proposed Lake Champlain naval force for use by the British Army. A rare example of a colonial subject who rose through the Royal Navy's ranks, Boston-born Loring gained his naval commission from his privateering success during the War of Austrian Succession (1740–1748).[24] He was specifically chosen for the Lake Champlain command because of his prior experience on inland waters, which included commanding a brig on Lake Ontario in 1756 and superintending the building and operation of vessels on Lake George in 1758.[25]

The smaller vessels used on Lake George, such as bateaux and whale boats, were some the first British military vessels used on Lake Champlain. Amherst needed these bateaux—simple flat-bottomed boats—in the first stages of moving the army and supplies down the lake.[26] These bateaux and other small boats, however, were not suited for use in high waves or heavy winds, and a number of them were damaged in a storm off Fort Crown Point (an earthwork built by Amherst alongside the ruins of Fort Saint-Frédéric). The bateaux were clearly no match for the French sloops and schooner cruising the lake.[27] Thus, even from the early stages of planning the 1759 campaign, Amherst intended to build larger vessels for the lake. He wrote to Loring

[23] Lewis, "The Naval Campaign," 203.
[24] The campaigns in North America, known as King George's War (1744–1748), made up the third of the four French and Indian Wars. The War of Austrian Succession ended with the Treaty of Aix-la-Chapelle.
[25] Lewis, "The Naval Campaign," 204; Douglas, "Loring, Joshua."
[26] Webster, *The Journal of Jeffery Amherst*, 137. Lake Champlain flows north (down the lake).
[27] Webster, *The Journal of Jeffery Amherst*, 153.

stating, "I shall have occasion for two Brigs… from your experience & knowledge of the place where they are to be Employed, you must be the best Judge of what burthen & strength they ought to be."[28]

Loring began to accumulate materials for the vessels after receiving Amherst's orders in June, but it was not until mid-August that Loring started sawing timbers at the newly named Fort Ticonderoga (formerly known as Fort Carillon). This was due to the time it took to find an adequate dockyard site and to construct the necessary shipbuilding and storage facilities for this new "King's Shipyard." In a small bay 400 meters southeast of the fort, Loring ordered his carpenters to build a wharf, a naval storehouse, and an iron forge to furnish fasteners and other ship tackle; to dig pits for sawing timber by hand; and to prepare the launch slipway for guiding the vessels into the water when finished.[29] A nearby water-powered sawmill aided some of this new shipyard-focused construction, but its services were in high demand because repairs and new buildings at Fort Ticonderoga and Fort Crown Point were also needed. On top of this, Amherst ordered Loring to supply timber for an additional vessel, a large flat-bottomed, cannon-carrying radeau to be built at Fort Crown Point under the direction of Major Thomas Ord of the Royal Artillery.[30] The construction of the radeau was in response to a report from a French deserter on August 16, 1759. His British captors learned that the French fleet was composed of the following:

> La Vigilante [schooner] of 10 Pieces of Cannon 6 & 4 Pounders,… a Sloop called Musquelongy...2 brass 12-pounders and 6 Iron six pounders, la Brochette of 8 Guns 6 & 4 pounders, [and] L'Eturgeon of 8 Guns of 6 & 4 pounders. All of them have Swivels mounted. Three were built this year; one is an old one, and there is another repairing.[31]

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[28] PRO, W.O.R. 34/64, 196, Amherst to Loring, 13 June 1759.
[29] Lewis, "An Interim Report on the History of the Sloop *Boscawen*," 4; PRO, W.O.R. 34/64, 149, 151, 153.
[30] This vessel was to carry six 24-pounders.
[31] Webster, *The Journal of Jeffery Amherst*, 157.

Loring found himself in contest with Ord for supplies, carpenters, and the sawmill, which was in constant disrepair from overuse.[32] After receiving scouting reports that the French had built an additional sloop of sixteen guns, Amherst ordered Major Joseph Hopkins and four Rangers to attempt to burn the vessel with fire darts. When this attempt failed, Loring was under even more pressure to finish fitting his first vessel, an eighteen-gun brig, so that he could also build a sixteen-gun sloop.[33]

Despite the many delays, complications,[34] and criticisms from Amherst and other officers, Loring built and fitted the brig *Duke of Cumberland* and the sloop *Boscawen* in the extremely short time of two months. *Duke of Cumberland*'s keel was laid shortly after August 10, 1759, and the hull was launched twenty days later, on August 30. *Boscawen*'s keel was laid down on September 16, 1759, and its hull was launched twenty-two days later, on October 7.[35] Only four days after this, all three newly built vessels—the brig, the sloop, and Ord's radeau *Ligonier*—were loaded with ammunition and stores at Crown Point and given orders to sail down the lake to pursue the French fleet (Figures 2 and 3).[36] Loring had command of *Duke of Cumberland* and its crew of 130 seamen and soldiers. Command of *Boscawen* and its crew of 110 seamen and soldiers was given to Lieutenant Alexander Grant.[37]

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[32] PRO, W.O.R. 34/64, 148, Loring to Amherst, 4 Aug. 1759; PRO, W.O.R. 34/64, 162, Loring to Amherst, 19 Sept. 1759; Webster, *The Journal of Jeffery Amherst*, 145, 157. Repairs on the sawmill collectively took a number of weeks and delayed progress on all fronts.
[33] PRO, W.O.R. 34/64, 212, Amherst to Loring, 15 Sept. 1759.
[34] Amherst and Loring had considerable difficulty in finding adequate carpenters, cannons, and rigging for these vessels. These elements will be examined in greater detail in Chapters IV and V.
[35] Lewis, "The Naval Campaign," 205–207; PRO, W.O.R. 34/64, 149, 160.
[36] PRO, W.O.R. 34/64, 225, Amherst to Loring, 10 Oct. 1759.
[37] PRO, W.O.R. 34/64, 226, Amherst to Loring, 10 Oct. 1759; Kimball, *Correspondence*, 199.

Figure 2 "A South View of the New Fortress at Crown Point, with the Camp, Commanded by Major General Amherst in the Year 1759." Painting by Thomas Davies. (Courtesy of the Winterthur Museum)

Figure 3 A detail of "A South View of the New Fortress at Crown Point, with the Camp, Commanded by Major General Amherst in the Year 1759" showing *Boscawen* (left) and *Duke of Cumberland* (right). Painting by Thomas Davies. (Courtesy of the Winterthur Museum)

As the flotilla made its way north, Loring and Grant sailed ahead of Amherst (aboard *Ligonier*) and the other small radeaux and bateaux. The British brig and sloop continued north through the night and unknowingly sailed past three French sloops located south of Four Brothers Islands. Early the next morning, Loring and Grant spied the French topsail schooner *Vigilante* to the north and made chase, still unaware of the French sloops behind them. As Loring and Grant pursued *Vigilante* into Missisquoi Bay, both of their vessels ran aground on a small bar. After much effort, the vessels, surprisingly undamaged, were freed. When Loring and Grant continued their chase, they spotted the French sloops heading north to Île-aux-Noix to inform the garrison of the impending British attack. The commanders of the three French sloops did not realize that Loring and Grant had passed them the previous night. Fearing the loss of men and supplies in an unequal contest with their larger foes, the French commanders sailed into Cumberland Bay, scuttled their vessels, and made their retreat by land.[38] See Figure 4 for a map of Lake Champlain.

The next morning, Amherst ordered Loring to pursue *Vigilante* to the north, while Grant was instructed to salvage and raise the three scuttled French vessels. The search for *Vigilante* proved unsuccessful, and Amherst's hopes of leading an attack on Île-aux-Noix that year dwindled as winter weather set in. By 16 November 1759, both the British army and its small naval force, including the three recovered ex-French sloops, were back at the southern end of the lake.[39] Loring made preparations for the vessels to overwinter at Ticonderoga and put up a defensive wall on the waterfront to protect against French attacks. Amherst, also concerned about a possible incendiary attack on the moored vessels, wrote to Major John Campbell

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[38] Lewis, "The Naval Campaign," 212.
[39] Webster, *The Journal of Jeffery Amherst*, 182.

stationed at Ticonderoga, "The great temptation the Enemy must have to burn our Vessels, as they would thereby become again Masters of the Lake, deserves your utmost Attention."[40]

The following spring, *Duke of Cumberland*, *Boscawen*, and the captured French sloops were utilized as troop and supply transports for the 1760 campaign. Loring was assigned to Amherst's Lake Ontario attack, so Alexander Grant, who was promoted to the rank of captain and given command of the Lake Champlain naval force, took *Duke of Cumberland* as his "flagship." In preparation for the attack on Saint-Jean, Captain Grant aided Major Robert Rogers in an amphibious assault on Île-aux-Noix. On August 14, 1760, British forces arrived at Île-aux-Noix with the flotilla and army from Crown Point and began to lay siege to the fort. After two weeks, the French abandoned the fort and withdrew to Montreal. By September 6, Amherst's plan to converge on New France from three directions came to fruition. Only two days later, the French agreed to a complete surrender of the colony of New France.

Boscawen, *Duke of Cumberland*, and the rest of the British naval force were brought back to Fort Ticonderoga, still under the command of Grant, and were used only minimally as transports during the final years of the war. One of the ex-French sloops served as a transport in the years after 1763, but records of its particular use and subsequent disposition are scarce.

[40] Lewis, "The Naval Campaign," 214.

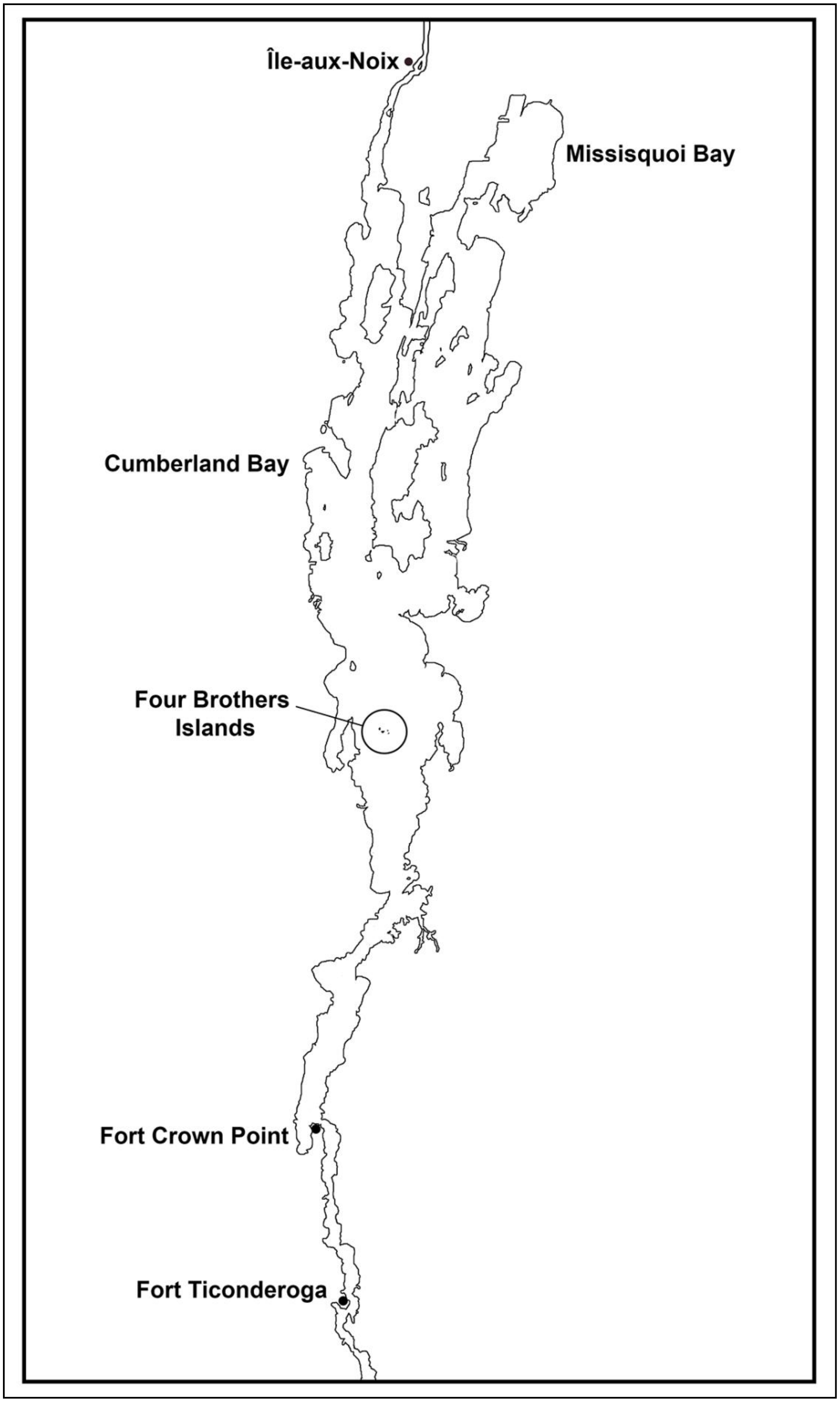

Figure 4 A map of Lake Champlain and notable locations in "Historical Background."

The Interwar Period

As previously mentioned, when the French withdrew from Fort Carillon, they exploded the fort's magazine to deprive the British of military stores left behind and to render the fort unusable—or at least force Amherst to dedicate valuable time and resources to the fort's repair.[41]

Even though British Army garrisons at Ticonderoga after 1759 attempted to rebuild the fortifications, it was never fully restored. One contributing factor was a fire in March 1760 that burned down most of the officers' barracks, forcing a number of the officers to find temporary quarters on *Duke of Cumberland* and *Boscawen* and others to live in field tents. The destruction of the barracks and their subsequent reconstruction halted much of the building effort on the rest of the fortification and the battery until mid-1761. To prevent future fires, the barracks were largely rebuilt of brick.[42]

Another reason the fort was never fully restored was that between 1759 and 1768, garrisons at Fort Ticonderoga rotated every one to one-and-a-half years. As Fort Crown Point became better established during the war, Fort Ticonderoga served more as an outpost to the larger fort. At this time, regiments were mostly headquartered in New York or Albany and sent their companies to garrison forts and outposts across the colonies. In the decade or so after the end of the Seven Years' War in North America, the number of companies gradually declined at forts like Crown Point and Ticonderoga.[43]

In the summer of 1768, the British frontier posts across North America were essentially abandoned. This was due in large part to the Townshend Acts of 1767 and 1768 and the

[41] Lewis, "The Naval Campaign," 203; Lonergan, *Ticonderoga: Historic Portage*, 55.
[42] The ex-French brickyard at Fort Ticonderoga was not back in operation until 1761, so these bricks were sourced from Fort George in 1760.
[43] In 1760, the 17th Regiment of Foot stationed six companies at Ticonderoga. In 1764, there were five companies from the 44th Regiment stationed there. The four companies of the 60th Regiment in 1766 would diminish to only two by the next year. Keagle, "Between the Wars: Peacetime Garrisons of Ticonderoga."

appointment of Lord Hillsborough[44] as Secretary of State for the Colonies in 1768. Regular troops were pulled from their frontier garrisons and reassigned to suppress opposition to the increased taxation of goods imported into the colonies. The removal of troops caused rebuilding efforts to fall by the wayside. By the early 1770s, most of Fort Ticonderoga was in a state of disrepair.

At this time, Ticonderoga and Crown Point were among the only forts in the interior that had companies garrisoned within them. General Thomas Gage, the Commander-in-Chief of British forces in North America, advocated to keep these forts garrisoned[45] despite their dilapidated conditions in order to protect the lines of communication and transportation between New York and Quebec.[46] In 1772, only a small force of less than twenty soldiers from the 26th Regiment of Foot, under the command of Lieutenant Jocelyn Feltham, was stationed at Ticonderoga. It was not until the winter of 1774 and the early spring of 1775 that the garrisons at Forts Ticonderoga and Crown Point were bolstered. The number of soldiers sent there still was not enough to adequately repair the forts—or to challenge the American rebel forces that easily captured them on May 10, 1775.[47]

The vessels and naval stores at Fort Ticonderoga also suffered during this interwar period, in much the same way that the fortifications did. In 1763, Grant wrote that the flotilla was laid up at Ticonderoga and consisted of a "large Brigantine which mounted 20 guns, two Schooners, two sloops, and some smaller craft; also a sloop constantly employed in the summer season between this place and St. John's [formerly Saint-Jean]."[48] The active sloop on Lake

[44] Wills Hill, the 1st Marquess of Downshire.
[45] This is especially the case after the Boston Massacre, in 1770.
[46] Shy, "Confronting Rebellion," 23, 54; Gage to Barrington, New York, 7 May 1766, and Gage to Barrington, New York, 4 March 1769.
[47] "Before Ticonderoga: The 26th Regiment in New Jersey and New York, 1767-1772."
[48] Naval Documents from the Gage Papers, Vol. 35.

Champlain that year was the ex-French *Muskelongy*; in 1767, it was one of four vessels (one from each of the Lakes Champlain, Ontario, Erie, and Huron) to be manned, maintained, and kept serviceable by the private contractor John Blackburn.[49] *Muskelongy* was in use during the 1760s and maintained the supply lines between the fortifications on Lake Champlain and the outposts on the upper Richelieu River. By 1771, the vessel was considered no longer fit for service and was scuttled and stripped for materials.[50]

For the rest of the vessels in the King's Shipyard, reports in 1765 and 1768 described the poor condition of the flotilla and noted that *Boscawen* and *Duke of Cumberland* were "Lay'd up And Decay'd."[51] In addition, an inventory of the naval stores at Fort Ticonderoga in March 1772 indicated that the only serviceable items remaining from the vessels were anchors, rope, and some of their sails.[52] The vessels were seemingly abandoned to sink at their moorings (see Figure 5 for an artist's rendition of the laid up vessels at the King's Shipyard).

The dwindling number of troops at Ticonderoga and the lack of financial support from the government contributed to the fort and vessels falling into a dilapidated state. It was in 1767, when only skeleton crews garrisoned the forts of the interior, that the British Army began to privatize the maintenance and provisioning of the active military vessels on the northeastern lakes. By the start of the War for American Independence, the forts were in such disarray that the additional small garrisons sent to them in 1774 had little to no chance of holding them when attacked by rebel forces.

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[49] Naval Documents from the Gage Papers, Vol. 35. John Blackburn obtained this contract through the Lords Commissioners of His Majesty's Treasury. It was fulfilled by his agents in North America.
[50] Laramie, "The French Lake Champlain Fleet," 28.
[51] Bellico, *Sails and Steam in the Mountains*, 109; Naval Documents from the Gage Papers, Vol. 35.
[52] "Return of Boatswains Stores," in Thomas Gage Papers, Vol. 101, #3-29-71. Still much is unknown about the interwar period, especially about the vessels that were allowed to sink in the King's Shipyard. Future projects on this period should look into letters written by commanding officers stationed at Fort Ticonderoga and explore whether the salvage rights to the vessels were ever sold to a contractor.

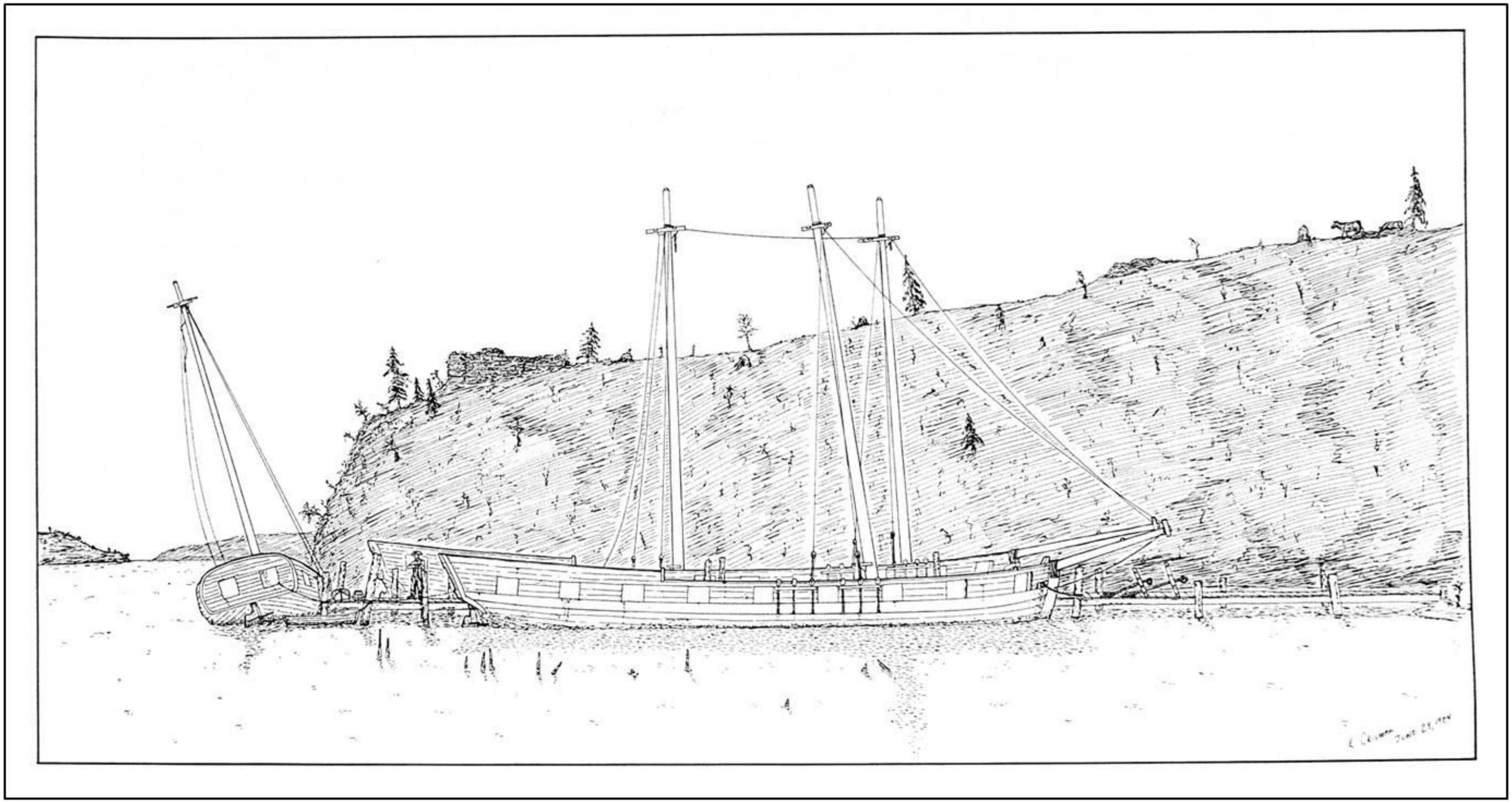

Figure 5 *Boscawen* (foreground), *Duke of Cumberland* (background), and one of the captured French vessels (to the left) laid up at the King's Shipyard. (Illustration by Kevin Crisman)

The Old King's Shipyard and the Great Bridge

After American rebel forces captured Fort Ticonderoga and Crown Point on May 10, 1775, major efforts to repair and garrison them were still not a priority of the Continental Congress and senior rebel military strategists, despite pleas from Ethan Allen and Benedict Arnold, the captors of the two forts. Congress believed that if they could hold the British forces in Canada, there would be little need to strengthen fortifications behind their own line. One of their strategies for preventing a British advance into the Northern Colonies from Canada was to establish a boom made of bar iron forged into large chain links. This barrier could be stretched across the Richelieu River at Sorrel to greatly hinder the southward passage of British vessels. The plan for a chain boom ultimately failed during the winter of 1775/76, when Continental forces in Canada suffered from supply shortages, waning support from Canadian allies, and a smallpox outbreak, causing them to stage a disorganized retreat south to the Champlain Valley.

American forces soon realized that if they could establish naval superiority on the lake, they might prevent a British advance southward up Lake Champlain. Benedict Arnold was selected to be in charge of the warship-building effort in Skenesboro, New York (today known as Whitehall), while others focused on repairing the fortifications at Crown Point and Ticonderoga. As soon as the small American squadron was ready, Arnold sailed north to discourage an impending British invasion. The Battle of Valcour ensued on October 10, 1776, and although Arnold's forces ultimately delayed the British invasion with this engagement, they lost most of their fleet. Over the winter of 1776/77, the American forces on the lake redoubled their efforts to repair Crown Point and Ticonderoga and installed the chain boom, this time extending it from Fort Ticonderoga (in New York) to Mount Independence (in Vermont).

In addition to the chain boom, American forces completed a floating bridge on October 25, 1776. This narrow bridge, constructed using large logs fastened together and secured in place with anchors,[53] allowed the Americans to more easily transport troops and supplies between Ticonderoga and a new fortification on the eastern side of the lake. By February 1777, plans were made to build an even greater bridge and obstruction between Fort Ticonderoga and Mount Independence, using the ice to facilitate the construction. This new "Great Bridge" would consist of twenty-two massive caissons, each around 24 feet square (7.3 m^2), that were connected by 12- to 14-foot-wide (3.7–4.3 m) floating sections and would connect to the pylons (smaller caissons) of the former King's Shipyard wharf and thereby extend over some of the now sunken vessels from the previous war (i.e., The Seven Years' War).[54]

In July 1777, British forces moved south from their position in Canada and took over Mount Defiance, a strategic position overlooking Fort Ticonderoga, which was left unfortified by the Americans. General Arthur St. Clair, the commander at Ticonderoga, called for retreat that evening. Some of the retreating rebel army utilized its surviving vessels to row south toward Skenesboro, while the remaining troops crossed the Great Bridge and followed the roads toward Castleton, Vermont. Throughout the first few years of the War for American Independence, when there was heightened activity around Fort Ticonderoga and Mount Independence, the waters around the bridge were used as a dumping ground for trash and as well as equipment or supplies that American and later British forces threw into the lake as they retreated to new strategic positions.

[53] Cohn, "The Great Bridge," 13; Wickman, "Built with Spirit, Deserted in Darkness," note 138.
[54] Cohn, "The Great Bridge," 17.

Fort Ticonderoga and the Growth in Lake Tourism

In 1785, only two years after the conclusion of the War for American Independence, ownership of Fort Ticonderoga was transferred to the State of New York. In 1803, ownership transitioned again; this time, the fort and its surrounding lands were transferred to Columbia and Union Colleges. Later in 1816, the colleges leased the fort and the grounds to William Ferris Pell and later sold them to him in 1820 for the sum of $6,008.[55]

The nineteenth century saw a drastic increase in tourism and historical enthusiasm in America. This shift was facilitated in the Champlain Valley by the rapid development and widespread use of steamboats in the first half of the century, and by competition of railroad lines around the lake in the second half. In fact, it was during a trip to Burlington, Vermont, that William Pell first saw the ruins of Fort Ticonderoga from the deck of a steamboat.[56]

As new owners, the Pell family built a summer estate, "The Pavillion," on the property for personal use, but they would later open the grounds as a tourist attraction. In 1841, they constructed a steamboat dock on the southern edge of the old King's Shipyard and, in 1848, converted "The Pavillion" to serve as a hotel when the railroad came to the Champlain Valley. The Pell family continued to improve the site as a tourist attraction and, in the early twentieth century, hired Alfred Bossom, a British architect, to help restore the fort and open it to the public as a historic site and museum in 1909, the tercentenary of the lake's "discovery" by Samuel de Champlain.[57]

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[55] Crego, *Fort Ticonderoga*, 76.
[56] Hamilton, *Fort Ticonderoga: Key to A Continent*, 227.
[57] Hamilton, *Fort Ticonderoga: Key to A Continent*, 228–229.

The Wreck-Raising Phenomena of the Twentieth Century

During the first half of the twentieth century, at dozen or more historical shipwrecks were raised from Lake Champlain and Lake George. The motives for dragging these vessels out of the water included shoreline clearing, recycling material, relic hunting, antiquarian interest, and the desire to host a public spectacle. Artifact conservation requirements and techniques were unknown at that time, so every wreck raised from Lakes Champlain and George (with the exception of the 1776 American gunboat *Philadelphia* and the War of 1812 schooner *Ticonderoga*[58]) was destroyed by these efforts. The only evidence of these vessels that exists today are photographs of their decayed hulls and, on rare occasions, small collections of artifacts and disarticulated fragments of hull timbers.

The brig *Duke of Cumberland* remained undisturbed in the King's Shipyard until 1909 when Stephen Pell decided to raise the vessel and display it in an effort to increase publicity for the Fort Ticonderoga Museum's opening and the tercentenary celebration. Pell and architect Alfred Bossom incorrectly associated the hull with the War for American Independence–Era schooner *Revenge*. During the winter, workers created a framework of logs on the ice above the wreck site and used chains, ropes, pulleys, and a team of horses to dislodge the brig's surviving lower hull from the silty lake bottom (see Figures 6 and 7). As they worked to haul the vessel onto the shore, many timbers were dislodged and torn from the wreck (see Figures 8 and 9).

The vessel was subsequently dragged up the hill from the shoreline, placed on five stone and concrete slabs, and surrounded by wire fencing to prevent souvenir hunters from taking pieces of the wreck. They soon realized that the hull needed support out of the water. This was

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[58] *Philadelphia* and *Ticonderoga* are not thriving, by any means. Both of the vessels' remains are suffering from improper conservation strategies. Lundeberg et al., *A Tale of Three Gunboats*, 75–82; Crisman, *The History and Construction of the United States Schooner* Ticonderoga, 39.

achieved by fastening iron bands and cables and wooden stanchions to the vessel's outer hull in an effort to prevent the timbers from sagging further (see Figures 10 and 11). They also erected a roof over the *Duke of Cumberland*'s remains, (which later collapsed on the wreck). See Figure 12 for an image of the roof that was once over the brig. No additional measures to preserve the wreck were pursued, as methods for conserving submerged archaeological material had yet to be invented. Over the years, *Duke of Cumberland*'s remains were left exposed and degraded due to the harsh elements of the northern climate.

When the vessel was brought to shore in 1909, numerous artifacts were recovered from the sediment within the wreck. The most notable were various types of shot, remains of guns, bayonets, and other ammunition.[59] However, it is difficult to say where these items are currently located. Throughout the twentieth and early twenty-first centuries, some of the museum's older (and less organized) collections were jumbled together because many artifacts lacked proper labeling and database association. A few of the artifacts recovered from *Duke of Cumberland* have retained their labels and remain with other pieces from the original collection.

In addition to this small collection of provenienced artifacts, the only other tangible pieces of the brig's hull timbers exist today as two gavels from a local Ticonderoga lodge, a chair given to President Warren Harding, and a small fragment gifted to Major Howland Pell, all of which were made or taken from *Duke of Cumberland* framing components.[60] The rest of the hull has now decomposed into the wooded hillside. There are, however, a number of photographs of *Duke of Cumberland*'s remains that were taken throughout the twentieth century at various stages of the vessel's degradation (see Figures 13–15).

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[59] Bossom, *The Restoration at Fort Ticonderoga or Fort Carillon*, 59.
[60] Bossom, *The Restoration of Fort Ticonderoga or Fort Carillon*, 59.

Figure 6 The log framework over *Duke of Cumberland*. (Courtesy of Fort Ticonderoga Museum)

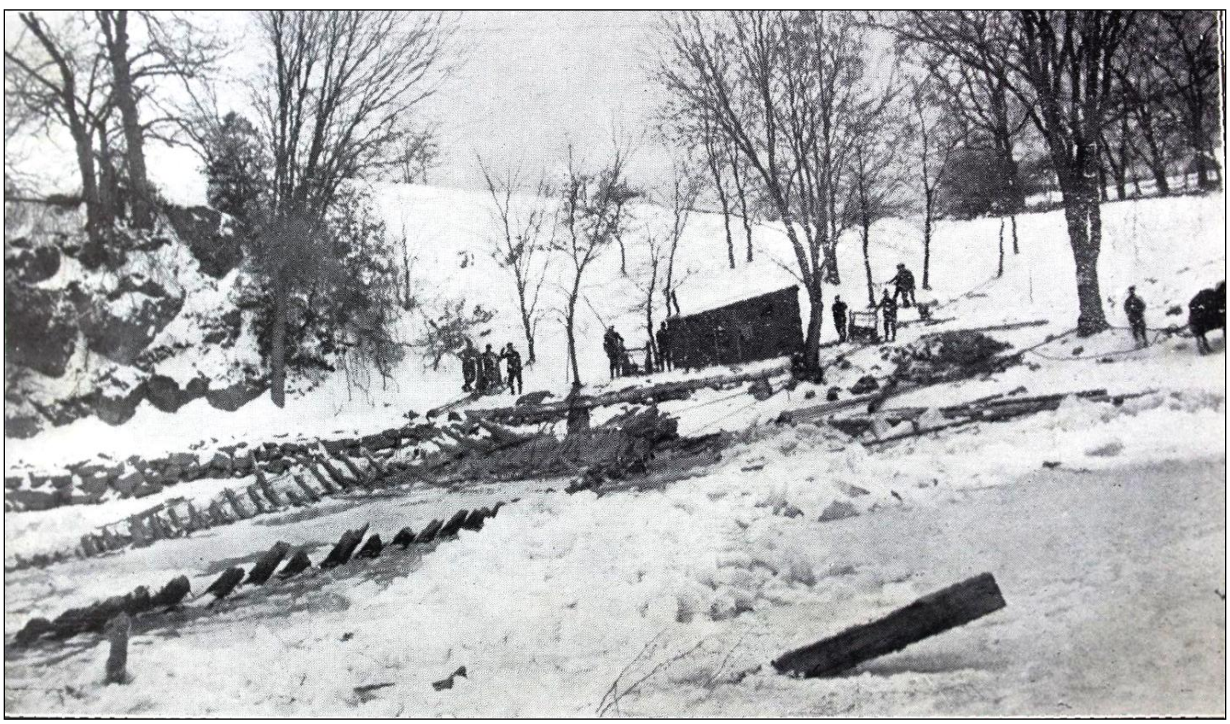

Figure 7 Dragging *Duke of Cumberland* ashore. (Courtesy of Fort Ticonderoga Museum)

Figure 8 *Duke of Cumberland* and the Tercentenary Celebration Committee (1). (Courtesy of the Adirondack History Museum)

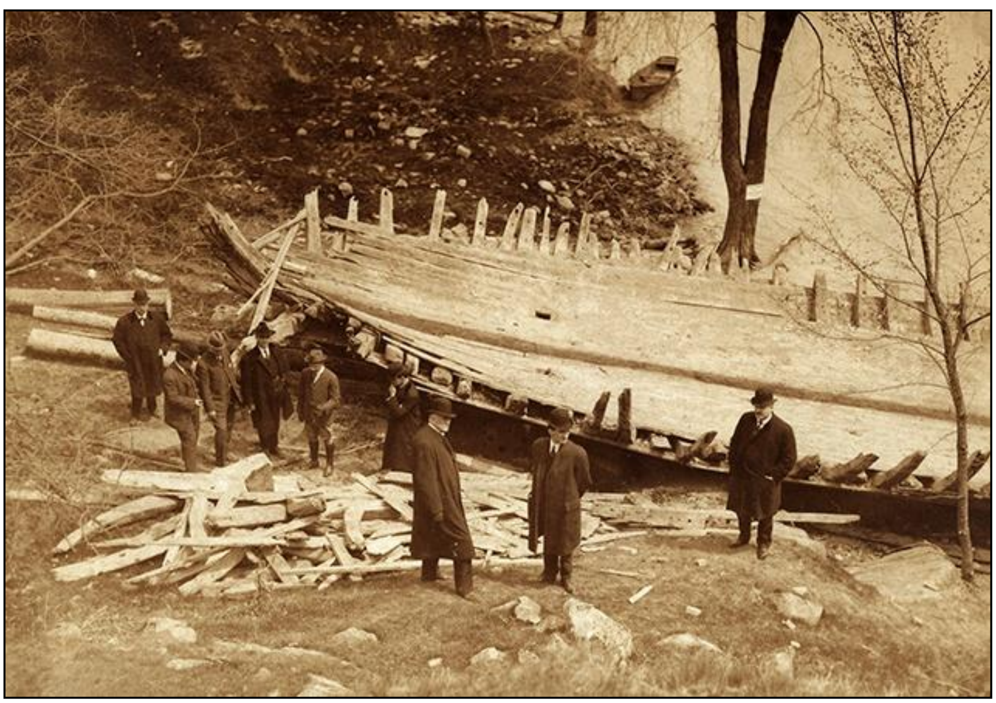

Figure 9 *Duke of Cumberland* and the Tercentenary Celebration Committee (2). (Courtesy of the Adirondack History Museum)

Figure 10 Sarah Pell and a friend near the stern of *Duke of Cumberland*. (Courtesy of Fort Ticonderoga Museum)

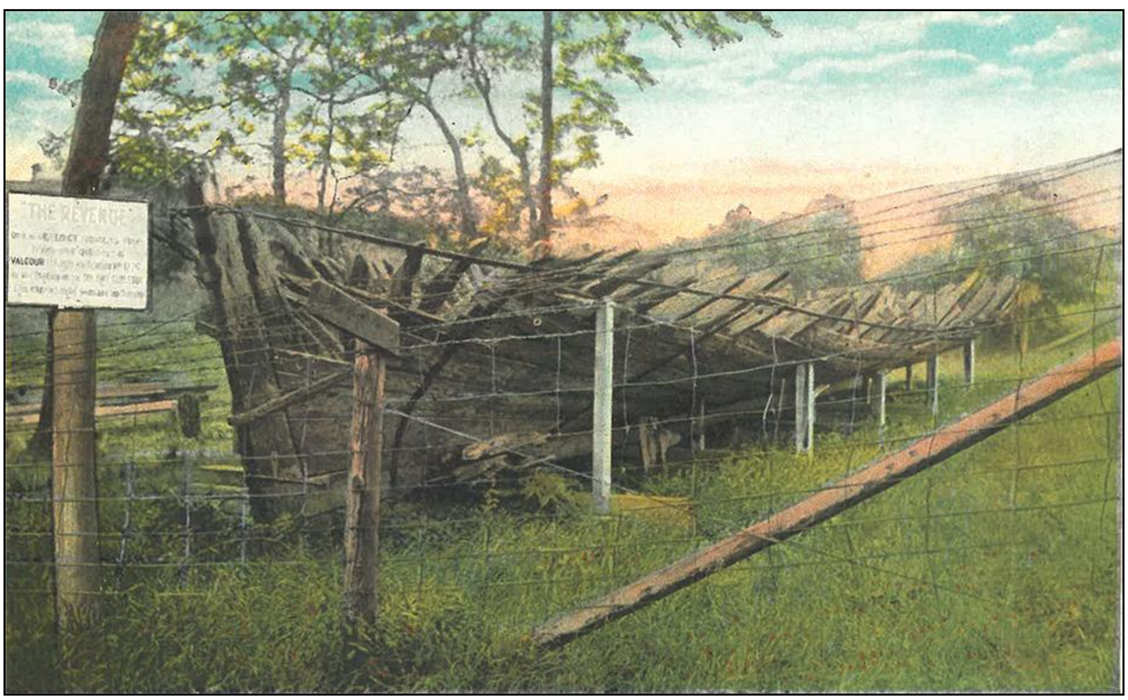

Figure 11 A colorized photographic postcard showing *Duke of Cumberland*'s stern. (Author's personal collection)

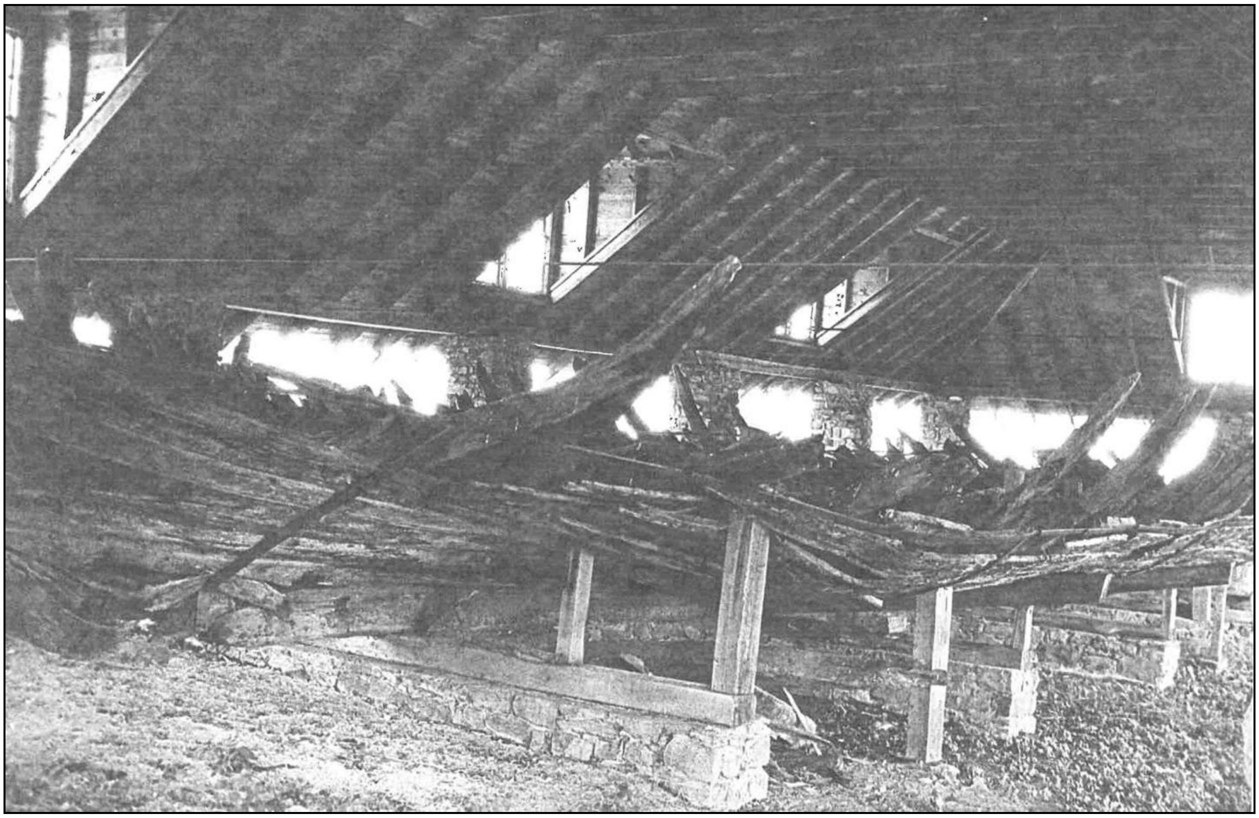

Figure 12 *Duke of Cumberland* and the shed (which later collapsed on the hull remains). (Courtesy of Fort Ticonderoga Museum)

Figure 13 *Duke of Cumberland* throughout the years (1). (Courtesy of Fort Ticonderoga Museum)

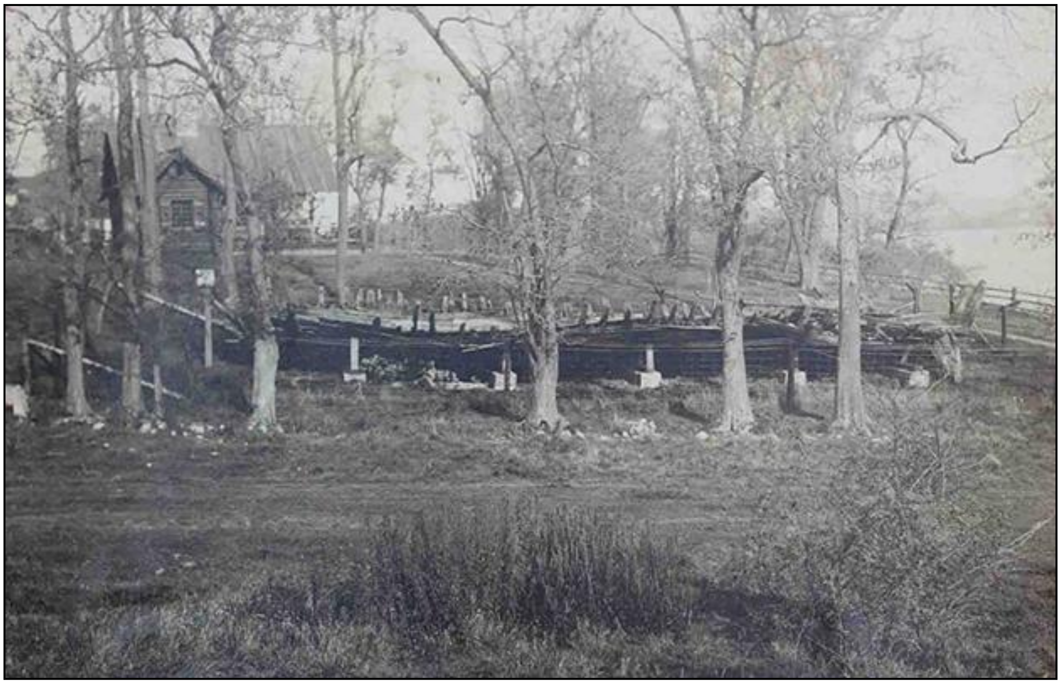

Figure 14 *Duke of Cumberland* throughout the years (2). (Courtesy of Fort Ticonderoga Museum)

Figure 15 *Duke of Cumberland* throughout the years (3). (Courtesy of Fort Ticonderoga Museum)

In 1903, another Seven Years' War vessel was raised from Lake George. Known today as the Tuttle Sloop or the Fort William Henry Sloop (1757), this vessel is likely one of the small British sloops burned and sunk by French forces during their retreat after attacking Fort William Henry in March 1757. After a plan to raise the wreck for display at the 1893 Chicago World's Fair fell through, William Tuttle of Glens Falls, New York, was awarded permission by state legislators to raise the hull remains to search for relics and treasure that were thought to be aboard the vessel. After removing ten tons of cobble ballast from the hull, the wreck was dragged on shore in 1903 with the assistance of the Delaware & Hudson no. 444 train engine. A number of artifacts were recovered from the hull, including buckles, buttons, pewter spoons, a clay pipe, knives, several flints, various ammunition, and a Spanish coin dated to 1743.[61]

Soon after the wreck was raised and moved to Fort William Henry Park, a number of its timbers were taken as material for making souvenirs.[62] Some of the timbers originally intended for souvenirs ended up in local museum and historical association collections. It is unclear how much of the vessel was dismembered, but it is likely that during a beach cleaning effort in 1920, the decayed remains were removed and burned.[63] Several photographs of this raised wreck have survived (although fewer than those of *Duke of Cumberland*), which are of paramount importance for archaeological research on vessels from this period (see Figures 16–18).

[61] This list of artifacts appeared on the back of each 1903 photograph of the raised sloop; the photographs are part of the Queensbury (NY) Town History Collection from the Lake George Historical Association.
[62] As of now, we know that a few wooden gavels, two candlesticks, and a clock were made from timbers from this vessel.
[63] "Improvement of Beach at Lake George," 24 June 1920.

Figure 16 A port stern view of the Tuttle Sloop. (Courtesy of the Lake George Historical Association)

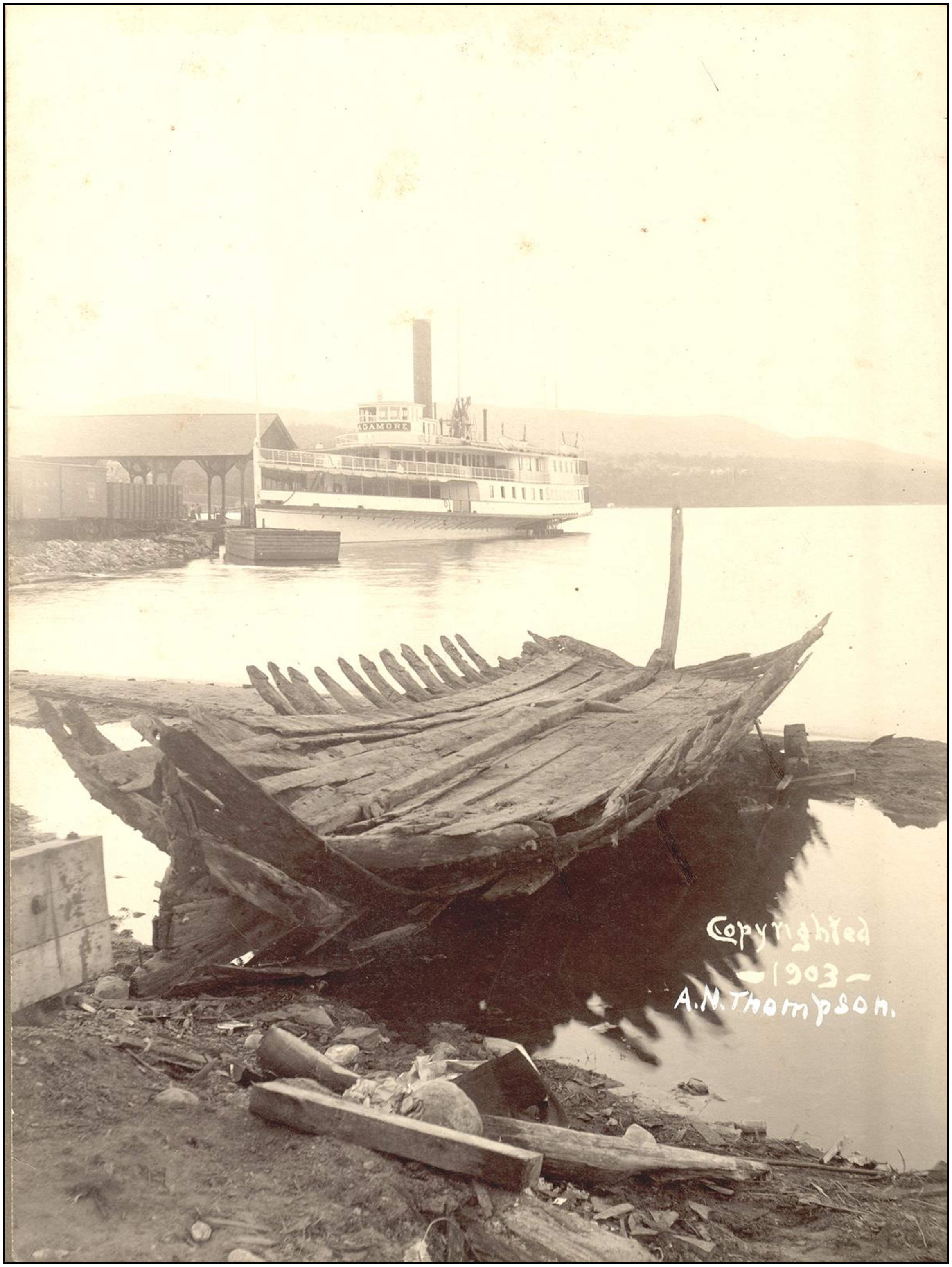

Figure 17 A starboard stern view of the Tuttle Sloop. (Courtesy of the Lake George Historical Association)

Figure 18 A port view of the Tuttle Sloop. (Courtesy of the Lake George Historical Association)

CHAPTER III

ASSOCIATED ARCHAEOLOGICAL WORK

Archaeological Investigations of **Boscawen** *(1983–1985)*

In 1983, the Champlain Maritime Society led a survey of south Lake Champlain, focusing its efforts on the waters around Fort Ticonderoga and Mount Independence. The survey team consisted of Kevin Crisman, Arthur Cohn, Anne Erwin, Scott Cooper, and William Bayreuther. They conducted this survey in the hopes of locating the remains of the Great Bridge that previously connected those key locations during the War for American Independence. On August 14, 1983, the survey began southeast of Fort Ticonderoga at the "old landing"—the western terminus of the Great Bridge and the former location of the King's Shipyard from the Seven Years' War.

During the survey, the team first located the remnants of Fort Ticonderoga's nineteenth-century steamboat wharf, which consisted of large wooden cribs filled with rocks. The support caissons of the Great Bridge, located soon after, were similar in construction. Each comprised stacked round logs, notched to fit together log cabin style and fastened at the corners with wooden treenails. The 24-foot-square (7.3 m^2) cribs were floored with logs and rough-finished planks and filled with stones to hold them on the bottom.[64]

An unexpected finding of the survey team was the remains of three vessels, each with eroded frame ends and stem and sternpost tips protruding above the sediment line. In the shallow water (around 15 feet [4.6 m]), the survey team measured the extent of the hull remains and recovered and recorded a few artifacts to shed light on the vessels' identities. The first wreck they found (KS-1) was over 50 feet (15.2 m) long and the next was even larger (later identified as

[64] Cohn, "The Fort Ticonderoga King's Shipyard Excavation," 338.

Boscawen), measuring over 65 feet (19.8 m) long.[65] The third wreck (KS-2) was a small, flat-bottomed vessel of indeterminate length. From the small test pits they dug, they recovered iron hooks and spikes, a polished stone ax head, and a brass spoon handle.[66] After photographing and recording the artifacts, they were reburied on the wrecks. Together, the hull dimensions, the artifacts, and further research into historical documents led the team to conclude that these wrecks likely dated to the Seven Years' War and were some of the earliest sailing vessels built on the lake (Figure 19).

The 1984 and 1985 Excavations

John H. G. Pell, the President of the Fort Ticonderoga Association at this time, understood the paramount importance of the 1983 survey and subsequent underwater excavations and provided considerable historical, logistical, and financial support for the project.[67] The team decided to focus its efforts on excavating the largest of the three hulls surveyed, the only one to be tentatively identified. Based on the wreck's size, location within the shipyard, and other historical documentation, they believed that the remains were those of *Boscawen*, the British sloop built at Ticonderoga in 1759.

A team was formed to excavate and document the wreck in the summers of 1984 and 1985 (see Figure 20 for *Boscawen*'s artifact distribution map): Arthur Cohn and Kevin Crisman served as project directors; Anne Erwin, Scott Cooper, William Bayreuther, and David Andrews as principal divers and excavators; Terry Stone and Peggy Zak as artifact illustrators and

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[65] I have chosen to include imperial values whenever they concern measurements related to British colonial vessels, since they were originally built using this system.
[66] Cohn, "The Fort Ticonderoga King's Shipyard Excavation," 339.
[67] The state of New York renewed and approved the project proposal and issued a permit for the investigation. All artifacts recovered would remain the property of the state, although the items were to be curated by, and remain on loan to, the Fort Ticonderoga Museum.

cataloguers; Heidi Miksch as artifact conservator; Eric Tichnouk and Lee Erwin as dredge tenders and dive support; Daniel Brown as project photographer; and James Squire, William Noel, Patty McGeorge, and Jason Mills as project assistants.

The team placed a grid system over the wreck to aid in the systematic excavation of the wreck and the accurate recording of artifact provenience within it. For the grid material, they settled on Kindorf channel, a steel channel used by electric contractors, which was manufactured and donated to the project by Midland Ross. The Kindorf channel allowed the team to construct two 25-foot-square (7.62 m^2) grids, with 5-foot-square (1.52 m^2) subdivisions for excavation units[68] that could be placed in sequence over the hull (see Figure 21).

The archaeological team had a number of safety and security concerns, including limited underwater visibility, livestock along the waterfront,[69] and recreational boater traffic (see Figure 22). The team consulted with the Coast Guard and established a "Safety Zone" around the dive site with marked buoys, and communicated with local boaters and marinas about the project, explaining the need to maintain a safe distance from divers on the site.

To excavate the shallow site, the team used two dredge pumps (2 inches in diameter) and flexible hoses with induction heads to move silt away from the area. They kept a third pump on-site as a backup. At the terminal end of each dredge system, a fine-mesh bag was attached to act as a screen, allowing silt and sediment to pass through but not debris or artifacts that were unknowingly sucked up. The pumps were operated from a single raft anchored just outside *Boscawen*'s remains so that the dredge tenders could keep an eye on diver bubbles from the surface and monitor the dredges and keep them running (see Figure 23).

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[68] Each unit was assigned a unique number to simplify excavation recording processes.
[69] Arthur Cohn wrote, "We discovered that we were to share the waterfront with a herd of approximately forty cows. Besides making walking hazardous, the cows congregated under the boathouse and rubbed against the building supports. Peaceful co-existence was established by our building a fence around the immediate working area." Cohn, "The Fort Ticonderoga King's Shipyard Excavation," 346.

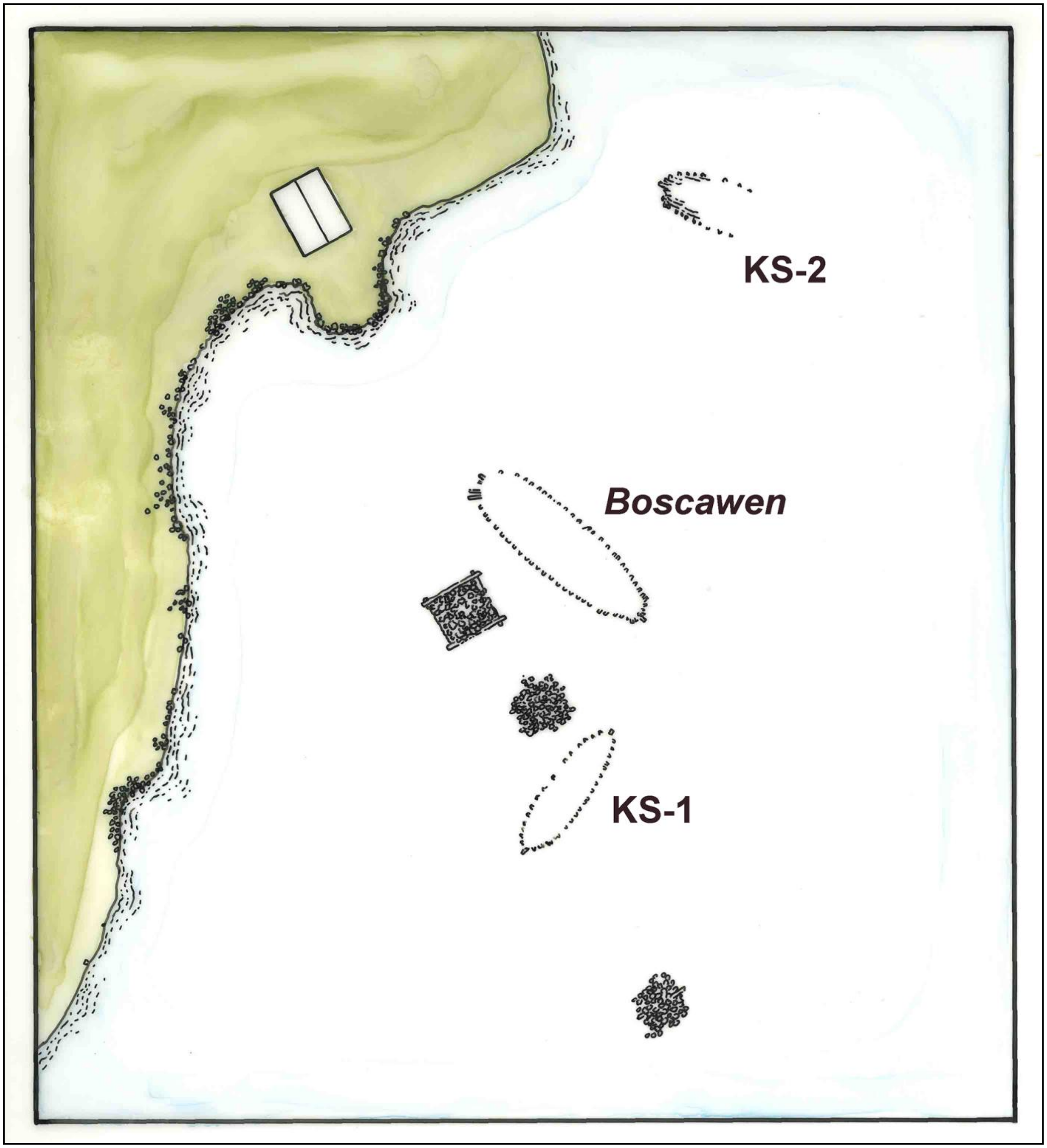

Figure 19 The vessels' frame tips and timber caisson locations at the King's Shipyard site. (Drawn by Kevin Crisman)

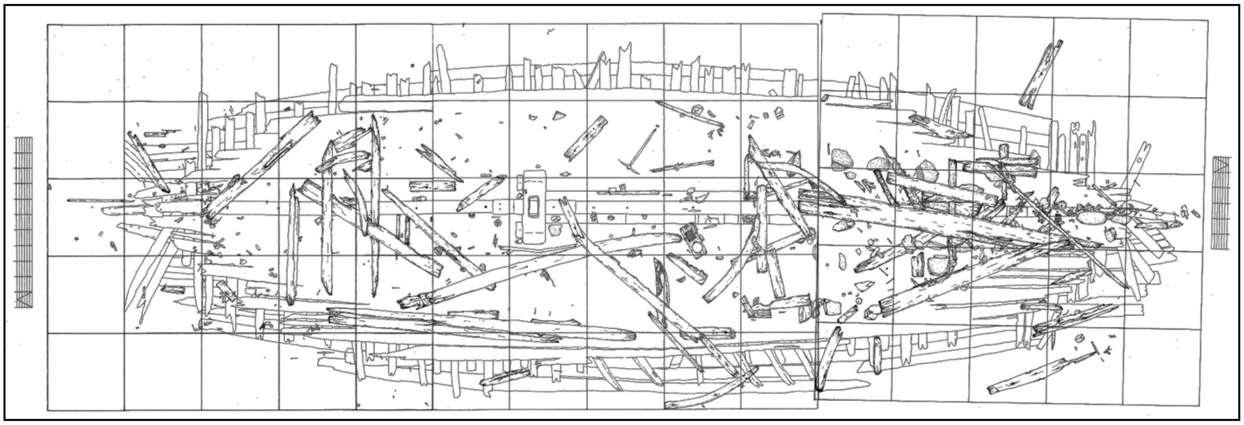

Figure 20 *Boscawen*'s artifact distribution map. (Drawn by Kevin Crisman and Gail Erwin)

Figure 21 The archaeological team preparing the Kindorf grid. (Courtesy of Kevin Crisman)

Figure 22 Archaeologists sharing the shoreline with cows. (Courtesy of Kevin Crisman)

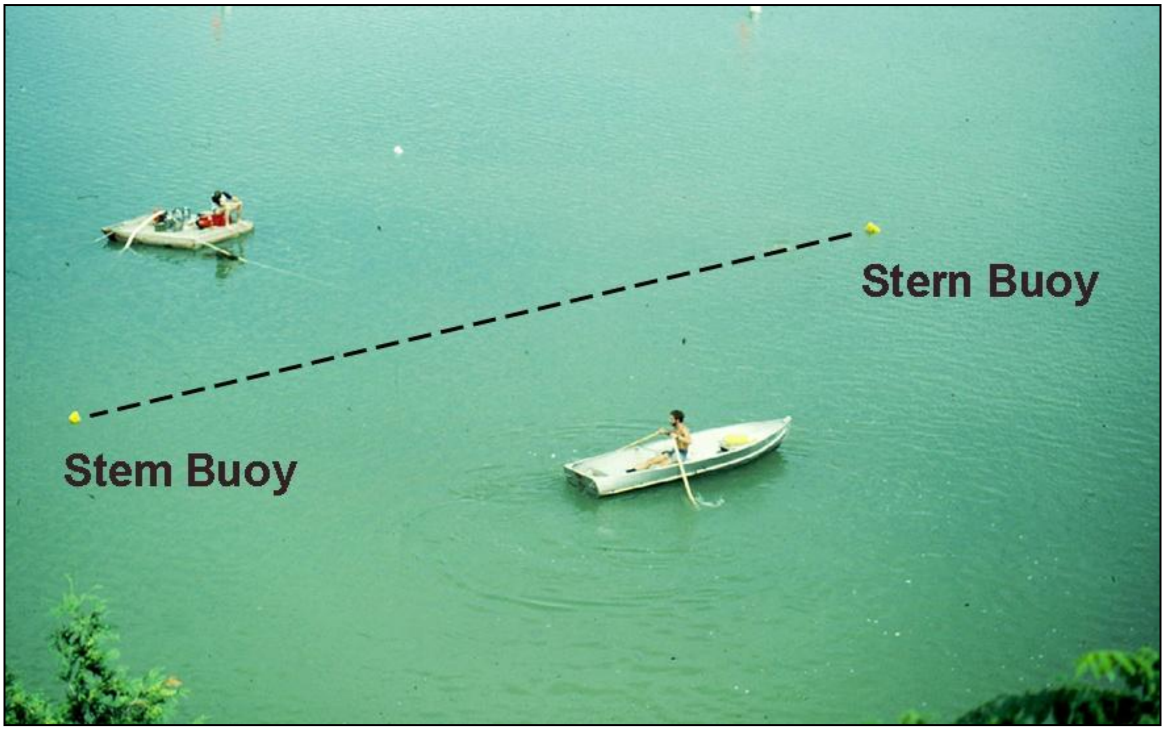

Figure 23 The *Boscawen* site and the dredge raft. (Courtesy of Kevin Crisman)

The team worked in groups to excavate and record specific 5-foot-square (1.52 m^2) sections of the hull. During each ninety-minute shift, divers removed the sediment in 4-inch (10.2 cm) increments, changing the dredge bags every layer, until artifacts, loose timbers, and internal hull components were exposed. Each level of sediment removed was assigned a letter (starting with "A" and continuing through the alphabet), until no sediment remained over the hull.

The divers then measured and sketched the artifacts, timbers, and hull features (relative to the unit's boundaries) and recorded their findings in pencil on plastic drafting film. Because *Boscawen* was built using the imperial system of measurement, all dimensions were recorded in feet and inches in an effort to better observe the intentional construction and assembly decisions made by the sloop's carpenters.[70]

Special attention was given to the recording of key hull components such as the stem, stern, mast step, and frames. To record angles of specific timbers or the curvature of features like the frames, a manual goniometer (an angle-recording device) was used. To ensure accurate recording of frame curvatures (where the outside edge of the frame meets the outer hull planking), the archaeologists removed portions of the ceiling planking fastened over the frames on the port side. The port side was favored for recording the frame sections because the hull remains listed to that direction, thus enabling better timber preservation.[71]

At the end of each dive, divers worked on their excavation records, interpreting what they uncovered and transcribing their underwater sketches and notations for clarity and accuracy. This process continued until the entire hull was exposed and all artifacts and loose timbers were recorded.

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[70] Crisman, "The Construction of the *Boscawen*," 357–358.
[71] Crisman, "The Construction of the *Boscawen*," 358.

In the final year of the excavation, Crisman, Cohn, and a few others collaborated on a series of articles that examined some of the vessel's history, excavation, hull documentation, and artifacts. These articles were published together in *The Bulletin of the Fort Ticonderoga Museum*.[72]

Conservation of Boscawen*'s Artifacts*

The 1984 and 1985 excavations yielded over 5,000 artifacts, nearly fifty times the amount the team had originally anticipated finding. This underestimation was due to the fact that the number of artifacts located in the 1983 test pits in *Boscawen* was not representative for the rest of the hull.

After being mapped under water, the artifacts were typically brought up by the divers in plastic bags or boxes, or on trays and screens for the more delicate finds like leather, rope, and other rigging elements. Some artifacts, as mentioned previously, were recovered in the dredge bags. The contents of the bags, after they were brought to the shore, were screened for small, overlooked artifacts such as brass pins and buttons.

All artifacts were processed similarly: After being recovered and cleaned, all were catalogued and tagged. Field conservator Heidi Miksch and her assistants photographed and recorded information about each artifact, noting the location (unit and excavation level) and date of recovery, along with a brief description of the artifact's condition and the diver team that had recovered it. Scale drawing of many of the artifacts were also prepared at this time. Artifacts

[72] *The Bulletin of the Fort Ticonderoga Museum* 14, no. 6 (1985). *Boscawen* is also featured in Bass, *Ships and Shipwrecks of the Americas: A History Based on Underwater Archaeology*, 129–148.

were separated into one of six major material categories: organic (general), wood, leather, inorganic (general), metals, and ceramics and glass.[73]

The organic artifacts recovered on this project were brought back to an archaeological conservation laboratory in Groton, Massachusetts, under the supervision of Betty Seifert. In her brief article in *The Bulletin of the Fort Ticonderoga Museum*, Miksch explained how the conservation treatment largely consisted of impregnating the artifacts with polyethylene glycol (PEG) and allowing them to air or freeze dry.[74] The specific treatment steps used (including the molecular weight of the PEG) are unclear.

Miksch did not offer specific information regarding the methods used to treat the metal artifacts. After personally examining the *Boscawen* artifact collection, I presume that the Groton laboratory used electrolytic reduction (ER) with tannic acid and microcrystalline wax as the treatment method for ferrous artifacts.[75] For the remaining metallic artifacts (plumbous and cupreous), it appears that the Groton laboratory only cleaned their surfaces before sealing them in microcrystalline wax.

Master's Theses on **Boscawen***'s Artifact Assemblages and Interpretation*

Boscawen's artifact collection in Fort Ticonderoga Museum's repository is one of the largest assemblages from a mid-eighteenth-century vessel in the world. The collection has been the source of a number of research projects, including four master's theses completed at Texas A&M University. Each thesis not only catalogues specific artifacts found on board but also

[73] Miksch, "The Conservation Program," 371.
[74] Miksch, "The Conservation Program," 374.
[75] Some of the iron artifacts were not conserved in the Groton Lab, but at Texas A&M University's Conservation Research Laboratory by Alan Flanigan and David Grant in the 1990s. They used ER to conserve these remaining items following the conservation methods outlined in Hamilton, *Basic Methods of Conserving Underwater Archaeological Material Culture*.

provides important analyses of the assemblages, contributing to our understanding of life on colonial vessels. The theses also examine how the provincial forces were supplied (compared to their British counterparts) and demonstrate how the colonial vessels built for use on Lake Champlain were extensions of the terrestrial fortifications and invariably tied to the landscape around the lake.

In 1994, Gail Erwin completed her master's thesis, which focused on artifacts connected to life aboard *Boscawen*. Of the 5,000-plus artifacts recovered from the *Boscawen* excavations, Erwin determined that 1,345 were related to clothing, diet, and recreation. *Boscawen*'s personal-item assemblage and Erwin's analysis provide a fascinating glimpse into the people who served on board: what their uniforms and clothing looked like, what their diets consisted of, and how the crew spent their time outside of military duties.[76]

Brinnen Carter submitted his master's thesis on *Boscawen*'s armament in 1995. Carter analyzed a variety of artifacts, including musket parts and accessories, lead shot, pole arms, and artillery munitions. His interpretation of this assemblage reveals information about the supply lines to the interior at this time, the organization of the officers supervising the material, the quantity and diversity of outdated weapons and ordnance found in the bilges, and insights into the operation of *Boscawen* as an armed transport in 1760.[77]

In 1996, David Grant completed his thesis on the seventeen tools and tool fragments excavated from *Boscawen*. There were only a few complete tools related to the operation and maintenance of the vessel (carpenter's and shipwright's tools) for Grant to analyze. The bulk of

[76] Erwin, "Personal Possessions from the H.M.S. *Boscawen*." Liquor was somewhat regulated by the garrison commanders, but at Fort Ticonderoga and other interior garrisons, spirits provided a modicum of relief. Officers at Ticonderoga in 1760 formed the "Swizzle Club" and Colonel William Haviland accused them of "being addicted to Liquor… they don't take care of themselves and vessels." PRO, W.O.R 34/51:28. Haviland to Amherst, 26 May 1760.
[77] Carter, "Armament Remains from His Majesty's Sloop *Boscawen*."

the tool collection and Grant's interpretation and catalogue centered on the types of tools more commonly associated with the construction and upkeep of fortifications and siege earthworks and which were likely transported as leftover military stores after the war.[78]

Alan Flanigan submitted his thesis in 1999 on the ninety artifacts recovered from *Boscawen* related to rigging. The artifacts and construction features Flanigan contextualized with historical documents include the mast step, mast cap, deadeyes, blocks, sheaves, parrel beads and trucks, fairleads, iron hooks, rope, and leather parcelling. Flanigan's research provides a glimpse into military organization at the time, the acquisition and manufacture of rigging material in colonial America, and Loring and Amherst's decision-making process that went into rigging the British naval force on Lake Champlain.[79] Flanigan's research proved essential for my recent reinterpretation and reconstruction of *Boscawen*'s rig.[80]

Although each thesis examines a separate artifact assemblage from *Boscawen*, they all come to a similar conclusion about the wider trends seen across military sites in colonial America, especially in the interior. The artifacts found on *Boscawen* indicate that North America was likely used by both the British and the French as a dumping ground for old military supplies and may have been considered less consequential for military strategists and quartermasters. The less stringent adherence to standardization and regulation, the poorer quality of the personal items, the underprovisioning of victuals, and the use of outdated armament and munitions collectively point to this interpretation.

In addition, the conclusions of the four theses fit within the wider context of the abandonment of British fortifications and associated material (such as vessels) in the interior after the conclusion of the Seven Years' War in North America. These structures and their

[78] Grant, "Tools from the French and Indian War Sloop *Boscawen*."
[79] Flanigan, "The Rigging Material from *Boscawen*."
[80] See Chapter IV for a more in-depth analysis of *Boscawen*'s rig and the reconstruction.

already-outdated materials were forsaken and left to decay because their maintenance and repair were not considered a primary objective by policymakers in England.

Investigations of **Duke of Cumberland** *(1985, 1999, and 2018)*

In 1983, archaeologists Kevin Crisman and Arthur Cohn conducted a brief survey of *Duke of Cumberland*'s remains on the property of Fort Ticonderoga, measuring the principal dimensions of the wreck and recording some of the visible construction features.[81] They also recovered two iron artifacts—the vessel's lower gudgeon and stern post dovetail plate—to prevent their loss to souvenir hunters or natural degradation. It was also during this survey that they concluded the vessel was not *Revenge*, as originally identified by Stephen Pell in 1909, but rather *Duke of Cumberland*. The principal dimensions of the wreckage, historical research, and archaeological evidence from *Boscawen* all reinforce this new identification. Cohn and Crisman did not conduct any additional research or analysis on this site.

Another examination of the *Duke of Cumberland* wreck was organized in August 1999. This time, Chris Fox (then Curator of Collections at Fort Ticonderoga Museum) along with local archaeologists Scott Padeni and Frank Schlamp conducted a brief survey of the now nearly decomposed remains of the brig (see Figure 24). They drew a basic site plan, dug test pits, and recorded surface finds, including iron fasteners, two gunflints, a burned bone fragment, and a salt-glazed stoneware (scratch blue ceramic) sherd (see Figure 25).[82]

In the summer of 2018, I conducted a brief survey and surface recovery of visible iron fasteners on the site with Margaret Staudter, one of Fort Ticonderoga Museum's site registrars and archaeologists. By that time, the hull had fully decomposed into the wooded hillside. We

[81] Historian Russell Bellico also came to the site in 1984 and took pictures of the decaying hull.
[82] No formal report was generated from this 1999 survey, but some of the photographs and basic site and unit drawings are kept at the Thompson-Pell Research Center at Fort Ticonderoga Museum.

recorded the locations of the few recovered fasteners, the surviving foundation blocks, and the nineteenth-century metal support structure in an overall site plan (see Figures 26 and 27). I brought the recovered fasteners and the *Duke of Cumberland* artifacts collected in 1909 to Texas A&M University's Conservation Research Laboratory (CRL) for conservation treatments.

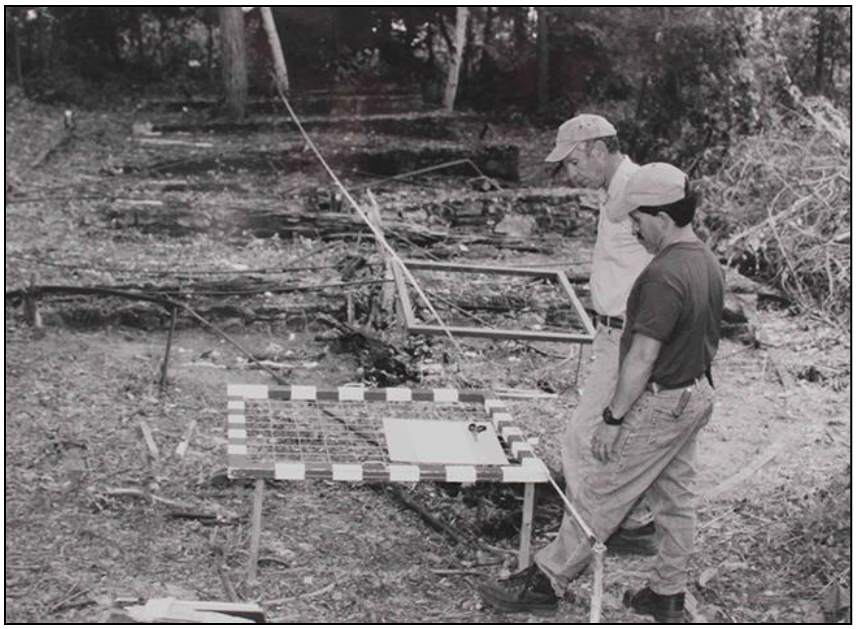

Figure 24 Archaeologists examine one of the grid squares at *Duke of Cumberland* site in 1999. (Photo by Russell Bellico)

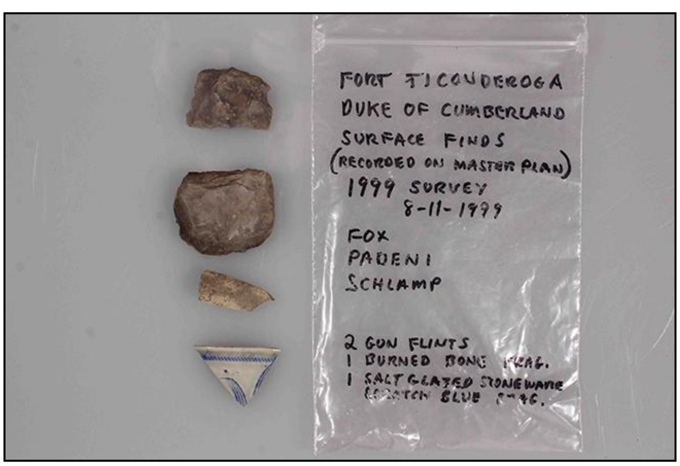

Figure 25 Artifacts recovered during the 1999 *Duke of Cumberland* survey. (Photo by Russell Bellico)

Figure 26 The *Duke of Cumberland* site in 2018. (Photo by author)

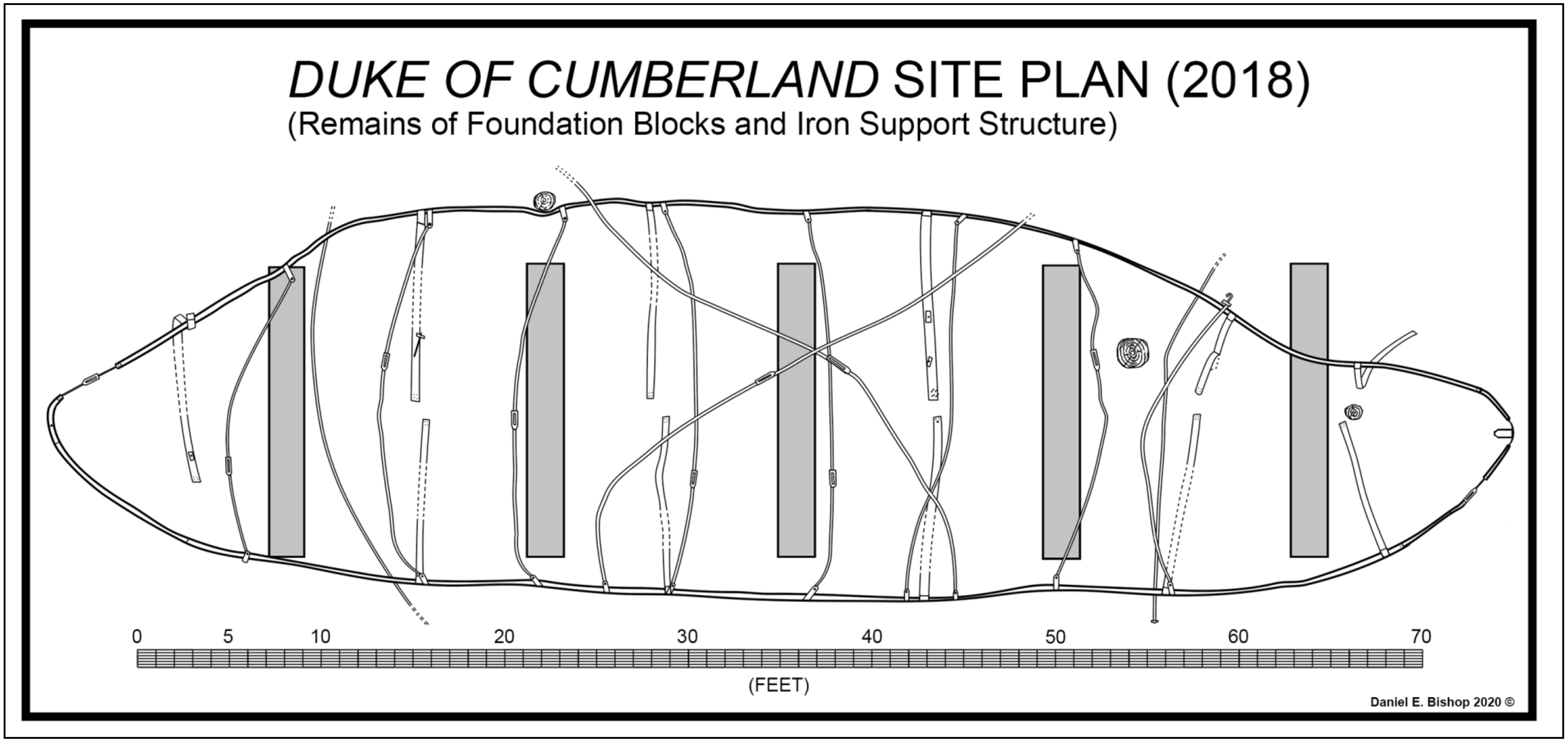

Figure 27 *Duke of Cumberland* site plan (2018). (Drawn by author)

There is still on-site work that should be done for *Duke of Cumberland*. I have discussed with Fort Ticonderoga Museum's staff the potential to conduct a more in-depth survey of the entire site to record and recover the remaining fasteners. In addition, I believe that the metal support structure could reveal additional information about the brig's hull shape at the time it was raised from the water in 1909. The lake bottom where *Duke of Cumberland* was raised could likewise be surveyed to better understand site deposition and to locate associated artifacts.

Archaeological Investigations of Lake George's Colonial Vessels (1960–2000)

During the French capture of Fort William Henry in March 1757, a large number of buildings and vessels (including bateaux and sloops) were destroyed. In August of that year, French forces under Montcalm successfully forced the surrender of the British garrison. However, they would soon abandon Fort William Henry and retreat to Fort Carillon (Ticonderoga) in fear of stretching their forces too thin. Before their retreat north to Lake Champlain, French forces seized the opportunity to destroy as much of Fort William Henry as they could and to burn a considerable portion of the British naval force on Lake George.

The next year, the British began to rebuild their Lake George flotilla. In addition to building many new bateaux and one small radeau, Captain Samuel Cobb built a large radeau named *Land Tortoise*. Because there was no significant garrison of British troops at Fort William Henry to protect these new vessels from enemy attempts to burn them (as had happened in the winter of 1757), the British decided to intentionally sink their vessels, with plans to raise them the following spring. In October 1758, British troops scuttled their sloop *Halifax*, the two radeaux, a few rowed galleys, and 260 bateaux. Their attempt to sink *Land Tortoise* did not go as planned: as they were scuttling the large radeau, it drifted into deeper water and sank outside the intended area. The following spring, the British could not locate the vessel and had to hastily build another radeau, *Invincible*. In addition, many of the other vessels (primarily bateaux) from the "Sunken Fleet of 1758" were not recovered.[83]

Bateaux Projects (1960s, 1990s, 2015)

The bateaux of Lake George have gone through an unfortunate series of disturbances in the years since they were intentionally sunk. In 1960, fourteen bateaux were discovered by teenage divers. Three of those bateaux were raised by US Navy divers and conserved by staff from the Smithsonian Institution and the Adirondack Museum, who used an early version of the PEG treatment.[84]

Between 1963 and 1964, a more formal survey called "Operation Bateaux" was conducted in the area where the three bateaux had been raised. These new efforts revealed an additional thirty colonial bateaux. The bateaux discovered in the 1960s all showed signs of deliberate sinking (holes had been drilled in their bottoms and some were filled with rocks). Various artifacts were recovered from these bateaux, including clay pipe fragments, musket and bird shot, and cuff links.[85]

Following the 1964 survey of these bateaux, the site was used as a training ground for the New York State Police. During these training exercises, many of the bateaux were damaged and looted, and the site was greatly disturbed.[86] The site was additionally plagued over the years by

[83] This was not because they could not locate them but was because in 1759, British forces were prioritizing their assembly of a naval force for Lake Champlain.
[84] Gallagher, "The Lake George Bateaux," 30.
[85] Gallagher, "The Lake George Bateaux," 36; Zarzynski and Benway, *Lake George Shipwrecks and Sunken History*, 20–21.
[86] No measurements were taken, and no analysis was conducted.

recreational divers wanting souvenirs, despite state laws prohibiting the disturbance and looting of archaeological sites.

In 1987, New York archaeologists Joseph Zarzynski and Duncan Mathewson led a workshop to teach recreational divers how to properly record underwater heritage. This group would later form Bateaux Below, Inc., which pursued efforts to locate, record, and preserve the sunken archaeological remains in Lake George. They conducted a number of surveys between 1987 and 1992 on the remaining bateaux of Lake George, including a group of seven (now known as the Wiawaka Bateaux Cluster).[87]

One of the three raised bateaux from the 1960s was displayed by the Adirondack Museum between 1966 and 1993. During this time (in 1986), Kevin Crisman and Arthur Cohn documented its timbers before the vessels were returned to the New York State Museum where they are currently in storage.[88] This documentation served as the focus for Nathan Gallagher's master's thesis from Texas A&M University. Gallagher evaluated and compared the construction and design of the previously recorded bateaux to others located in northeastern North America.[89]

The Radeau: Land Tortoise *(1991–1994)*

After it was discovered in 1990, *Land Tortoise* was surveyed between 1991 and 1994 by Bateaux Below, Inc. and volunteer divers. The archaeological team, working under a permit from the State of New York, recorded the 52-foot-long (15.85 m), 18-foot-wide (5.48 m) wreck and its peculiar construction features. Its heptagonal hull, made of oak and pine, had seven gunports, twenty-six sweep ports, and sharply angled sides. Its framing and side construction

[87] Gallagher, "The Lake George Bateaux," 37.
[88] Gallagher, "The Lake George Bateaux," 34. In his thesis, Gallagher noted how this off-site facility is not climate controlled and is harmful to the longevity of the wood.
[89] Gallagher, "The Lake George Bateaux."

consisted of sixteen hardwood frames with an adjacent knee serving as support for the upper sides.[90] To date, this is the only confirmed radeau to have been archaeologically recorded. After the survey, Bateaux Below, Inc. was authorized to install an underwater fence around the radeau to serve as a "passive protective reminder" for recreational divers who visit the site. *Land Tortoise* was registered in 1998 as a National Historic Landmark.[91]

Northern Lake George Survey, 1998

In 1998, Scott Padeni led an archaeological study, with assistance from Lake Champlain Maritime Museum and Bateaux Below, Inc., of the submerged cultural remains at the northern end of Lake George. Of the sixteen watercraft and other sites located in that survey, two are believed to be the remains of colonial-period vessels. The survey area, especially near the second colonial vessel (CV-2) was largely broken up. This may have been due to the site being disturbed by William S. Tuttle after he was given authorization by the New York legislature to remove sunken vessels from the lake during the late nineteenth and early twentieth centuries. Alternatively, these shallow sites may have been "blown out" from boat propeller wash from nearby marina traffic or pilfered for souvenirs by divers.[92]

The more intact of the two sites, CV-1, was surveyed in 1998. Ten feet (3.05 m) of the wreck's port bow framing components were exposed above the sediment line. The rest of the vessel remained buried beneath the silt. The exposed timbers were recorded, and the buried portion of the site was surveyed using probes to better understand the extent of the hull. The

[90] Bellico, *Sails and Steam in the Mountains*, 83.
[91] Bellico, *Sails and Steam in the Mountains*, 83.
[92] More about the Tuttle Sloop and the current research is has generated is covered later in this chapter.

small wreck's dimensions were estimated to be around 37 feet (11.3 m) long and 12 to 14 feet (3.7–4.3 m) wide.[93]

The CV-2 Project, 2000

Padeni returned to the colonial vessel sites in 2000 to investigate the more disturbed wreck, CV-2, since it was at a higher risk for further degradation. Because of the disturbed nature of the site, the wreckage covered roughly 400 square feet (122 m^2) of the lake bed (see Figure 28). The archaeological team surveyed the outer perimeter of the known site to ensure that all of the scattered remains associated with this wreck were observed. They also probed for the wreck's timbers beneath the sediment line with 4-foot-long (1.22 m) rods. No further remains were discovered outside the original site area.[94]

The hull remains were almost entirely disarticulated and fragmented, but the team was able to record a timber believed to be the stem, numerous planks, and other larger timbers that had treenails attached to them. Only a few artifacts, including a possible shot garland, were observed. The team also excavated a test pit under the debris site using a small grid and dredge; this investigation revealed additional buried disarticulated timbers, which were documented. However, further excavation was halted to prevent any more destabilization of the site. After the test unit was backfilled, the timbers recovered from the lake bed were relocated to a nearby cove and buried beneath the sediment.[95]

The team spent a few days reexamining the CV-1 site as well as some of the other submerged wreck sites nearby. During this resurvey, they observed that "a significant amount of

[93] Sabick et al., "Lake Champlain Underwater Cultural Resources Survey," 179.
[94] Kane and Sabick, "Lake Champlain Underwater Cultural Resources Survey," 210.
[95] Kane and Sabick, "Lake Champlain Underwater Cultural Resources Survey," 211–215.

silt had been removed from the vessel since the last inspection dive the previous summer."[96] They were unable to determine whether this sediment removal was a result of relic hunters or natural current and sediment shifting. Sixteen feet (4.9 m) of the wreck was exposed, revealing important hull features such as the mast step, false keel, and ceiling and outer hull planking (see Figure 29). Due to the increased disturbance of the site, additional signage was placed on the wreck to remind divers of the illegality of disturbing and removing artifacts from submerged wrecks.[97]

Figure 28 CV-2 site timber scatter. (Fig. 13-8 from Kane and Sabick, "Lake Champlain Underwater Culture Resources Survey") (Photo by Russell Bellico)

[96] Kane and Sabick, "Lake Champlain Underwater Cultural Resources Survey," 216.
[97] Kane and Sabick, "Lake Champlain Underwater Cultural Resources Survey," 216.

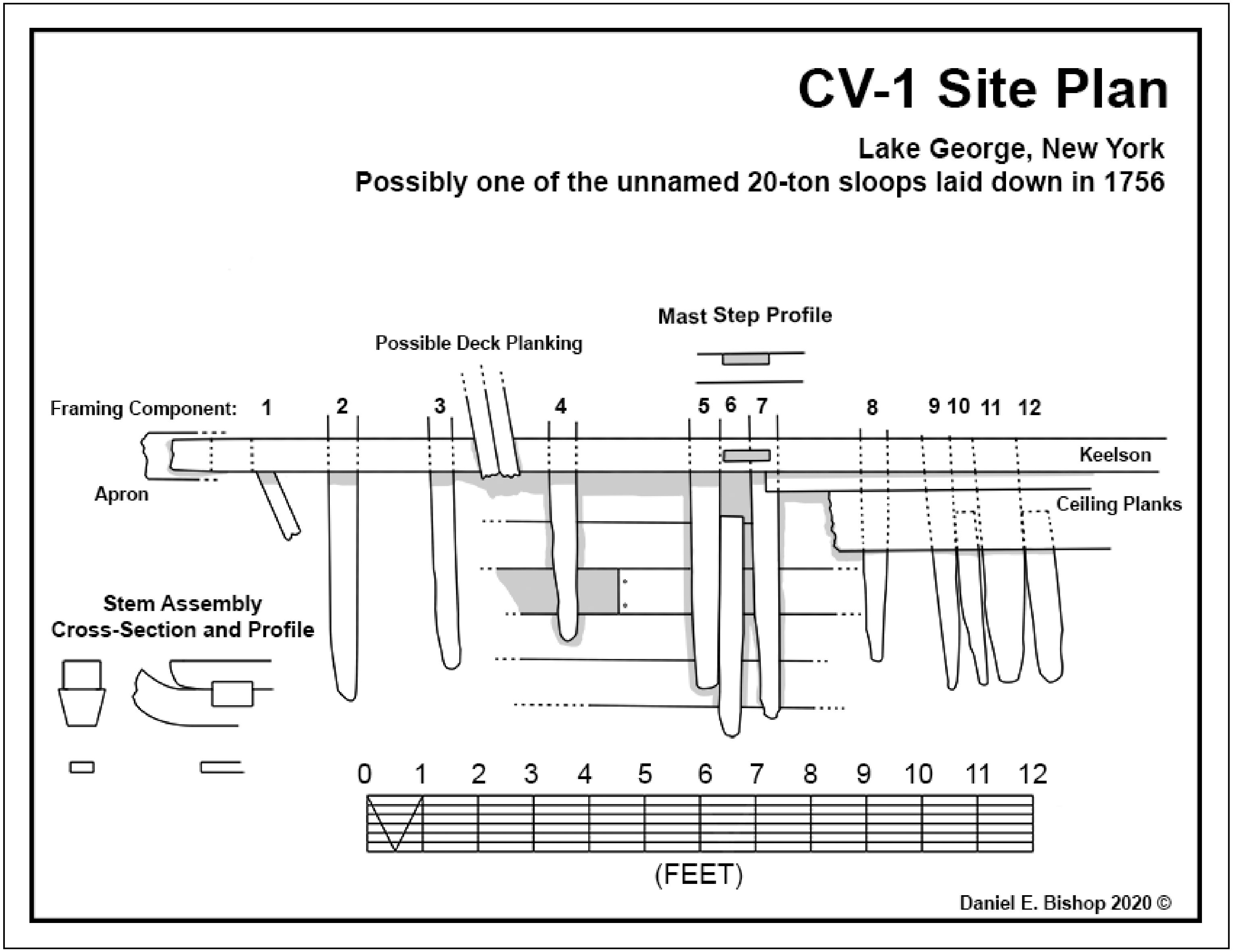

Figure 29 CV-1 site plan. (Based on unpublished CV-1 archaeological notes.) (Drawn by author)

Winter Geophysical Survey of the King's Shipyard (2019)

In late February 2019, I led a team of archaeologists in conducting a four-day through-ice geophysical survey over the King's Shipyard site off Fort Ticonderoga's shore to better identify the submerged cultural heritage sites located there. The team consisted of Dr. William Chadwick, a professor and geophysics expert from Indiana University of Pennsylvania; Dr. Chadwick's graduate student, Stephen Campbell; Lake Champlain Maritime Museum archaeologists Christopher Sabick and Cherilyn Gilligan; and Fort Ticonderoga Museum archaeologist Margaret Staudter.

The equipment used to conduct this survey consisted of two ground-penetrating radar (GPR) systems (models SIR 3000 and SIR 4000 from Geophysical Survey Systems, Inc.), supplied by Dr. Chadwick. Each unit was assembled in a three-wheel configuration with encoder wheels, a design that worked well with the site's varying conditions, which ranged from bare ice to a couple of inches of snow, to a slushy snow mixture on warmer days. Had deeper snow accumulated on the ice, we were prepared to reconfigure one of the GPR units to work on a sled system with an external survey wheel.

In addition, I borrowed a Geometrics G858 Magnetometer system from Dr. Mark Everett in Texas A&M University's Geophysics Department. The magnetometer was set up in the vertical gradiometer configuration, with its two cesium sensors spaced 1 meter apart. The gradiometer was placed in the "Continuous Mode," where it would collect data points at a fixed time interval (in our case, every second).

Half of the project's first day was dedicated to establishing a grid of thirteen 20-meter-square plots (5,200 m^2 total) aligned on the magnetic north–south axis. Placement of the grid was determined using the same shoreline compass sightings taken during the 1980s excavations that indicated the location of submerged material. The survey grid was focused largely around the remains of the British sloop *Boscawen* and included the area around other previously observed wrecks. The corners of the plots as well as other shore features were recorded using a total station.

Chadwick and Campbell were the primary operators of the GPR systems, and I was the sole operator of the gradiometer unit (to ensure that each transect was recorded at a consistent speed). Lake Champlain Maritime Museum and Fort Ticonderoga Museum staff contributed by maintaining transect accuracy, total station recording, and auxiliary GPR operation (see Figures 30 and 31).

The original goal was to record each plot with the GPR at 25-centimeter intervals along both the south–north and west–east axes. This "interweaving" of the axes would produce the highest resolution of the lake bed. All south–north transects (1,053 intervals in total) were recorded in the allotted four days, but due to time and weather complications, only one grid was recorded along the west–east axis (i.e., one of the plots above *Boscawen*).

The gradiometer transects were recorded along the south–north axis only, at 1-meter intervals (a total of 273 transects). Because the GPR units create an active magnetic field, the gradiometer needed to be operated at least 40 meters away from the other geophysical equipment. This constraint, along with battery limitations due to the cold weather, necessitated that I record four plots with the gradiometer on a fifth day. In addition, I recorded ice thickness and water depth at each plot corner with the assistance of Margaret Staudter and Frederick and Linda Bishop, using an ice chisel to break through the ice and a weighted tape measure to record the water depth and ice thickness. The ice measured between 15 and 33 centimeters thick over the survey area.

Each night, the team evaluated the latest raw GPR data, which helped determine the following day's grid priorities. The gradiometer data were processed using the G-858 MagMapper program, and each 20-meter-square plot was "stitched" together using the Surfer mapping and modeling software.

During these preliminary data evaluations, we noticed some irregularities in the magnetometer data for the southwestern and northeastern plots. In the southwestern plots, we experienced some unexpected magnetic interference, making it difficult to observe definable magnetic features (see Figure 32). Everyone was stumped as to why this interference was occurring, and it was not until the in-water survey during the summer of 2019 that we learned the reason (see next section). We also observed some interesting GPR data results: it appeared as though there were additional "wreck-shaped" anomalies in these southwestern plots (see Figures 33 and 34).

In the northeastern plots, we experienced some issues with "pings" and "drop-offs," which made us wonder if the cesium vapor in the sensors was not warming up properly due to the extremely cold temperatures we experienced on some of the days we recorded or whether the main console or the sensors were malfunctioning. It was later realized that this recording inconsistency was caused by the northeastern plots having essentially no magnetic signatures.

Preliminary data from the winter survey proved useful during the summer 2019 in-water survey when these geophysical features were "ground-truthed." The results of the geophysical survey continue to be analyzed and are contributing to the refinement of through-ice geophysical survey methodologies.

Figure 30 GPR operation on the ice. Stephen Campbell (foreground) and Dr. William Chadwick (background). (Photo by author)

Figure 31 Gradiometer operation on the ice. Daniel Bishop (foreground) and Margaret Staudter (background). (Photo by Christopher Sabick)

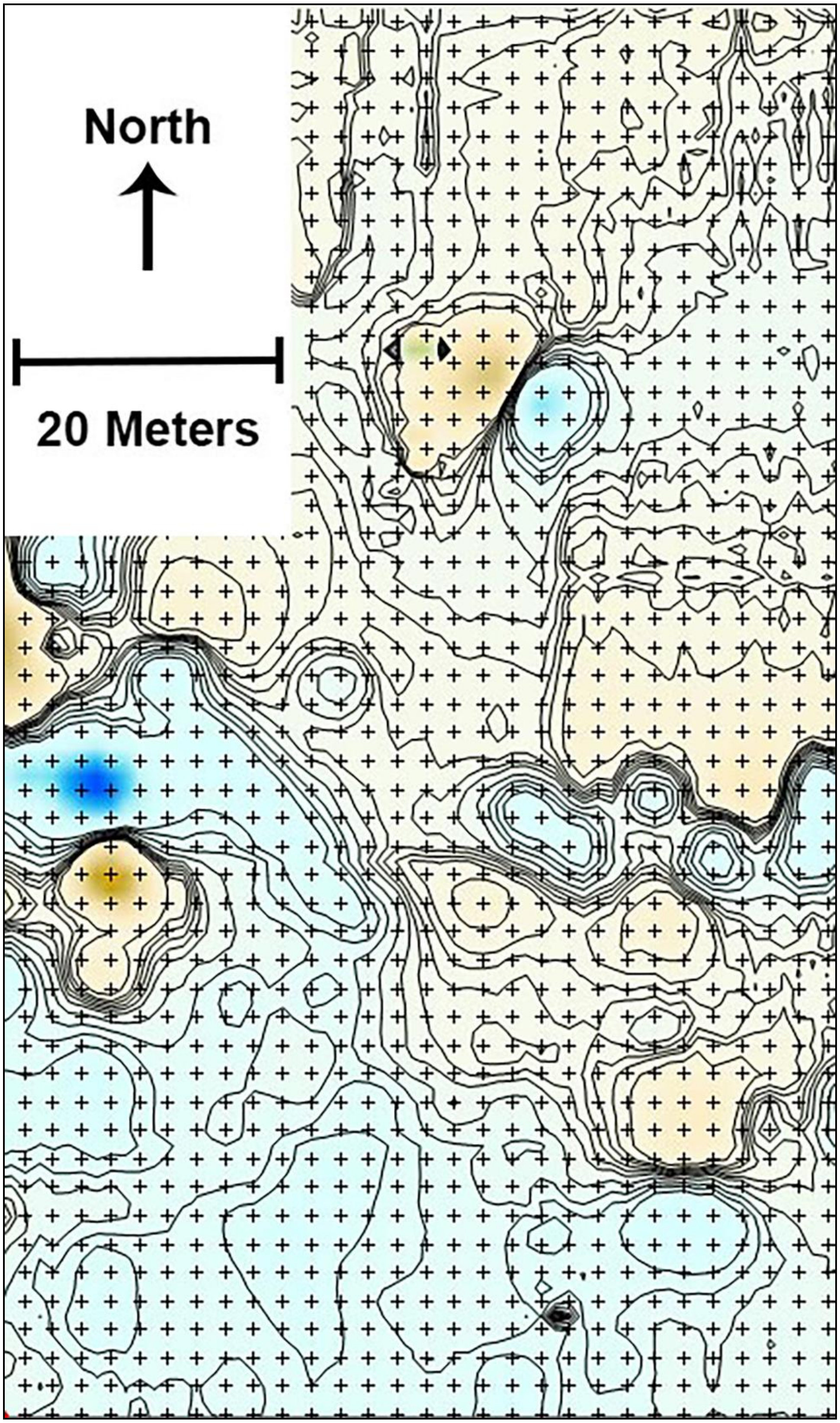

Figure 32 The King's Shipyard magnetic feature map.

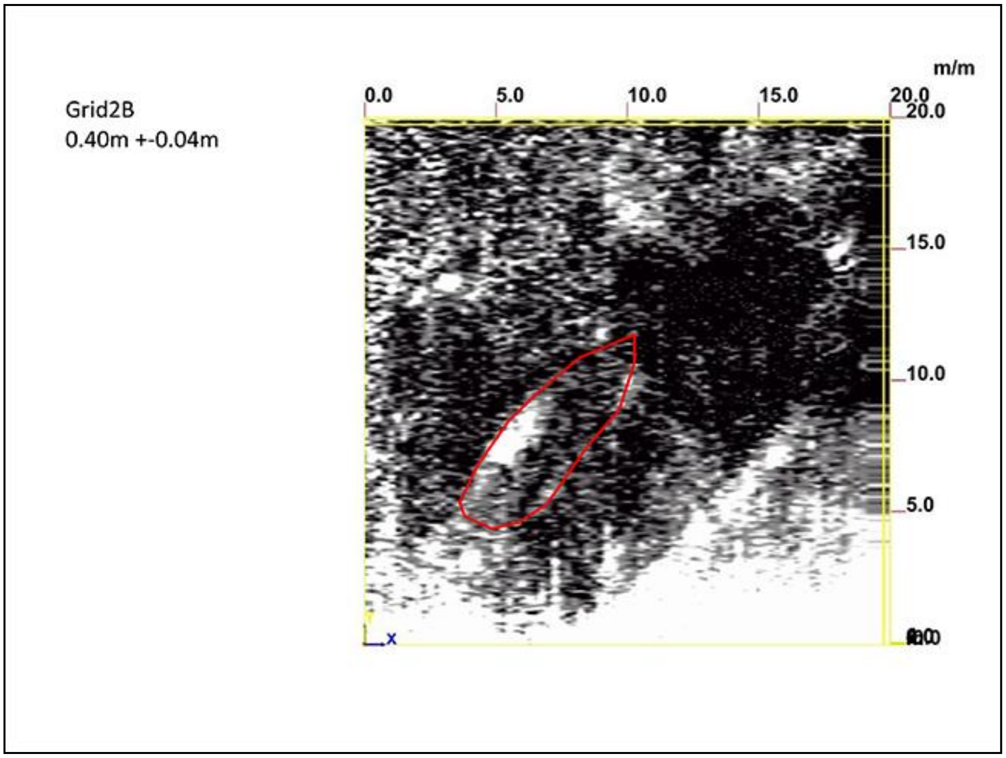

Figure 33 Wreck-shaped anomaly observed in the GPR data (1). (Image provided by William Chadwick)

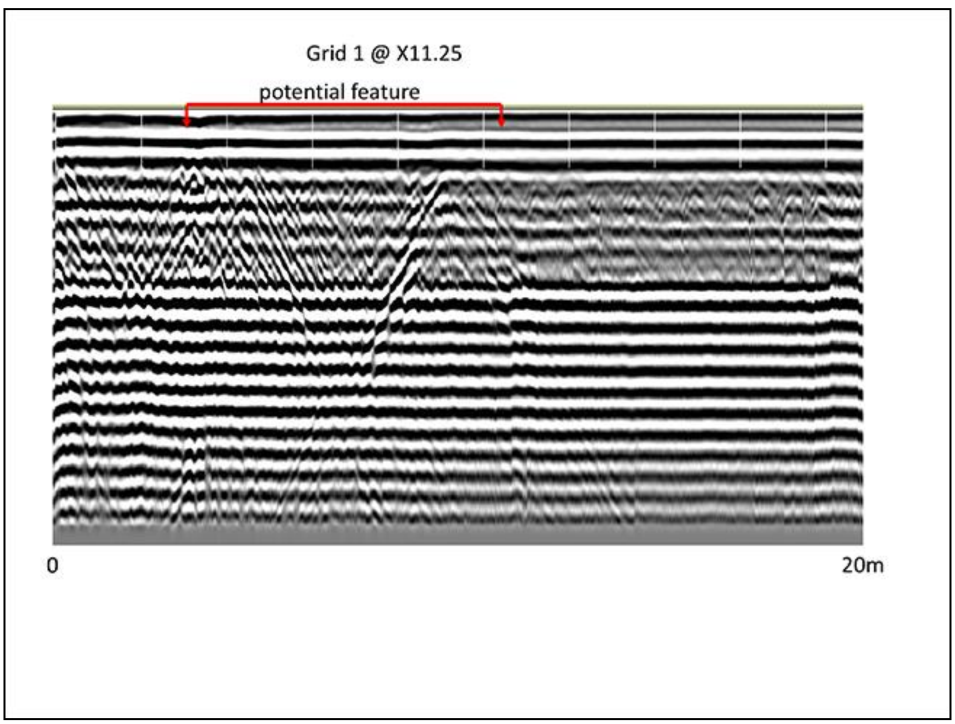

Figure 34 Wreck-shaped anomaly observed in the GPR data (2). (Image provided by William Chadwick)

Summer Archaeological Investigation of the King's Shipyard (2019)

In mid-May 2019, I led a six-week underwater investigation of the King's Shipyard site. The archaeological team included staff from Lake Champlain Maritime Museum: Christopher Sabick (Project Co-Director), Cherilyn Gilligan, Patricia Reid, and Sophie Stuart; graduate and undergraduate students from Texas A&M University: Ryan Theis, Julia Herbst, Mason Parody, Benjamin Ioset, and Nicole Deere; and local volunteer divers: Edwin Scollon and Dave Potter. We also had on-site coordinators from Fort Ticonderoga Museum: Miranda Peters, Matthew Keagle, and Margaret Staudter (see Figure 35).

The team began by searching for easily locatable targets from the through-ice geophysical survey (i.e., the 1759 dock pylons). Once the dock pylons were pinpointed, our next objective was to relocate the remains of KS-1, the possible sloop found in 1983. Aided by the geophysical data collected in February, the team quickly identified the site and proceeded to search for the wreck-shaped anomalies that the geophysical data suggested were southeast of KS-1.

This search took longer than anticipated. Poor visibility, complications of diver-to-surface communication, and dense lake weed growth slowed our progress during the initial weeks (see Figures 36 and 37). Most troublesome were the piles of coal slag (clinker) and random pieces of timber from the nineteenth-century steamboat dock (see Figure 38 and 39). We hoped to find mid-eighteenth-century vessels beneath the nineteenth-century deposits, but this was not the case. The wreck-shaped anomalies observed in the GPR data and the magnetic interference within those geophysical plots were simply the piles of coal slag themselves. This realization was disheartening, but we refocused our efforts on the two known vessels (KS-1 and KS-2).

For the remaining three weeks of the project, the team uncovered and recorded the stem and stern of KS-1 and a portion of the KS-2. The team also documented the principal dimensions of KS-1 and the construction of its upper (exposed) framing components. Initial analysis of their construction indicated that these two vessels were built in a different tradition than *Boscawen* and *Duke of Cumberland*. The dissimilarities with the British-built vessels and other features suggest that the two were originally built by the French and captured by the British during the conflict.[98] If they are indeed of French origin, they would be the first archaeological evidence of French shipbuilding on Lake Champlain and be among the earliest known colonial French-built sailing vessels of the North American inland waterways.

As the team uncovered the possible French sloop's (KS-1's) stem and stern and a partial frame section, artifacts were uncovered that reveal more about the vessel's use and abandonment. Among the artifacts recovered from both KS-1 and KS-2 are a pewter bowl, leather shoe fragments, animal bone (horse, pig, and deer), seeds, nuts, a gun flint, lead shot, a chisel for wood carving, whiteware ceramics, a 26th Regiment button from a British Army uniform, brass buckles, barrel staves, and a small anchor (see Figures 40–43). These artifacts are in the final stages of their conservation treatments, after which they will be stored in Fort Ticonderoga Museum's repository.[99]

[98] A more in-depth examination of the construction features of these possible French-built vessels is conducted in Chapter V.
[99] More information about the artifacts and their conservation treatments is presented later in this chapter.

Figure 35 The 2019 King's Shipyard summer survey team. Left to right: Ben Ioset, Julia Herbst, Nicole Deere, Daniel Bishop, Mason Parody, Christopher Sabick, Ryan Theis, Edwin Scollon, and Cher Gilligan. (Photo by Margaret Staudter)

Figure 36 Daniel Bishop after going through a weedy section of the site. (Photo by Edwin Scollon)

Figure 37 Operations during the 2019 King's Shipyard survey. (Photo by author)

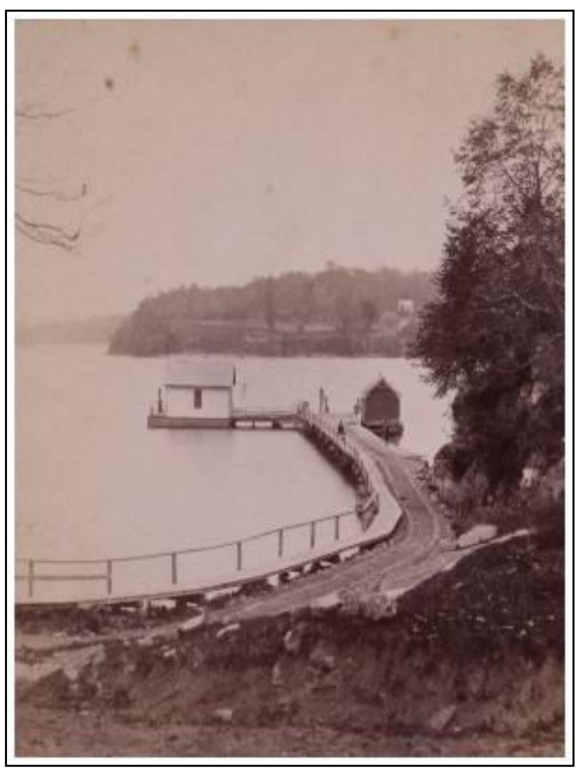

Figure 38 Photograph of the Fort Ticonderoga steamboat dock. (Courtesy of the Fort Ticonderoga Museum)

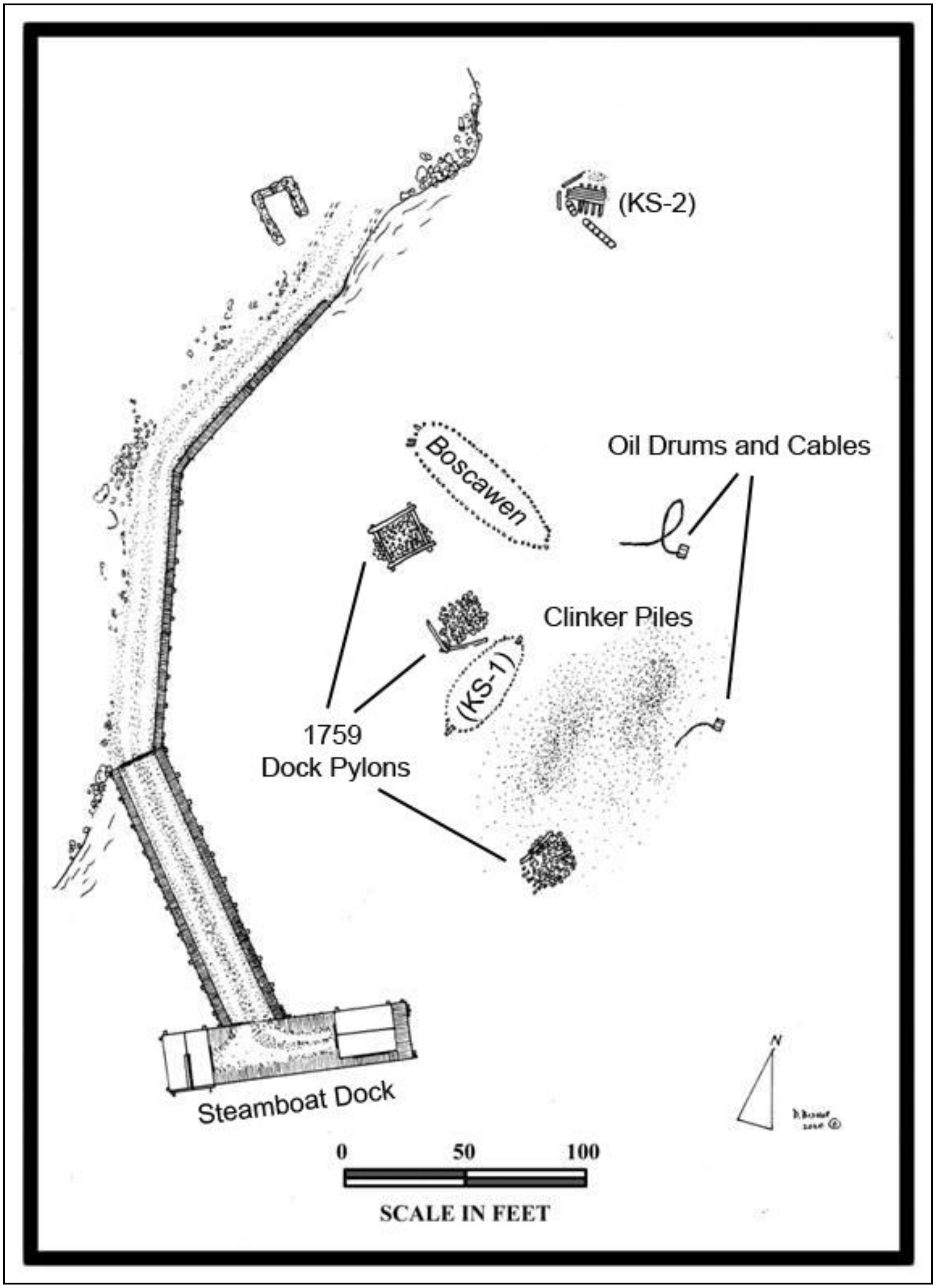

Figure 39 Fort Ticonderoga steamboat dock location and the King's Shipyard site. (Drawn by author)

Figure 40 One of the horse bones recovered from KS-1. (Photo by Cherilyn Gilligan)

Figure 41 Pewter bowl recovered from KS-1. (Photo by Cherilyn Gilligan)

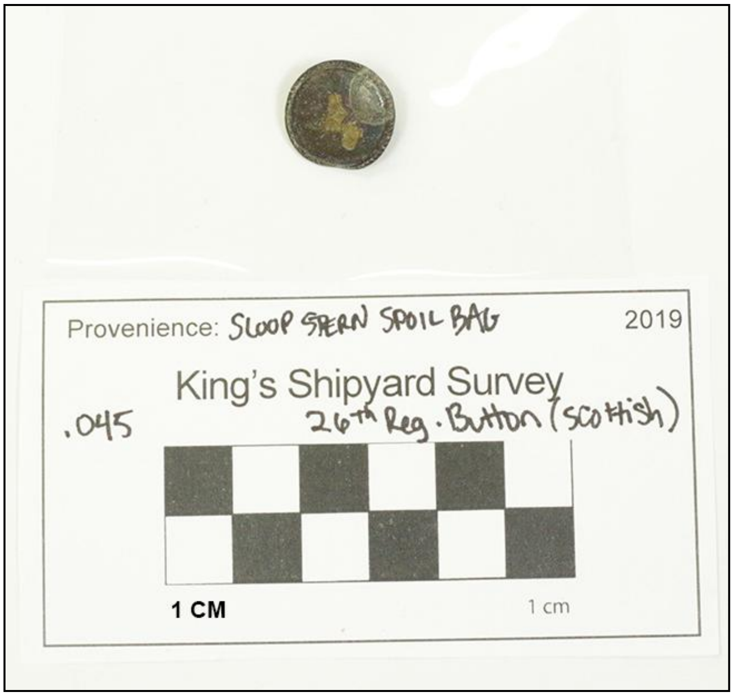

Figure 42 A 26th Regiment button recovered from KS-1. (Photo by Cherilyn Gilligan)

Figure 43 Anchor recovered from KS-2. (Photo by Cherilyn Gilligan)

During the project, we applied many of the methodologies and technologies that have been used successfully in other archaeological projects since the early 1970s, including SCUBA, dredging, probing, and baseline mapping. Divers used open circuit SCUBA gear to conduct the underwater work and employed archaeological dredges to remove sediment around the wrecks in targeted areas. The dredges (small 2-inch, two-horsepower water pumps with Tigerflex hoses and induction dredge head attachments) were equipped with mesh bags at the terminus of the Tigerflex hose to catch any unobserved artifacts. At the end of the project, the dredges were used to replace previously removed and screened sediment over the KS-1 and KS-2 sites to help protect them from further degradation by aerobic bacteria and invasive zebra mussels.

In addition to the vessel surveys, the team ground-truthed the other geophysical targets. These targets were mostly all nineteenth- and twentieth-century material, including fragmented structural remains from the Fort Ticonderoga steamboat wharf, 55-gallon oil drums with long cables attached that likely served as makeshift moorings for small twentieth-century watercraft, and most surprisingly, an old New York State Historical Marker (see Figures 44 and 45).

Archaeologists and researchers associated with the project presented the findings of both the winter and summer surveys and a history of the site at the 2020 Society for Historical Archaeology Conference in Boston, Massachusetts.

The King's Shipyard Survey has provided useful information on the construction of these possible French-built vessels,[100] yielded a number of artifacts that give a glimpse into the living conditions on board these vessels (especially KS-1), and helped plan for future archaeological work to be done at the site. We are in the process of conducting comparative research of the artifacts recovered from KS-1 and KS-2 and those in the *Boscawen* collection, particularly focusing on the foodstuffs found on these sites.

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[100] The construction of KS-1 and KS-2 is discussed in Chapter V.

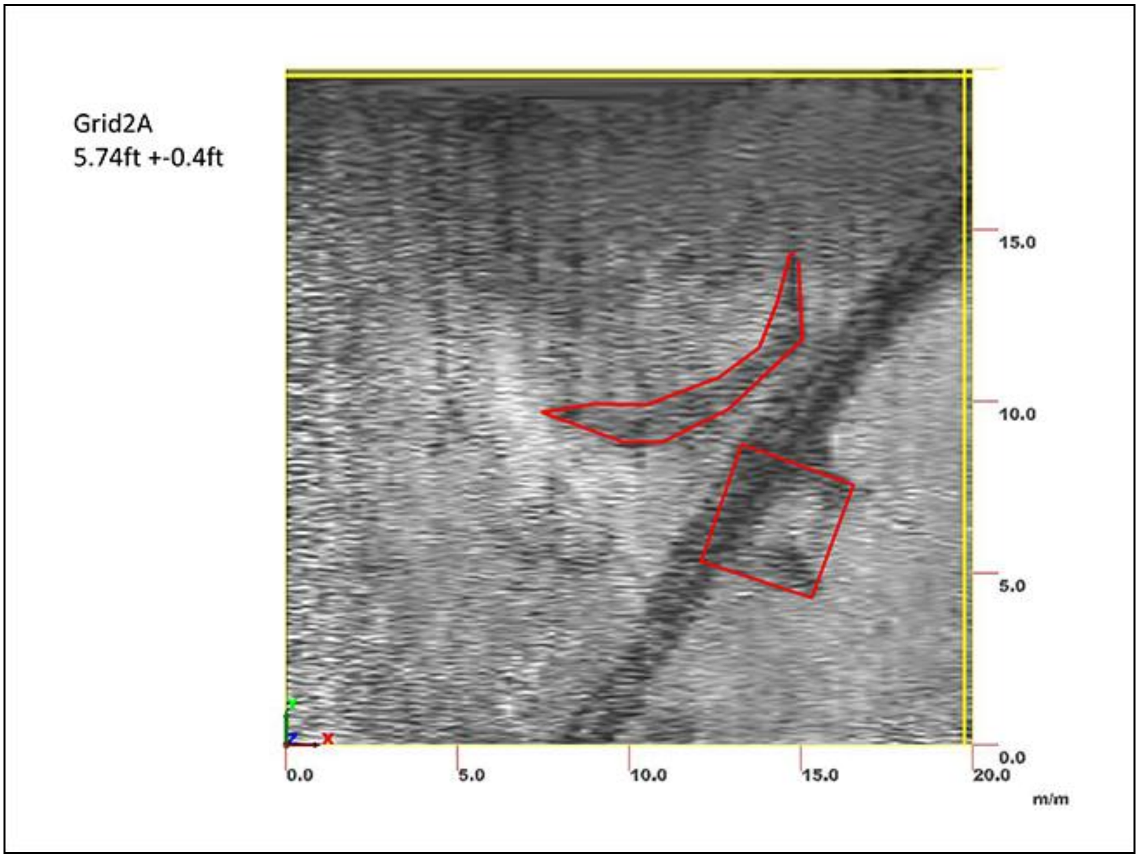

Figure 44 GPR data showing the 55-gallon oil drum and cable. (Image generated by William Chadwick)

Figure 45 The New York State historical marker discovered on the site. (Photo by Christopher Sabick)

Historical Photograph Photogrammetry Project

Until recently, attempts to analyze the construction and fitting of vessels whose original structures no longer exist, as is the case with many historic vessels raised from the lakes in the early twentieth century, seemed unachievable. However, combining historical records with photographs of vessels' raised remains has allowed us to extract details about these important vessels and periods of history. By examining the vessels' observable construction features in the photographic record, applying photogrammetric techniques to generate three-dimensional (3D) data models of their hulls, and analyzing their surviving diagnostic artifacts and timbers, I sought to shed even more light on how these vessels fit within the larger context of colonial shipbuilding traditions and design practices. Because only a few warships from the inland waterways of the mid-eighteenth century have been excavated or analyzed, the information gleaned from this analysis and from future research on these vessels can be invaluable.

Several studies have examined how photogrammetric techniques can be applied to historical photographs. Researchers in various fields have taken advantage of collections of archived aerial photographs (taken from airplanes). Using updated software and techniques, these researchers were able retrieve information about historical landscapes that have been lost to modern development.[101] Other scholars have utilized large repositories of photographs taken of popular cultural heritage sites, including the Great Wall of China and the Kronentor,[102] to digitally "reconstruct" their structures to show how they would have appeared prior to commercial, natural, and wartime degradation.[103] Having access to such large repositories for

[101] Martinez Batlle, "Photogrammetry of Historical Aerial Photographs Using Open-Source Software"; Sevara et al., "Surfaces from the Visual Past: Recovering High-Resolution Terrain Data from Historic Aerial Imagery for Multitemporal Landscape Analysis."
[102] The "Crown Gate" of the Dresden Zwinger, in Germany.
[103] Bitelli et al., "Use of Historical Images for the Documentation and the Metrical Study of Cultural Heritage by Means of Digital Photogrammetric Techniques"; Ioannides et al., "Online 4D Reconstruction Using Multi-Images Available under Open Access"; Snavely et al., Modeling the World from Internet Photo Collections"; Maiwald et

popular sites enables these researchers to select the highest quality photographs, which are often less than sixty years old. In addition, the structures they are reconstructing still exist today, albeit in their altered states, which allows the users to properly scale constrain and geo-reference their generated point clouds.

In 2017, two New York archaeologists explored the possibility of utilizing photogrammetric techniques to analyze historical photographs of a raised shipwreck that no longer exists. They chose to examine the Tuttle Sloop (aka the Fort William Henry Sloop), one of the British vessels built in 1757 for use on Lake George. As mentioned earlier, its remains were raised from the lake in the early twentieth century, photographed, and left to decay (Figures 16–18). The archaeologists used six of the seven known surviving photographs to digitally reconstruct the sloop's hull, reportedly with some success.[104] However, their digital model, methodology, and the data they generated are not accessible for evaluation (unlike the other studies cited above). In addition, based on the single, low-resolution composite image provided in a newsletter publication, the model of the sloop may not accurately reflect the hull's design and construction. This model is likely not accurate enough to provide useful data: the archaeologists reported that they could "use the model to measure parts of the ship with an accuracy of around +– 5 feet."[105]

In an effort to digitally reconstruct hull lines for a similar vessel raised from Lake Champlain (*Duke of Cumberland*), I developed my own photogrammetry methodology. I

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al., "Photogrammetric Analysis of Historical Image Repositories for Virtual Reconstruction in the Field of Digital Humanities."

[104] Not all of the images used in that project were original copies, which may have led to the subsequent inaccuracies of their model. Zarzynski and Shaw, "The Tale of the Dismembered 1757 Fort William Henry Shipwreck."

[105] In addition to their photogrammetric study of the Tuttle Sloop, Zarzynski and Shaw took measurements and laser scanned some of the vessel's timber fragments housed in the New York State Museum's collection. These measurements have not yet been published. Zarzynski and Shaw, "The Tale of the Dismembered 1757 Fort William Henry Shipwreck"; Zarzynski, *Ghost Fleet Awakened: Lake George's Sunken Bateaux of 1758*.

determined that the Photometrix iWitness Close Range Photogrammetry program (iWitness) was the best option for producing the most accurate and archaeologically useful 3D data.[106]

iWitness, like other photogrammetry programs, converts two-dimensional information (x and y coordinates from two or more photographs) into 3D information (x, y, and z coordinates). This process is made possible through triangulation of intersecting ray bundles (illustrated in Figure 46). The most important element for accurate triangulation is the relative orientation among the perspective centers of the camera lenses. If these locations are unknown, iWitness determines them through a series of complex calculations based on the common points and designated focal lengths.

There are other, less expensive options for researchers, including insight3d, a free open-source software that has many of the same features as iWitness, but users may run the risk of having a less accurate model, depending on the program's source code used to triangulate points and mitigate calculation errors.[107] Crucially, the iWitness 3D data represents only the points manually selected by the user. The generated basic 3D point cloud provides enough data to "retrieve" vessel shape and, with enough additional information, can then be scaled to the correct size (see Figure 47).

To the best of my knowledge, this is the first time that forms have been accurately generated from a photogrammetric point cloud using historical images of a shipwreck. Although the methodology in this project is applied to colonial-era shipwrecks raised in the early twentieth century, it has the potential to be useful for other subfields of archaeology as well as for architecture and historic preservation.

[106] I used a combination of iWitnessPRO-V4 and iWitness-V4 (standard) for this project.
[107] Zarzynski and Shaw used the insight3d program to create their model of the Tuttle Sloop.

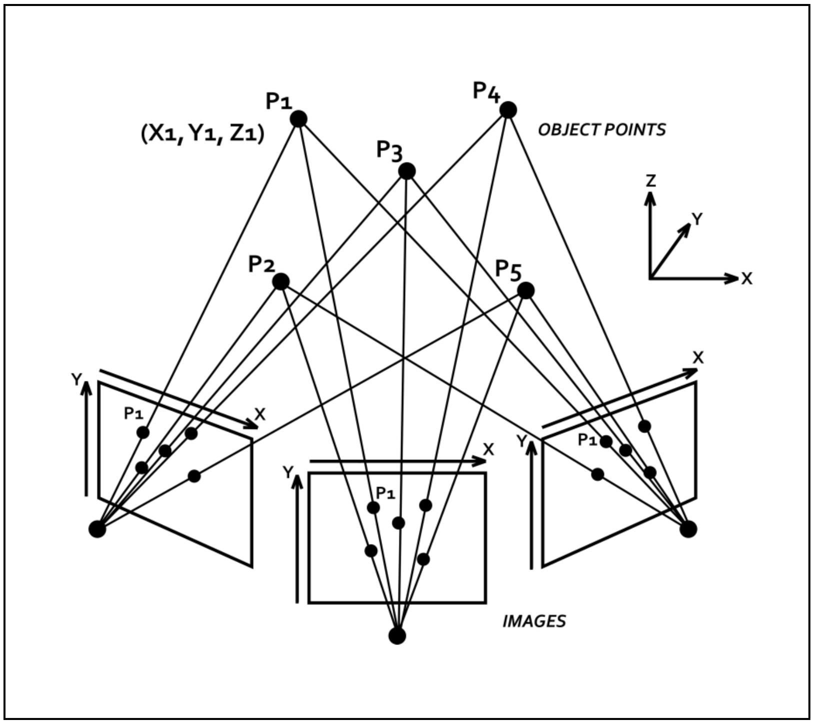

Figure 46 Triangulation of intersecting ray bundles for photogrammetry. (Drawn by author)

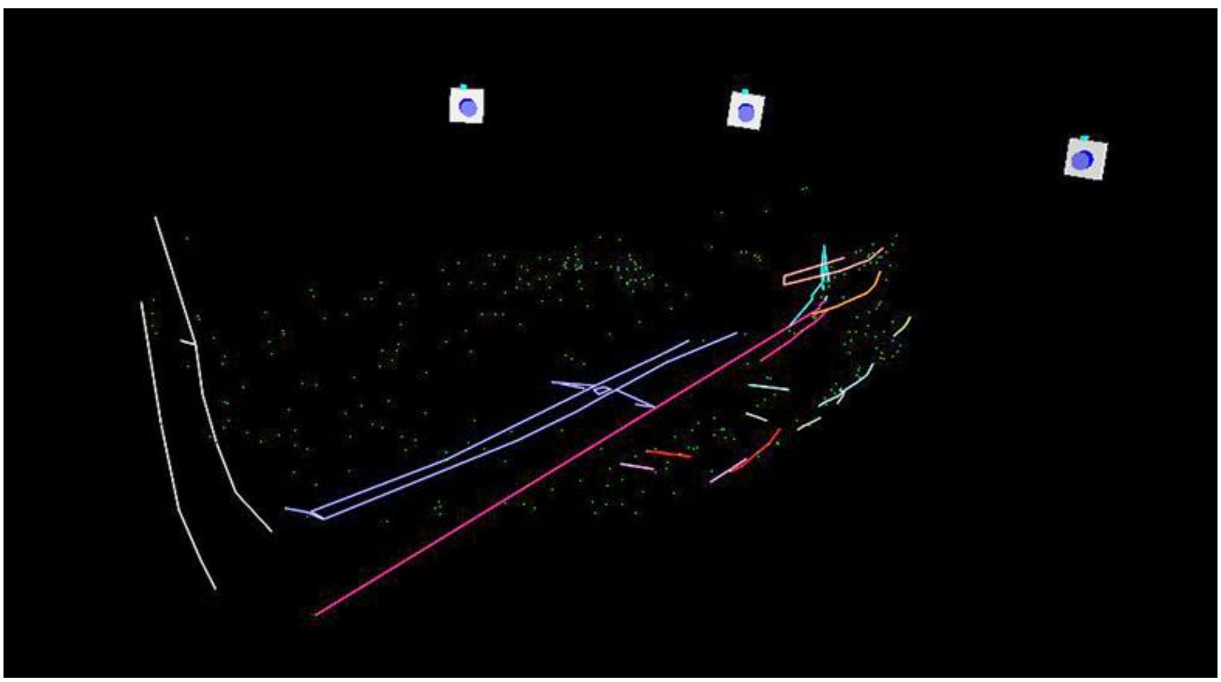

Figure 47 A manually generated point cloud and feature highlights (of the Tuttle Sloop). (Image generated in iWitness V4)

There are several limitations when applying photogrammetric techniques to historical photographs, including lack of lens information, the quality of the available photographs, and lack of scale. It is important to understand these limitations when applying photogrammetric techniques to historical photographs. For some of these problems, there are creative solutions and mindful steps one can take to mitigate their effects. In certain cases, however, there will be no solution to circumvent or reduce the effects of these issues, such as when all surviving photographs of a structure are blurry or when they are taken from a single position or from the same side of a structure. Even in these cases, there is the potential to add new information to the field.

Although information about the particular lenses and cameras used to take historical photographs would be useful in photogrammetry, it is unlikely to be available today. In the case of *Duke of Cumberland,* we do know that the two best photographs were taken on the same day in 1909 and most likely with the same camera (Figures 8 and 9). Similarly, four of the seven photographs of the Tuttle Sloop were taken by Albert N. Thompson on July 4, 1903.

No records of the specific cameras or lenses used to take these photographs have been discovered thus far. However, after research into historical photography equipment and analyzing the photographs' sizes and quality, I suspect that the camera used for the two photos of *Duke of Cumberland* was similar to a Houghton "Triple Victo" half-plate, a field camera that was produced in the late nineteenth and early twentieth centuries. This style camera had a focal length of 240 mm, equivalent to a standard 43-mm lens in a 35-mm format.[108] Regardless of any acquired lens data, the chosen photogrammetry program must allow the user to manually input, or bypass, the lens data for each photo.

[108] This 35-mm focal length format is an adequate number to start with for an unknown focal length.

In addition to the lack of lens information, other issues can arise during photogrammetric model creation. After multiple attempts to reference the *Duke of Cumberland* images, I observed a model distortion away from the photographs' perspective centers (at the furthest aft frames on the starboard side). This distortion could be caused by a few things, including (1) image quality (i.e., of the photograph itself, the camera's focus, and/or the scan of the image), (2) incorrect focal length and pixel dimension of the images, and (3) user error when selecting the reference points. A fourth explanation or contributing factor to the observed model distortion could be distortion of the vessel itself, as a great deal of force was presumably exerted on some of the futtocks, especially near midships, when the hull was dragged ashore. The first two possibilities are difficult for an iWitness user to overcome, but the third and fourth are more easily corrected. Although this distortion may be caused by one of more of the above-mentioned factors, the most likely explanation is that our two best photos of the forward half of the vessel did not have a significant angular separation between them, thus introducing a bias near midships on the starboard side (see Figure 48).

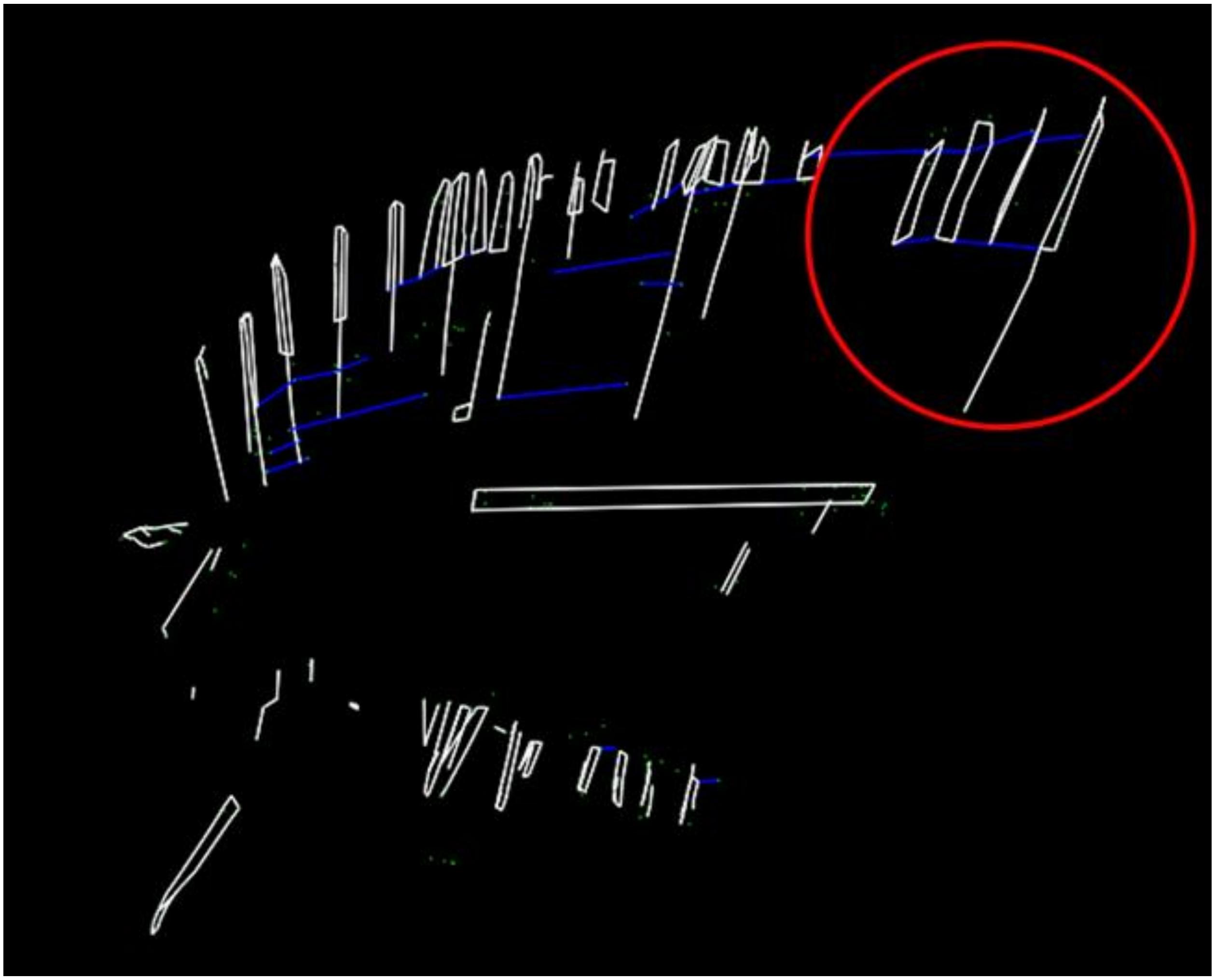

Figure 48 Area of perspective distortion on *Duke of Cumberland* model. (Image generated in iWitness V4)

One of the biggest issues encountered when generating ship lines from historical photographs is the lack of visible diagnostic features (such as frames). This is especially the case for *Duke of Cumberland*, where most of the frames are covered up by overlying ceiling planking, making the frame curve difficult to record. Additionally, ship lines should illustrate the outboard faces of the frames, and it is difficult, if not impossible, to photographically capture this feature in vessels with little deadrise. In cases like *Duke of Cumberland* and the Tuttle Sloop, the researcher must therefore use as much of the outer frame face as possible but ultimately estimate—based on the tops of the frames and ceiling visible in the photographs and other contemporary lines—the lower curve of the frames.

Generating ship lines from historical photographs is also hindered by the lack of a scale. iWitness does not automatically create scale—it is always assigned by the user. There were a few possibilities for scaling the photogrammetric point clouds of *Duke of Cumberland* and the Tuttle Sloop. The first method I considered was historical documentation. It is unfortunate that the principal dimensions of both vessels at the time they were launched have yet to be found in the written record—only their rough estimations of tons burthen were recorded, and these estimates vary from source to source.[109] Both wrecks, however, had their basic dimensions recorded when they were raised in the early twentieth century. These measurements helped considerably when introducing scale to the point clouds and when generating the hypothetical set of hull lines.[110]

A second method I utilized to scale *Duke of Cumberland*'s models involved the concrete and stone pedestals and the wreck's metal support straps (seen in Figures 12–15). Because these elements have not been removed from the display site, their dimensions and spacing helped

[109] Perley, *Diaries of Lemuel Wood*; Crisman, *Struggle for a Continent*; Lewis "The Naval Campaign of 1759"; Bellico, *Empires in the Mountains*; Dunne, "The 35th Regiment of Foot."
[110] The final results of the point cloud scaling and a full analysis of each of these vessels' construction and design are covered in Chapter V.

provide the stern photogrammetric point cloud with its initial scale. Although these elements enabled me to scale the stern point cloud, the two images of *Duke of Cumberland*'s forward half (used to generate the photogrammetric point cloud) were taken before it was put on display and do not include the support slabs.

To test the accuracy of the initial scale from the pedestals and metal cribbing, I utilized the surviving artifact collection, primarily the bolts recovered from the site in 2018 and the gudgeon recovered in 1985 (Figures 49 and 50). The longest bolt measures 3 feet, 4 inches (1.016 m), which could indicate the collective molded dimension of the keel, floors, and keelson. This length was used to check the initial scaling estimates. In addition, the gudgeon recovered in 1985 seems to have maintained its original shape and size. When I compared the measurements of the gudgeon to the scaled version of the point cloud, the accuracy proved to be within 0.5 inches (1.27 cm).

The most frustrating aspect when referencing the better-quality images of *Duke of Cumberland* was that the vessel was rarely shot in its entirety. Therefore, I had to digitally reconstructed the hull in two parts, with data missing between the forward and the after thirds. This discontinuity presented considerable challenges in scaling one section to the other, which was accomplished by using the metal cribbing and other known artifact dimensions. To properly orient the two models relative to one another for line reconstruction, I calculated the frame spacing in the gap between the two models. Figure 51 shows how the hull lines were generated from the 3D model data, and Figure 52 displays the final hypothetical hull lines of *Duke of Cumberland*. It was important to compare and combine all of the elements for scaling these models and to employ theories of vessel design and construction to ensure the most accurate reconstructed lines possible.

Photographs of the Tuttle Sloop, on the other hand, showed the vessel fully within the image frames. This enabled a more accurate, single point cloud to be generated. However, there were fewer elements that could be used to provide scale (as opposed to *Duke of Cumberland*'s gudgeon, foundations, and metal cribbing), so it was difficult to confirm the accuracy of the point cloud's hypothetical scale.

Through careful calculations and the use of the preliminary set of hull lines, I was able to determine a plausible scale of the overall point cloud (see Figure 53 for the Tuttle Sloop's reconstructed hull lines). I applied the maximum dimensions of the Tuttle Sloop wreck recorded in 1903 (44 feet [13.4 m] long, 7 feet [2.13 m] deep, with a 14-foot [4.27 m] beam), to the point cloud. To double check the accuracy of the initial scaling, the only measurements that could be used were those taken from the timber fragments in the Lefner Collection at the New York State Museum.

Another, albeit less reliable, method I used to check the scale of this point cloud was to compare the dimensions of certain features (i.e., framing components, stem, and mast step) to those of two smaller sunken colonial vessels (CV-1 and CV-2, surveyed between 1998 and 2000), which were thought to be the 20-ton British sloops built on Lake George in the same shipyard by the same shipwright and carpenters. Using this accuracy test, all of the measurements in the generated point cloud proved to be within 1.5 inch (3.81 cm) when compared to the actual measurements of tangible artifacts and archaeological notes from the CV-1 and CV-2 sites.[111]

[111] Sabick et al., "Lake Champlain Underwater Cultural Resources Survey"; Kane and Sabick, "Lake Champlain Underwater Cultural Resources Survey."

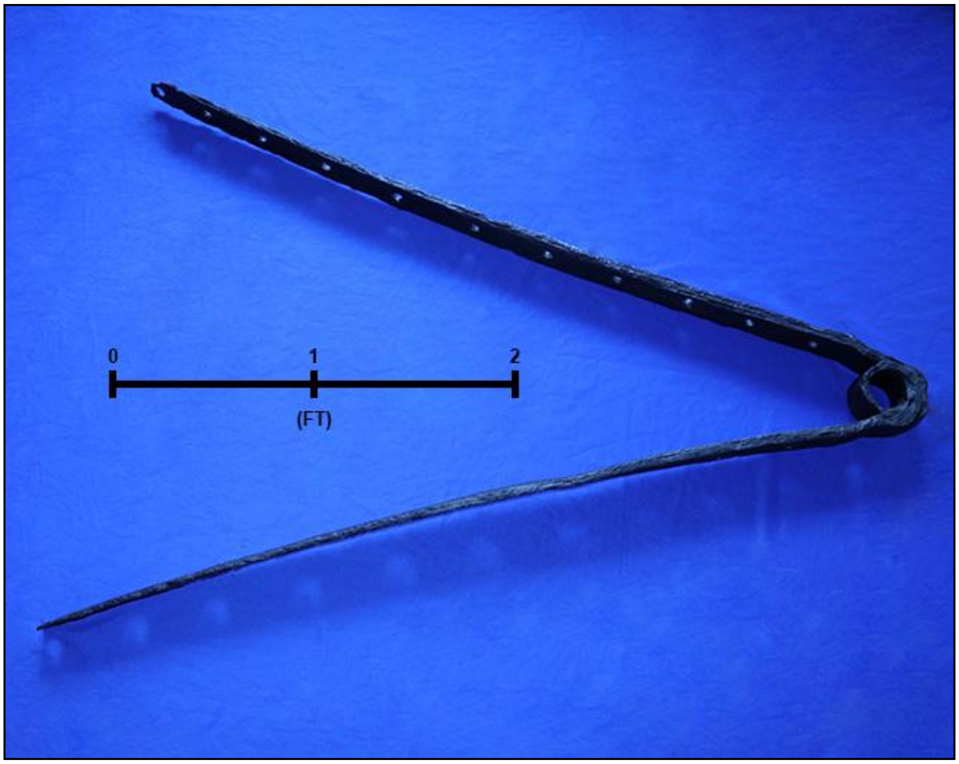

Figure 49 *Duke of Cumberland*'s lower gudgeon. (Photo by author)

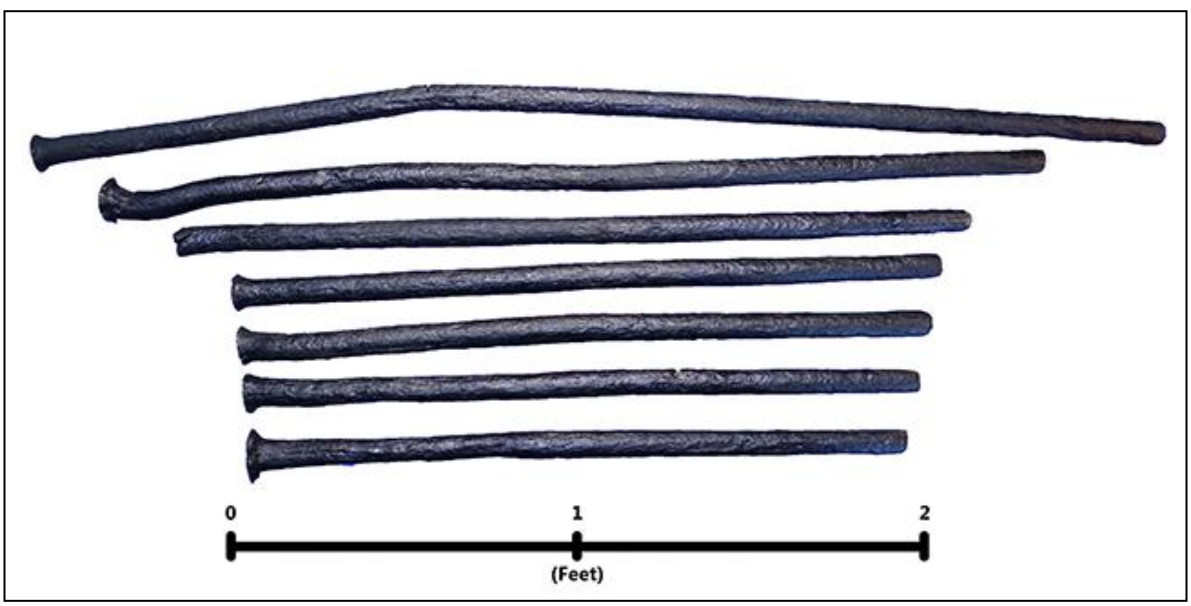

Figure 50 *Duke of Cumberland*'s bolts (recovered in 2018). (Photo by author)

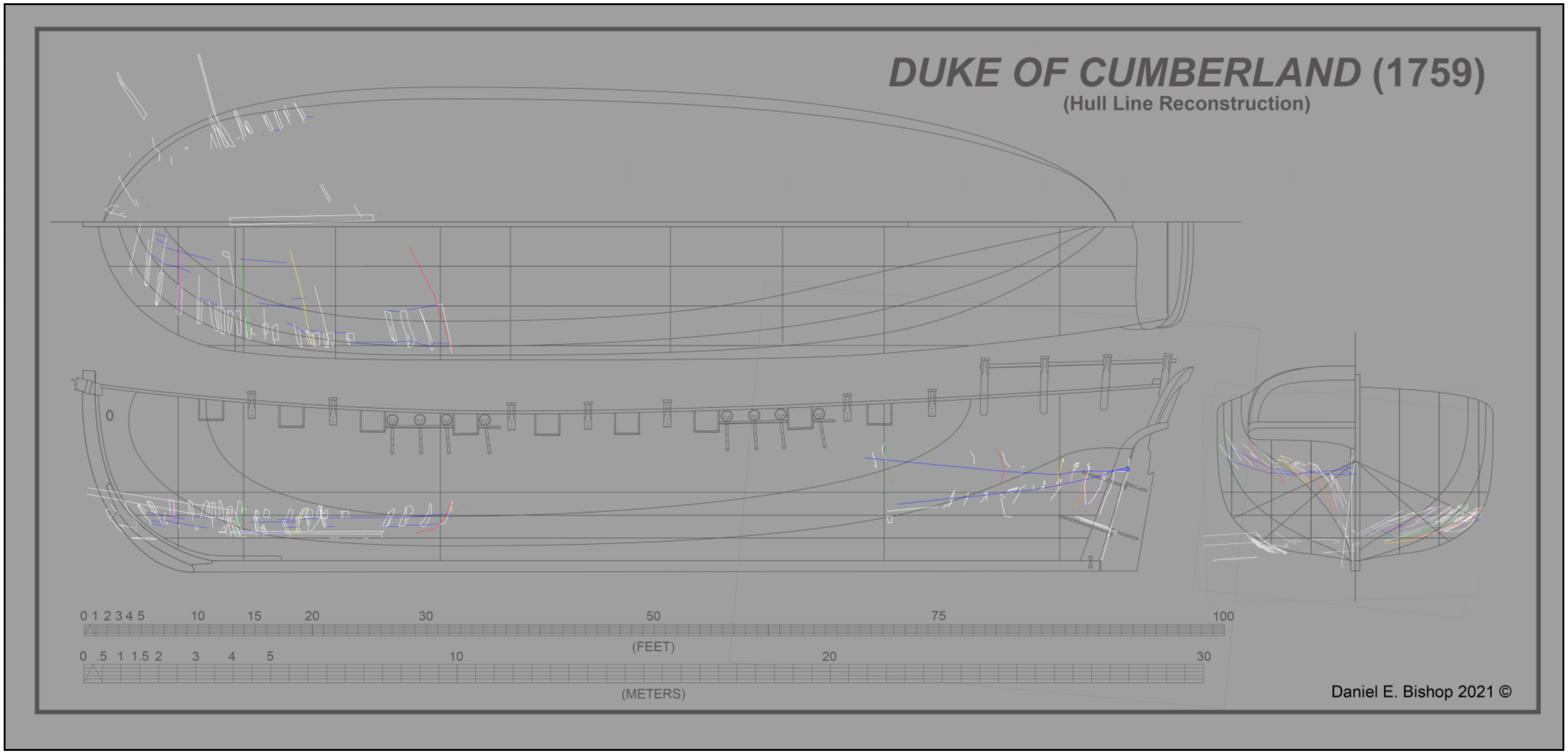

Figure 51 Generating *Duke of Cumberland*'s hull lines using the exported photogrammetry model views. (Drawn by author)

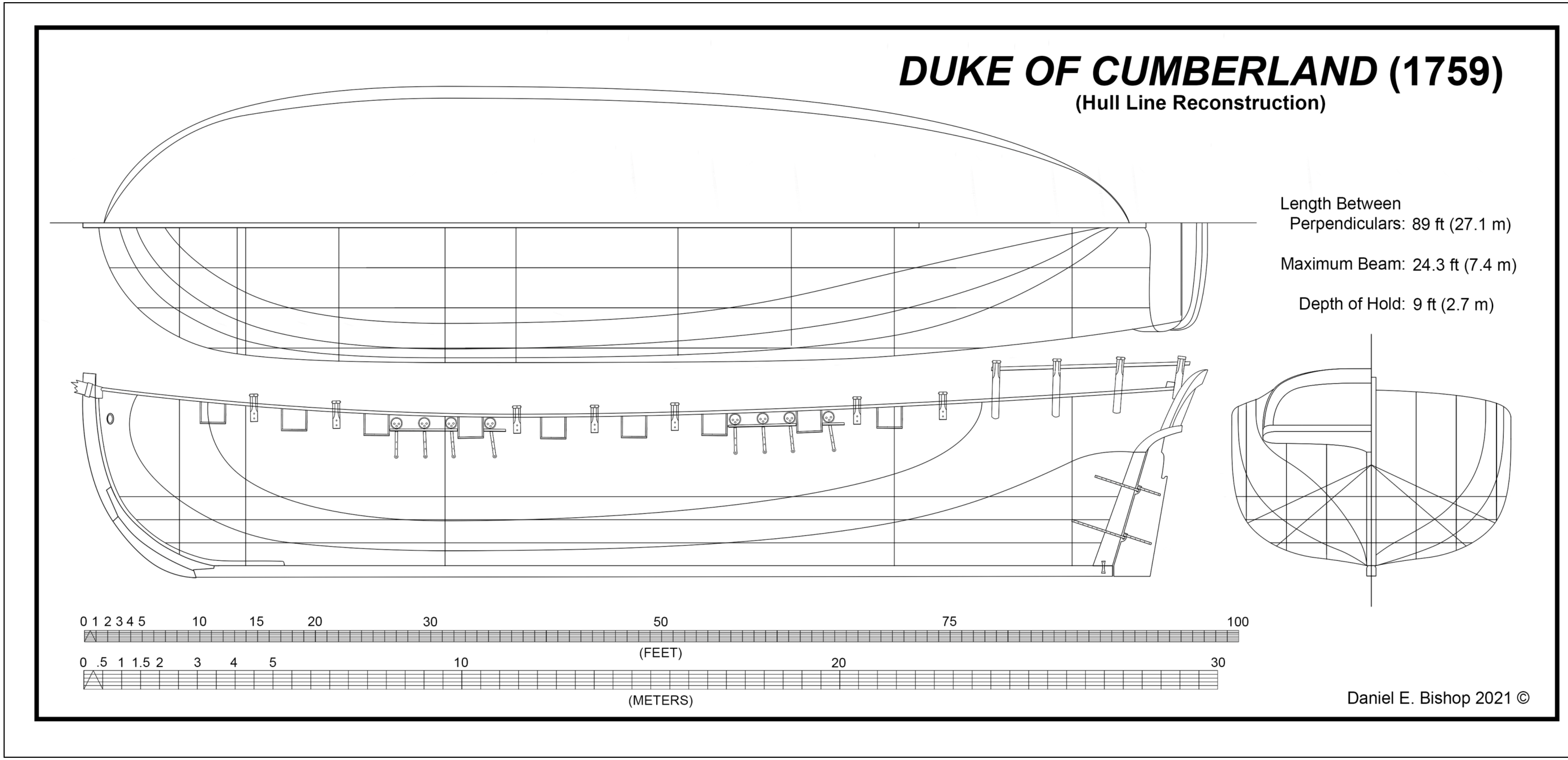

Figure 52 *Duke of Cumberland*'s hull lines reconstruction. (Drawn by author)

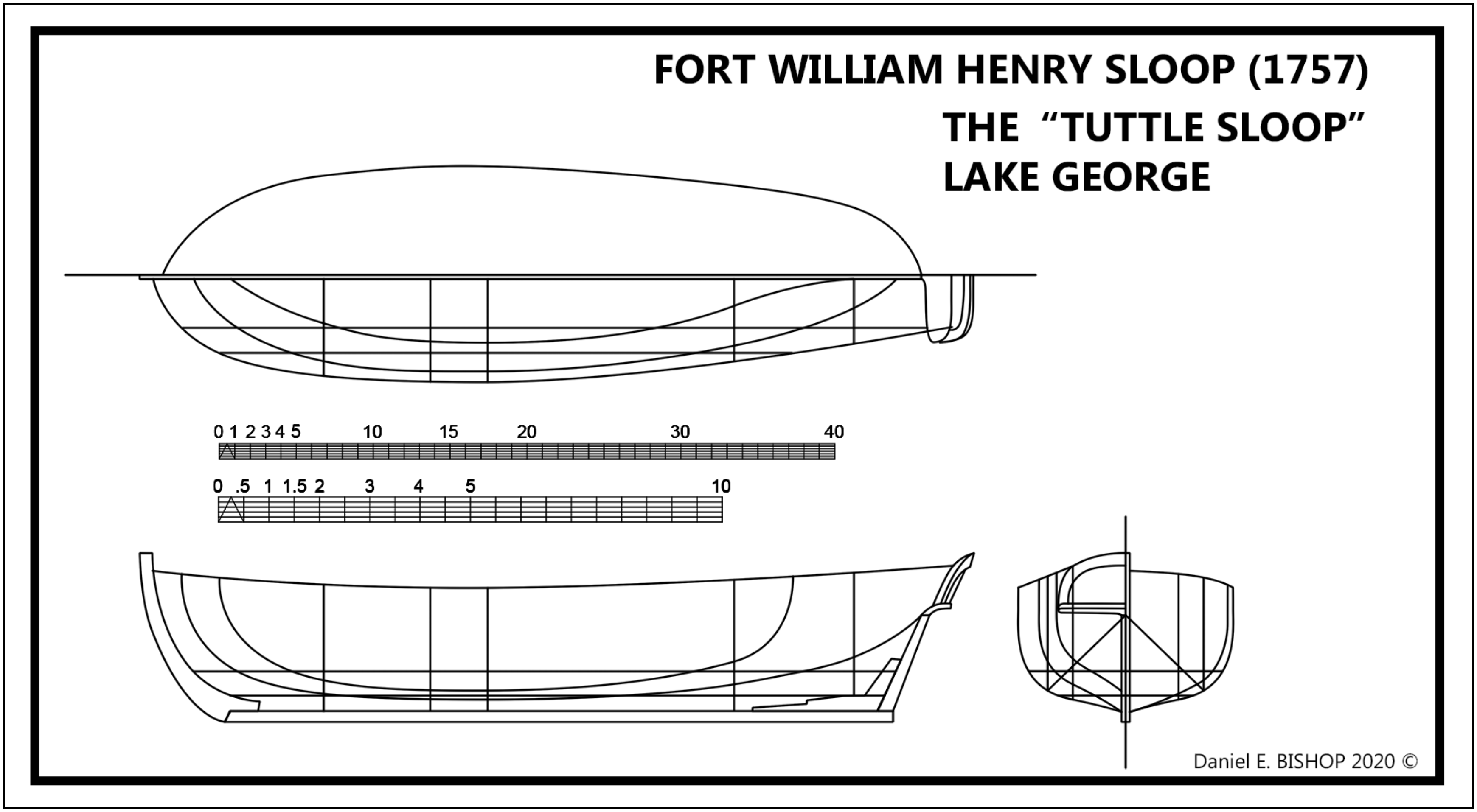

Figure 53 The Tuttle Sloop's hull lines reconstruction. (Drawn by author)

The final method to confirm the accuracy of the Tuttle Sloop's point cloud and the generated hypothetical set of lines was to calculate the vessel's tons burthen and compare it to the tonnage listed in historical documentation. Many sources list the 1903 raised sloop as the larger, 30-ton sloop built for Lake George.[112] The calculated tons burthen for the Tuttle Sloop, using its reconstructed hull lines, is 30.97, which suggests a plausible reconstruction and scaled point cloud.[113]

Although the models of *Duke of Cumberland* and the Tuttle Sloop presented here may have inaccuracies, they provide the field with hypothetical models that can be retested and refined. Accuracy tests carried out on the photogrammetric point clouds derived from historical photographs demonstrate that under the right conditions, they have the potential to be accurate within 10 cm.[114] The new information generated from this study is an improvement upon the current absence of data on either of these vessels. The point clouds and resulting hull lines for the two vessels in this project can be refined and evaluated as more images or related data are uncovered and analyzed.

Duke of Cumberland *Artifact Conservation Project*

When *Duke of Cumberland* was raised in the winter of 1909, a number of artifacts were collected and placed in Fort Ticonderoga Museum. The museum's earliest collections were not organized, catalogued, or conserved using the same standards we have today. After being displayed, artifacts were likely sorted by type and use and placed with similar items, mixing

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[112] Dunne, "The 35th Regiment of Foot"; Kane and Sabick, "Lake Champlain Underwater Cultural Resources Survey"; Zarzynski, *Ghost Fleet Awakened*; Bellico, *Empires in the Mountains.*
[113] Explanation on how tons burthen is calculated here can be found in Chapter V.
[114] Bishop, "Reconstructing 'Lost' Vessels."

collections and periods of history—and making the efforts of current museum staff, researchers, and conservators much more challenging.

I observed intrusive artifacts when I first examined the extant *Duke of Cumberland* collection at Fort Ticonderoga Museum, some of which appeared to date to a later period (post-1765).[115] We do not know whether these were mixed in later on from other museum collections, if they were stored onboard the brig after its use in the war, or if they were deposited on the wreck site after the brig sank.[116] One item in the collection is not thought to be an artifact at all. This "arti-fiction" was previously identified as a possible tool handle. Despite its oval cross-section, it is most likely a naturally formed root or branch.

Pre-Conservation Artifact Analysis

With the exception of the lower gudgeon and the dovetail plate,[117] all the other artifacts in the *Duke of Cumberland* collection had not been previously conserved. Lack of proper conservation significantly impacts the longevity and treatability of artifacts, especially those made of wood. The artifacts in this collection were allowed to air-dry after excavation in 1909, resulting in nearly all of the wooden artifacts being extremely desiccated and brittle. Although I observed some shrinkage, surprisingly little twisting or warping of the wood was evident. It is possible that the cold winter conditions at the time of the wreck's raising contributed to the slow the evaporation (or possible sublimation) of water within the artifacts.

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[115] In particular, a supposed "canister shell plug."

[116] Records and archaeological surveys indicate that trash and other supplies were thrown off the dock/western side of the bridge that spanned from Fort Ticonderoga to Mt. Independence during the Revolutionary War. Cohn, "The 1992 Fort Ticonderoga–Mount Independence Submerged Cultural Resource Survey"; Crisman, "The 1992 Mount Independence Phase One Underwater Archaeological Survey"; Cohn, "The Great Bridge."

[117] Previously conserved at the Groton, MA, conservation laboratory.

Very apparent, however, was the severe collapse of the wooden artifacts' cellular structures. Large deep cracks and splits cover the surfaces of the artifacts, especially on the ends of the wood grain (see Figure 54). This damage cannot be reversed; conservation treatment at this time would provide only mechanical strength. Some of the wooden artifacts showed signs of a previous attempt to preserve them. It is unknown when the observed surface coatings were applied or if they were a type of natural or synthetic resin. This substance seems to have protected the wood from degradation, albeit minimally.

For the metal artifacts, all of which were ferrous, 110 years without conservation enabled corrosion to further degrade most of their surfaces (see Figure 55). Similar to the wood artifacts, some of the metal ones were previously treated with a surface application of a resin or lacquer. The artifacts that had been heavily coated with this substance (or, at least those that still had the coating present) exhibited slightly less surface corrosion.

All *Duke of Cumberland* collection artifacts were assigned an artifact number and then photographed, measured, weighed, and evaluated as part of pre-conservation analysis and documentation. In addition, some of the higher-priority artifacts were laser-scanned with a Faro Arm to digitally record their pre-conservation dimensions. This was done to have a 1:1 digital representation of the artifact if anything happened to it during the conservation process (see Figure 56).

Figure 54 Cracks in the wood show compromised cellular structure (*Duke of Cumberland* deadeye). (Photo by author)

Figure 55 Iron corrosion products on one of *Duke of Cumberland*'s artifacts. (Photo by author)

Figure 56 Daniel Bishop laser scanning *Duke of Cumberland*'s stove door. (Photo by Julia Herbst)

Conserving Duke of Cumberland*'s Wooden Artifacts*[118]

An important consideration was whether certain wooden artifacts within this collection needed to be conserved. Although artifact importance (or diagnostic value) contributed to these decisions, it was not the most significant factor. Rather, a determination was made on the basis of whether treatment would benefit the stability of already-desiccated wood.

The key components of conserving waterlogged wooden artifacts are removing the water and bulking the cellular structure. However, *Duke of Cumberland*'s wooden artifacts were allowed to air-dry over a hundred years ago, so there was no water to remove and the cellular structure was already compromised. There are considerable concerns when conserving desiccated wood: any attempt to "rehydrate" (and bulk) fragile wooden artifacts may cause them to be ripped apart by the water's surface tension or by any bulking agent as it travels through the wood's damaged cellular structure. Therefore, treatment must be a gentle process without rehydration.

In this case, conservation treatment was deemed necessary when an artifact was potentially too fragile for future handling and storage. Some of the artifacts were not subjected to any treatment (other than iron removal) because their wooden structures were durable enough not to need additional mechanical strength and because these artifacts, as mentioned above, were already coated with a type of resin.

The two composite artifacts (especially DOC.017.01) presented the biggest challenge. Embedded into their wood were ferrous metal fasteners that will continue to corrode and expand, putting considerable pressure on the fragile surrounding wooden structures (see Figure 57). The fasteners needed to be removed carefully, with the least amount of damage to both components.

[118] Conservation techniques and methodologies utilized for all artifacts were derived from Hamilton, *Basic Methods of Conserving Underwater Archaeological Material Culture*.

After iron removal, the artifacts' surfaces were gently cleaned with acetone and cotton swabs. In some areas, repurposed dental tools were used to remove caked mud and other debris. If stains, debris, or sediments were too difficult to remove without damaging the artifact, they were left alone.

There are not many options to treat desiccated wooden artifacts. The main purpose of treatments such as freeze-drying, PEG, acetone–rosin, paraffin wax–hexane, and so forth, is to remove water from an artifact through processes of dehydration and replace it with natural solvents/alcohols or through sublimation. These treatments also bulk an artifact's cellular structure (with either PEG, wax, or rosin). For the air-dried *Duke of Cumberland* artifacts, these processes were unnecessary and, in some cases, would be detrimental to their already-desiccated wood. Any treatment applied to these artifacts would only provide mechanical strength and a barrier against atmospheric moisture. Treatment options were evaluated based on their longevity, effectiveness as a moisture barrier, and the mechanical strength they provided.

I decided that a surface application of silicone oil would benefit the fragile artifacts the most. Silicone oil has a much greater half-life than some of the other chemicals such as PEG; when catalyzed, it helps prevent moisture from entering the artifact and is as strong as any other treatment option available.

Methyltrimethoxysilane, or MTMS (a silicone oil cross-linker), was mixed into the silicone oil at a 20 percent solution. The cross-linked silicone oil was applied directly to the surface of *Duke of Cumberland*'s wooden artifacts with a brush and allowed to naturally soak in (see Figure 58). The artifacts were not fully submerged into the cross-linked silicone oil in an effort to prevent putting too much stress on them due to surface tension or suction when removed. Instead, multiple coats of silicone oil were applied until the artifact would not accept any more.

The artifacts' surfaces were cleaned of excess silicone oil and then subjected to the fumes of the catalyst (dibutyltin diacetate, DBTDA) within a sealed container for three days. Catalyst was only applied directly to the artifact where the silicone oil was slow to react. After catalyzing the silicone oil, any pockets of thicker silicone oil were removed with repurposed dental tools.

Figure 57 The most fragile composite *Duke of Cumberland* artifact. (Photo by author)

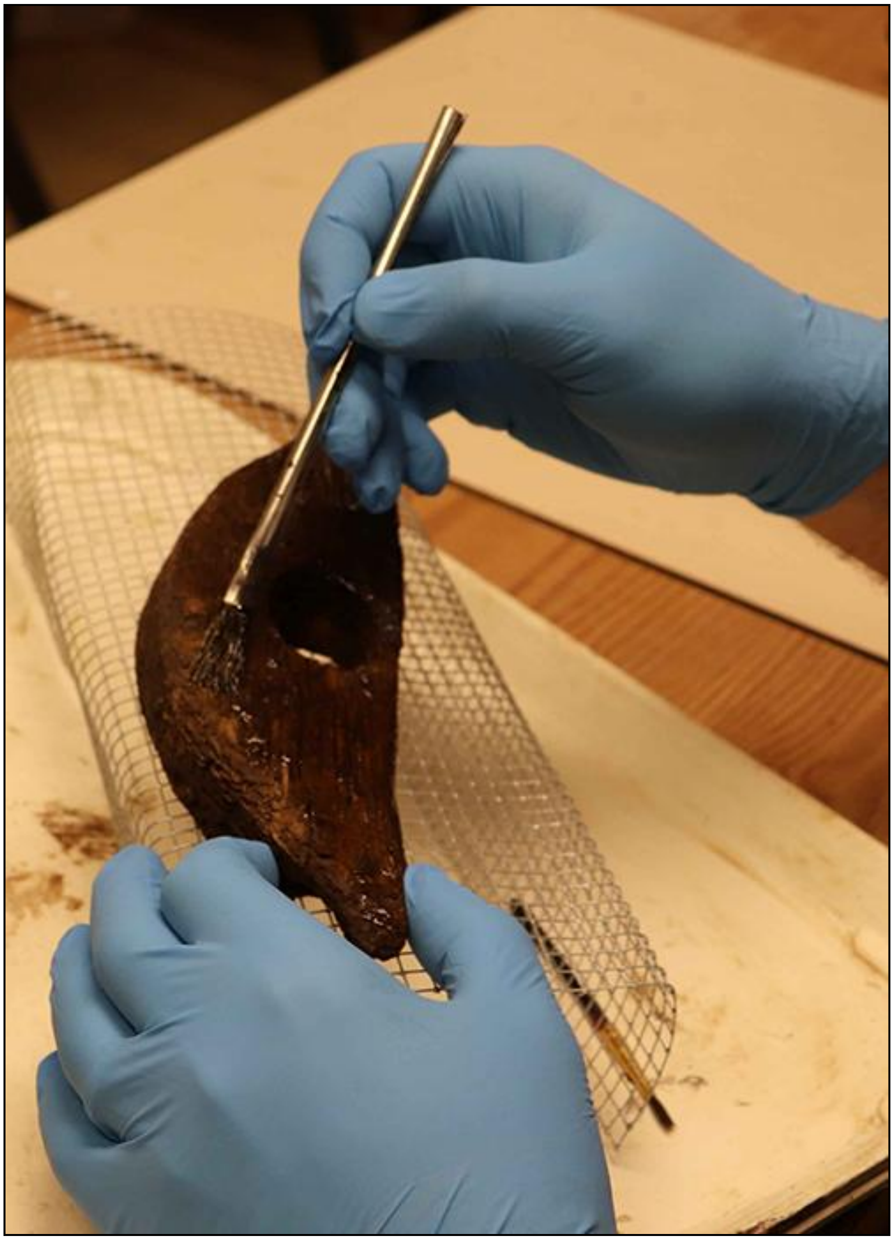

Figure 58 Applying the surface silicone oil treatment. (Photo by Catherine Brooks)

Conserving Duke of Cumberland*'s Ferrous Artifacts*

All the metal artifacts from the *Duke of Cumberland* collection were ferrous. Although some artifacts were more fragile than others and needed to be carefully monitored throughout their conservation treatment, all were durable enough for conservation. This allowed me to streamline the conservation process, as I was able to apply a single conservation methodology for all the iron artifacts. A single iron treatment methodology also ensured that the results among the metal artifacts (i.e., the visual aesthetic) would remain similar.

All of these artifacts still had solid metal cores, durable enough for ER. This likely had to do with their previous freshwater context and how they were stored in a reasonably dry environment over the past 110 years.

I chose ER as the conservation treatment because it offers a conservator the most efficiency, flexibility, and control during the treatment process. I was able to conserve twenty-seven of the iron artifacts in two ER batches, control how vigorous hydrogen evolved off the artifacts' surfaces, and evaluate the level of chlorides present in the artifacts (see Figure 59).

Because the artifacts originally came from a freshwater environment, I used a 5 percent solution of sodium hydroxide in deionized (DI) water as the electrolyte in order to maintain electrolyte conductivity, effectively remove any remaining chlorides and anions within the artifacts, and to more readily measure how much of these compounds was pulled into the electrolyte solution. I used a DC power supply to control the electrical current flowing through the anode (a positive charge for the sacrificial metal) and the cathode (a negative charge for the artifact). I chose to use a low to medium current in order to consolidate the corrosion layers and eliminate any chlorides. The hydrogen that evolved off the artifacts at this current was sufficient to facilitate moderate mechanical cleaning.

Figure 59 One of the electrolytic reduction treatment vat setups. (Photo by author)

After electrolysis, all of the metal artifacts were rinsed in at least three baths of boiling DI water to ensure that all chemicals were removed from the artifacts' surfaces and to heat the artifacts before applying their first coats of 20 percent tannic acid. In addition, these boiling rinses reduced the pH of the artifact and oxidized the surface of the artifact, turning it a dark gray. The heat from the boiling rinse also helps to dry the artifacts once they are removed from the water and encourages a better tannic acid bond. After the initial coat of tannic acid, two more coats were applied (one after the first coat had dried and the other after eight hours of drying). Tannic acid bonds to the surface of the metal and discourages corrosion products to form.

Following the three tannic acid coats, all of the ferrous artifacts were subjected to a molten microcrystalline wax bath. Submerging the artifacts in molten wax boils off any remaining water on or in the artifact and creates a physical barrier that protects the artifacts from atmospheric moisture. In addition, the wax coating can provide a small amount of mechanical strength for more fragile artifacts.

Other surface treatments (such as Corroseal and similar rust-inhibitor paints) were considered as an alternative to tannic acid and microcrystalline wax. The reason for this debate was that one of the larger artifacts, the gudgeon, did not fit into the wax vats and required being treated in two stages. After discussions with Fort Ticonderoga's Director of Collections, we determined that despite logistical challenges in the conservation, the traditional treatment (tannic acid and microcrystalline wax) was more than sufficient to protect the all the ferrous artifacts and would facilitate artifact monitoring for potential corrosion blemishes in the future.

Conserving Duke of Cumberland*'s Ceramic Artifact*

The conservation of ceramic artifacts from freshwater environments is fairly straightforward. Since there are negligible chlorides present within these artifacts, the only steps required for conservation are surface cleaning (if needed) and consolidation within an adhesive. Consolidation helps provide structural support for the artifact and can act as a slight barrier against oils from skin contact. For the single ceramic artifact from the *Duke of Cumberland* collection (a brick fragment), minimal surface cleaning was needed, and it was consolidated in a diluted Paraloid B-72 resin.

The 2019 King's Shipyard Survey Artifact Conservation Project[119]

The King's Shipyard presents a challenge to archaeologists trying to understand artifact provenance. The site (and associated fort, Ticonderoga) has seen continuous use from the mid-eighteenth century to the present. From the outset of this project, we expected that some of the artifacts we recovered would be intrusive or, at the least, from one of three periods (mid-eighteenth, late-eighteenth, or nineteenth century). While most artifacts are easily identifiable and can be at least approximately dated, others defy typical methods of seriation and typological/technological classification and rely on associated material in order to be correctly identified. These types of artifacts make vessel identification much more complicated, especially when trying to determine whether a vessel was built in one period or another only ten to fifteen years later. When conservation of the King's Shipyard artifacts is complete, further analysis should help shed light on these issues of provenance.

[119] Conservation techniques and methodologies utilized for all artifacts were derived from Hamilton, *Basic Methods of Conserving Underwater Archaeological Material Culture*.

Pre-Conservation Artifact Analysis

All artifacts were assigned an artifact number and then photographed, measured, weighed, and evaluated as part of pre-conservation analysis and documentation. Much of this analysis was done in Vermont at the Lake Champlain Maritime Museum, with considerable help from one of their staff, Cherilyn Gilligan.

Conserving the King's Shipyard Organic Artifacts

The seventy-nine organic artifacts (wood, leather, fabric, bone, and botanical remains) retrieved during the King's Shipyard survey in 2019 will undergo a silicone oil treatment at the CRL. The organic artifacts are currently undergoing dehydration, whereby they are being put through a series of ten baths of increasing alcohol and natural solvent percentages, ultimately ending in 100 percent acetone.

Because there are a number of fragile organic artifacts (such as leather shoe fragments and seeds), most of the artifacts will be conserved with silicone oil treatment to provide additional mechanical strength. The treatment also helps prevent moisture from entering the artifact. MTMS will be mixed into the silicone oil at a 20 percent solution.

The artifacts' surfaces will be cleaned of excess silicone oil and then subjected to the fumes of the catalyst (DBTDA) within a sealed container for three days. Catalyst will be applied directly to the artifact only if silicone oil is slow to react. After catalyzing the silicone oil, any pockets of thicker silicone oil will be removed with repurposed dental tools.

Conserving the King's Shipyard Metal Artifacts

The conservation treatment for the twenty-five King's Shipyard ferrous artifacts was nearly identical to that used for *Duke of Cumberland*'s. The only difference was that the artifacts' chloride levels and surfaces were not checked on a regular basis to determine how they fared during the conservation process. This protocol did not affect the end result or quality of the ferrous artifact treatment.

The collection also includes six cupreous and plumbous artifacts that will undergo conservation. Because chloride levels of the artifacts are already low (less than 35 ppm), it was decided that the cupreous artifacts would need treatment only to address surface corrosion. Chemical cleaning techniques that use acid and alkaline solutions help remove cupric and cuprous corrosion compounds from the artifacts' surfaces but may also redeposit copper (from the corrosion products) back onto the artifact. At times, this copper is plated on the surface of the metal and can be very difficult to remove. Copper stripping solutions are often paired with surface cleaning treatments in order to return the artifact back to its brass or bronze color.

I chose to use a 5 percent ethylenediaminetetraacetic acid (EDTA) solution to remove corrosion compounds, and silver nitrate to strip the redeposited copper from the cupreous artifacts' surfaces. EDTA conservation treatments are relatively inexpensive and less hazardous to the conservator than some of the other treatments. In addition, EDTA treatments can be used for many other types of artifact materials, such as plumbous, organic, and ceramic.

The cupreous artifacts will be submerged in the 5 percent EDTA solution from one to three hours, depending on corrosion levels. After the EDTA solution, the cupreous artifacts will be rinsed under DI water and then dipped in a 0.2N solution of silver nitrate in DI water before being buffered with a baking soda paste. This will be repeated until the desired aesthetic effect is reached. After the final buffering and rinse, I will submerge the cupreous artifacts in the copper corrosion inhibitor benzotriazole (BTA) mixed at a 5 percent solution in ethanol and then seal them using the microcrystalline wax, as discussed above for the ferrous artifact treatment.

Lead corrosion compounds are fairly stable and do not produce hydrochloric acid like copper and iron corrosion compounds. Reasons for conserving plumbous artifacts include reducing corrosion products back into a metallic state and cleaning for aesthetic purposes. The surface corrosion on the plumbous artifacts in this collection will be treated only if it will improve the artifact's aesthetic appearance and reveal important surface details.

Similar to how I will treat the cupreous artifacts, I plan to use a 5 to 10 percent solution of EDTA to remove surface corrosion compounds. Because copper will not be redeposited onto the plumbous artifacts' surfaces, I do not need to use a stripping formula. The artifacts will only need to be rinsed under DI water once they have reached the desired appearance. I will use microcrystalline wax to seal these artifacts, taking care not to damage or melt the plumbous artifacts by overheating the wax.

Conserving the King's Shipyard Ceramic Artifacts

Ceramic artifacts from freshwater environments have negligible chlorides present within them, so conservation of consists only of surface cleaning when needed and consolidation within an adhesive. Consolidation, which helps provide structural support for the artifact, can also act as a barrier against oils from skin contact. For the King's Shipyard artifacts, minimal surface cleaning will be required, and the artifacts will be consolidated in a diluted Paraloid B-72 resin, if deemed necessary.

Suggestions for Artifact Curation and Storage

Fort Ticonderoga's curation facility, the Thompson-Pell Research Center, currently houses the *Duke of Cumberland* artifact collection and is making preparations to accommodate the 2019 King's Shipyard Survey artifacts. Conditions at the research center are adequate for storing the material long-term—in that they discourage further corrosion and bacterial deterioration—but if the artifacts are displayed to the public, some considerations must be observed.

It is suggested that artifacts (particularly ferrous ones) always be kept below 60 percent humidity to discourage corrosion products from forming. Lower humidity also reduces the possibility of fungal growth on organic artifacts.

It is recommended that temperatures of the artifacts, display cases, and the storage facility do not fluctuate greatly (to prevent condensation) or exceed 90 degrees Fahrenheit.

The artifacts should be monitored for corrosion blemishes and mold growth on a monthly basis, especially during the first six months of storage. If any corrosion blemishes or mold growth is observed, it is recommended that the collections director inform me or the CRL to discuss retreatment, retouching, or a new storage strategy.

Duke of Cumberland *Preliminary Artifact Interpretation*

Although the *Duke of Cumberland*'s timbers no longer exist in physical form, the remaining photographs of the brig's hull taken during the early twentieth century and the recovered artifacts are crucial pieces of evidence that can be used to interpret the original vessel's construction and rigging. Any information gleaned from the artifacts is potentially useful to this endeavor.

The bolts within the collection can help determine the thicknesses of certain timbers. The longest bolt (3 feet, 4 inches [106 cm]) is suspected to have spanned the thicknesses of the keel, floors, and keelson. This bolt's length has been compared to some of the other, shorter bolts (around 2 feet long [61 cm]) to determine the keelson's thickness, as the shorter bolts likely fastened the floors to the keel. In addition, some of the other small fasteners can tell us more about the types of nails used to plank the vessel.

The deadeye is one of the most significant artifacts within the *Duke of Cumberland* collection. This artifact has already revealed some of the principal dimensions of the brig's rig.[120] The only downside is that it shrank when it air-dried in the early twentieth century. The amount of reduction will never be known, but estimations based on *Boscawen*'s rigging components could help shed light on where this deadeye was used (e.g., shrouds, bowsprit) and what its original size may have been (see Figure 60).

The stove door and a brick fragment are the only artifacts from the brig's galley/cambouse assembly (see Figure 61). Their dimensions and their composition will be compared to finds from *Boscawen* and the other ceramics found at the King's Shipyard. They will also be used to better inform a hypothetical shipboard layout.[121]

The 2019 King's Shipyard Survey Preliminary Artifact Interpretation

After an initial analysis of the artifacts, as well as the vessels from which they were recovered, we are beginning to have a better understanding of the vessels' identities (i.e., their nationalities) and overall site context. Some of the most informative artifacts are the fasteners. Many of the square nails used to laterally fasten the framing components of the sloop were of a

[120] Although there is additional information about the deadeye and *Duke of Cumberland*'s rig in Chapter VI, a formal study of its rig will be conducted in a future article.
[121] A full internal reconstruction of *Duke of Cumberland* will be conducted in a future article.

clenched design, which is typically diagnostic for French ship construction. A similar square clenched nail was found associated with the flat-bottomed vessel (see Figure 62).[122] Other than these fasteners, we did not observe any diagnostic artifacts suggesting French origin; this does not necessarily mean that there are no other diagnostically French artifacts on this wreck, as we only excavated around 2 percent of this site.

Before beginning conservation treatment of the organic artifacts, I worked with Cherilyn Gilligan, Lake Champlain Maritime Museum's archaeologist and bone analyst. Gilligan evaluated the faunal remains and made some surprising discoveries, the most significant of which were horse bones with butcher marks on them (see Figure 63). This, together with the identified remains of deer and evidence of seeds and nuts, demonstrates that the sailors aboard this vessel had a fairly diverse diet. It also reveals that they relied on foraging and hunting game because they were underprovisioned (see Figures 64 and 65 for charts related to the 2019 faunal and botanical assemblages). Determining who actually did the hunting and foraging of these foodstuffs will either substantiate conclusions previously made about British provisioning (from *Boscawen*'s artifact assemblage) or contribute to a broader conclusion about American and French colonial military provisioning at the time.

Above all, the King's Shipyard artifacts will be most useful when we compare them to those of *Boscawen*. Many similarities among the collections have already been noted, but a more formal artifact analysis and overall interpretation will take place when conservation treatment of all the King's Shipyard artifacts is complete.[123]

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[122] A separate study on the fasteners recovered from the possible French-built King's Shipyard vessels is underway.
[123] The King's Shipyard Artifact Conservation Project will likely wrap up in May 2021.

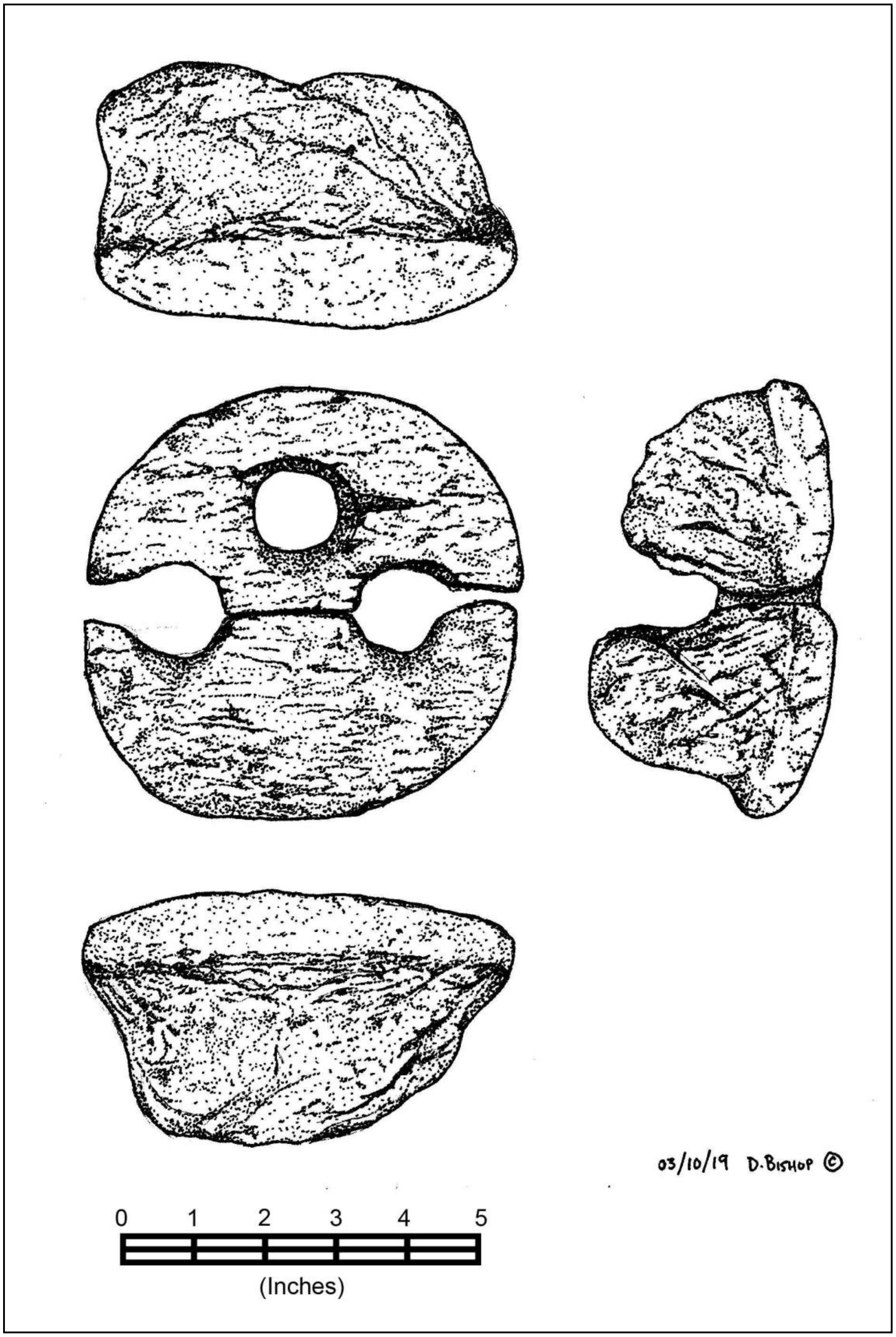

Figure 60 *Duke of Cumberland*'s only surviving deadeye (two pieces). (Drawn by author)

Figure 61 *Duke of Cumberland*'s stove door. (Photo by author)

Figure 62 Square iron clench nail from KS-1. (Photo by Cherilyn Gilligan)

Figure 63 Horse scapula with butcher marks. (Photo by Cherilyn Gilligan)

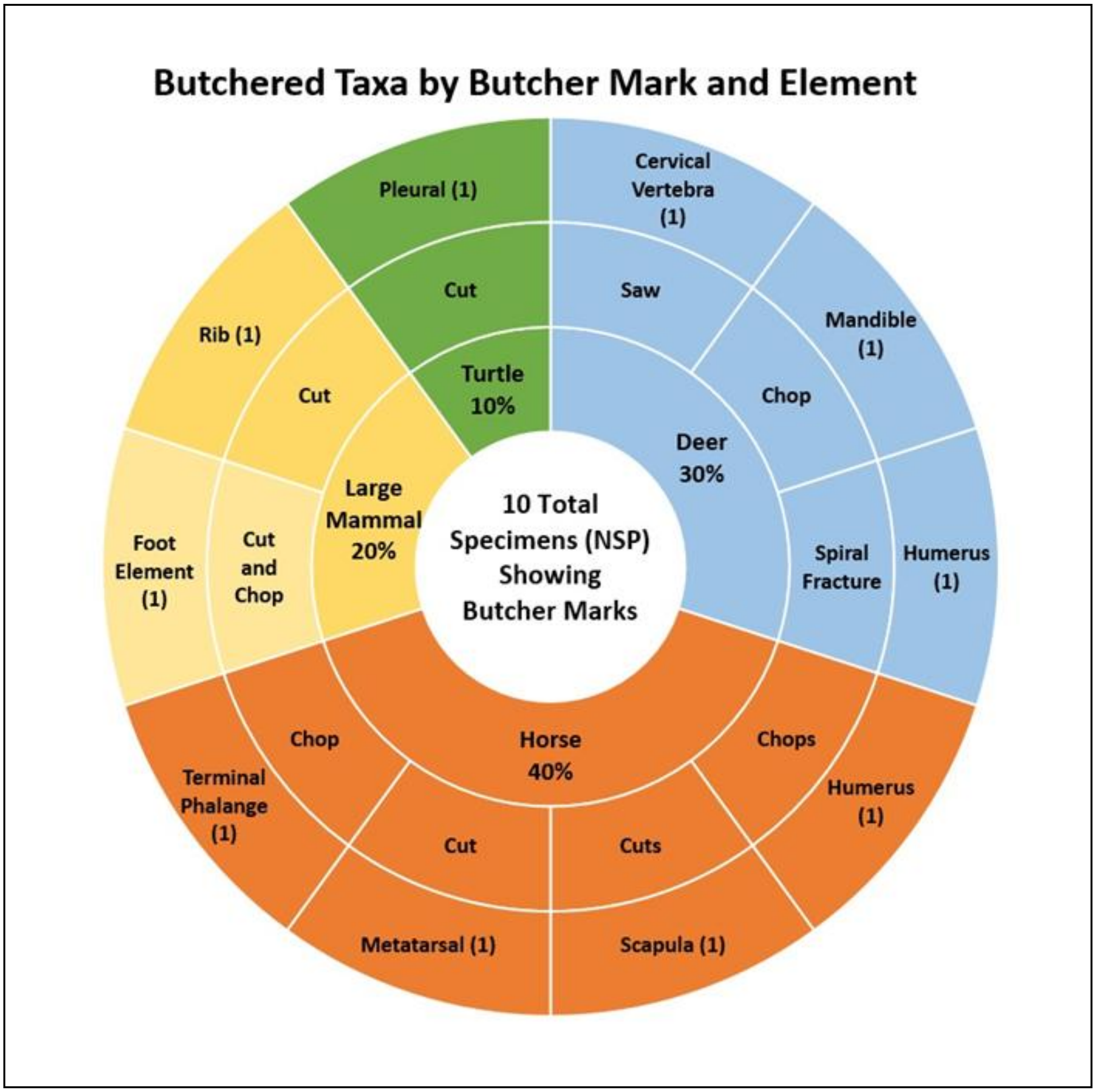

Figure 64 Butchered taxa by butcher mark and element. (Chart generated by Cherilyn Gilligan)

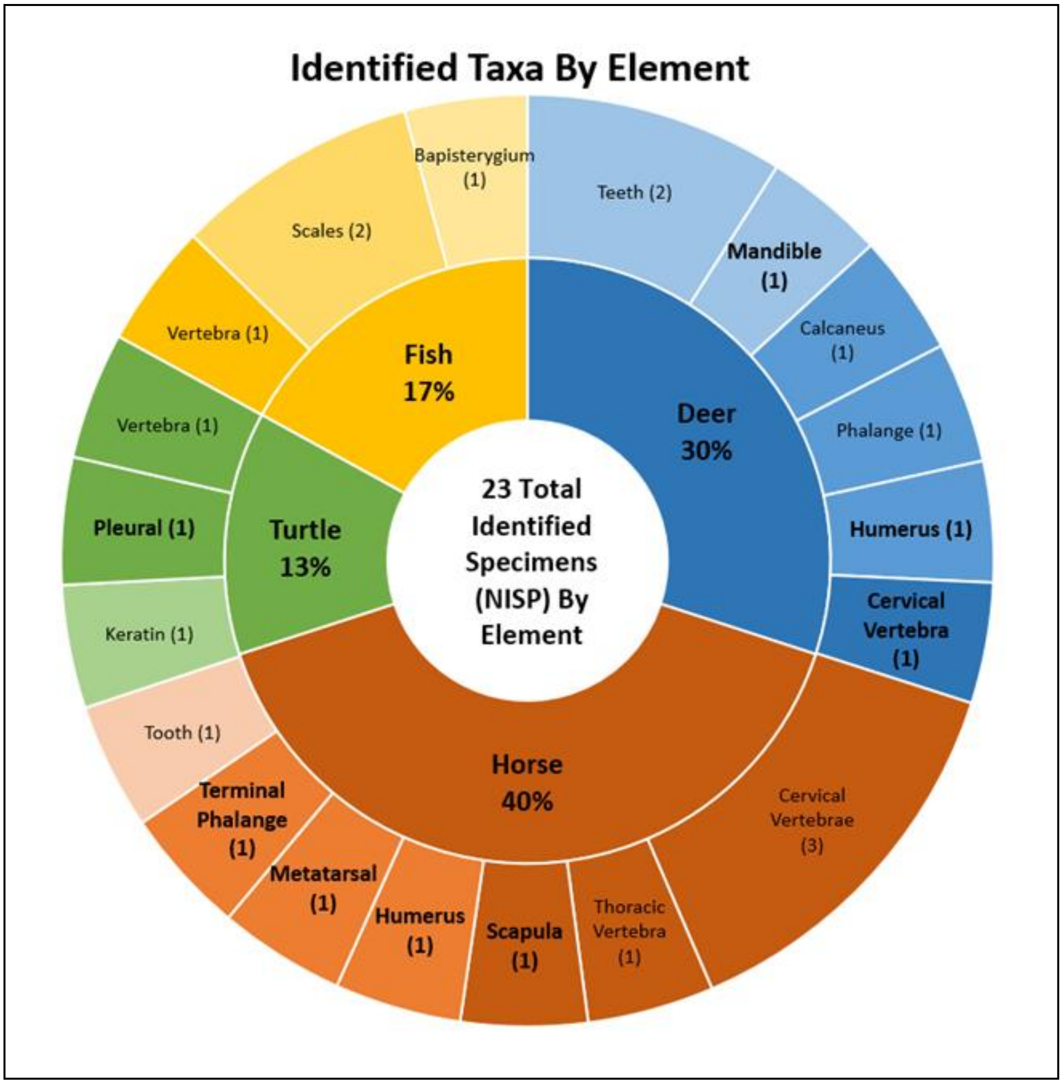

Figure 65 Identified taxa by element. (Chart generated by Cherilyn Gilligan)

CHAPTER IV

RIGGING RECONSTRUCTION: *BOSCAWEN*

Historical Background and Source Discussion

General Jeffery Amherst had ambitious plans for the vessels to be built on Lake Champlain to support his invasion of Canada in 1759. In May, nearly three months before carpenters began constructing the brig *Duke of Cumberland*, Amherst ordered Captain Joshua Loring to acquire materials to build and rig two brigs. A few weeks later, Amherst modified this initial order to "Two Snows, capable of Mounting Eighteen Six Pounders"[124] and he repeatedly asked Loring to find and purchase an additional set of rigging for the proposed flotilla, since there was already one set in storage.[125] In July, Amherst and Loring again amended the previous plans and elected to finish only a single brig. Their decision to launch only one larger vessel was most likely due to reports that the French only had a handful of smaller sloops on the lake. This reduction to one warship also reflects the limited resources (especially rigging material) that Loring had at his disposal.

By September 1, 1759, Amherst and Loring reassessed the strength of the French fleet on the lake. At this time, the French had a 10-gun schooner, four 8-gun sloops, and plans for a larger, 16-gun vessel on the lake.[126] In response to these new reports, Amherst and Loring decided that it would be necessary to construct a large radeau (*Ligonier*) to carry the British Army's heavy guns, and a 16-gun sloop (*Boscawen*) in addition to the brig (*Duke of*

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[124] PRO, W.O.R. 34/64, 197. A typical snow rig consisted of two square-rigged masts (each carrying a main, a top, and a topgallant sail), fore and jib headsails, and an additional fore-and-aft gaff-rigged mainsail (either boomed or loose-footed) that was hoisted on a separate snow mast or trysail mast, stepped abaft the main mast. The snow rig is nearly identical to that of a brig's, but instead of a square course on the main mast, the brig has only a gaff-rigged mainsail, and it has no snow mast.

[125] PRO, W.O.R. 34/64, 196, Amherst to Loring, 13 May 1759; PRO, W.O.R. 34/64, 197, 19 May 1759.

[126] Knox, *Journal of Captain John Knox*, 52–57.

Cumberland) already under construction. After the vessels were built, they were brought to Fort Crown Point for final preparations before the 1759 campaign.

There are few sources that indicate how these vessels were rigged. It is unclear whether Loring fulfilled Amherst's earlier request to acquire two snow/brig rigs at "as Cheap a Rate as possible."[127] If he did, it is uncertain whether he had to "cannibalize" one of those acquired rigs to have sufficient sails for the newly ordered radeau and sloop. A 1759 painting by Thomas Davies[128] depicts *Boscawen*, *Duke of Cumberland*, and *Ligonier* anchored off the fort's shore. See Figure 2 for a detail of the original painting that focuses on *Boscawen* and *Duke of Cumberland*. Paired with this visual representation, a recent archival discovery has provided new information regarding the rigs of the Seven Years' War flotilla on Lake Champlain. After the war, the maintenance and upkeep of the flotilla laid up at Ticonderoga was outsourced to John Blackburn and his local agents.[129] Included within this contract was a report on the naval inventory at Fort Ticonderoga, which lists the various rigging components (and their condition) for each of the vessels transferred to Blackburn.[130]

One of the biggest questions previous scholars faced when examining *Boscawen*'s rig was whether the sloop carried a square topsail and multiple headsails. The recently found archival evidence agrees with Davies's visual representation of the rig. *Boscawen* carried a basic sloop rig consisting of three fore-and-aft sails: a main, a fore, and a jib. Although these sources help illuminate the type of rig *Boscawen* had, they do not provide any solid evidence for the

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[127] PRO, W.O.R. 34/64, 198.
[128] Thomas Davies was a British officer and artist stationed at Fort Crown Point in 1759.
[129] Carter, *The Correspondence*, 554.
[130] Stores related to *Duke of Cumberland* were listed as "Three anchors good, three cables half worn, lower and upper standing rigging half worn, main sail, foresail, flying jibb, middle staysail all half worn, spritsail, topsail bad; one large copper kettle, one large join combouse [*sic*]; all the rest expended." Stores related to *Boscawen* were listed as "Two anchors good, two cables half worn, standing rigging half worn, main sail, foresail and jibb half worn; all the rest expended." Thomas Gage Papers, vol. 101, 29 March 1771; Thomas Davies's painting, "A South View of the New Fortress at Crown Point," 1759 (Figures 2 and 3).

dimensions of the spars and rigging components used onboard. Such empirical evidence of the individual components would help scholars better understand the conventions (or lack thereof) for vessels rigged for sailing the inland waterways of North America in the 1750s and 1760s.

When *Boscawen* was excavated in 1984 and 1985, over 5,000 artifacts were recovered. Within that collection, 90 artifacts were identified as potentially relating to the sloop's rig and were later discussed in Alan Flanigan's 1999 Master's thesis.[131] Deadeyes, blocks, parrel trucks, iron hooks, and rope were among this collection of rigging artifacts. Although this is a relatively small portion of the overall artifacts recovered from the wreck, it is one of the larger collections of rigging components from a single mid-eighteenth-century vessel in northeastern North America. It is important to note that the archaeological evidence, although tangible, may not in fact represent the actual rigging components that were used on *Boscawen*. Much of the rigging material was found in a concentrated area near the stern (see Figure 66). It has been suggested that the components came from a boatswain's locker of spare materials or were spare parts possibly from other vessels and stored on *Boscawen* after its use in the war.[132]

Since there are only a handful of vessels excavated from this period and region, comparisons among available rigging collections are limited. The excavation of the French-built frigate *Machault* (1760) yielded only a few rigging components (mainly two deadeyes). The excavation of the Revolutionary Era privateer *Defence* produced a handful of blocks and sheaves. These vessels, although roughly from the same period as *Boscawen*, were built in similar regional contexts but under different expectations and constraints.[133] While future comparisons among these vessels' rigging artifacts may generate useful information on

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[131] Flanigan, "The Rigging Material from *Boscawen*," 26–54.
[132] Flanigan, "The Rigging Material from *Boscawen*," 26.
[133] Sullivan, *Legacy of the Machault*; Switzer, "The Excavation of the Privateer *Defence*."

technological differences seen in the manufacture of the individual components, conclusions regarding larger rigging practices may still remain elusive.

Contemporary treatises and theories are also useful sources to better understand how vessels such as *Boscawen* were rigged. However, many of the shipbuilding treatises of the time focused largely on hull construction rather than rigging.[134] The most useful and reliable treatise for understanding *Boscawen*'s rig is David Steel's four volumes on rigging eighteenth-century vessels (first published in 1794).[135] Although he dedicated most of his treatise to the rigging of larger, sea-going vessels, Steel does provide formulae to calculate spar dimensions and rigging components of smaller, single-masted vessels such as sloops, cutters, smacks, and hoys.[136]

Here, Steel's formulae are used in concert with other mid- to late eighteenth-century archival sources, as well as with the visual documentation and archaeological material mentioned above, to generate a hypothetical reconstruction of *Boscawen*'s rig (see Figure 67). The reconstruction and evaluation of the rigging components allows us to better comprehend how the sloop may have sailed and how the lake environment, material availability, and builder intent contributed to the vessel's rig.

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[134] See especially Chapman's *Architectura Navalis Mercatoria, 1768*. Chapman stated that above function, the rig should "make a handsome appearance," 95.
[135] Steel, *Steel's Elements*. The book was released three decades after the Seven Years' War.
[136] Steel, *Steel's Elements*, 47.

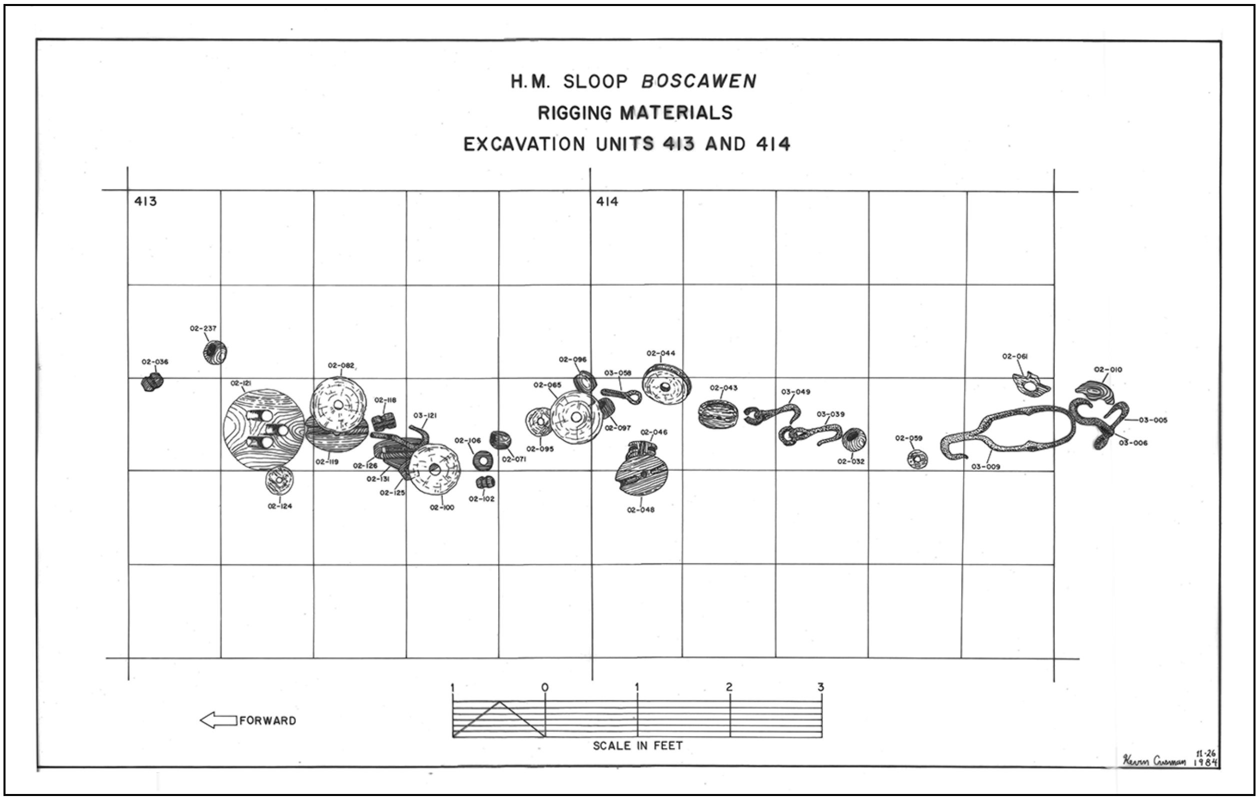

Figure 66 A concentration of *Boscawen*'s rigging material recovered from the stern. (Drawn by Kevin Crisman)

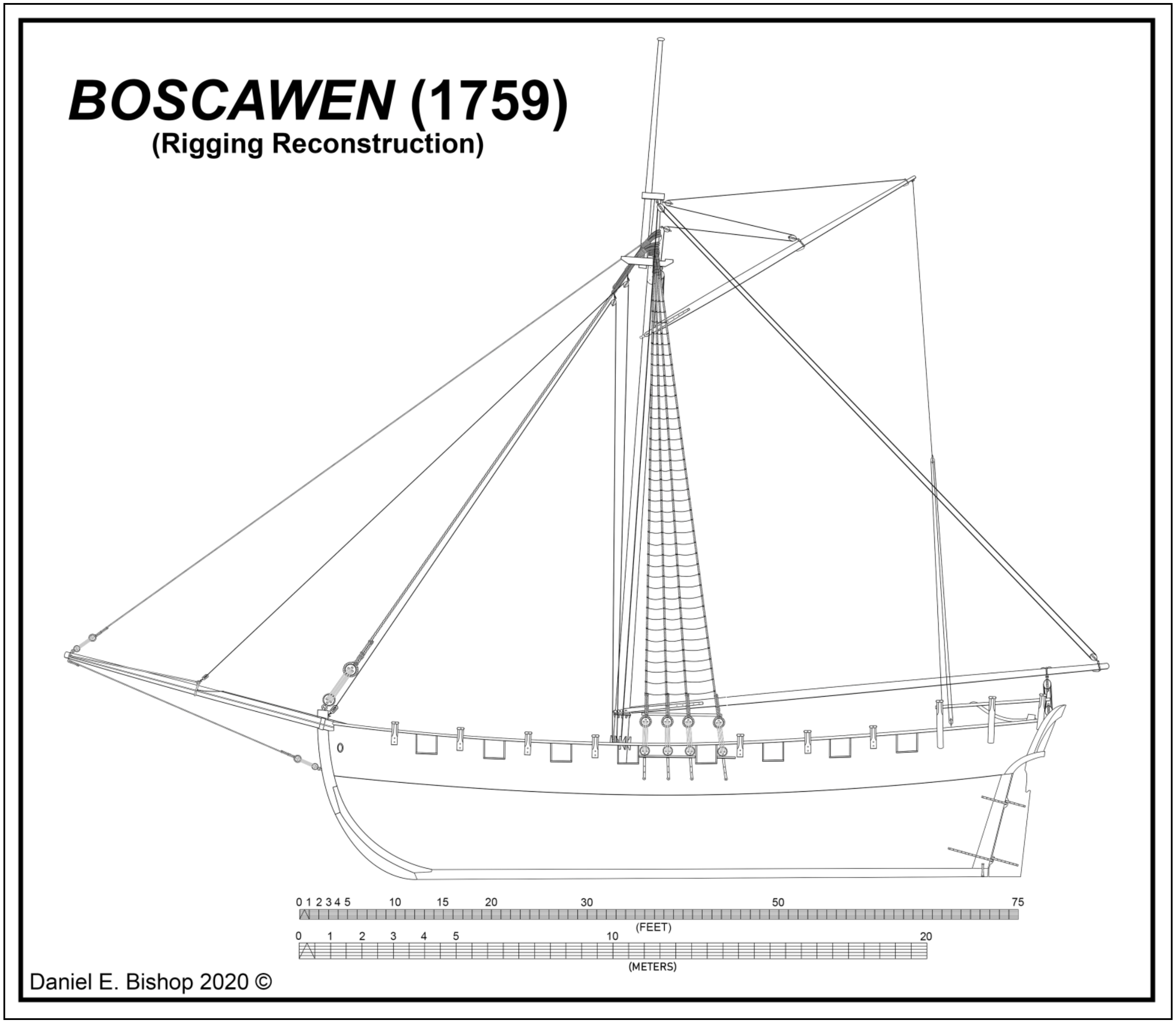

Figure 67 *Boscawen*'s rigging reconstruction. (Drawn by author)

Investigations of Rigging Components

Masts and Spars

Davies's painting and the survey of naval stores after the war together suggest that *Boscawen* had a basic sloop rig.[137] This rig consisted of a mainmast and topmast, but with only fore-and-aft sails (main course, fore, and jib). The mainsail was bent to a gaff and was boom-footed. The foresail was secured to the forestay with hanks, and both the foresail and jib were swayed on their respective halyards.

During the two 1980s excavations, the only observed evidence of *Boscawen*'s masts and spars was the mast step and a mast cap. These two components provide us with a starting point to determine the dimensions of the mainmast and main topmast and, subsequently, the other spars. See Table 2 for a list of *Boscawen*'s reconstructed spar dimensions.

Mainmast and Topmast

Boscawen's white oak saddle-type mast step is 4 feet, 3 inches (1.29 m) long; 16 inches (40.64 cm) molded; and 18 inches (45.72 cm) sided (see Figure 68). The mast step mortise is 16 inches (40.64 cm) long and 8.5 inches (21.59 cm) wide. The step is notched to fit laterally over the keelson and held in place with two 2-foot-long (60.96 cm) triangular wedges that are fastened to the keelson with iron spikes forward and aft of the step. In addition, two small wooden blocks (one on either side of the keelson) are fastened to the ceiling planking forward of the mast step to prevent the step from twisting in place. This type of mast step (which is not directly fastened to the keelson) allows the mast to be repositioned along the keelson, if needed, providing the commanding officer with greater flexibility in "tuning" the rig.

[137] Thomas Gage Papers, vol. 101, 29 March 1771; Thomas Davies's painting, "A South View of the New Fortress at Crown Point," 1759 (Figures 2 and 3).

Table 2 *Boscawen*'s Reconstructed Spar Dimensions

Spar	Length	Diameter	Rake/Steeve
Mainmast	68 feet (20.7 m)	Heel: 16 inches (40.6 cm); max.: 18 inches (45.7 cm) Mast Cap: 7 inches (17.8 cm) square	86 degrees
Topmast	24 feet (7.3 m)	9 inches (at mast cap)	—
Topmast Doubling	8 feet (2.4 m)	—	—
Boom	51 feet (15.2 m)	10.5 inches (26.7 cm)	—
Gaff	32.5 feet (82.6 m)	10 inches (25.4 cm)	—
Bowsprit	38 feet (11.6 m)	14 inches (35.6 cm)	15 degrees

Boscawen's mast step is located roughly three-fifths of the sloop's length forward of the sternpost. This position agrees with a trend seen in plans of single-masted vessels of the early to mid-eighteenth century, but not in the late eighteenth century when sloop masts were stepped more forward.[138]

The mast cap, made from a single piece of white oak, is 27.25 inches (69.22 cm) long, 7.5 inches (19.05 cm) molded, and 12.875 inches (32.7 cm) sided (see Figure 69). The cap has a 9-inch-diameter (22.86 cm) hole carved through its forward half and a 7-inch (17.78 cm) square mortise cut 5 inches (12.7 cm) deep in its after half. The circular hole is where the topmast passed through; the square notch held the head of the mainmast. The cap was originally fastened to the masthead with a small spike. There were also three iron eyebolts secured to the underside of the cap; these would have held topping-lift blocks and a peak-halyard block, the latter to help raise the mainsail and the former to support the weight of the boom.

A British construction plan for two sloops "to be built on Lake Champlain" in 1776, which included spar dimensions, featured an identically sized saddle-type mast step that supported a nearly 16-inch-diameter (40.64 cm) mast heel (see Figure 70).[139] According to Steel, the heel of a mast should be six-sevenths of the mast's maximum diameter (typically near the mast partners or deck level).[140] Using this ratio, *Boscawen*'s mainmast had a 16-inch-diameter (40.64 cm) heel (the same as *Boscawen*'s mast-step sided dimension and mortise length) and expanded to 18 inches (45.72 cm) around deck level.

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[138] This trend is evident in the plans housed in the National Maritime Museum (Greenwich, UK) collections. No mast step is seen in the photographic record of *Duke of Cumberland*, yet there are what look like protruding fasteners atop the keelson that may have secured part of the mast step assembly. The only image that displays *Duke of Cumberland*'s upperworks and rig is the 1759 Thomas Davies painting (see Figures 2 and 3). Using Davies's scale, the painted foremast location appears to coincide with the bolts in the suspected area in Figure 9. If this is indeed a location of the mast step, it would most likely have been of the saddle type found on *Boscawen* (Figure 68).
[139] These plans were designed by John Williams, Surveyor of the Royal Navy between 1765 and 1784. National Maritime Museum, "Unnamed 56ft single-masted Sloops (Circa 1776)."
[140] Steel, *Steel's Elements*, 47.

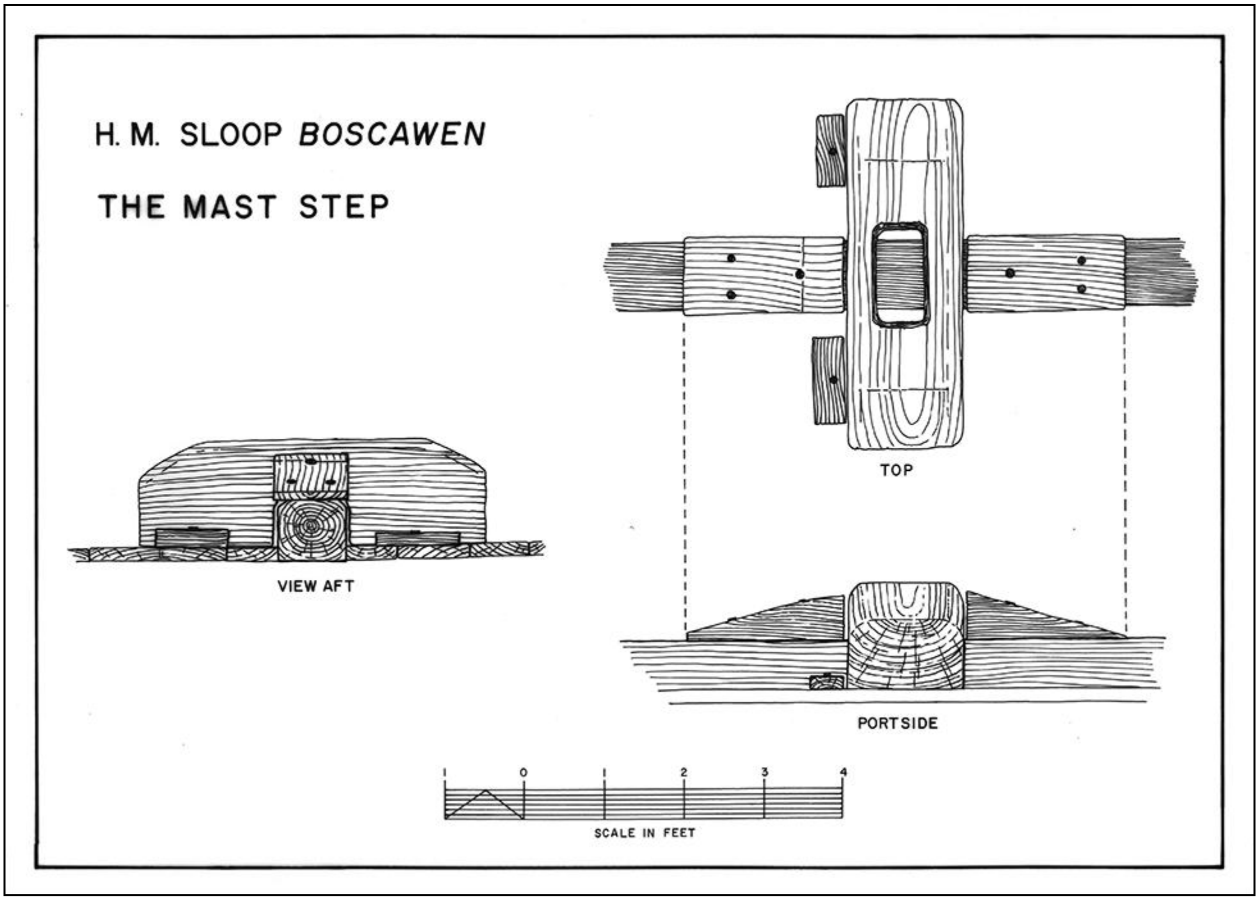

Figure 68 *Boscawen*'s mast step. (Drawn by Kevin Crisman)

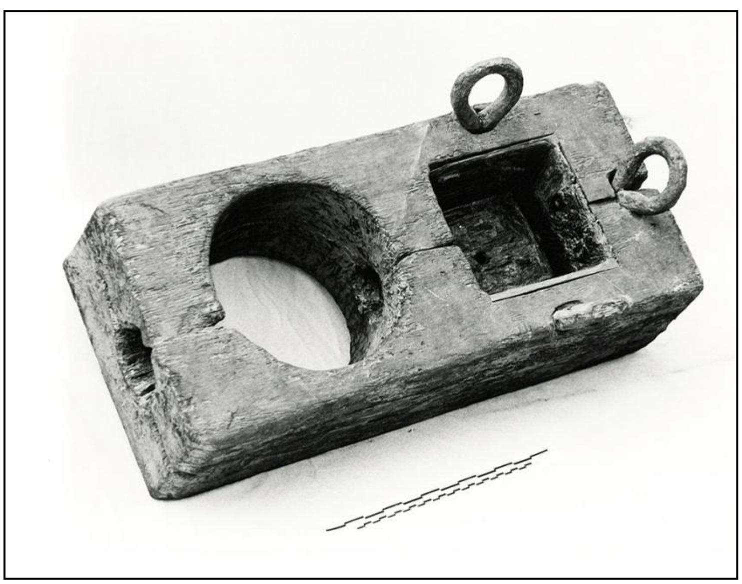

Figure 69 *Boscawen*'s mast cap. (Courtesy of Kevin Crisman)

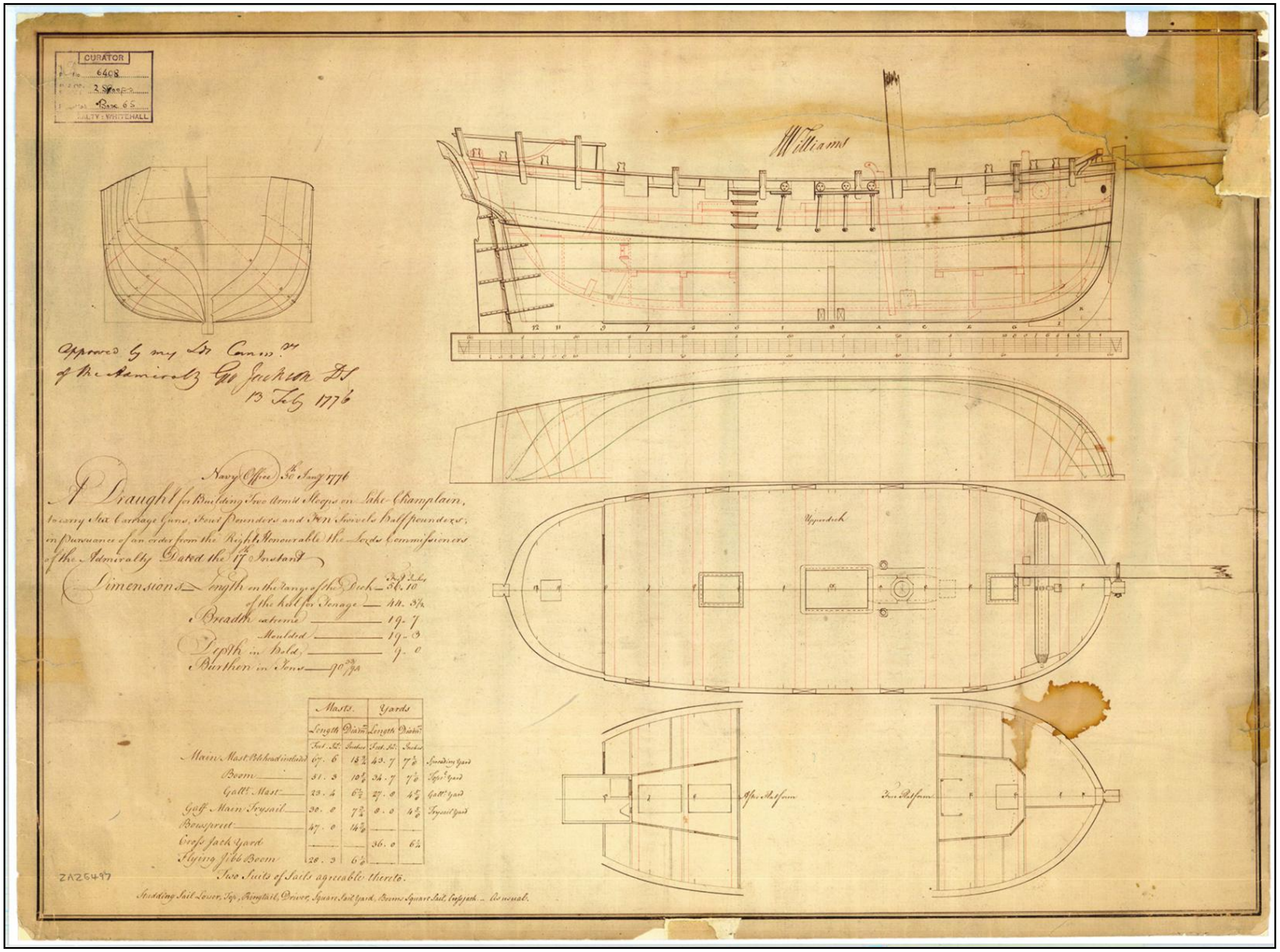

Figure 70 Reproduction of "Unnamed 56ft single-masted Sloops (Circa 1776)". (Object ID: ZAZ6497, from the National Maritime Museum, Admiralty Collection, Greenwich, UK). (Designed by John Williams, Reproduction in author's collection)

Continuing to adopt the 1776 sloop plan measurements, the mainmast would be nearly 68 feet (20.73 m) tall, and the topmast, with just under 8 feet (2.43 m) of doubling, would be nearly 24 feet (7.31 m) long. According to Steel's formula for calculating mast and spar lengths for smaller vessels such as sloops, the height of the main- and topmasts (together) should equal 3.75 times the vessel's breadth.[141] The hypothetical lengths of *Boscawen*'s masts are slightly less than Steel's formula suggests.[142] Because Steel's formulae are largely intended for loftier ocean-going vessels, the shorter mast lengths seem appropriate. The height of the mainmast hounds (and thus the doubling) is also reconstructed slightly lower than what Steel recommended.[143]

For mast rake, the *Boscawen* reconstruction adopts an angle similar to that found in the 1776 sloop plan. According to Steel's calculations, masts should rake 1.5 inches (3.81 cm) for every yard (0.91 m) of mast length.[144] Although Steel's formula recommends a rake of 89.7 degrees (nearly vertical), *Boscawen*'s mast is raked 86 degrees. This slight rake aft was used in the proposed reconstruction, as it would have provided greater mast stability and rig tension.

Since there is no archaeological evidence of the bowsprit, boom, and gaff, we must rely on the dimensions provided in the 1776 sloop plan, on Steel's formulae, and on other contemporary sources to determine their sizes and positions.

Bowsprit

The 1776 sloop plan calls for a 47-foot-long (14.2 m) bowsprit, 15 inches (38.1 cm) in diameter. Steel's formula (five-ninths of the length of the mainmast) calculates the bowsprit to be

[141] Steel, *Steel's Elements*, 47.
[142] The length of the combined main- and topmasts for the *Boscawen* reconstruction are only 3.5 times its breadth (24 feet [7.31 m]).
[143] Steel, *Steel's Elements*, 47. Steel recommends that the main hounds should be three-fourths (0.75) up the mast. *Boscawen*'s reconstruction has its hounds 0.73 up its mast.
[144] Steel, *Steel's Elements*, 4.

37.8 feet (11.52 m) long and 14 inches (35.56 cm) in diameter. The 1776 plan is intended for a sloop with an additional headsail (or possibly an extra-large jib) as well as a flying jib (on a jibboom), so an extra-long bowsprit would have been necessary.

Looking to other eighteenth-century sources, only a few provide bowsprit dimensions. One of these is found in the *Journals of Ashely Bowen*. As a master rigger in Marblehead, Massachusetts, Bowen recorded many of the spar dimensions of the schooners and sloops he rigged (see Figure 71). Many of these vessels were slightly smaller than *Boscawen* but had similar mainmast lengths. For the six sloops and schooners that had comparable data, bowsprit lengths ranged from 34 to 43 feet (10.36–13.1 m), with an average of 38 feet (11.58 m). This, along with Steel's formula, is why the hypothetical reconstruction has a 38-foot-long (11.58 m) bowsprit. However, the bowsprit length could potentially be increased in a future reconstruction to accommodate a larger jib sail.

There are fewer standards when determining the steeve of a bowsprit. Most of the British conventions for larger, ocean-going vessels suggest a steeve between 30 and 36 degrees above horizontal.[145] However, the 1776 plan for sloops intended for Lake Champlain had very little steeve. Through personal communication with Peter Rindlisbacher, a renowned maritime artist and experienced gaff-rig sailor, and by examining contemporary illustrations of small inland watercraft (such as paintings by Davies), I gave *Boscawen*'s reconstruction a 15-degree steeve. There was less need for steeve on inland watercraft because waves, although considerable at times, were not as severe as those of the open ocean; thus, *Boscawen* would have had less danger of dipping its head rig into the water.

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[145] Steel, *Steel's Elements*, 4; Anderson, *The Rigging of Ships*, 14; and Marquardt, *Eighteenth-Century Rigs*, 26.

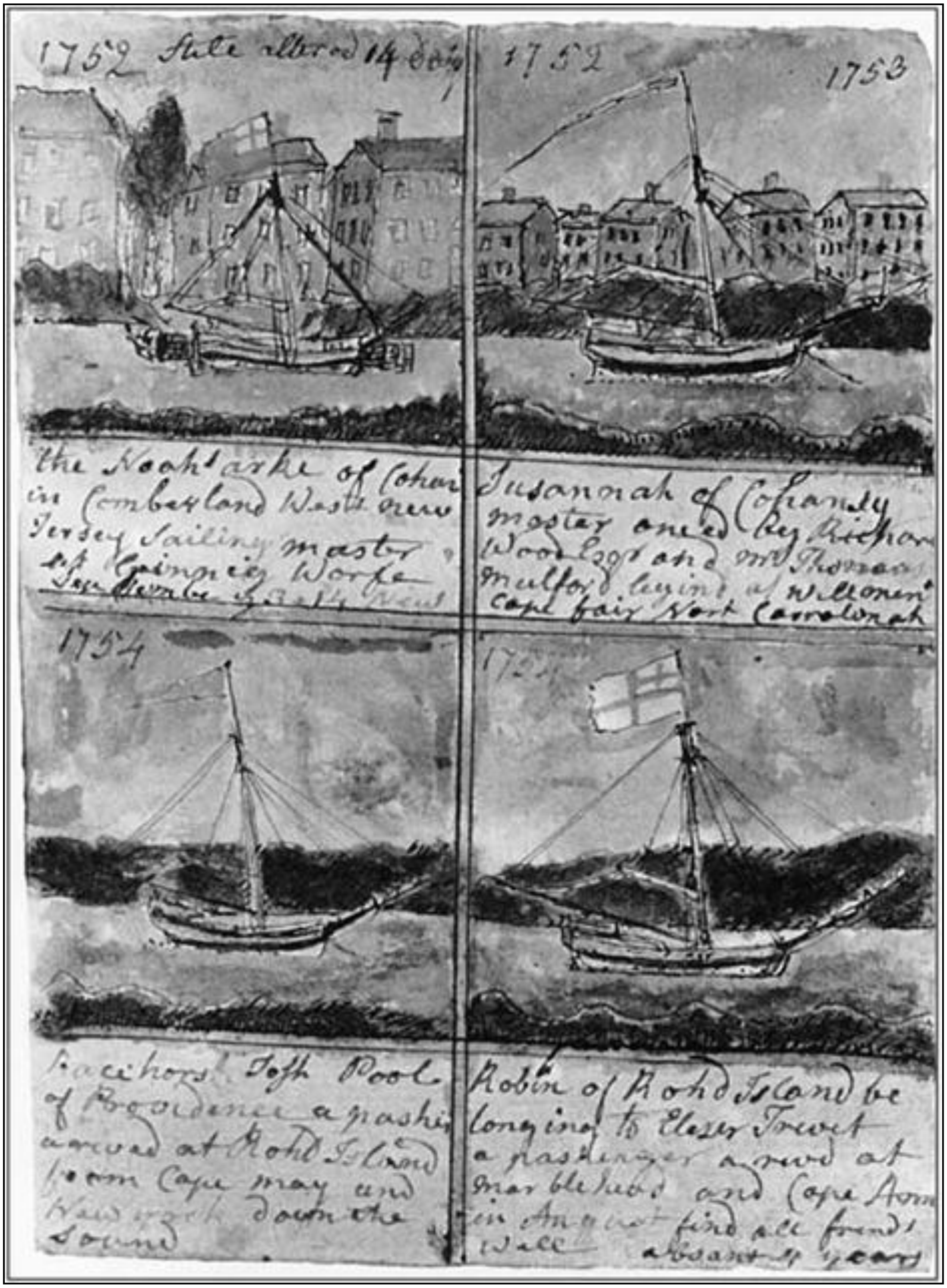

Figure 71 Four sloops depicted in the *Journals of Ashley Bowen* (Plate VIII). (Upper left) Sloop *Noah's Ark* of Cohansey, NJ (1752). (Upper right) Sloop *Susannah* of Cohansey at Wilmington, NC (1752–1753). (Lower left) Sloop *Racehorse,* Josiah Pool, of Providence, RI (1754). (Lower right) Sloop *Robin* of Rhode Island, owned by Eleazer Trevett (1754). (From the Marblehead Historical Society, Marblehead, MA).

Boom and Gaff

The boom's length, according to Steel, should be two-thirds of the mainmast's length, and its diameter should measure three-sixteenths inch (0.47 cm) for every foot (30.48 cm) of the boom's length.[146] However, a spar having these dimensions (around 45 feet [13.72 m] long and 8.5 inches [21.59 cm] in diameter), when compared with the 1776 sloop plan and the 1759 Davies painting, seems on the small side. In the painting, *Boscawen*'s boom overhangs its transom. This means that the boom would need to be closer to 51 feet (15.24 m) long and 10.5 inches (26.67 cm) in diameter (which match the dimensions of the boom from the 1776 plan). Until additional information is revealed about *Boscawen*'s mainsail and associated spars, these latter measurements offer the most logical size.

As for the mainsail gaff, both Steel and the 1776 plan suggest similar-sized gaffs compared to the hypothetical *Boscawen* boom dimensions—that is, around three-fifths (0.6:1) of the boom's length.[147] However, a comparison between the gaff and boom in Davies's painting suggests a ratio closer to 0.68:1. For the hypothetical reconstruction, I decided that an average of the two (0.64:1) would generate an acceptable length gaff of 32.5 feet (9.9 m).

The parrel trucks for both the gaff and boom were based on those found during *Boscawen*'s excavations. The recovered parrels were roughly 2.5 to 3 inches (6.35–7.62 cm) tall and 3 inches (7.62) in diameter. Their interior diameters were 1.5 inches (3.81 cm).

[146] Steel, *Steel's Elements*, 47.
[147] Steel, *Steel's Elements*, 47; National Maritime Museum, "Unnamed 56ft single-masted Sloops (Circa 1776)"; Smith, *The Journals of Ashley Bowen*, 627–636.

Shrouds, Stays, and Deadeyes

Most of the sources for this hypothetical reconstruction indicate that mid-eighteenth-century sloops like *Boscawen* had four main shrouds per side (the Davies painting likewise depicts *Boscawen* with four shrouds).[148] These shrouds (with their respective channels and chainplates) would either be split into two separate groups along the bulwark on either side of a gunport, or split into a group of three with an additional shroud on the opposite side of the closest gunport aft. Shrouds positioned too far aft could affect the maximum swing of the boom and thus lessen the rig's sailing capability (especially when sailing downwind). For the reconstruction, the spacing of the gunports accommodates three shrouds between the fourth and fifth gunports, with an additional shroud just aft of the fifth gunport. This particular arrangement of the shrouds keeps them as far forward as allowed by the gunports and is similar to the 1776 sloop plan.

The 1984 and 1985 excavations of *Boscawen* produced only three deadeyes, made from black locust (see Figures 72–74). The largest deadeye is 10.5 inches (26.7 cm) in diameter, with a channel width of 1.375 inches (3.5 cm). This diameter is only 0.5 inches (1.27 cm) larger than the main deadeyes on the 1776 plan and those from Steel's dimensions for a small sloop of 130 tons but is still well within the expected size for *Boscawen*'s main shrouds. Using the conventions of both Steel and James Lees for the ratio of shroud cable circumference to deadeye diameter,[149] the shroud cables used with these main deadeyes would have been around 7 inches (17.78 cm) in circumference and 2.25 inches (5.71 cm) in diameter.

[148] Smith, *The Journals of Ashley Bowen*, 627–636; National Maritime Museum, "Unnamed 56ft single-masted Sloops (Circa 1776)"; Steel, *Steel's Elements*, 267.
[149] Lees, *The Masting and Rigging of English Ships of War*, 168, 188. Lees specified that the diameter of a deadeye should be around 1.5 to 1.6 times the circumference of its shroud cable. These proportions are similar to the one displayed in Steel, *Steel's Elements*, "Appendix."

The upper and lower main deadeyes were lashed together with lanyards roughly 1.25 inches (3.17 cm) in diameter. The lower deadeye was secured with a metal strop, bolt, and plate through the channels and fastened to the outer hull planking.

The other deadeyes recovered from *Boscawen* are roughly 5.5 inches (13.97 cm) in diameter and suggest that they may have been used for the jibstay, bobstay, or bowsprit shrouds. Their respective cables would then have had 3.6-inch (9.1 cm) circumferences, or diameters of around 1.5 inches (3.81 cm). As mentioned above, even though the archaeological examples of deadeyes were found on the wreck, they may not represent the actual components used on *Boscawen*. These deadeyes may have been spares or odds and ends in storage, possibly from another vessel. For the most part, however, the archaeological evidence seems to agree with the reconstructed rig.[150]

Boscawen carried no topsail; therefore, fore- and backstays to the topmast were not required. The lack of topstays is also corroborated by contemporary depictions of colonial-built sloops. These depictions include the Davies painting and Ashley Bowen's watercolors of sloops from the mid-eighteenth century (see Figures 2, 3, and 71). For this reason, *Boscawen*'s topmast is secured only by the mast cap and trestletree.

Since there were no top shrouds on *Boscawen*, only the main shrouds carried ratlines. The dimensions and spacing likely followed the conventions of the period—that is, approximately 1 inch (2.54 cm) in diameter and roughly 15 inches (38.1 cm) apart.[151]

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[150] The only archaeological evidence of *Duke of Cumberland*'s rig is a severely desiccated and eroded deadeye (Figure 60). This deadeye (in its current state) is roughly 6.5 inches (16.5 cm) in diameter and has an estimated maximum thickness of nearly 5 inches (12.7 cm). Its lanyard holes are, on average, 0.65 inches (1.65 cm) in diameter. This is likely an upper deadeye due to the curved channel that was cut into its outer edge to fit a rope strap (and not a sharper groove to accept a lower deadeye's iron strap). The channel measures nearly 3 inches (7.62 cm) at its maximum surviving width. We will never know where this deadeye was used on the brig, but it was likely used for either the main or fore top shrouds or the backstay shroud (due to its smaller dimensions).

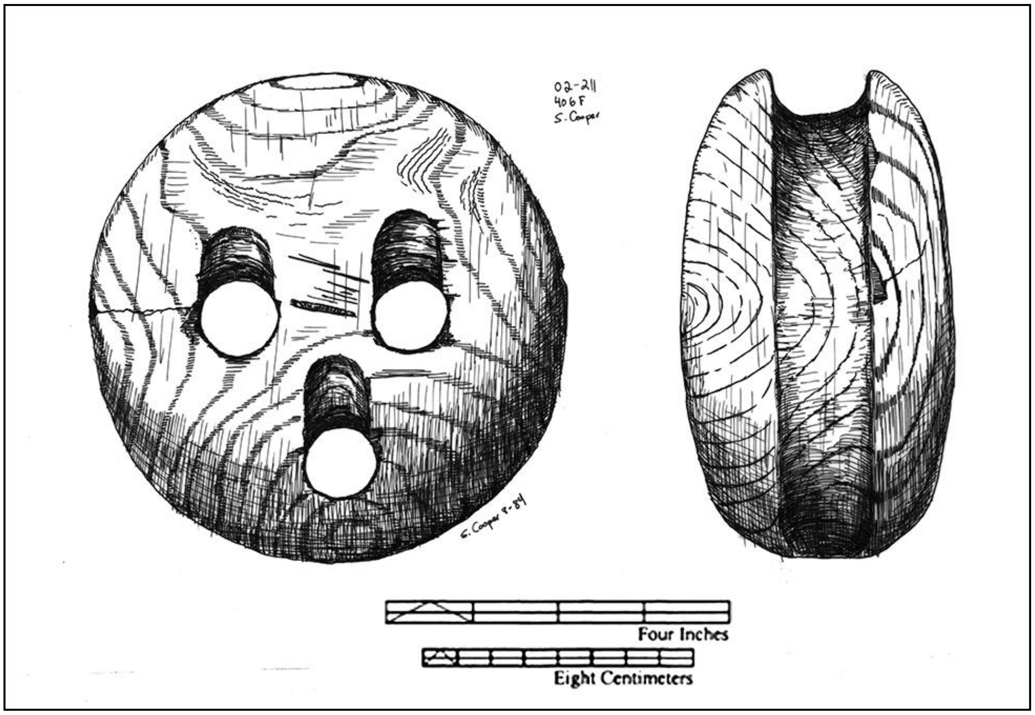

Figure 72 *Boscawen*'s deadeye (1) 02-211. (Drawn by Scott Cooper)

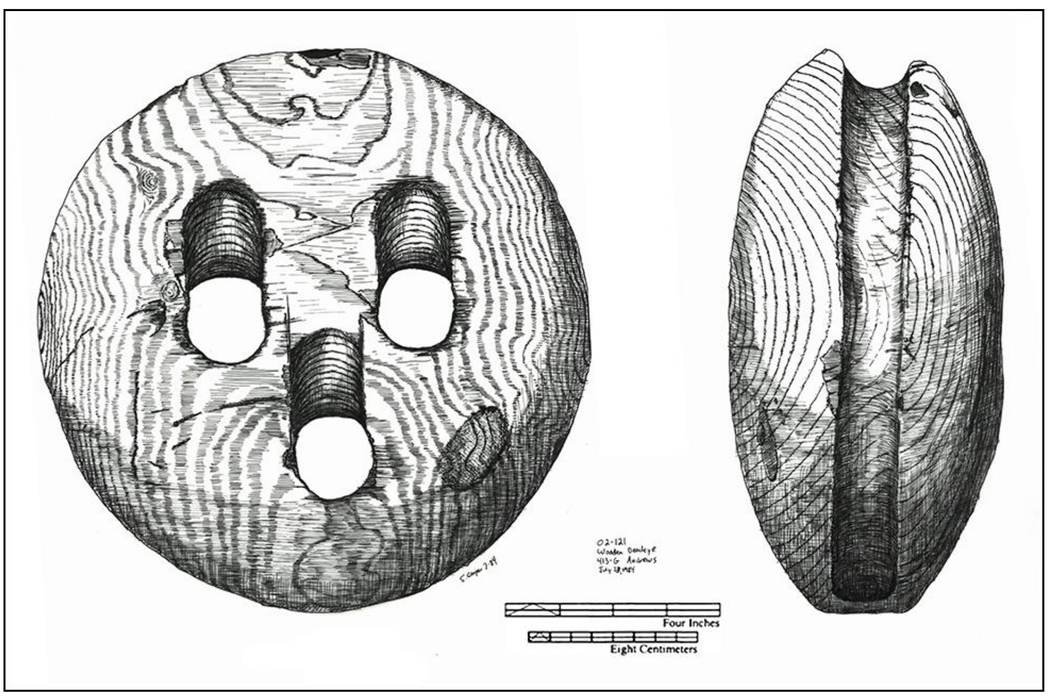

Figure 73 *Boscawen*'s deadeye (2) 02-121. (Drawn by Scott Cooper)

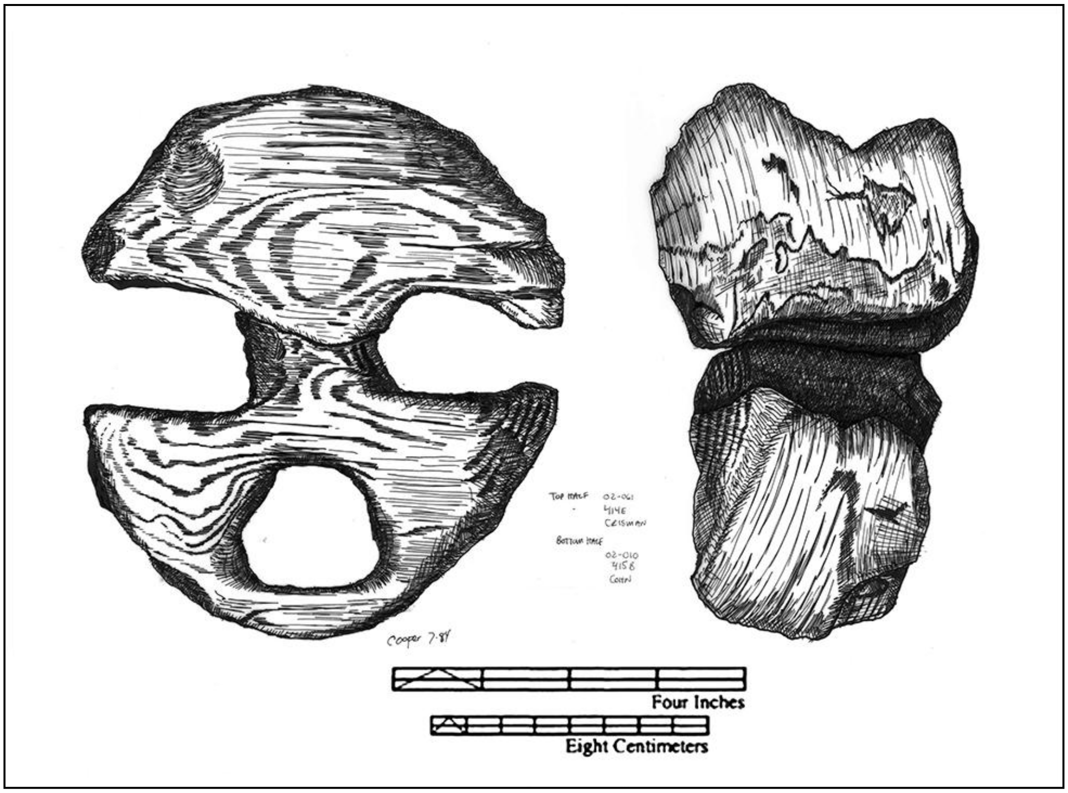

Figure 74 *Boscawen*'s deadeye (3) joined fragments 02-010 and 02-061. (Drawn by Scott Cooper)

Trestletree and Bolster

The tops of the shrouds were looped over the mainmast and held aloft by the trestletree (supported by the hounds). Steel stated that trestletrees should be one-fourth the length of the topmast and one-half the diameter in its molded dimension.[152] This length seems unnecessarily long for *Boscawen*, so its trestletree is reconstructed slightly shorter than that convention but still long enough to accommodate the main- and topmasts: 5.5 feet (1.67 m) long and 9 inches (22.9 cm) in depth. Above the trestletree, a simple bolster on each side to the mast to "soften" the corner of the trestletree (for the shrouds) would have been ideal to preserve the longevity of the shroud cables, and a bolster is included in the reconstructed rigging plan.

According to the Davies and Bowen paintings, the fore- and jibstays attached to the mainmast above the shrouds, all supported by the trestletrees.

Running Rigging

During the 1980s excavations, archaeologists recovered a number of black locust and elm blocks, lignum vitae sheaves, sheave pins, and rope that could be from *Boscawen*'s running rigging. Block sizes (taken from blocks as well as calculated from single sheaves) range from 5 inches long and 4 inches wide (12.7 × 10.16 cm) to 14 inches long and around 10 inches wide (35.56 × 25.4 cm). It would be nearly impossible to determine which blocks were used for the various rigging components, so the hypothetical reconstruction uses the various sizes of the blocks as a starting point and relies on sources such as *Steel's Elements of Mastmaking, Sailmaking, and Rigging* to inform the running rigging. However, it is likely that some of the

[152] Steel, *Steel's Elements*, 29.

smaller blocks and sheaves, especially those painted red, may have been a part of the sloop's gun or deck tackle.[153]

Two of the ten blocks display evidence of hasty construction and wear (see Figures 75 and 76).[154] This suggests that while some of the rigging components were purchased (new or used), others were made on site by Loring's carpenters. In addition, the archaeological record hints there was less variation in block sizes aboard *Boscawen*.[155] Fewer block sizes would allow the carpenters and riggers to prepare for and make repairs more effectively. For these reasons, the reconstruction uses Steel's proportions for a sloop the size of *Boscawen* (130-tons) to inform the approximate size of the rigging components. The blocks and ropes are consolidated roughly into three main groups based on their size.

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[153] Flanigan, "The Rigging Material from *Boscawen*," 72; Kemp, *The Oxford Companion to Ships and the Sea*, 362. It has been suggested that *Boscawen*'s main deck bulwarks and gun tackle were perhaps painted red so that the blood of those injured or killed was not distracting to the gun crews. Flanigan also posits that these particular blocks could have been painted to denote their status as a spare or discarded piece.

[154] Approximately half of the sheaves and pins show signs of heavy wear.

[155] A total of nineteen sheaves were recovered from *Boscawen*. Four of these sheaves were considered large (around 7 inches [17.8 cm] in diameter and over 1 inch [2.5 cm] thick); one sheave is rather small (2.75 inches [6.3 cm] in diameter and 0.5 inches [1.3 cm] thick). The minimal variation among the remaining fourteen sheaves is not enough to suggest that different-diameter cordage was used. The average diameter and thickness of these fourteen sheaves is 3.5 inches (8.9 cm) and 0.75 inches (1.9 cm), respectively.

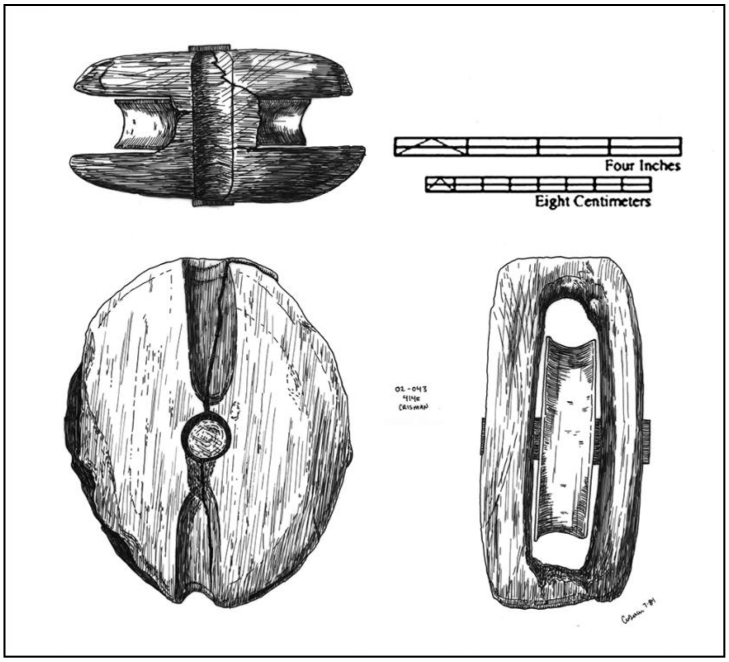

Figure 75 One of *Boscawen*'s single sheave blocks 02-043. (Drawn by Kevin Crisman)

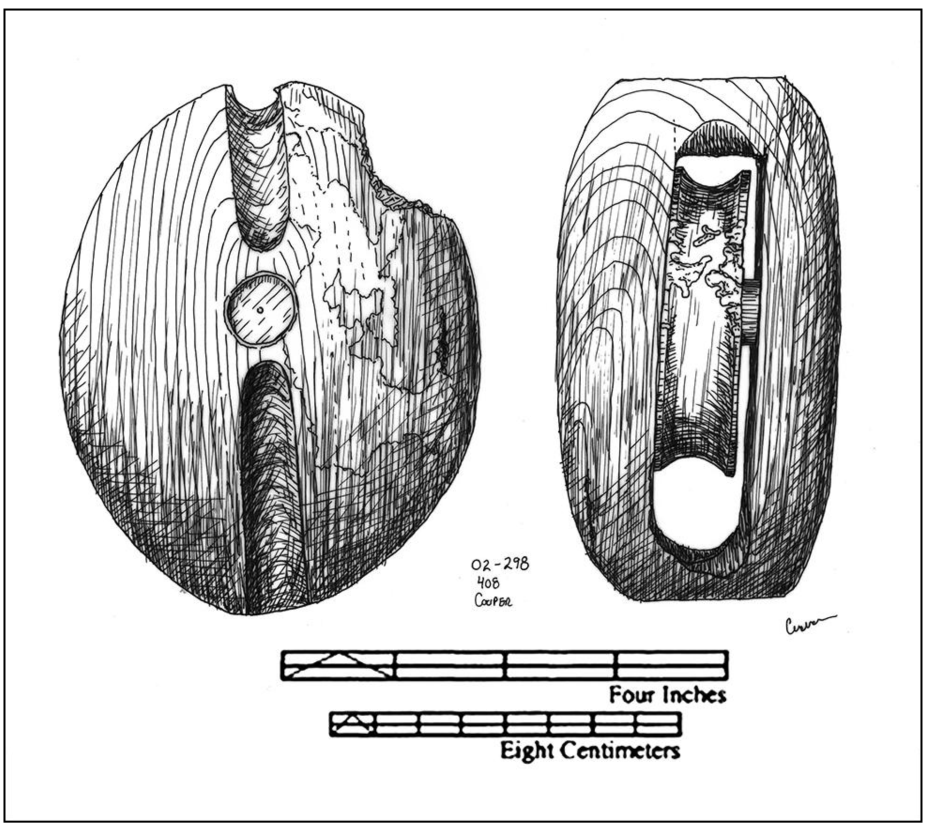

Figure 76 One of *Boscawen*'s single sheave blocks 02-298. (Drawn by Kevin Crisman)

Jib, Fore, Throat, and Peak Halyards

Steel's sloop has jib and foresail halyards that are 2.5 inches (6.35 cm) in circumference. *Boscawen*'s reconstruction utilizes Karl Marquardt's specifications for approximating sheave and block size based on their corresponding rope.[156] Using these calculations, the jib and foresail halyard block sizes would be 7.5 inches long and 5.25 inches wide (19.05 × 13.33 cm) with a sheave that is 4.4 inches (11.17 cm) in diameter. Inspired by an eighteenth-century British Naval cutter rig illustrated in Lennarth Petersson's *Rigging: Period Fore-and-Aft Craft*,[157] I depict in *Boscawen*'s reconstruction the upper blocks of the halyards lashed to served cable loops that wrap around the mainmast.

Steel recommended marginally smaller ropes (i.e., 0.16 inches [0.4 cm] smaller in diameter) for the peak and throat halyards compared to the jib and foresail halyards. It is doubtful that Loring would have taken the time to find this smaller-diameter rope; he most likely obtained the rigging material as quickly as he could for the lowest cost possible.[158] It is thus probable that Loring simplified *Boscawen*'s rig by using similar (if not the same) size ropes and blocks when he could, which would have ensured that future repairs could be made with standardized spare material, ultimately lowering the overall cost and logistical complication. With this in mind, *Boscawen*'s peak and throat halyards and their blocks are represented in the reconstruction as having the same sizes as those of the jib and foresail.

The peak halyard starts at the end of the gaff and roves through a block attached to the aftermost eyebolt on the underside of the mast cap. The halyard is then run through two more

[156] Marquardt, *Eighteenth-Century Rigs*, 248. Marquardt stated that "the sheave's thickness was one tenth more than the diameter of the rope, and its diameter was five times the thickness; the sheave hole was one sixteenth wider than the sheave's thickness; the length of a block was eight times the width of the sheave hole, the breadth six times the thickness of the sheave, and the thickness half the length."
[157] Petersson, *Rigging*, 25.
[158] PRO, W.O.R. 34/64, 198.

blocks before continuing down to tackle where it is cleated off near the pin rail. This particular setup is based on the rigging plan of a fore-and-aft sloop by William Falconer.[159]

The throat halyard utilizes the same diameter of rope as the other halyards but is rove through a pair of double blocks—one attached to the top of the gaff at the base of its jaws and the other attached to an eyebolt on the underside of the trestletree. The remainder of the throat halyard continues down to the deck through tackle and is secured on a pin rail.

Vangs and Jib Outhauler

The vangs of Steel's 130-ton sloop are smaller in diameter than the halyards. They are 2 inches (5.08 cm) in circumference and had blocks 6 inches long and 4.25 inches wide (15.24 × 10.8 cm) with a 3.5-inch-diameter (8.9 cm) sheave.[160] The vangs attached to the end of the gaff and rove through tackle down to the quarterdeck.

The jib outhauler design is based on the naval cutter in Petersson's work and Falconer's fore-and-aft sloop.[161] It consists of an iron ring (covered in greased leather) that encompasses the bowsprit, a short sling inhaul, and an outhaul rope that runs forward through a ring at the end of the bowsprit and returns inboard. For simplicity, these ropes are shown to have diameters similar to those of the vangs.

Boom Sheet Horse and Tackle and Topping Lift

The boom tackle was slightly more substantial than some of the other running rigging components. It utilized double blocks to provide more mechanical advantage to maneuver the

[159] Falconer's sloop, as found in Marquardt, *Eighteenth-Century Rigs*, 129.
[160] Steel, *Steel's Elements*, 267; Marquardt, *Eighteenth-Century Rigs*, 248. The block and sheave sizes are calculated using Marquardt's formula.
[161] Petersson's illustrations are based on a contemporary model from the second half of the eighteenth century. Falconer's sloop, as found in Marquardt, *Eighteenth-Century Rigs*, 129.

heavy boom, especially when it was under sail. The blocks were estimated to be a bit larger than the others previously mentioned. They are shown to be nearly 14 inches (35.56 cm) long and 9.5 inches (22.86 cm) wide. (This size block could accommodate the largest sheave found on *Boscawen*.)

The topping lifts also had larger rope diameters (1.2 inches [3.05 cm]).[162] This was necessary to support the heavy weight of the boom when the sloop was not under sail. Their corresponding blocks needed to be 10 inches long and 7.5 inches wide (25.4 × 19.05 cm). The reconstructed topping lifts are attached to the aft end of the boom and to the eyebolts of the mast cap on either side of the mainmast. Their position is informed by Bowen's sketches of 1750s merchant sloops of Boston, in which each of the topping lifts appears to attach to the underside of the mast cap.[163]

Discussion and Evaluation of **Boscawen***'s Rigging Reconstruction*

Boscawen's hypothetical rig reconstruction was generated in consideration of the economic, material, operational, and environmental constraints of the period and region. *Boscawen* has a basic sloop rig consisting of only fore-and-aft sails (main, fore, and jib).[164] This simple rig was less expensive to purchase and maintain than a topsail sloop or another more complex rig.[165] As stated previously, it is possible that Loring acquired the blocks, deadeyes, chainplates, and cordage for two snow or brig rigs, using one set for *Duke of Cumberland* and

[162] Derived from Steel, *Steel's Elements*, 267.
[163] Smith, *The Journals of Ashley Bowen*, Plate VIII.
[164] From what we are able to gather, *Duke of Cumberland*'s mainmast carried a fore-and-aft gaff-rigged mainsail, and possibly a main topsail. Between the mainmast and the foremast, *Duke of Cumberland* carried a staysail. The brig's foremast appears to have held, at a minimum, a foresail and a fore topsail. Between the foremast and the bowsprit, *Duke of Cumberland* also was shown as carrying a fore staysail and a jib. However, additional research is needed to better understand the specifics the brig's potential rig.
[165] The yards of a mainsail and main and fore top gallants for *Duke of Cumberland* were not portrayed by Davies. It is possible that these were not included in the painting, or that the brig's rig was likewise simplified by Loring.

cannibalizing the second in order to rig both the sloop and radeau. [166] This could explain why *Boscawen* had only fore-and-aft sails. Alternatively, Loring may have had access to only leftover (and cobbled together) rigging components or to one or more rigs of a smaller merchant crafts.[167] Some of the roughly made rigging components, such as the block shells, suggest that Loring had his carpenters fashioned at least some of the rig locally. Lastly, it is possible that Loring may have intentionally simplified the rigging, not only due to shortages in supplies, but for the sake of a less experienced and smaller crew.

Boscawen's rig was reconstructed with consideration of navigation conditions on the lake. The steeve of the bowsprit, although low for the Royal Navy conventions of the period, is sufficient to deal with the lake's waves, even in the worst swells and during squalls. *Boscawen*'s fore-and-aft rig allowed it to sail close into the wind. This would be especially optimal for Lake Champlain, as the prevailing winds in the Champlain Valley typically blow out of the north or south, depending on the season. Additionally, this rig was easier for inexperienced crew members to sail, as each of the sails could be manipulated from the deck. I suspect that the height of the main mast may have been intentionally short relative to the sloop's length to provide a simple, serviceable rig that reflected the evident shortage of rigging components available to Loring.

[166] *Ligonier* was rigged with simple square sails. It is possible that Loring had to share sails and cordage from the two sets of rigging among the three main vessels of the flotilla.

[167] Loring sent for additional cordage right before the brig and sloop were rigged. PRO, W.O.R. 34/64, 156, Loring to Joh [*sic*] Appy, Esq., 30 Aug. 1759.

CHAPTER V

COLONIAL VESSEL SCANTLING REPORTS: LAKES CHAMPLAIN AND GEORGE

Timber measurements form the basis for hypothetical line reconstructions and comparative analyses among wrecks. In this chapter, I have compiled the scantling reports in an effort to document known archaeological examples of colonial sailing vessels from Lakes Champlain and George and to make them accessible in a single place. These reports shed light on the similarities and differences among the vessels of this study and will assist future scholars investigating eighteenth-century wrecks.

***The Sloop* Boscawen *and the Brig* Duke of Cumberland**

I generated the information that follows using historical sources, the 1980s archaeological notes on *Boscawen*, and the iWitness photogrammetry point cloud of *Duke of Cumberland*. It should be noted that much of what is reported in this chapter for the scantlings and other measurements of *Boscawen* differs from Crisman's 1985 publication of them in *The Bulletin of the Fort Ticonderoga Museum*.[168] The reason for these differences is that a number of the measurements provided in the bulletin article were estimations based on limited data; that is, the publication was written before the archaeological team had fully exposed the wreck in their final field season. Moving forward, the data presented in this chapter reflect a more complete collection of scantlings and hull measurements for *Boscawen*.

[168] Crisman, "The Construction of the *Boscawen*," 357–370.

The Shipwrights and Carpenters at the King's Shipyard

As mentioned in Chapter II, during the early stages of planning for the 1759 campaign, General Jeffery Amherst selected Royal Navy Captain Joshua Loring to oversee the building and command of a Lake Champlain naval force for the British Army. Amherst ordered Loring to find a master shipwright and enough carpenters to build the vessels he envisioned: "Engage… Seventy good Ones… divide[d] into Two Companies, wherefore it will also be necessary to have a good Overseer to Each of said Companies."[169] Finding a master shipwright and enough carpenters with experience on the northern lakes proved difficult. One master shipwright from "the Jerseys" who had previously worked at Oswego, on Lake Ontario (prior to 1756), refused to take up the position, since he was never paid for his previous work there.[170] Needing to look elsewhere, Loring sent word to a Mr. Wentworth in Boston, requesting that Wentworth recruit a master builder and carpenters and send them immediately to Albany. Loring also sent word to a shipwright named Peter Jacquet, who at the time was under the employ of Colonel John Bradstreet at Albany, to travel to Philadelphia to recruit a number of carpenters. Loring, however, was unable to secure the full complement of seventy carpenters, as they were in high demand throughout the Northeast.[171] Amherst was keenly aware of the "scarcity of Carpenters and the Exorbitant Wages they insist[ed] upon."[172] Thirteen carpenters, including Jaquet, appear on a payroll list,[173] but it is unclear just how many shipwrights and carpenters formed the initial group employed to build the brig *Duke of Cumberland*, and where they came from.

[169] PRO, W.O.R. 34/64, 198, Amherst to Loring, 22 May 1759.
[170] PRO, W.O.R. 34/64, 145, Loring to Amherst, 2 June 1759; PRO, W.O.R. 34/64, 199, Amherst to Loring, 8 June 1759.
[171] PRO, W.O.R. 34/64, 156, Loring to John Appy, Esq., 30 Aug. 1759.
[172] PRO, W.O.R. 34/64, 199, Amherst to Loring, 8 June 1759.
[173] Jacquet was paid 207 shillings per day and regular carpenters were paid 9 shillings per day. The carpenters were employed between 17 June and 11 December 1759. PRO, W.O.R. 64/20, File 6.

When Amherst first ordered the sloop *Boscawen* to be built, on September 3rd, Loring had a total of forty-six carpenters. However, fourteen of them became sick and four others were assigned to care for them, leaving only twenty-eight carpenters to build the vessel. In addition, Loring reassigned carpenters working on *Duke of Cumberland* and ordered them to acquire timber for the sloop to hasten its construction. These carpenters were aided by timber sawyers and both regular and provincial forces, largely detachments from Major General Phineas Lyman and Colonel David Wooster's Connecticut regiments who were tasked with shipyard labor and timber acquisition duties.[174]

Further archival research is needed to uncover the origins and backgrounds of the shipwrights and carpenters at Ticonderoga. Knowing more about these individuals may help clarify their shipbuilding traditions and the specific techniques and methods they used to construct the vessels.

Timber and Repairs

After engaging the carpenters, Loring had them locate and cut down trees needed for the vessels. A letter from Loring to Amherst related that the carpenters working on *Duke of Cumberland* were sent out to collect additional timber for vessel construction, suggesting that it was locally sourced from forests around Ticonderoga.[175] A wood species analysis of the timbers from *Boscawen* provides additional evidence to support this: the preferred species used by the Ticonderoga shipwrights were white oak and white pine. *Boscawen*'s keel, keelson, frames, and stem and stern components were made of white oak. The sloop's sampled deck beams and a few

[174] PRO, W.O.R. 34/64, 159, 160; Lewis, "An Interim Report," 5.
[175] PRO, W.O.R. 34/64, 160, Loring to Amherst, 16 Sept. 1759. Even by 1757, some documents report that good oak near Ticonderoga was becoming harder to find. This is likely due to the amount of timber that was previously harvested for the construction of the fort. Bourlamaque Papers, Vol. 20, 269–271. Hebecourt to Bourlamaque, 11 Nov. 1757.

of the strakes were made of white pine.[176] These wood species were commonly used in northeastern North American shipbuilding during the eighteenth century because they were ubiquitous in the region and considered the best types for ships.

Although the British flotilla was constructed with adequate woods, the hasty acquisition and processing of the logs, along with rushed construction of the vessels, forced the shipwrights to use green, unseasoned timbers. Using timbers before they have time to season causes a vessel's seams to open up and ultimately contributes to a shorter working life of the vessel.[177] This appears to have been the case, especially for the brig. Within one year of *Duke of Cumberland*'s launch, Lieutenant Alexander Grant observed that "the Brig is very leaky" and was in need of regular repairs.[178] At some point over the next two years, a report of the vessels on Lake Champlain recommended "overhauling down her [*Duke of Cumberland*'s] Bottom" in order to make the brig serviceable.[179]

The degradation of the vessels on the lake cannot be attributed solely to unseasoned timbers or hasty construction. Both *Duke of Cumberland* and *Boscawen* were heavily built for their lake service and constructed by knowledgeable shipwrights. What may have substantially contributed to these vessels' shorter lives was the lake itself. Each winter, the vessels remained in the water.[180] Freezing during the winter months and the ice breakup in spring likely damaged the vessels' hulls, forcing the British to make necessary repairs before their next campaigning season.

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[176] Most of the planks (ceiling and outer hull) were made from white oak. Crisman, "The Construction of the *Boscawen*," 364–365.
[177] Goldenberg, *Shipbuilding*, 31–3, 57, 71; Gwyn, "Shipbuilding for the Royal Navy," 22–23.
[178] PRO, W.O.R. 34/51, 59, Grant to Haviland, 21 June 1760; PRO, W.O.R. 34/51, 65, Grant to Haviland, 5 July 1760.
[179] PRO, W.O.R. 34/65, 109, No Date (most likely reported in 1761/62).
[180] PRO, W.O.R. 34/51, 220, 20 Jan. 1762.

Keel

The full length of *Boscawen*'s white oak keel timber(s) is 60 feet (18.3 m).[181] Near the stem, it has a maximum molded dimension of around 12 inches (35.5 cm), and its sided dimension narrows from 10.5 inches (26.7 cm) to around 6 inches (15.2 cm) at its forward end. Toward the stern, the keel slowly tapers in its molded and sided dimensions to 9.5 inches (24.1 cm) and 4.5 inches (11.4 cm), respectively. Likely fashioned from a single timber, the keel has rabbets cut into its side roughly 1 inch (2.5 cm) below its upper corners, to accept the 2-inch-thick (5.1 cm) garboard strakes.

The keel of *Duke of Cumberland* was difficult to observe in the photographic record, just as *Boscawen*'s was hard to access during the excavation. Even at the ends of the vessel, where the keel "should" be more visible, *Duke of Cumberland*'s other timbers often obscure it or leave it in shadow. However, from the limited number of photos that do capture it, *Duke of Cumberland*'s keel was at least 12 inches (30.5 cm) molded and 11 inches (27.9 cm) sided. The total length of the reconstructed keel is nearly 80 feet (24.4 m) and it was likely fashioned out of two timbers. Similarly to *Boscawen*, *Duke of Cumberland* did not appear to have a false keel.[182] The photographs also suggest that the brig's keel had rabbets cut into each side. This is evidenced by the garboard strakes and possible rabbet lines near the stem seen in Figures 11 and 13.

Stem and Bow Assembly

Both *Boscawen* and *Duke of Cumberland*'s stems were constructed from three timbers: a main stem, a gripe (or outer post), and an apron.[183] These three components were fastened

[181] This length differs from what has been previously reported in Crisman, "The Construction of the *Boscawen*," 358.
[182] Crisman, "The Construction of the *Boscawen*," 358–359.
[183] *Boscawen*'s three stem timbers were made of white oak.

together using iron drift bolts. *Boscawen*'s main stem attaches to the keel with a roughly 2-foot-long (61 cm) flat scarf and is also secured with iron drift bolts (Figures 77 and 78).[184] It was originally thought that a keel-stem scarf on *Duke of Cumberland* is visible in Figure 13, but it seems only to be gouges or scratches on the timbers' vertical faces. It is likely, however, that the brig's stem was attached to the keel similarly to *Boscawen*'s assembly.

The curved length of the sloop's surviving lower main stem is nearly 11 feet (3.3 m). The stem's maximum sided dimension is approximately 6 inches (15.2 cm) and tapers to 5.5 inches (14 cm) at the forward end. Its inboard corners were chamfered to form the lower half of the stem rabbet. The maximum molded dimension of the main stem, located just forward of the keel, measures 11 inches (27.9 cm) and it gradually tapers to 8 inches (20.3 cm) toward the top.

The remains of the gripe measure around 9 feet (2.7 m) along its curve and are butted against the forward end of the keel. The only observed fasteners that held this timber in place are two 1-inch-diameter (2.5 cm) drift bolts that were secured through the main stem and apron.[185] The gripe's maximum sided dimension is 5.5 inches (14 cm) on its inboard face where it attaches to the main stem, and tapers to 3.75 inches (9.5 cm) on its outboard face. The gripe is 6 inches (15.2 cm) molded at its junction with the keel, expanded to a maximum molded dimension of 11 inches (27.9 cm) as it moves forward, and reduces back to around 6 inches (15.2 cm) at its surviving upper terminus.

Boscawen's apron is badly eroded near the sediment line and was not recorded in great detail during the 1984 excavation.[186] The total recorded surviving length of the apron is nearly 12 feet (3.6 m) long. This timber begins just aft of Frame F and is 12 inches (30.5 cm) sided and 4

[184] All of the drift bolts used to fasten the stem components were 1 inch (2.5 cm) in diameter.
[185] Only one bolt had been observed at the time of the publication of Crisman, "The Construction of the *Boscawen*."
[186] This is why the dimensions published in Crisman, "The Construction of the *Boscawen*," do not reflect those presented in this dissertation.

inches (10.2 cm) molded. As the apron runs forward, both its maximum sided and molded dimensions gradually increase to 16 inches (40.6 cm) and 6 inches (15.2 cm), respectively, and its lower corners are chamfered to form the upper rabbet. In addition, the apron is notched to accept the bases of the futtocks on either side of Frame H.[187]

For *Duke of Cumberland*, only a few photographs portray the remains of its fragmented bow timbers (see Figures 8 and 9). As evidenced by the splintered remains of the stem complex, the missing gripe, and the dislodged forward hood ends of some of the strakes, the workers who raised the wreck likely used the stem as an attachment point for their chains and rope. However, comparing the photographs that show the brig's stem assembly in more detail to *Boscawen*'s stem construction, the resemblance between the two becomes apparent. Among the more noticeable similarities are the shape and size of *Duke of Cumberland*'s stem timbers (especially the apron) and the fasteners used to secure them. Overall, the shape and dimensions of *Duke of Cumberland*'s bow assembly—that is, the radius of the main stem and the portions that were able to be photogrammetrically mapped—appear to match *Boscawen*'s almost identically.

Stern

Boscawen's stern was the most challenging hull feature to record. Many of the timbers, especially the lower deadwood, were inaccessible and their measurements were made indirectly. *Boscawen*'s stern assembly (see Figures 79 and 80) was constructed from four timbers: one white oak sternpost, one large stern knee, and two deadwood timbers (one above and below the stern knee). Most of the timbers are fastened to one another and the keel using 1-inch-diameter (2.5 cm) drift bolts. It should be noted that the deadwood timbers and the stern knee narrow in their

[187] This frame is one of the master (or mould) frames that would have been preassembled and erected early in the building process to help guide the sloop's hull shape. This is also where the furthest forward of the five frame curvatures was recorded.

sided dimensions—down to the keel and from fore-to-aft toward the sternpost—to maintain the tapered shape of the sloop's stern lines.

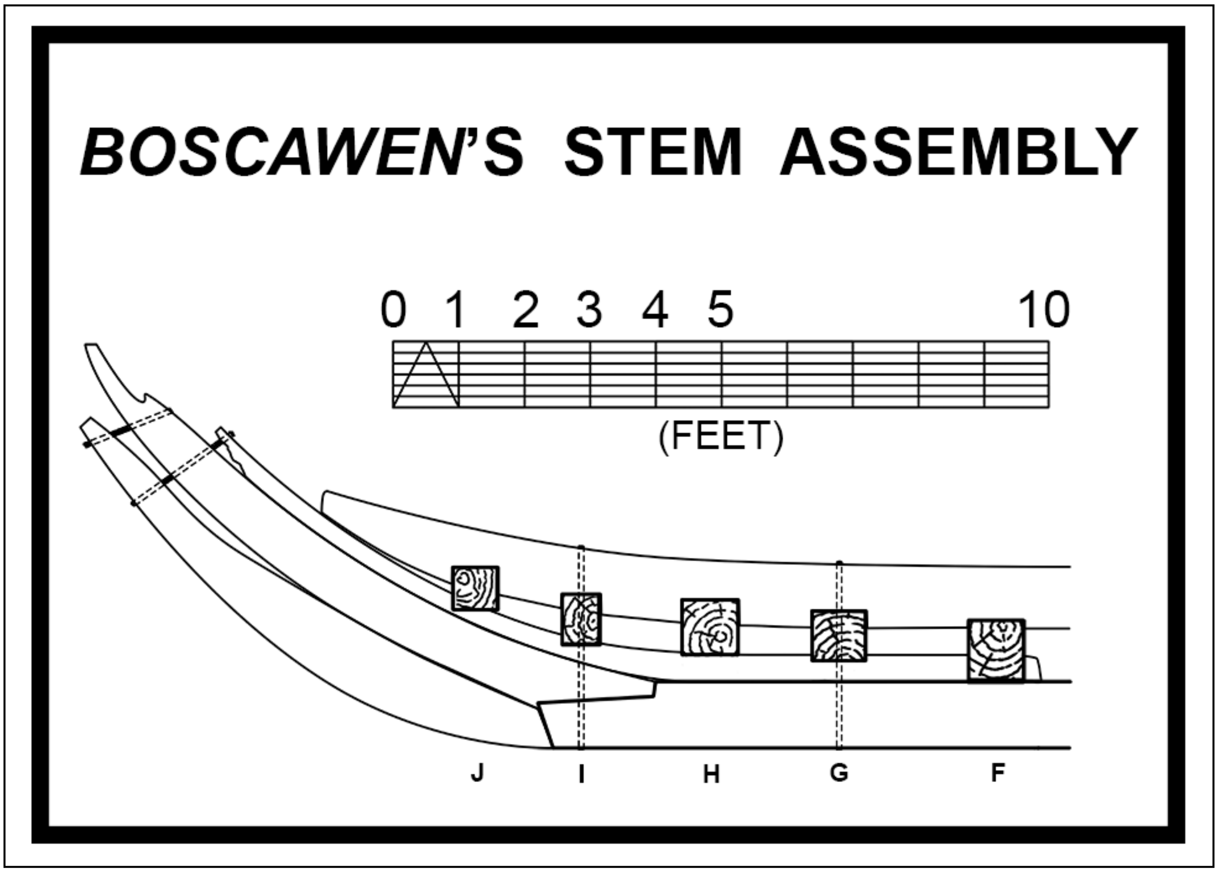

Figure 77 *Boscawen*'s stem assembly. (Drawn by author)

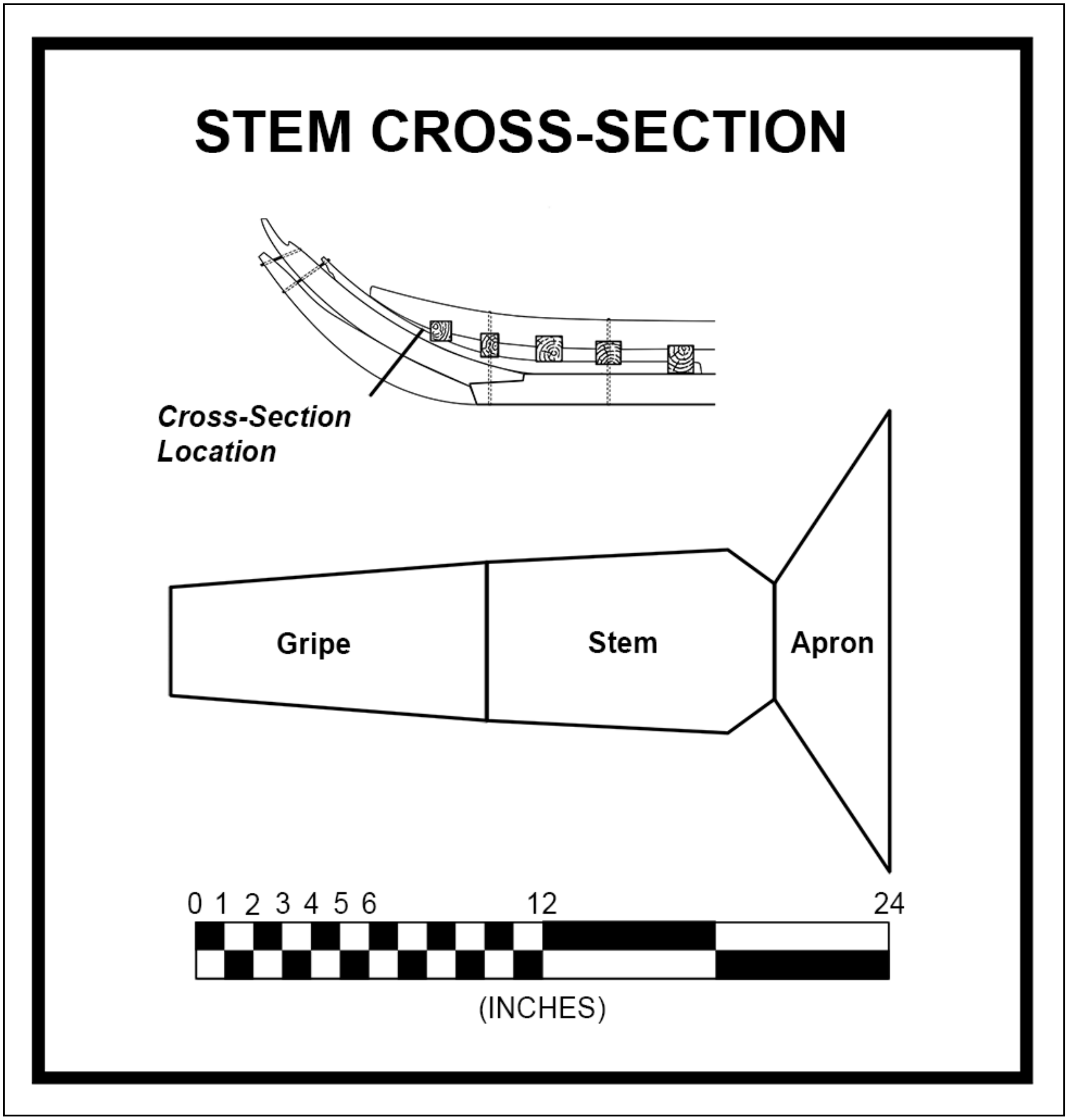

Figure 78 *Boscawen*'s stem cross-section. (Drawn by author)

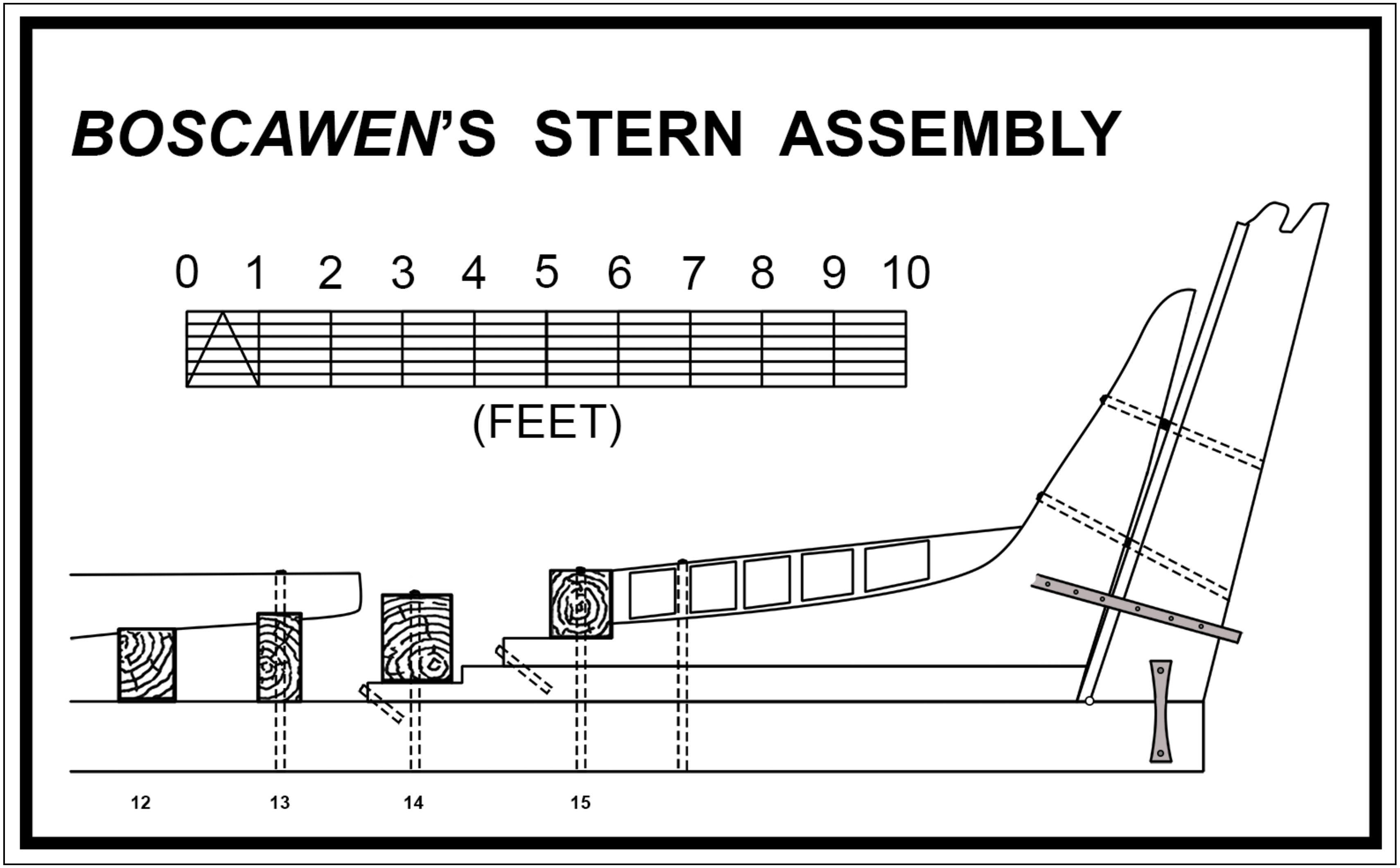

Figure 79 *Boscawen*'s stern assembly. (Drawn by author)

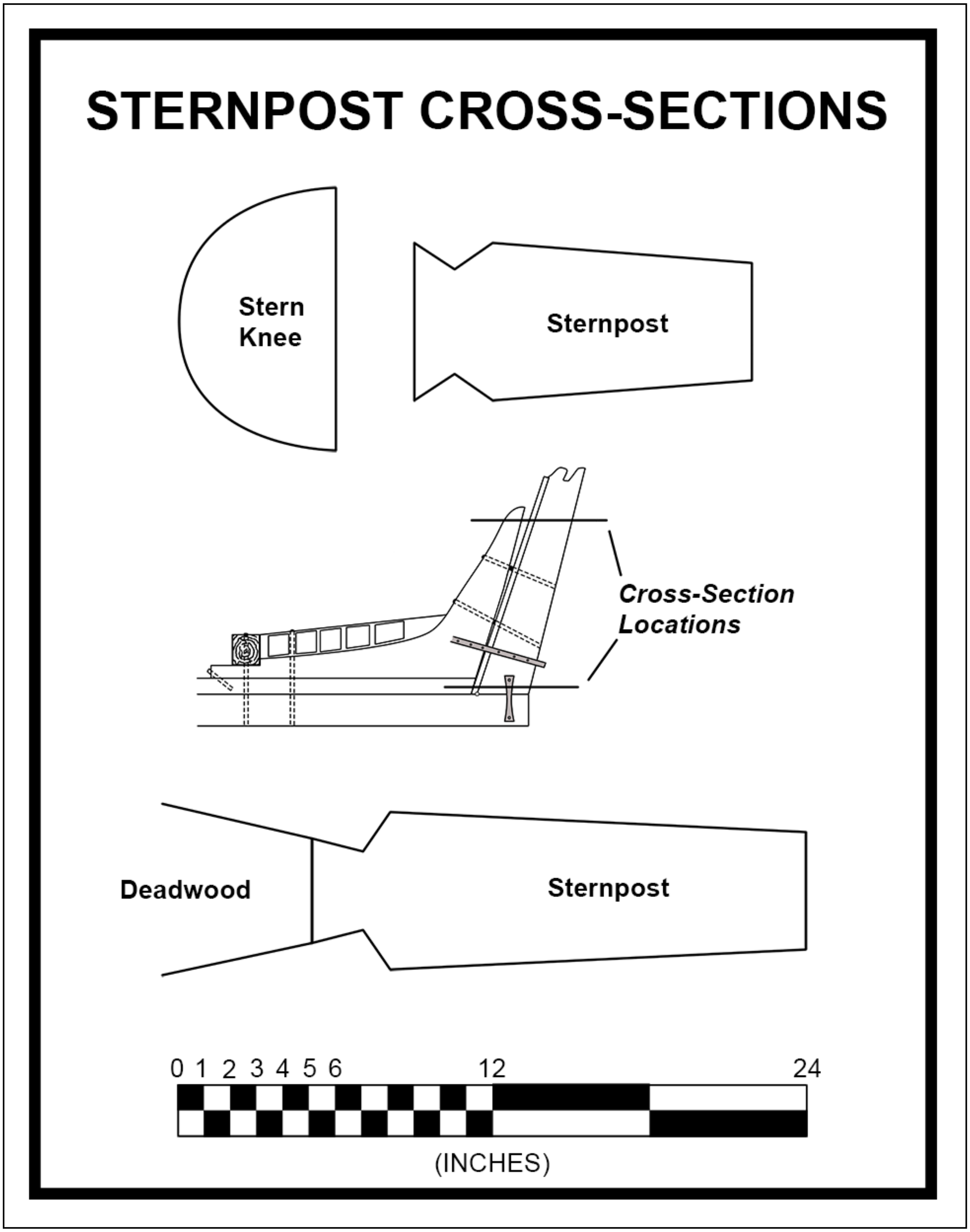

Figure 80 *Boscawen*'s sternpost cross-sections. (Drawn by author)

The sloop's sternpost was secured to the keel using a pair of iron dovetail plates and possibly a vertical wooden tenon at the base of the post that fit into a mortise in the top of the keel. The dovetail plates are 16.5 inches (41.9 cm) long and 2.5 inches (6.3 cm) wide at their ends, narrowing to 1.25 inches (3.2 cm) wide in their middles. The sternpost was made from a single timber that narrowed in its molded dimension from forward to aft and is raked aft 76 degrees.[188] Its forward corners are notched 2 inches (5.1 cm) square to form a rabbet for the hood ends of the planks. At its base, the sternpost is 19 inches (48.3 cm) molded, has a maximum sided dimension of 6 inches (15.2 cm) at the bearding lines, narrowing to 4.5 inches (11.4 cm) on its after face. The sternpost remains extend approximately 7 feet (2.1 m) above the keel and, at its top, the post is closer to 13 inches (33 cm) molded and its sided dimension remains consistent with its lower portion.

A lower iron gudgeon is attached to the sternpost 13 inches (33 cm) above the top of the keel. Its port and starboard arms (straps) are 4 feet, 7 inches (1.4 m) long and 2.5 inches (6.3 cm) wide and were fastened to the hull every 4 inches (10.2 cm) with 0.75-inch-diameter (1.9 cm) nails. The gudgeon hole could have accommodated a 2-inch-diameter (5.1 cm) pintle. The upper gudgeon,[189] rudder, and the rudder pintles were not located during the excavation.[190]

The lowest deadwood timber is seated directly on the keel, just forward of the sternpost. A 1.25-inch-diameter (3.2 cm) stopwater was installed at the junction between these three timbers. The lowest deadwood timber is around 9 feet, 5 inches (2.9 m) long; it is 6.5 inches (16.5 cm) molded and has a maximum sided dimension of 11.5 inches (29.2 cm) at its forward end, and tapers to around 4 to 5 inches (10.2–12.7 cm) at the forward face of the sternpost. The

[188] The sternpost rake was taken from its after side.
[189] There would have been at least one other gudgeon attached to the sternpost.
[190] It is likely that the rudder was removed to better preserve it or to scrap/recycle its components.

forward 13.5 inches (34.3 cm) of the lower deadwood, where the floor of Frame 14 rested upon it, steps down to 3.5 inches (8.9 cm) molded.

The stern knee, fashioned from a single, naturally grown timber, was installed above the lower deadwood. Similar to the deadwood, 15 inches (38.1 cm) of the knee's forward (horizontal) arm measures 4 inches (10.2 cm) molded and formed a base for Frame 15's floor. Aft of the floor, the stern knee steps up 2 inches (5.1 cm) before it continues its curve up and aft. Near the sternpost, as its vertical arm curves upward, the stern knee's maximum molded dimension is 22 inches (55.9 cm) thick. The knee's horizontal arm has a maximum sided dimension of 14 inches (35.6 cm) and tapers to 3 to 4 inches (7.6–10.2 cm) at the forward face of the sternpost, or at its back rabbet lines. The 6-inch (15.2 cm) sided vertical arm of the stern knee extends roughly 5 feet (1.5 m) above the lower deadwood and rakes aft around 60 degrees, following the forward face the sternpost. Two 1-inch-diameter (2.5 cm) bolts were used to fasten the knee to the sternpost.

The topmost deadwood timber was placed above the horizontal arm of the stern knee, butting against the after edge of the floor of Frame 15. This timber is approximately 5 feet (1.5 m) long and 7.5 inches (19 cm) molded. The forward and after ends are 7.5 inches (19 cm) sided, but over the course of its forward 4 feet (1.2 m), the deadwood's sided dimension tapers to 5.5 inches (14 cm) to accommodate the bases of the five stern half frames.

Duke of Cumberland's stern assembly, at least from its observable features, appears almost identical to *Boscawen*'s. Seen in Figures 10, 11, and 14, the sternpost was likewise made from a single timber, and its rake is observed to be 74 degrees. This angle is nearly identical to that of *Boscawen*'s at 76 degrees. The roughly 9 feet (2.7 m) of sternpost that survived was fastened to the keel with a pair of dovetail plates.[191] As mentioned in Chapter III, these plates were recovered from the 1909 display site and conserved. The dovetail plates are 14.5 inches (36.8 cm) long, 2.75 inches (7 cm) wide at their ends, and 1.25 inches (3.2 cm) wide in the middle.

Figure 11 also depicts an unusual U-shaped iron strap that wraps around the after face of the sternpost near its base. This was likely a modern fastener, attached during the early twentieth century as part of the supportive strapping.

The iron cribbing used to support *Duke of Cumberland*'s structure was attached to the sternpost with a unique bracket that wrapped around the top of the post. Although the timber no longer exists, the remains of the metal support structure and sternpost bracket are still present at the display site (Figures 10 and 11). Using the photogrammetric point cloud and the dimensions of both this supportive bracket and the recovered gudgeon, we know that the molded dimension of the base of *Duke of Cumberland*'s sternpost was 19 inches (48.3 cm) and tapered up toward the sternpost bracket to 12 inches (30.5 cm). Its sided dimension remained a consistent 6 inches (15.2 cm) sided, tapering to 4.5 inches (11.4 cm) on it aft-most face. The brig's sternpost also had square rabbets cut into it forward edge, as observed in Figures 11, 14, and 15.

As mentioned, a single iron gudgeon (visible on the brig remains in Figures 10 and 11) was recovered from the site in 1985 (see Figure 49 of the conserved gudgeon). The vessel had at least one additional gudgeon/pintle pair further up the post, although it was not visible on the wreck in 1909. The lower gudgeon was attached to the sternpost around 20.5 inches (52.1 cm) above the keel and could have accommodated a 2-inch-diameter (5.1 cm) pintle. This gudgeon's arms are 4 feet, 6 inches (1.4 m) long; 2.5 inches (6.2 cm) wide; and 0.75 inches (1.9 cm) thick—nearly identical to *Boscawen*'s.

[191] Only the starboard-side dovetail plate is visible in Figure 11, but there is most likely another on the port side.

Only the top of *Duke of Cumberland*'s stern knee is visible in a couple of historical images (thereby eluding photogrammetric recording), but what is visible of this timber appears to be similar to *Boscawen*'s stern knee. The viewpoint of the historical photographs and the outer hull planking obscure the rest of the stern assembly. Although it is unknown whether (or how) deadwood was installed below or atop the stern knee, it likely would have been done in a similar, if not exact, method as observed in *Boscawen*.

Frames

Boscawen had two pairs of canted half frames and fillers in its bow, twenty-six square frames, and six half frames with fillers at its stern. A 1-inch (2.5 cm) drift bolt was used to fasten the keelson, floor, and keel, on every other floor. However, the aft-most three floors were each fastened with such a bolt. After Frame H (in the bow), every fourth frame was a master frame, or mould frame (for a total of six), and these were used to help dictate the shape of the hull. Of interest is that the bolting pattern skipped these mould frames. In addition, only one of the mould frames' floors on the port side (Frame 4) was noted by the 1980s archaeological team to be laterally fastened with a treenail to its corresponding first futtock.[192] The other mould frames' floors lacked (or were not observed to have) floor-to-first futtock treenails.[193] However, each of the mould frames' first and second futtocks were laterally fastened together with treenails.[194]

To examine frame curvature, the archaeological team cut away portions of the ceiling planking in five locations along the port side of the hull, focusing on the areas of suspected

[192] Only the curves and scantlings of the port side framing components were recorded by the archaeological team. This was done because the vessel listed slightly to port, causing better preservation of the timbers there.
[193] Only one floor-futtock pair on the port side (Frame D) was noted as not having any lateral fasteners securing them together. The archaeologists did not record lateral fasteners among the remaining four pairs, but this does not mean that the pairs were not laterally fastened.
[194] These treenails were often left long, sometimes extending 6 inches (15.2 cm) out from their futtocks. Leaving treenails untrimmed like this would save carpenters time during the construction process.

mould frames. They recorded the outer hull planking widths, ceiling planking widths and thicknesses, the curvature of the frames on their outboard faces, and detailed dimensions of the floors and futtocks. These frame sections are illustrated in Figures 81–85.

The dimensions and spacing of the sloop's floors are irregular, a possible byproduct of the hasty construction process. Along the keel, the floors are spaced between 19.5 and 28.5 inches (49.5–72.4 cm) apart on their centers, with an average of 25.7 inches (65.4 cm). The floors' molded dimensions range from 8 to 15 inches (20.3–38.1 cm), averaging around 10.5 inches (26.7 cm) at the keel. Their sided dimensions along the vessel's centerline are between 7 and 12.5 inches (17.8–31.7 cm), for an average of near 10 inches (25.4 cm). These floors narrow up to an inch (2.5 cm) in their sided dimensions and by roughly 5 inches (12.7 cm) in their molded dimensions over their 6-foot (1.8 m) arms. There is also evidence of the carpenters not finishing, or square-cutting, *Boscawen*'s floors, leaving the rounded log surface (a waney edge) and even bark on these timbers. This was done purely to save time during construction.

Most of the square frame floors have watercourses, or limber holes, cut into their bottoms on either side of the keel to allow bilge water to flow to the pump well. The only floors that were not constructed with limber holes were the forward-most four (as these were resting on, or obstructed by, the apron) and Frame 3. Frame 3 did not have a limber hole because there was already a natural gap between the bottom of the floor and the outer hull planking. Limber holes on *Boscawen* typically were square cut by making two parallel saw cuts and then chiseling out the intervening wood; the holes range from 1 to 2 inches (2.5–5.1 cm) wide and from 1 to 4 inches (2.5–10.2 cm) tall. However, five limber holes on *Boscawen* (at Frames 11, 8, 5, 2, and E) were triangular cut by making two inward-angled saw cuts; this deviation might have been another shortcut used by the carpenters to save time.

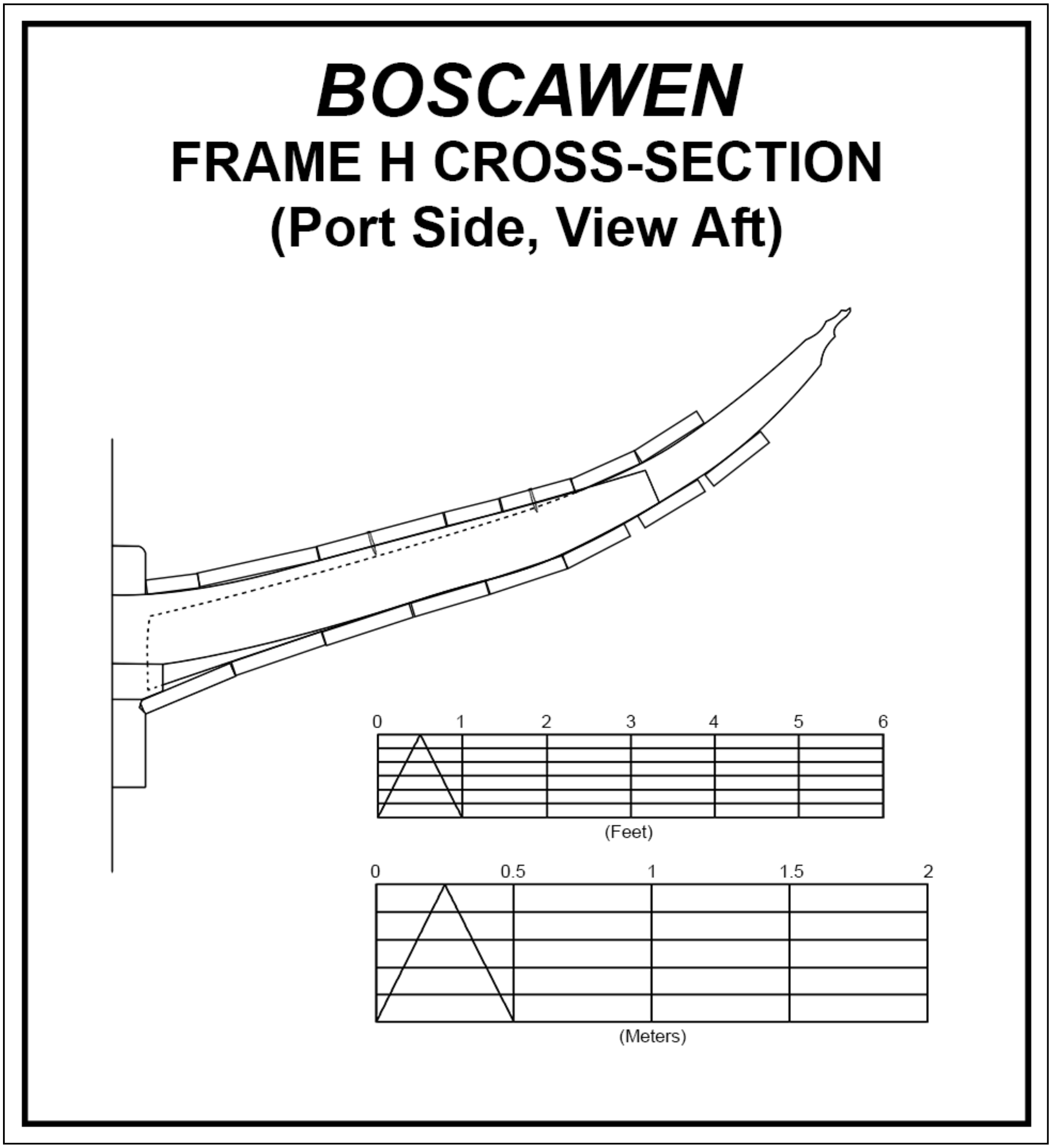

Figure 81 Cross-section at Frame H. (Drawn by author)

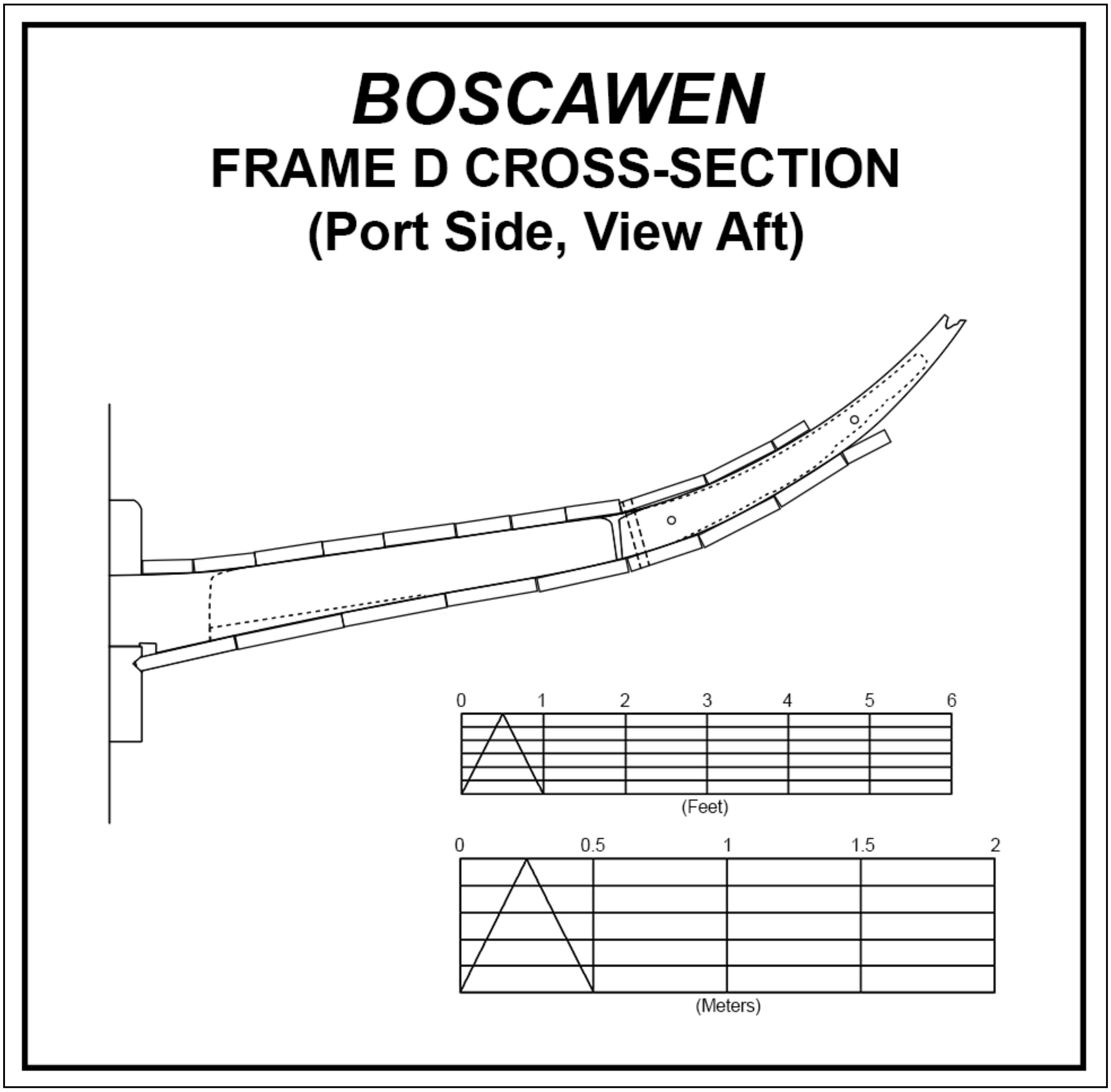

Figure 82 Cross-section at Frame D. (Drawn by author)

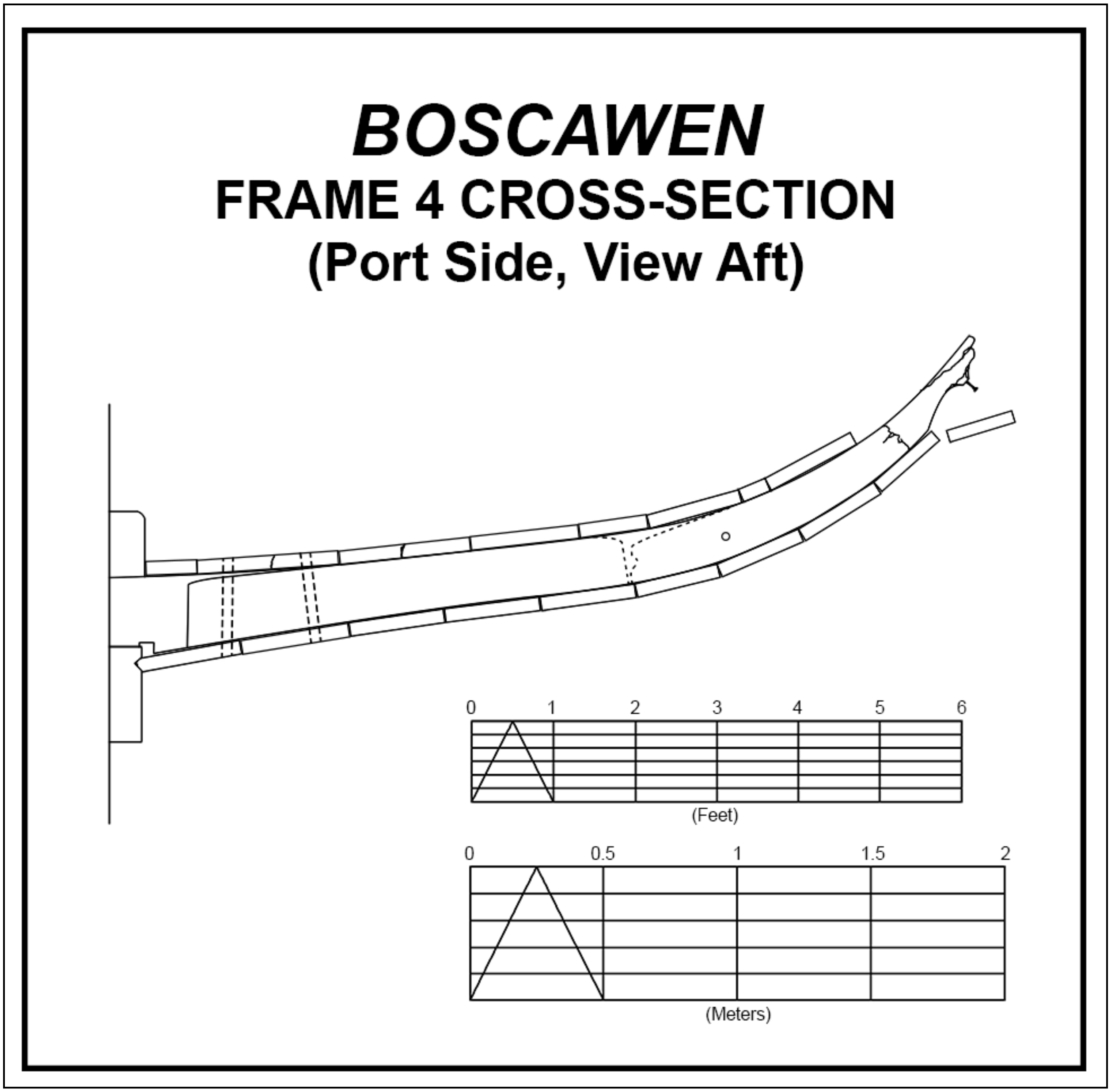

Figure 83 Cross-section at Frame 4. (Drawn by author)

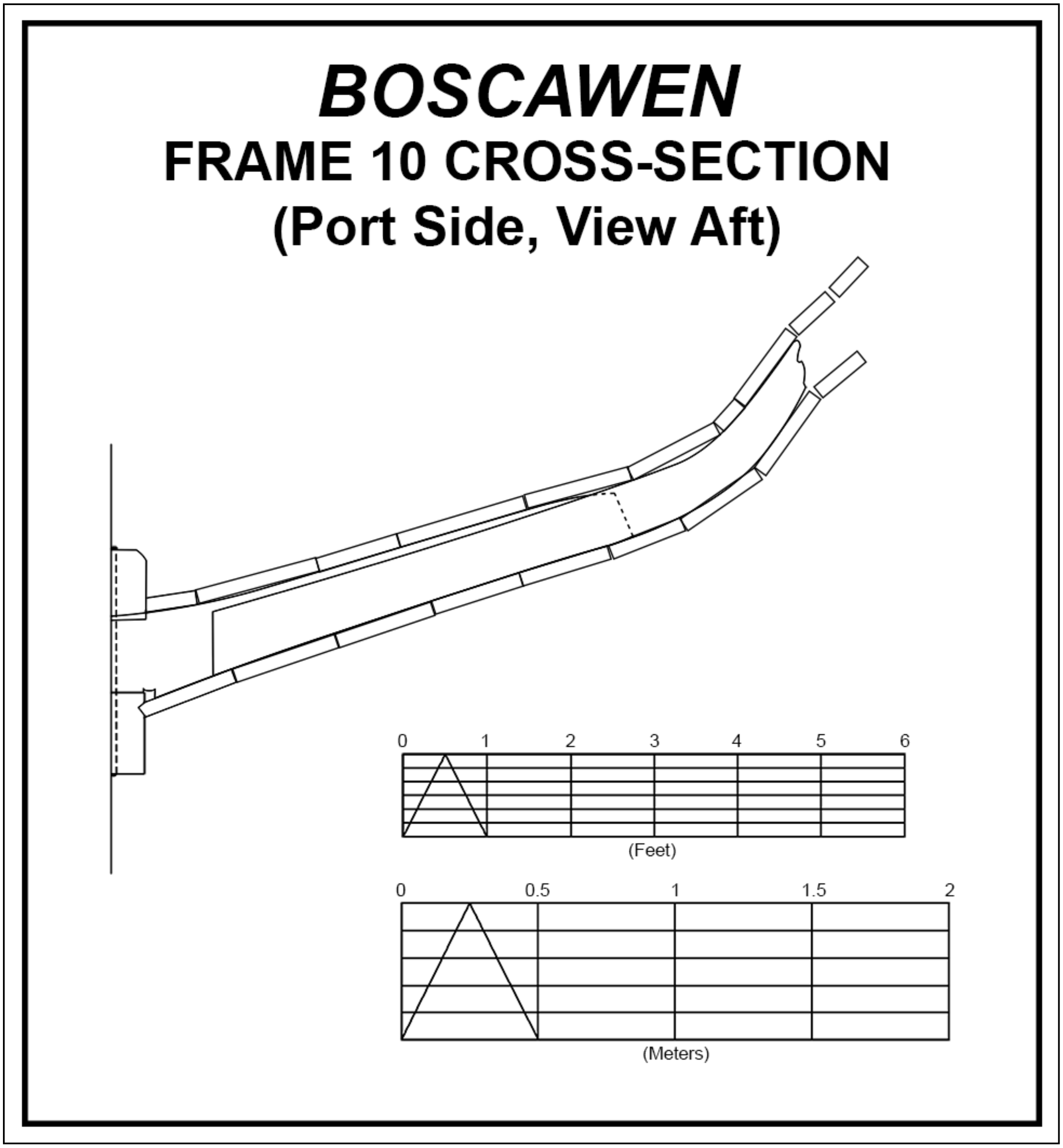

Figure 84 Cross-section at Frame 10. (Drawn by author)

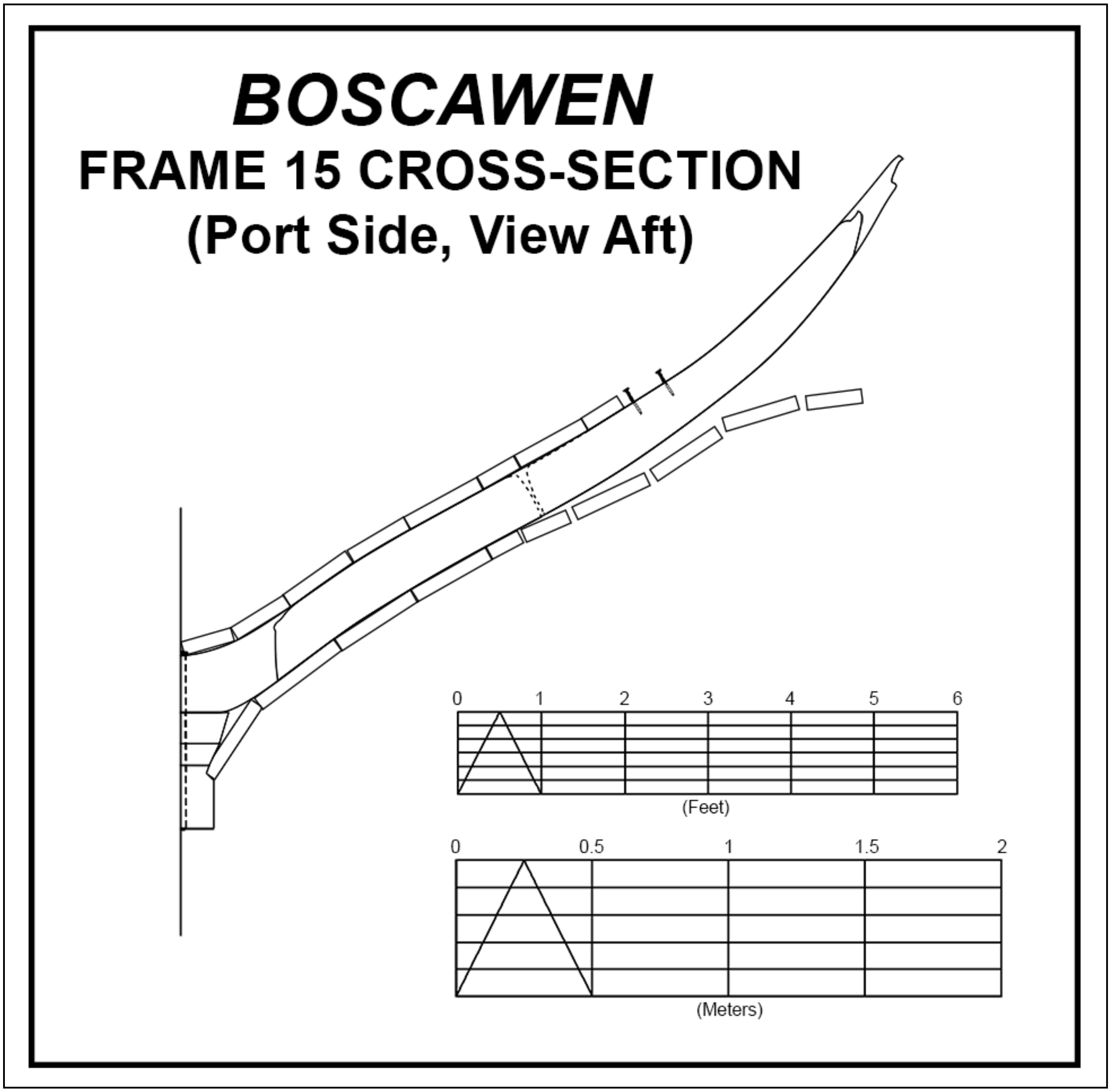

Figure 85 Cross-section at Frame 15. (Drawn by author)

The futtocks also vary considerably in their spacing and dimensions. However, one consistent aspect of futtock placement is where they were installed in relation to their floor. Forward of the midship frame (the eleventh square frame from the bow), futtocks were installed aft of their corresponding floor timber; aft of the midship frame, futtocks were placed forward of their associated floors. This consistency is noticeable only for the mould frames: for the non-mould frames, futtocks and their corresponding floors had 1.5 to 6.5 inches (3.8–16.5 cm) between them, for an average of 4 inches (10.2 cm). This translates to a spacing of 10 to 16.75 inches (25.4–45.5 cm) apart on their centers, averaging around 13 inches (33 cm). Some of the futtocks recorded by the archaeological team were similar to certain floors, with rounded or having bark-covered surfaces. The shipbuilders likely used this strategy to save time and effort and because (with the exception of the mould frames) the futtocks did not need to fit tightly against the floors or other futtocks.

The heels of the first futtocks typically did not extend to the keel, with the exception of three futtock pairs at *Boscawen*'s ends (Frames 14, H, and I), which overlapped the keel by a few inches. This may have strengthened the sloop's ends (especially for the two bow futtocks, which nest into the apron), or it may have been an inconsequential oversight (particularly for the futtocks near the stern). The heels of all the other futtocks terminated anywhere between 1 and 11.5 inches (2.5–27.9 cm) outboard of the keel, with an average of around 7 inches (17.8 cm).

The bases of *Boscawen*'s first futtocks are 8 to 10.5 inches (20.3–26.7 cm) molded with an average of 9.5 inches (24.1 cm) and are 6 to 10 inches (15.2–25.4 cm) sided, averaging between 8 and 9 inches (20.3–22.9 cm). These timbers narrow over their 9- to 10-foot (2.7–3 m) lengths up to 3 inches (7.6 cm) in their sided dimensions and upwards of 5.5 inches (14 cm) in their molded dimensions.

Only broken and eroded second futtocks remain on *Boscawen*. The surviving second futtocks have partial lengths of around 6 feet (1.8 m). They have average molded and sided dimensions of 7 to 8 inches (17.8–20.3 cm), which taper as they curve outboard and upward. The heels of the second futtocks were installed anywhere between 2 and 4 inches (5.1–10.2 cm) away from the heads of the floors. These gaps could be evidence of a speedy building process and had the added benefit of allowing air circulation around the timbers and delaying the inevitable spread of rot.

As mentioned, *Boscawen* has two pairs of canted half frames at its bow. These timbers do not cross the keel; instead, they butt against the keelson and forward-most floor. The half frames are 5.5 to 7 inches (14–17.8 cm) molded and 6 to 8 inches (15.2–20.3 cm) sided. In the stern, *Boscawen* has six pairs of half frames that fit against the deadwood timber above the stern knee. These frames are canted slightly aft to accommodate the rising and narrowing of the stern. These timbers are between 7 and 8 inches (17.8–20.3 cm) molded and 7 and 10 inches (17.8–25.4 cm) sided, with an average of 2 inches (5.1 cm) of space between them. See Appendix A (Tables 3 and 4) for each of *Boscawen*'s individual framing measurements).

It is unfortunate that most of *Duke of Cumberland*'s framing components (especially its floors) are hidden beneath the ceiling planking in the historical photographs. However, the visible elements of *Duke of Cumberland*'s frames appear to emulate the patterns, spacing, and size seen in *Boscawen*'s hull. The average dimensions of the heads of the visible floors recorded from the scale-constrained photogrammetry model are around 9 to 10 inches (22.9–25.4 cm) sided and molded, and the futtocks measured around 8 to 9 inches (20.3–22.9 cm). Master frames, canted bow and stern frames, and disarticulated futtocks all appear to be represented in Figures 7–15. It was difficult to ascertain *Duke of Cumberland*'s exact number of frames from the historical photographs, but by cross-referencing multiple images, thirty-five square frames and four to five canted bow and stern half frames are visible.

Keelson

Boscawen's keelson was made from two lengths of white oak connected by a nearly 36-inch-long (91.4 cm) flat scarf. The forward section of the keelson is 17.6 feet (5.9 m) long, 10 inches (25.4 cm) molded, and 11 inches (27.9 cm) sided. The forward end of this timber tapers above the apron to 6 inches (15.2 cm) molded and 10 inches (25.4 cm) sided. The longer aft section of keelson is approximately 38.1 feet (11.6 m) long and roughly maintains its 10-inch (25.4 cm) molded and 11-inch (27.9 cm) sided dimensions along its length. The keelson was fastened to the floors and keel using 1-inch (2.5 cm) drift bolts following a pattern previously described in the framing section. One peculiarity of *Boscawen*'s keelson is that it terminates 3.25 feet (1 m) short of the upper stern deadwood. This would have made for a weaker transition to the stern assembly here, and over the longer term of the sloop's career made the stern more prone to hogging. It is unclear whether this gap is a planned construction feature, evidence of a lack of straight and longer oak timber at the time of construction, or an error in the shipwright's calculations. The third explanation seems most likely.[195] During the 1980s excavations, this area contained many artifacts.[196]

Using the scale-constrained photogrammetry model of *Duke of Cumberland*, the keelson appears to have been around 10 inches (25.4 cm) sided and molded (which, unsurprisingly, is similar to *Boscawen*'s keelson). Its flat scarf is visible in Figure 9. This particular scarf was located roughly 20 feet (6.1 m) aft of the stem assembly and is around 2.5 to 3 feet (0.7–0.9 m)

[195] The keelson was not reported to have any stanchion notches on its upper face.
[196] Crisman, "The Construction of the *Boscawen*," 364.

long. What is not clearly visible in the historical images, however, is the after end of *Duke of Cumberland*'s keelson. In Figure 13, one can see a timber that appears to be the keelson and terminates roughly in the same place as *Boscawen*'s (short of the stern assembly). If it had indeed stopped there, the keelson would have been around 72 feet (21.9 m) long.

External and Internal Hull Planking

The outer hull strakes of *Boscawen* are made from white oak planks butted together; they are 2 inches (5.1 cm) thick and range between 5 and 16 inches (12.7–40.6 cm) wide, averaging 12.25 inches (31.1 cm) wide. As mentioned, these planking widths were measured at the five exposed frame sections on the port side. The individual measurements for each plank from the five sections can be viewed in Table 5. The planks typically are widest near the keel (especially the garboard strakes that fit into the keel rabbets) and decrease in width as they move outward. Outer hull planking is fastened to the framing components with iron spikes and treenails (of white oak or white ash). The butt joints of the planks fall on the center of a framing component, and the planks' corners are spiked to secure these timbers.[197]

Duke of Cumberland's visible outer hull planking echoes the building practices seen in *Boscawen*. Figures 11–13 best illustrate the brig's outer planking, spikes, and general dimensions. Near the stem, viewers can see nailheads and treenail ends protruding approximately 2 inches (5.1 cm) from the frames;[198] these fasteners were left behind after the outer hull planks eroded away. No outer hull planking butts are clearly defined, but hood ends for strakes at the

[197] No additional fastener patterns or a spike-to-treenail ratio was reported in the 1980s archaeological notes.
[198] This measurement is estimated from interpreted dimensions of the keel and framing components. It appears that each strake was fastened to every floor or futtock with a treenail. It is difficult to determine the spike-to-treenail ratio, but it seems like treenails were utilized more regularly than spikes for fastening external planking.

stem are most clearly seen in Figure 13, and plank attachments to the sternpost rabbet can be viewed in Figure 11.

Outer planking butts and seams were originally filled with oakum, a common caulking material of the time. In a letter to Amherst, Loring asked for "any spare oakum from Ft. George in order to caulk the brig." Perhaps Loring should have asked for even more caulking material because *Duke of Cumberland* quickly became a leaky vessel.[199]

The dimensions of *Boscawen*'s ceiling planking are similar to those of its outer hull planks. Most of the ceiling is two inches (5.1 cm) thick, ranging between 5.5 and 21 inches (14–53.3 cm) wide and averaging 11.2 inches (28.6 cm) wide. As mentioned, these planking widths were measured at the five exposed frame sections on the port side. For the section at Frame D, ceiling planking thicknesses transition to 1.5 inches (3.8 cm) beyond the floor head. The rest of the individual ceiling plank measurements can be viewed in Table 5. The widest ceiling plank is 5 inches (12.7 cm) wider than the largest outer hull plank. Similar to the exterior planking, ceiling planks are typically widest toward the center of the vessel. Ceiling planks were secured to the floors and futtocks using iron spikes, but they were fastened in no discernible pattern.

The archaeological team recorded the limber boards—the ceiling planks directly adjacent to the keelson. These boards were not typically fastened down to any framing components, which would permit access to the bilge. However, Crisman noted that the removable boards were tightly fitted, which suggests that they were not removed regularly during the sloop's short life.[200] *Boscawen*'s limber boards are 7.5 inches (19 cm) wide and two inches (5.1 cm) thick.

Duke of Cumberland's ceiling planks (i.e., their thicknesses, patterns, and widths) appear to be similar to *Boscawen*'s. Using the photogrammetry point cloud, the width of two wider

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[199] PRO, W.O.R. 34/64, 152, Loring to Amherst, 22 Aug. 1759.
[200] Crisman, "The Construction of the *Boscawen*," 365.

ceiling planks on the starboard side toward the bow measure around 20 inches (50.8 cm). The brig's ceiling plank butts and limber boards are clearly visible in Figures 9 and 13. Ceiling plank ends were butted only on frame centers.

Table 5 Planking Widths at Hull Sections

Plank Number (out from center)	Hull Section									
	Frame H		Frame D		Frame 4		Frame 10		Frame 15	
	Ceiling Planking	Outer Hull Planking	Ceiling Planking	Outer Hull Planking	Ceiling Planking	Outer Hull Planking	Ceiling Planking	Outer Hull Planking	Ceiling Planking	Outer Hull Planking
Limber board	7.5 inches (19 cm)	—	7.5 inches (19 cm)	—	7.5 inches (19 cm)	—	7.5 inches (19 cm)	—	7.5 inches (19 cm)	—
1	17.5 inches (44.4 cm)	14 inches (35.6 cm)	9 inches (22.9 cm)	15 inches (38.1 cm)	21 inches (53.3 cm)	15.5 inches (39.4 cm)	18.5 inches (47 cm)	14.5 inches (36.8 cm)	9 inches (22.9 cm)	12.5 inches (31.7 cm)
2	18.75 inches (47.6 cm)	13.5 inches (34.3 cm)	10 inches (25.4 cm)	16 inches (40.6 cm)	19.5 inches (49.5 cm)	16 inches (40.6 cm)	19 inches (48.26 cm)	15.5 inches (39.4 cm)	11 inches (27.9 cm)	14.25 inches (36.2 cm)
3	8 inches (20.3 cm)	13 inches (33 cm)	9 inches (22.9 cm)	15.5 inches (39.4 cm)	16 inches (40.6 cm)	14 inches (35.6 cm)	15.5 inches (39.4 cm)	14.5 inches (36.8 cm)	9.5 inches (24.1 cm)	13 inches (33 cm)
4	10.5 inches (26.7 cm)	11 inches (27.9 cm)	10.5 inches (26.7 cm)	13.5 inches (34.3 cm)	10 inches (25.4 cm)	14 inches (35.6 cm)	14 inches (35.6 cm)	13.25 inches (33.7 cm)	12 inches (30.5 cm)	12.5 inches (31.7 cm)
5	10 inches (25.4 cm)	11.5 inches (29.2 cm)	8 inches (20.3 cm)	13.5 inches (34.3 cm)	14 inches (35.6 cm)	14 inches (35.6 cm)	4.5 inches (11.4 cm)	13.25 inches (33.7 cm)	6 inches (15.2 cm)	5 inches (12.7 cm)
6	10.5 inches (26.7 cm)	10 inches (25.4 cm)	8 inches (20.3 cm)	11 inches (27.9 cm)	4.25 inches (10.8 cm)	12.5 inches (31.7 cm)	12.5 inches (31.7 cm)	11 inches (27.9 cm)	11 inches (27.9 cm)	7 inches (17.8 cm)
7	—	10 inches (25.4 cm)	8 inches (20.3 cm)	12.5 inches (31.7 cm)	14.25 inches (36.2 cm)	13 inches (33 cm)	7 inches (17.8 cm)	13 inches (33 cm)	6 inches (15.2 cm)	11.5 inches (29.2 cm)
8	—	—	13 inches (33 cm)	11.5 inches (29.2 cm)	—	13 inches (33 cm)	6 inches (15.2 cm)	13.5 inches (34.3 cm)	—	11.25 inches (28.6 cm)
9	—	—	11 inches (27.9 cm)	7 inches (17.8 cm)	—	11.5 inches (29.2 cm)	—	8 inches (20.3 cm)	—	11 inches (27.9 cm)
10	—	—	5.5 inches (14 cm)	—	—	10 inches (25.4 cm)	—	—	—	8 inches (20.3 cm)

Orlop Deck Beams and Planking

Five to seven orlop deck beams were recorded on *Boscawen*. These beams run perpendicular to and on top of the keelson to both sides of the hull and support a flat deck structure for storage, which would have been especially useful at the curved and narrowing ends of the vessel. They are made of white pine logs, which degrade much faster than white oak. Because of this, the recovered beams are "spongy," with some being more fragmentary than others. These beams consist of logs 5 to 7 inches (12.7–17.8 cm) in diameter, with their tops, and sometimes their bottoms, dubbed flat with an adze. One of the orlop beams in the bow was noticeably notched 1 to 2 inches (2.5–5.1 cm) on its underside to fit over the keelson (see Figure 86). Their ends were roughly shaped to conform to the inside curve of the hull and are spiked to the ceiling planking on their respective sides. Orlop deck planking was installed on top of the beams but minimally fastened to them. Only fragmentary evidence of the orlop deck planking survived until archaeological recording. These fragments, as well as the length of the nailheads that stick up from the deck beams, indicate that the orlop planking was between 0.75 and 1.25 inches (1.9–3.2 cm) thick.

Previous interpretations of *Boscawen*'s lower deck construction have suggested that these orlop deck beams may have run along the entire length of the vessel.[201] The surviving archaeological evidence (i.e., the locations of the three beams fastened to the interior hull, and where the other beams were loosely resting) suggests that *Boscawen* instead had two orlop half decks, one in the bow and the other in the stern. Based on the pattern and placement of the recorded deck beams, the forward orlop half deck started directly above Frame B and extended roughly 20 feet (6.1 m) toward the bow. The aft orlop half deck started at Frame 12 and extended around 12 feet (3.6 m) toward the sternpost. This arrangement left 30 feet (9.1 m) of the hold

[201] Crisman, "The Construction of the *Boscawen*," 366–367.

(the flattest portion of the interior hull) open for storage of ballast, munitions, provisions, and similar supplies.[202]

Orlop deck beams were not observed in the historical photographs of *Duke of Cumberland*. This does not mean that they were not there originally. The beams may have been removed when the vessel was laid up, they may have degraded during their time on the lake bottom, or they may have been destroyed during the raising event in 1909. Nevertheless, if an orlop deck (or two half decks) had been previously installed on *Duke of Cumberland*, then (as with *Boscawen*), the space below would have been minimal and filled only with ballast stones.

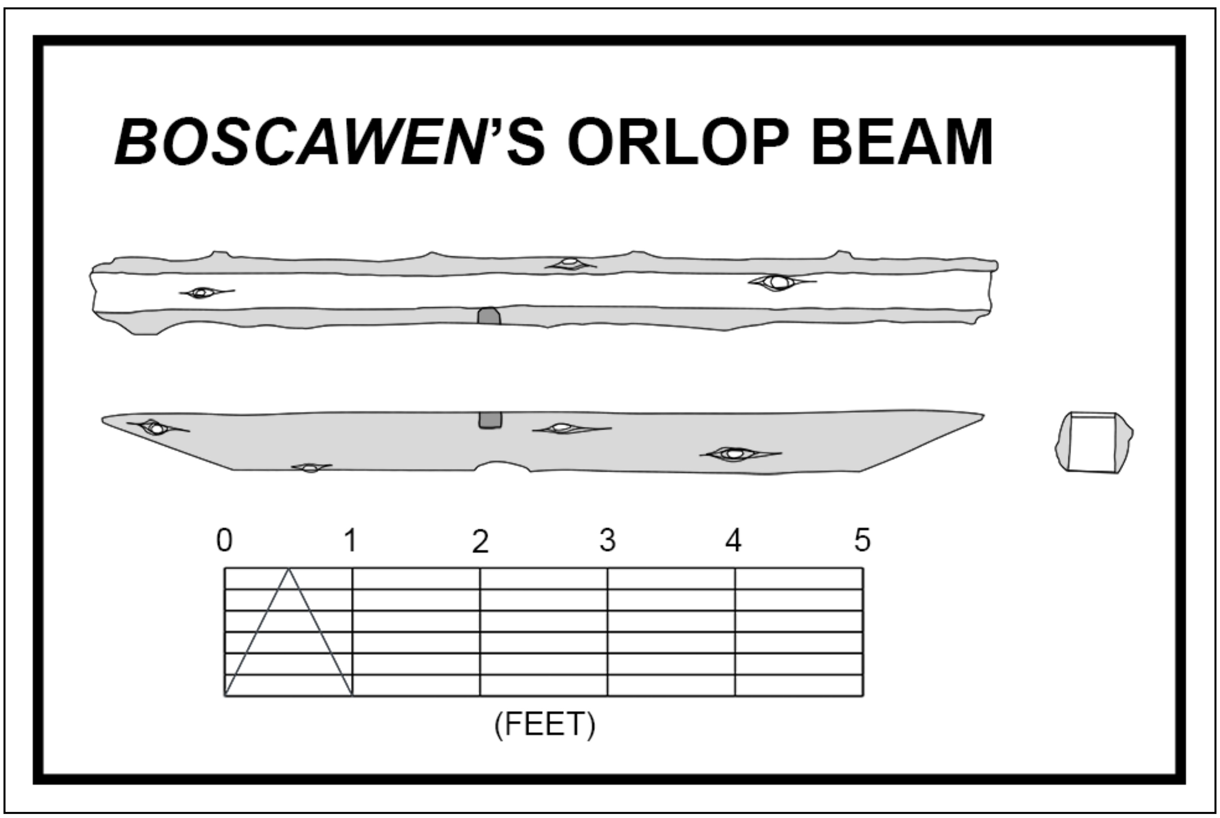

Figure 86 One of *Boscawen*'s orlop deck beams. (Drawn by author)

[202] The 1776 sloop plans (Figure 70) also have two orlop half decks. However, these decks were raised above the keelson around 3 feet (0.9 m).

Main Deck Beams and Planking, and Armament Related to Construction

Amherst originally requested that *Boscawen* and *Duke of Cumberland* have decks strong enough to support nine-pounders. But the availability of good-quality guns and the space on deck needed to operate them, as well as the moderate strength of the deck, permitted the use of only a few "six pounders, or nine upon occasion."[203] The only nine-pounders available were, according to Loring, the "long sort. they will weigh more then [*sic*] the Ship Guns of twelve pounders, which I am afraid will be to [*sic*] heavy for our Decks, and there [*sic*] Length makes them very Inconvient [*sic*] on Board small vessels."[204] Even many of the six-pounders intended for these vessels were too long and heavy.[205]

It was not until late September that Loring settled on the combined total of thirty-four guns for the brig and sloop and would "make use of all the Six pounders that [were] fitt [*sic*] for Service."[206] The most definitive source regarding the number and caliber of guns aboard the two vessels when they arrived at Crown Point in October 1759 is Amherst's journal. The entries reported that "the Duke of Cumberland brigantine… has six 6 pounders, twelve 4 poundrs. & twenty Swivels… [and] the Boscawen sloop… has four 6 pounders, twelve 4 pounders & twenty two [*sic*] Swivels."[207] The four- and six-pounders had twenty rounds of ammunition each.[208]

Much is unknown about *Boscawen*'s main deck and quarterdeck construction, including the number and spacing of their associated beams.[209] A single eroded white pine main deck beam

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[203] PRO, W.O.R. 34/64, 150, Loring to Amherst, 11 Aug. 1759.
[204] PRO, W.O.R. 34/64, 160.
[205] These "bad" guns weighed "nineteen hundred weight instead of the normal thirteen hundred weight of a ships gun." PRO, W.O.R. 34/64, 161.
[206] PRO, W.O.R. 34/64, 164, Loring to Amherst, 23 Sept. 1759.
[207] Doughty, *Appendix*, 64.
[208] PRO, W.O.R. 34/64, 168–169, Loring to Amherst, 7 Oct. 1759; Carter, "Armament Remains from His Majesty's Sloop *Boscawen*," 28.
[209] One of the few historical sources noting the deck construction is a letter from Loring to Amherst explaining how *Duke of Cumberland*'s quarterdeck was laid only after the vessel had been launched "in order to keep her as Light abaft as posible [*sic*]." PRO, W.O.R. 34/64, 157, Loring to Amherst, 31 Aug. 1759.

and two disarticulated strakes of what are believed to be main deck planking (found amidships) are all that remained at the time of the 1980s excavation (see Figure 87). The deck planking remains are around 2 inches (5.1 cm) thick and 12 inches (30.5 cm) wide. The surviving length of the main deck beam is 18.25 feet (5.6 m) long and is around 10 to 11 inches (25.4–27.9 cm) molded and sided.

This main deck beam has notches cut into its upper corners to fit support beams (carlings) that run perpendicular to the main beams. These carling notches are variably spaced along the main beam, ranging from 35 inches (88.9 cm) to 87 inches (221 cm) apart. The notches themselves measure between 7 and 11 inches (17.8–27.8 cm) sided, around 7 inches (17.8 cm) molded, and were cut approximately 2 inches (5.1 cm) deep into the main beam.

Overall, without additional beams, clamps or waterway timbers, or preserved sections of bulwark, *Boscawen*'s deck reconstruction is a highly conjectural assembly. The deck beam spacing and dimensions, seen in the internal construction reconstruction (Figure 88), are generated from measurements taken from the single deck beam and the 1776 hull plans for two Lake Champlain sloops designed by John Williams, Surveyor of the Royal Navy.

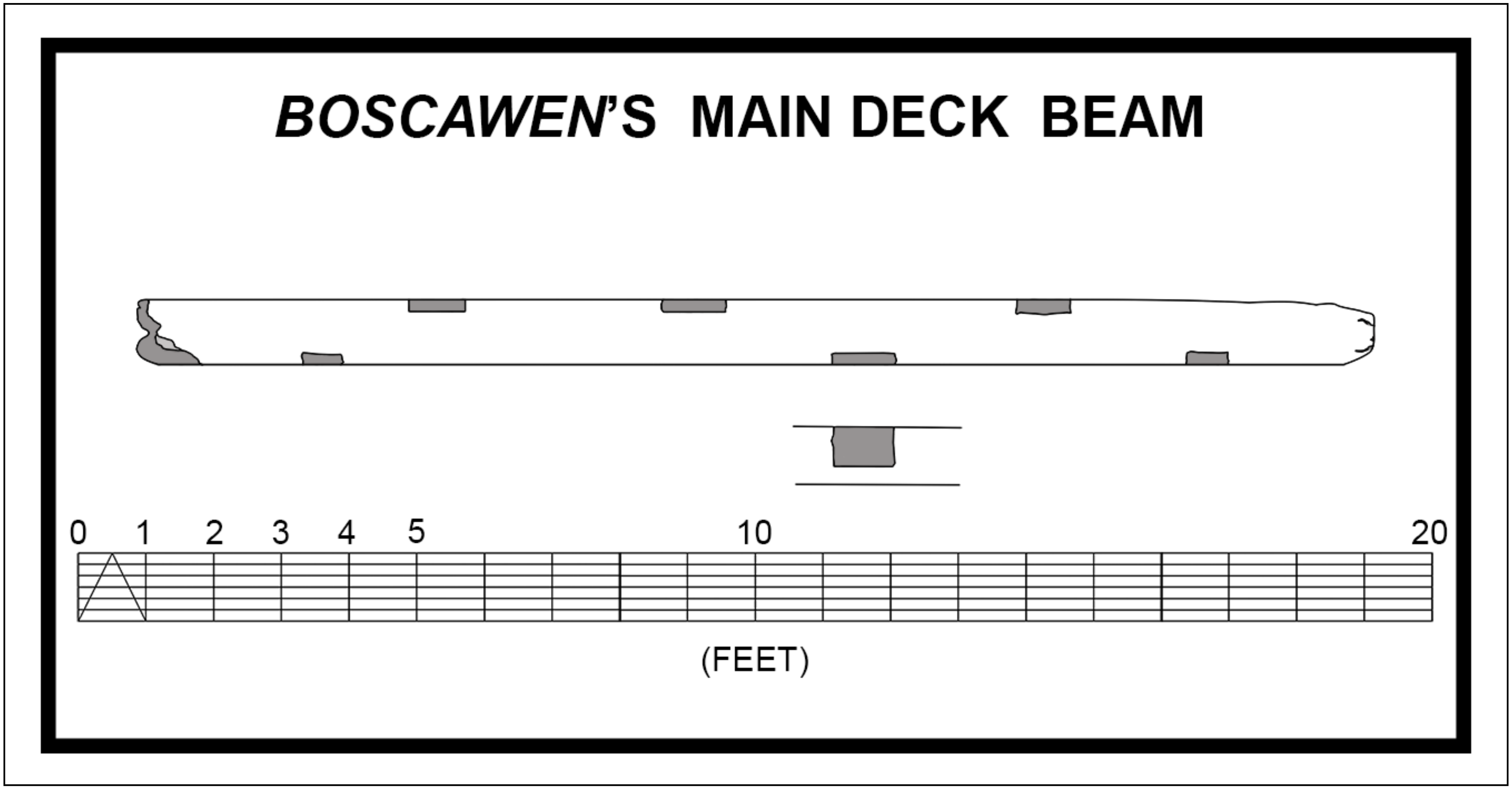

Figure 87 *Boscawen*'s only surviving main deck beam. (Drawn by author)

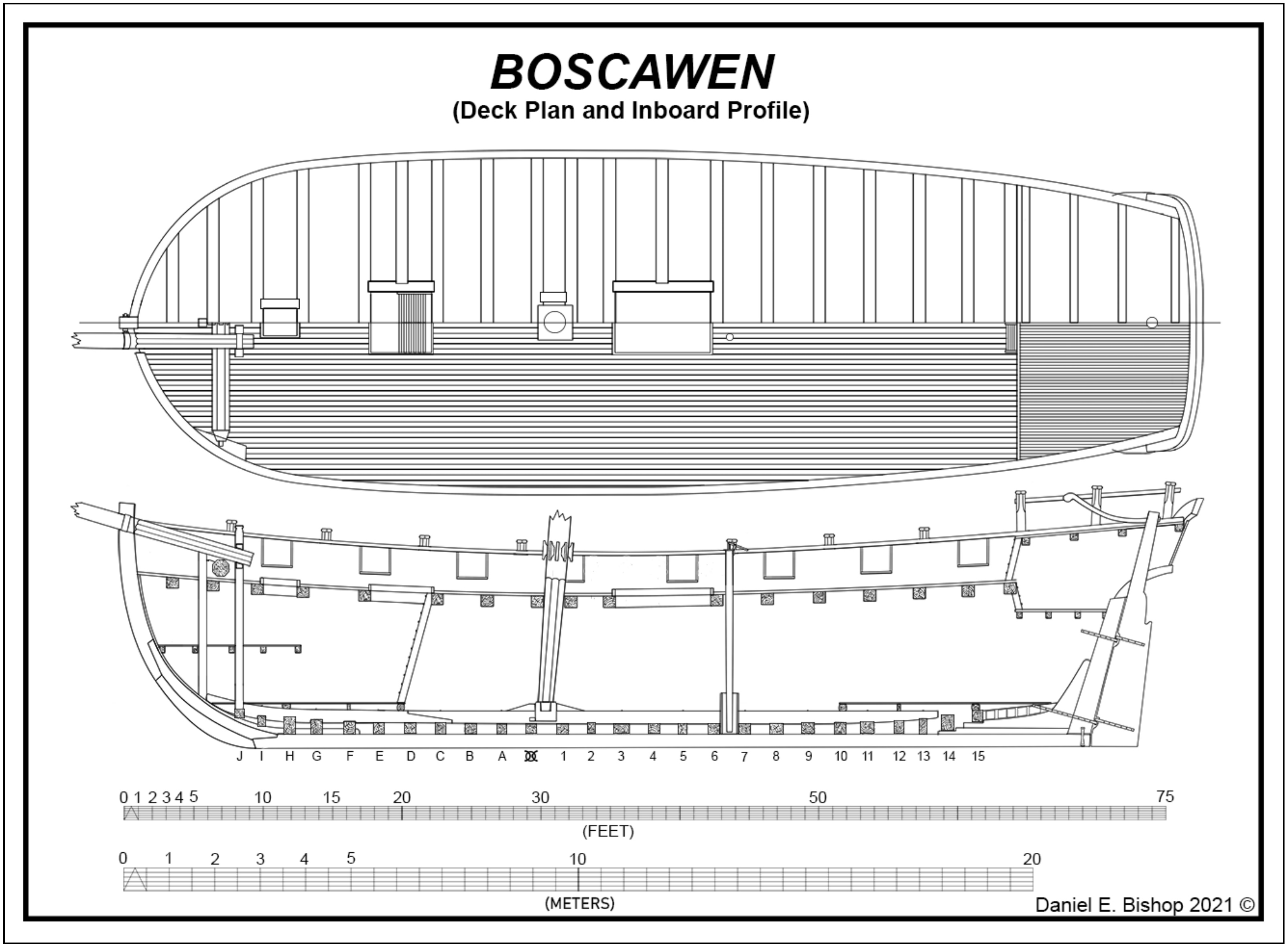

Figure 88 A reconstruction of *Boscawen*'s deck plan and internal construction. (Drawn by author)

Bilge Pump and Well

Boscawen's pump wells are identified as being aft of Frame 6, next to the keelson. In these locations, there are no limber boards present. Another pump well, possibly a backup, is identified only as being on the port side, next to the keelson forward of Frame 6. There are no observable pump well structures or enclosures, just the holes from the absence of limber boards. The sediment in the pump well was noted by the excavators as being "sandy" and "gritty." This is particularly interesting since the lake sediment near Ticonderoga is more silty than it is sandy: the grittiness of the bilge material may have been the result of finer silts being removed by the pumps while coarser-grained sands tended to settle out between the frames.

The pump wells are not very wide. The futtocks of Frame 7 are only 7 inches (17.8 cm) away from the keel on either side, and the futtocks of Frame 6 are even closer, at 5.5 inches (14 cm). The spacing between Frames 7 and 6 is 16.5 inches (41.9 cm); between Frames 6 and 5, it is 18 inches (45.7 cm).

The historical photographs of *Duke of Cumberland* do not depict potential pump well areas. I previously considered that the two holes cut into the ceiling planking—the first about 1 to 2 feet (0.3–0.6 m) from either side of the keelson and the second roughly 10 to 15 feet (3–4.5 m) from the after end of the stem (seen in Figure 9)—may have served as pump wells. According to the *iWitness* point cloud, these holes measured around 10 inches (25 cm) square. Just forward of their location was one of the limber boards (seen on the port side). In *Boscawen*, the pump wells are located roughly 35 feet (10.7 m) aft of the stem assembly and directly beside the keelson. This pump location, near the base of the main mast, was typical for vessels in the eighteenth century. The forward position of the square holes in *Duke of Cumberland*'s ceiling planking, therefore, were likely cut for another purpose. If they were part of the original construction, these holes might have been cut to secure the heels of the bitt posts.

Ballast

More than two dozen ballast stones were discovered along the centerline of *Boscawen* near its stern during the archaeological investigations in the 1980s. These stones range in size from 6 inches (15.2 cm) to 2 feet (61 cm) in length and seem to have been sourced from the rock outcrop at the dockyard location. Their combined weight is less than 1,000 pounds (453.6 kg), which would have been too light to properly ballast the sloop on their own.[210] In 1760, when *Boscawen* served as a troop and supply transport, it is likely that ballast was removed when loading captured military stores, supplies, and British and colonial troops moving south from Canada. *Boscawen* was probably left unballasted after its final voyage as a transport, or had its ballast removed when it was laid up.

It is unknown how much ballast stone was used in *Duke of Cumberland*'s hull. When the brig was in its final stages of preparation, Loring wrote to Amherst asking about the quantity of artillery stores to be put on board because he would need to calculate this into the "forty tuns [*sic*] of Ballast" he intended to stow.[211] There was no mention of a large pile of rocks or ballast stones in *Duke of Cumberland*'s hold when it was raised in 1909. It is possible that the brig, too, may have been left unballasted or cleared of ballast after its final voyage.

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[210] Crisman, "The Construction of the *Boscawen*," 367.
[211] PRO, W.O.R. 34/64, 157, Loring to Amherst, 31 Aug. 1759.

Tons Burthen

Originally, Amherst had called for two brigs of 120 to 130 tons burthen.[212] Previous scholarship has suggested that *Duke of Cumberland* and *Boscawen*'s tonnages were closer to 155 and 115, respectively.[213] Historical documents suggest otherwise. On a foggy October 7, 1759, Ensign Ebenezer Dibble of the 30th Connecticut Regiment wrote in his diary that *Boscawen* "was Lantched [*sic*] this day 130 ton."[214] Another diary entry, this time from a soldier from the Amherst Expedition named Lemuel Wood, recorded on September 17, 1759 that the army at Crown Point was "to go forward to St johns as Soon as they get ye great Raddow [*sic*] finished which is building at Crown Point and ye Brig [*Duke of Cumberland*] be Ready to Sail from Ticonderoga which is of 200 touns [*sic*] Burthen built there."[215] These are the only two contemporary sources located thus far that describe the vessels' sizes. The question now becomes how did these individuals calculate tons burthen? Since direct listings of *Boscawen*'s and *Duke of Cumberland*'s overall length, length of keel, beam, and hold depth have yet to be found in the archival record, we must look to archaeological data[216] and contemporary sources to calculate these numbers.

In the 1980s excavations, the *Boscawen* site was measured to around 70 feet (21.3 m) long and 24 feet (7.3 m) wide. Because *Boscawen*'s upper structure (sides and deck) did not survive, we must estimate its original depth of hold, beam, and other principal dimensions by using other historical sources such as the 1776 admiralty hull plans for two small sloops "to be

[212] PRO, W.O.R. 34/64, 196, Amherst to Loring, 13 May 1759.
[213] Crisman, "Struggle," 142; Lewis, "The Naval Campaign," 209; Flanigan, "The Rigging Material from *Boscawen*," 2.
[214] Dibble, *Diary of Ebenezer Dibble*, 318.
[215] Amherst had considered heading down the lake to pursue the French before *Boscawen* was finished, as Wood's diary entry suggests, but ultimately waited until all the vessels were ready. Perley, *Diaries of Lemuel Wood*, 38.
[216] Including historical photograph photogrammetry data.

built on Lake Champlain" (see Figure 70).[217] Combining information from contemporary sources (like the 1776 sloop plans) with archaeological data, we are able to generate hypothetical reconstructions of *Boscawen*'s hull lines and internal construction (see Figures 88–90).[218]

The 1776 small sloops were designed to have a length on deck of 56 feet, 10 inches (17.3 m); a maximum beam of 19 feet, 7 inches (6 m); and a 9-foot (2.7 m) depth of hold.[219] Although the 1776 plans are for sloops roughly 15 feet (4.6 m) shorter than *Boscawen* and were drawn up seventeen years later, the vessels share similar design characteristics that help inform the reconstruction of the 1759-built sloop. *Boscawen*'s reconstructed lower hull lines, the curve of its stem, and the rake of its sternpost are strikingly similar to what is seen in the 1776 plans. These commonalities are likely due to the vessels' intended purpose as military vessels that could transport troops and cargo, as well as the specific sailing environment of an inland lake.[220] These similarities also may allow us to use the 1776 hull lines to make several estimations for *Boscawen*'s "missing pieces."

Boscawen's length on deck was reconstructed to 74.5 feet (22.7 m). Its maximum outboard beam was 24 feet, 4 inches (7.4 m), and its depth of hold was estimated to be 9 feet (2.7 m).[221] Using these measurements, we can begin the tons burthen calculation and the comparison to Ensign Dibble's report.

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[217] These plans were designed by John Williams, Surveyor of the Royal Navy between 1765 and 1784.
[218] The generation of hypothetical hull lines is first informed by archaeological remains, after which the missing elements (often the upperworks) are "filled in" using contemporary textual and pictorial sources, other relevant archaeological material, and hull shape theory, or "Basic Ship Theory." Rawson and Tupper, *Basic Ship Theory*. Generating hypothetical ship lines (and construction draughts, for that matter) can be seen as a form of experimental archaeology: by reverse-engineering a vessel's construction, we can enter the mind of the shipwright and begin to understand the decisions that went into designing and building the vessel.
[219] National Maritime Museum, "Unnamed 56ft single-masted Sloops (Circa 1776)."
[220] This discussion is explored in further detail in Chapter VI.
[221] The 1776 sloop plans were designed with a 9-foot (2.7 m) depth of hold. I chose to use the same deck height of the smaller vessels for *Boscawen*'s reconstruction because it would provide adequate head room for the crew, while maintaining a stable center of gravity.

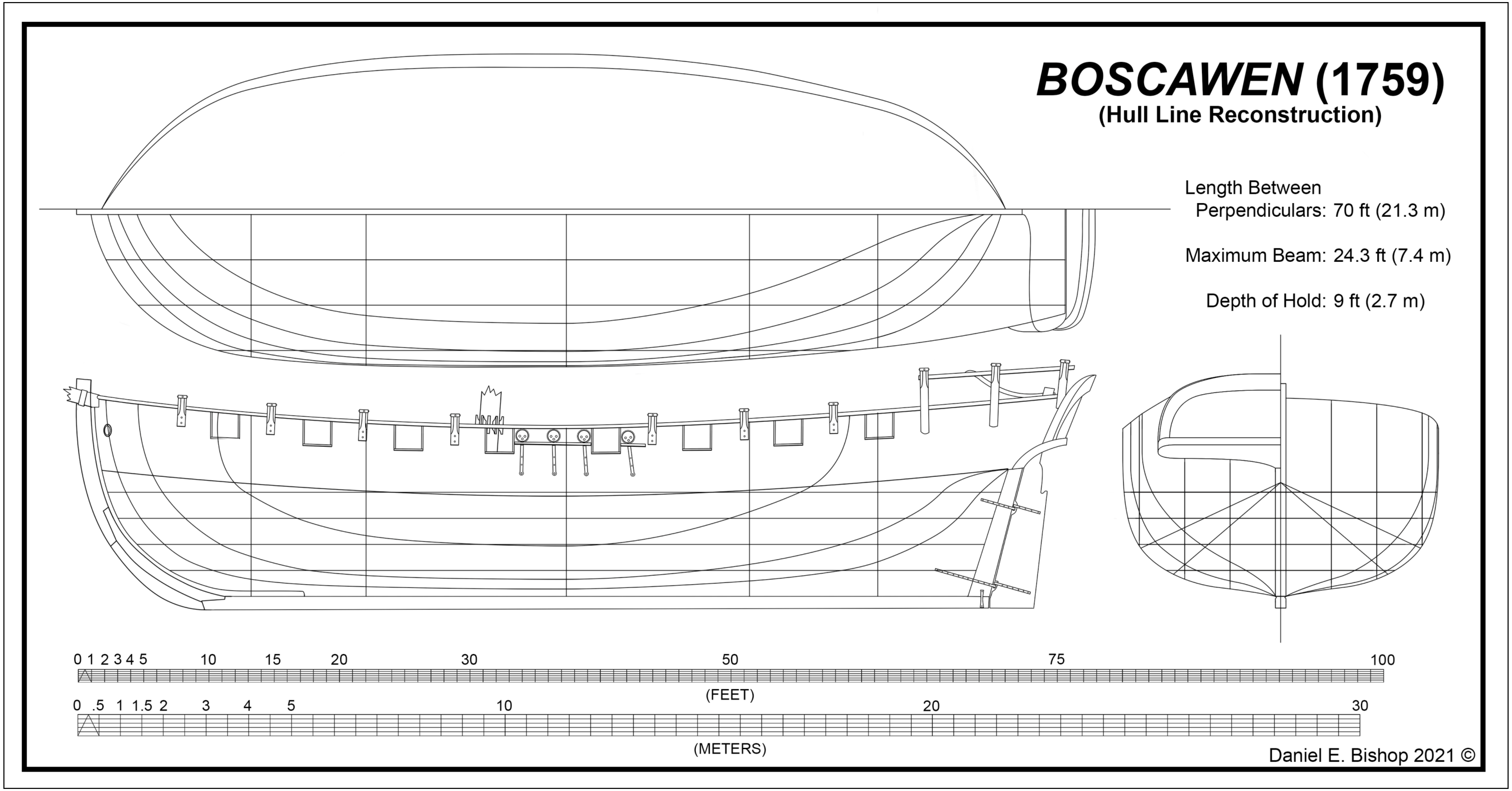

Figure 89 *Boscawen*'s reconstructed hull lines. (Drawn by author)

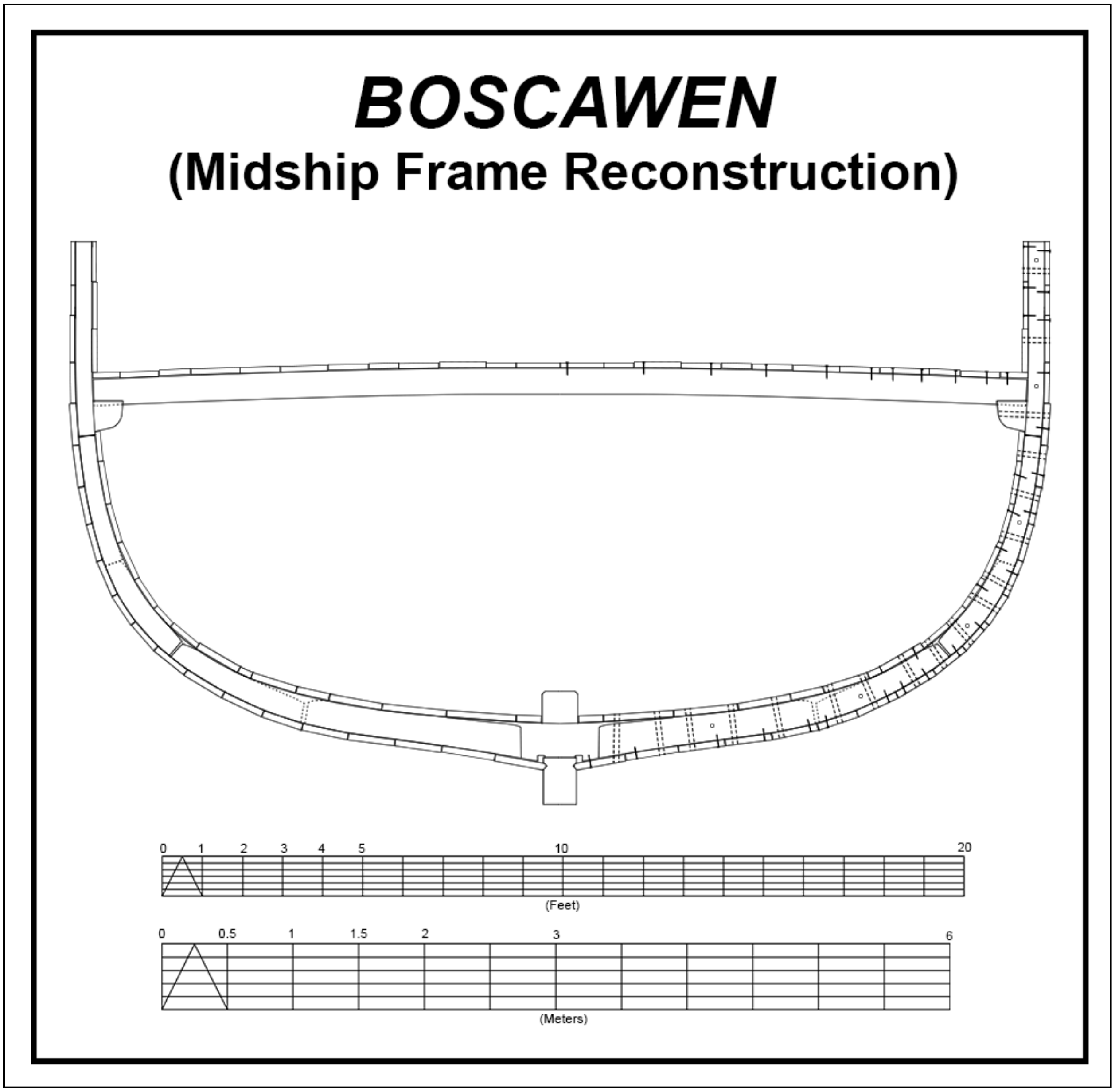

Figure 90 A reconstruction of *Boscawen*'s midship cross-section. (Drawn by author)

Throughout the eighteenth century, tons burthen was calculated in a variety of ways, depending on hull shape, the distinction between mercantile and military craft, and the mathematical calculation being used at the time.[222] One of the most commonly cited ways to calculate tons burthen is to divide the product of the length of the keel,[223] beam,[224] and depth of hold[225] by 94.[226] Using this formula, *Boscawen*'s reconstructed tons burthen is 129.99, which verifies Dibble's recording from 1759.[227]

In 1909, *Duke of Cumberland*'s hull remains were reported to be 90 feet (27.4 m) long and 22 feet (6.7 m) wide.[228] I used these dimensions, as well as the other aforementioned methods used to introduce scale into the *Duke of Cumberland*'s photogrammetry point cloud, to generate a scale-constrained hull line reconstruction for this vessel (see Figure 52). *Duke of Cumberland*'s reconstructed maximum breadth is identical to *Boscawen*'s, at 24 feet, 4 inches (7.4 m), and its depth below the main deck is also the same at 9 feet (2.7 m). It is reasonable to

[222] For a more comprehensive look at the development and variations of the tons burthen calculation from the late seventeenth century through the eighteenth century, see Salisbury, "Rules for Ships Built for, and Hired by, the Navy," 173–180 and Salisbury, "Early Tonnage Measurement in England," 251–264.

[223] Definitions of the "length of the keel" are not always listed in burthen calculations. Rarely does it ever mean the full length of the keel timber(s); rather, "length of the keel" is often understood to be a value generated specifically for calculating tons burthen, sometimes referred to as "the length of keel for tonnage." A number of burthen formulas acquire a length of the keel by measuring the "straight line along the rabbet of the keel of the ship, from the back of the main stern-post to a perpendicular line from the fore-part of the main-stem under the bowsprit [or, at the height of the hawse holes]; from which, subtracting three-fifths of the breadth, the remainder must be esteemed the just length of the keel to find the tonnage." Steel, *The Shipwright's Vade-Mecum*, 249–251; Sutherland, *The Ship-Builders Assistant*, 76; Salisbury, "Early Tonnage Measurement in England," 251–264.

[224] In most burthen calculations, the maximum beam is understood to be measured from the outboard face of the outer hull planking, at the broadest place of the hull. Steel, *The Shipwright's Vade-Mecum*, 249–251. Some calculations also use "the extreme breadth of the ship withinboard [*sic*]." This is understood to be measured from the inboard face of the interior planking, at the broadest place of the hull. Falconer, *Dictionary of the Marine*, 67.

[225] The depth of hold is understood to be the distance between ceiling planking to the main deck planking at midships. In some of these formulas, it is recommended that half of the extreme breadth be used instead of the depth of hold. This was done mainly for larger, ocean-going craft with pronounced V-shaped hulls (the half-breadth was understood to be a more accurate representation of those vessels' hold space. Sutherland, *The Ship-Builders Assistant*, 76. For smaller, lake-going craft like *Boscawen* and *Duke of Cumberland*, the former method was likely preferable and more accurate for their hull design.

[226] Falconer, *Dictionary of the Marine*, 67.

[227] *Boscawen*'s length of keel for tonnage was calculated as 55.802 feet (17 m), the extreme breadth was 24.3 feet (7.4 m), and the depth of hold was 9 feet (2.7 m), as previously mentioned.

[228] "Raising Old Ship," *Plattsburgh Evening News*, 18 December 1908, p. 2.

assume that Loring and his carpenters, in an effort to locate adequate timber and save time and material, would likely have used the same timber molds for both vessels.[229]

Using the same tonnage formula as previously mentioned, *Duke of Cumberland*'s tons burthen would have been 184.99.[230] Although this value does not match Lemuel Wood's assessment of 200 tons, it is not necessarily incorrect. It is probable that Wood learned of a "casual calculation" of the brig's burthen[231] or attempted his own simplified version of the tonnage formula. For example, if one were to multiply *Duke of Cumberland*'s reconstructed length on deck (around 90 feet [27.4 m]) by its rounded down beam (24 feet [7.3 m]) and by its depth of hold (9 feet [2.7 m]) and divide the product by 94, one would get 206.8 tons burthen. If Wood had personally calculated the tons burthen, he likely would have used a similar method or, had he learned of the brig's tonnage through casual conversation, the tonnage may have been rounded up from 185 and declared as 200.

Lake George Colonial Sloops (CV-1, CV-2, and the Tuttle Sloop)

The following measurements of the colonial Lake George sloops CV-1 and CV-2 were taken when the vessels were archaeologically surveyed in 1998 and 2000. Measurements from a third colonial Lake George sloop, the Tuttle Sloop (aka the 1757 Fort William Henry Sloop) have been analyzed using historical photograph photogrammetry (in Chapter III). Although these vessels were likely built by different British carpenters and shipwrights than the ones who constructed the Lake Champlain brig and sloop, they were built for use in the same conflict (the

[229] Other time- and material-saving strategies were employed on these vessels as well, particularly around the shaping and installing of the framing components.
[230] *Duke of Cumberland*'s length of keel for tonnage was calculated as 79.412 feet (24.2 m), the extreme breadth as 24.33 feet (7.4 m), and the depth of hold as 9 feet (2.7 m).
[231] As far as we know, Lemuel Wood had nothing to do with the timbering, construction, or launching of the vessel, and probably learned of the vessel's dimensions (or tonnage) secondhand.

Seven Years' War in North America), under similar material availability conditions and time constraints, and for a comparable inland lake environment (albeit a smaller one than that of Lake Champlain). By examining how their construction methods and scantlings relate to those of *Boscawen* and *Duke of Cumberland* (and to one another), we can begin to identify the origins of shipbuilding knowledge and ascertain whether there are construction methodologies that are distinctly British, local, or individual in nature.

For the CV-1 survey, the archaeological teams used baseline mapping for the exposed hull remains and probing for the buried elements. The archaeologists did not excavate this vessel, so features of its construction, like the stern, remain obscured. For the CV-2 investigation, the team mapped the timber debris locations, recovered what was resting on the lake bed, and recorded the timbers above the water with photographs and direct measurements. The CV-2 site, as previously mentioned, was heavily disturbed and disarticulated, and the mostly fragmented timbers were strewn across the site. Similar to CV-1, there is much that is still unknown about this vessel.[232]

Aspects of the Tuttle Sloop are also concealed from us. In the case of this vessel, which was raised from Lake George in 1903 and has not survived to the present day, our knowledge is limited by what is depicted in historical photographs. Thanks to these detailed images, a considerable amount of information can still be retrieved from this wreck; more, in fact, than from CV-1 and CV-2, whose remains still exist today. By scale-constraining the photogrammetric model, I was able to recover enough timber dimensions and hull measurements to generate a hypothetical set of hull lines for this vessel (see Figure 53).

The three sloops are believed to be the ones built for the Fall 1756 campaign. The unnamed CV-1 and CV-2 are thought to be 20-ton sloops, and the Tuttle Sloop raised in 1903

[232] Kane and Sabick, "Lake Champlain Underwater Cultural Resources Survey," 210–216.

may have been the 30-ton sloop *Earl of Loudoun* that was burned in 1757 during the French siege of Fort William Henry. All three sloops were likely built under the direction of Colonel Nathaniel Meserve of the New Hampshire Provincial Regiment and a shipwright from Portsmouth, New Hampshire.[233] Therefore, these vessels may share similar construction features and scantlings, despite their slight size difference.

Keel

Of the two smaller sloops, only CV-1 (the more intact of the two) had any keel information for archaeologists to survey. The bow of CV-1 was exposed, but the keel was missing in this location and only a false keel remains. Although the archaeological survey team was unable record the actual keel, the measurements they took of the surrounding timbers allowed me to generate approximate molded and sided dimensions of the missing timber.

The false keel has a rectangular cross-section, and its molded dimension is 3 inches (7.6 cm). Using the false keel's sided dimension, we know that the keel timber was likely 5 inches (12.7 cm) sided. The space between the false keel and the apron was measured to around 8 inches (20.3 cm). See Figure 29 for an illustration of CV-1's surviving stem assembly.

The Tuttle Sloop's keel is visible in Figures 16–18. Using the scale-constrained photogrammetric model, I measured the keel's overall length and approximate molded and sided dimensions. The Tuttle Sloop's keel, likely where the reported length for the sloop was measured in 1903, was 43.5 feet (13.3 m) long. Its maximum sided dimension was 6 inches (15.2 cm), and its maximum molded dimension was estimated to be around 7.5 to 8 inches (19–20.3 cm). The latter dimension was derived from the visible 6 inches (15.2 cm) molded (up to the bottom of the

[233] Dunne, "The 35th Regiment of Foot," 24, 185. While on his way to join the Louisbourg Expedition (via Halifax) in 1757, Meserve (commanding a company of shipwrights, carpenters, and artificers) died of smallpox. Dunne, "The 35th Regiment of Foot," 301.

garboard strake) plus an additional 1.5 to 2 inches (3.8–5.1 cm) based on the external plank thickness.

Stem

The small surviving section of CV-1's apron is attached below the keelson and above where the keel would have been. This is one of the more substantial timbers recorded on the site. It is 7.5 inches (19 cm) molded and 10 inches (25.4 cm) sided on its upper side. The apron tapers to 6.5 inches (16.5 cm) on its lower side, where it once joined the keel. It does not appear to form the upper part of the planking rabbet, as seen on *Boscawen*. Its total length aft was not recorded but was shown in the archaeological notes to be at least 1 foot (30.5 cm) long. The main stem and gripe were missing from CV-1.

The CV-2 site had only a single timber fragment from the stem assembly, one interpreted to be a fragment of the main stem (see Figure 91).[234] This timber is heavily eroded but yielded some basic measurements: the maximum molded dimension is around 7 inches (17.8 cm) and its surviving sided dimension is close to 6 inches (15.2 cm). The curved length of this timber is nearly 4 feet (1.2 m).

The Tuttle Sloop had a more complete stem assembly visible in the photographs, which allowed me to take a number of measurements from the photogrammetric model. The surviving curved length of the main stem was around 10 feet (3 m). The stem maintained a molded dimension of between 9.5 and 10 inches (24.1–25.4 cm). The stem's maximum sided dimension was 6 inches (15.2 cm), and the sided distance between the stem's back rabbet lines was 4.25 inches (10.8 cm).

[234] Kane and Sabick, "Lake Champlain Underwater Cultural Resources Survey," 221.

The Tuttle Sloop also had a lower gripe forward of the main stem. This timber's heel butted against the forward face of the keel and was around 4.5 inches (11.4 cm) molded at that location. The gripe tapered in its molded dimension as it followed the curve of the main stem and terminated after around 6.5 feet (2 m). The inboard plane of the gripe was close to 6 inches (15.2 cm) sided, like the stem.

The apron on the Tuttle Sloop (best seen in Figure 18) was 5 to 6 inches (12.7–15.2 cm) molded and 9 inches (22.9 cm) sided. The apron was installed between the keelson and stem; its visible portion was around 2.5 feet (0.8 m) long. It is unclear how far the apron extended aft beneath the floors.

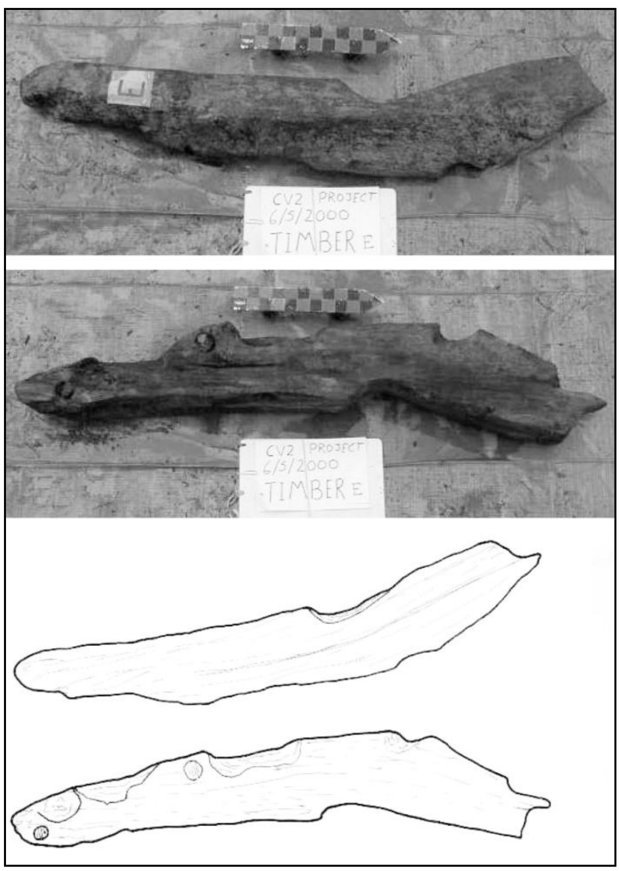

Figure 91 CV-2's possible stem fragment (Timber E). (Fig. 13-17 from Kane and Sabick, "Lake Champlain Underwater Cultural Resources Survey," 221) (Drawn by Adam Kane, photos by Chris Fox)

Stern

The photogrammetric model of the Tuttle Sloop's stern assembly was remarkably informative, despite the sternpost not surviving the raising event.[235] The distance between the stern knee and the end of the keel equates to the molded dimension of the sternpost base, which measured 13 inches (33 cm). The sided distance between back rabbet lines can be derived from the inside faces of the hood ends of the stern planking, at 4.5 inches (11.4 cm). The sternpost also shared the sided dimensions and shape of the keel at its terminus. The sternpost had a maximum sided dimension of 6 inches (15.2 cm) which, starting 3 inches (7.6 cm) from its after face, tapered aft 3 to 4 inches (7.6–10.2 cm) sided.

Forward of the missing sternpost, we can observe the stern knee.[236] The after face of the stern knee matches that of the sternpost's back rabbet line dimension, at 4.5 inches (11.4 cm). The stern knee's horizontal arm measures nearly 4 feet, 10 inches (1.5 m), and its vertical arm extends around 3.5 feet (1.1 m) above the keel. The square-cut forward end of the horizontal arm at least 7 inches (17.8 cm) molded. The maximum molded dimension of the stern knee (at the center of its curve) is 16 inches (40.6 cm).

Frames

The remains of twelve framing components were recorded on CV-1 (see Figure29). These included seemingly nine floors and three futtocks. Only disarticulated framing components were found on CV-2, but their scantlings are nearly identical to CV-1's. Most of the framing components were between 5 and 6 inches (12.7–15.2 cm) sided; however, one of the

[235] It seems that the sternpost was used to haul this vessel ashore but may have torn off in the process. A hole through the keel is visible in Figures 16 and 17. This hole may have been created by the salvagers to pull the vessel the rest of the way onto shore.
[236] It is unclear whether deadwood was installed in the Tuttle Sloop's stern assembly below the stern knee.

floors (Framing Component 11) was recorded to be 9 inches (22.9 cm) sided. Only one floor's molded dimension was recorded (Framing Component 3); it measured 7.5 inches (19 cm) near the vessel's centerline. This floor was shown as having limber holes cut on its bottom side, but they were not measured. Most of the floors extend around 4 feet (1.2 m) outboard before they terminate.

The few first futtocks that were exposed were recorded as having similar dimensions. The most observable futtock (Framing Component 5) was nearly 5 feet (1.5 m) long, and its heel was 9 inches (22.9 cm) outboard of the keelson. The floor-futtock placement strategy is also seen at Framing Component 5 and 6: futtocks (at least those forward of midship) were placed aft of their associated floor. For this reason, I have interpreted Framing Components 10 and 12 as futtocks (their heels are obscured by the ceiling planks and silt).

A number of floors (possibly around six) are missing from this forward section of the hull. By examining the spacing of the existing floors, as well as other features like the outer planking butt between Framing Components 4 and 5, we can determine the actual number of frames in this section and better estimate their average spacing. In this forward 17-foot (5.2 m) section of the exposed hull, there should have been around sixteen floors. They would have been spaced roughly 12 to 15 inches (30.5–38.1 cm) apart on their centers. Unfortunately, no frame curvatures were recorded for this vessel.

Most of the frames for the Tuttle Sloop were identifiable. On the port side,[237] the number of frames tallied around twenty-six, with three or four of them being stern half frames. No bow or stern canted half frames were observed in the photographs. It is likely that they fell away (or were forcibly removed) when the sloop was raised. Because most of the external and ceiling

[237] The port side was selected because the four photographs used to create the photogrammetric point cloud showed this side more clearly than the starboard side. Subsequently, the port side was also used to generate the hypothetical hull lines.

planking survived up to the heads of the floors, it was more difficult to take measurements of those timbers specifically. Instead, much of the information on frame spacing is derived from the first futtocks.

The heads of the floors that were visible were 6 to 7 inches (15.2–17.8 cm) sided and 4 to 5 inches (10.2–12.7 cm) molded. The first futtocks had sided dimensions between 5 and 6 inches (12.7–15.2 cm) and were 4 to 5 inches (10.2–12.7 cm) molded near their heads. Overall, the frames were spaced 18 inches (45.7 cm) apart on their centers. Much of the framing information gathered from the Tuttle Sloop point cloud echoes that of the two smaller sloops.

Keelson and Mast Step

The exposed length of CV-1's keelson measures 16 feet (4.9 m). The keelson timber is 6 inches molded and 7.5 inches (19 cm) sided but tapers to 6.5 inches (16.5 cm) sided at its forward end. Its underside was notched (roughly 1–1.5 inches [2.5–3.8 cm] deep) to fit over the floors. These dimensions and notches are consistent with the eroded fragment of the keelson found on CV-2.[238] A simple mast step mortise was also recorded on the upper side of CV-1's keelson. It was located 10 feet (3 m) aft of the start of the keelson. The mortise measures 10 inches (25.4 cm) long, around 3 inches (7.6 cm) wide, and 3 inches (7.6 cm) deep.

The Tuttle Sloop keelson's aft end is likewise obscured, but its length was estimated as being 34 to 35 feet (10.4–10.7 m) long. Over most of its observable length, the keelson measured roughly 8 inches (20.3 cm) molded and sided.[239] Near the stem, the keelson's sided dimension narrows to around 5.5 to 6 inches (14–15.2 cm). It is unknown whether the underside of the

[238] The keelson fragment from CV-2 was 4.5 inches (11.4 cm) molded and 5 inches (12.7 cm) sided. This piece was eroded and likely came from one of the timber's ends.
[239] The molded dimension of the keelson was calculated by using the measurement of the visible height of the keelson while adding the ceiling-plank thickness.

keelson was notched to fit over the floors, but it seems likely that it was. Similar to CV-1, a simple mast step mortise is observable on the upper side of the keelson. The Tuttle Sloop's mast step mortise was located 12.5 feet (3.8 m) aft of the keelson's forward edge. It was 10 inches (25.4 cm) long, 3 inches (7.6 cm) wide, and its depth was not ascertainable. In addition to the mortise, two wedge-shaped mast step crutches (lateral supports) were attached to the ceiling planking on either side of the keelson. The crutches' bases were around 12.5 inches (31.7 cm) long. They had a height and width of around 6 inches (15.2 cm).

Ceiling and External Hull Planking

Archaeologists recorded five external hull planks, one ceiling plank, and one limber board on the port side of CV-1. The outer hull planks were stated to be 1.5 inches (3.8 cm) thick, and range between 10 and 11 inches (25.4–27.9 cm) wide. The port garboard strake is the widest of the five hull planks recorded. Outer hull planks are butt joined on framing components, as evidenced by the third plank outboard of the keel between Framing Components 4 and 5. Only a single ceiling plank and limber board were exposed for archaeologists to measure. Both planks are 1.5 inches (3.8 cm) thick, but the ceiling plank is 13 inches (33 cm) wide while the limber board is only 4 inches (10.2 cm) wide. Two planks identified by the archaeologists as "deck planking" were observed laying on the keelson. These 4-inch-wide (10.2 cm) planks are more likely to be limber boards displaced by recreational divers. The dimensions of planking fragments found on CV-2 are nearly identical to the ones seen on CV-1.

The planking on the Tuttle Sloop is akin to that observed on CV-1 and CV-2. Outer hull planks were difficult to map in due to the photographs' orientations. However, the two planks I was able to measure were 8.5 and 10 inches (21.6 and 25.4 cm) wide and around 1.5 inches (3.8

cm) thick. It was marginally easier to obtain measurements from ceiling planking: the three planks I was able to record measured 9, 11, and 12 inches (22.9, 27.9, and 30.5 cm) wide and around 1.5 inches (3.8 cm) thick. Limber boards were also observed on the Tuttle Sloop. These planks measured around 1.5 inches (3.8 cm) thick and 4 inches (10.2 cm) wide.

Tons Burthen and Ballast

No ballast stones were observed on the CV-1 or CV-2 sites. However, 10 tons of cobble ballast were removed from the Tuttle Sloop when it was raised in 1903.[240] If the Tuttle Sloop was indeed the 30-ton *Earl of Loudoun*, then the vessel's hypothetical lines may help confirm this identity. Applying the same formula for tons burthen that I used for *Duke of Cumberland* and *Boscawen* to the Tuttle Sloop's lines generated from the scale-constrained point cloud, the vessel's tons burthen is calculated as 30.97 tons.[241]

The King's Shipyard's Possible French Sloop and Flat-Bottomed Vessel

The measurements that follow were taken of the two vessels believed to be a colonial French-built sloop (referred to as KS-1) and a flat-bottomed craft (referred to as KS-2) built in Saint-Jean between 1758 and 1759 for use on Lake Champlain. These two wrecks were initially located in 1983 but were surveyed by my team in 2019. The vessels were built for use in the same conflict as the other British vessels previously discussed. However, they were likely constructed at the opposite end of the lake, possibly under different material availability conditions, and by different shipwrights and carpenters. By comparing these two possibly French-built vessels with *Boscawen*, *Duke of Cumberland*, and the three Lake George sloops, we

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[240] Zarzynski and Shaw, "The Tale of the 1757 Fort William Henry Shipwreck," 2.
[241] The Tuttle Sloop's reconstructed length of keel for tonnage is 41.6 feet (12.7 m), its reconstructed beam is 14 feet (4.3 m), and its depth of hold was estimated to be 5.5 feet (1.6 m).

can examine how eighteenth-century construction methods and shipbuilding knowledge differed by nationality. Although the 2019 survey of these vessels provided a limited glimpse into their entire hull construction, the differences between these and the British vessels are noticeable, especially in their framing components and fasteners.

KS-2 was not investigated to the same degree as KS-1. This was largely because the flat-bottomed craft seems to lack some of the major hull features (i.e., stem, stern, and hull curve) that the other vessel has (see Figure 92). The only information derived from KS-2 comes from the framing components, the planking, and a possible keelson.

Stem and Keelson

KS-1's stem comprises three timbers (apron, main stem, and gripe), which are attached to the keelson with a large 1-inch (2.5 cm) drift bolt (see Figure 93). The maximum sided dimension of each of the stem timbers and the keelson is 6 inches (15.2 cm); the only timber that was observed to taper toward its outboard face is the gripe, which measured to 3.5 inches (8.9 cm). All of the stem timbers and keelson were fashioned from hardwood, likely white oak.

Moving from inboard to outboard, the exposed forward end of the keelson tapers to 3.5 inches (8.9 cm) molded as it curves upward following the stem's shape. The bolt that secures all four timbers together was fastened to the keelson 3 inches (7.6 cm) aft of its forward face. The apron's 3-inch (7.6 cm) molded dimension stays consistent (except for its heavily eroded upper end) over its exposed length.

KS-1's main stem has a maximum molded dimension of 7 inches (17.8 cm). The distance between the back rabbet line and the bearding line is around 3 inches (7.6 cm), and from the bearding line to the main stem's forward face is 4 inches (10.2 cm). The sided dimension between the port and starboard rabbet lines is estimated to be 3 inches (7.6 cm) due to the stem being heavily eroded here.

The gripe on KS-1, similar to the apron, seems to have a consistent molded dimension of 3 inches (7.6 cm). During the 2019 survey, we exposed roughly 3 feet (0.9 m) of the gripe. Due to the limited extent of our excavation, however, we do not know how much farther the gripe extends aft before it joins the keel.

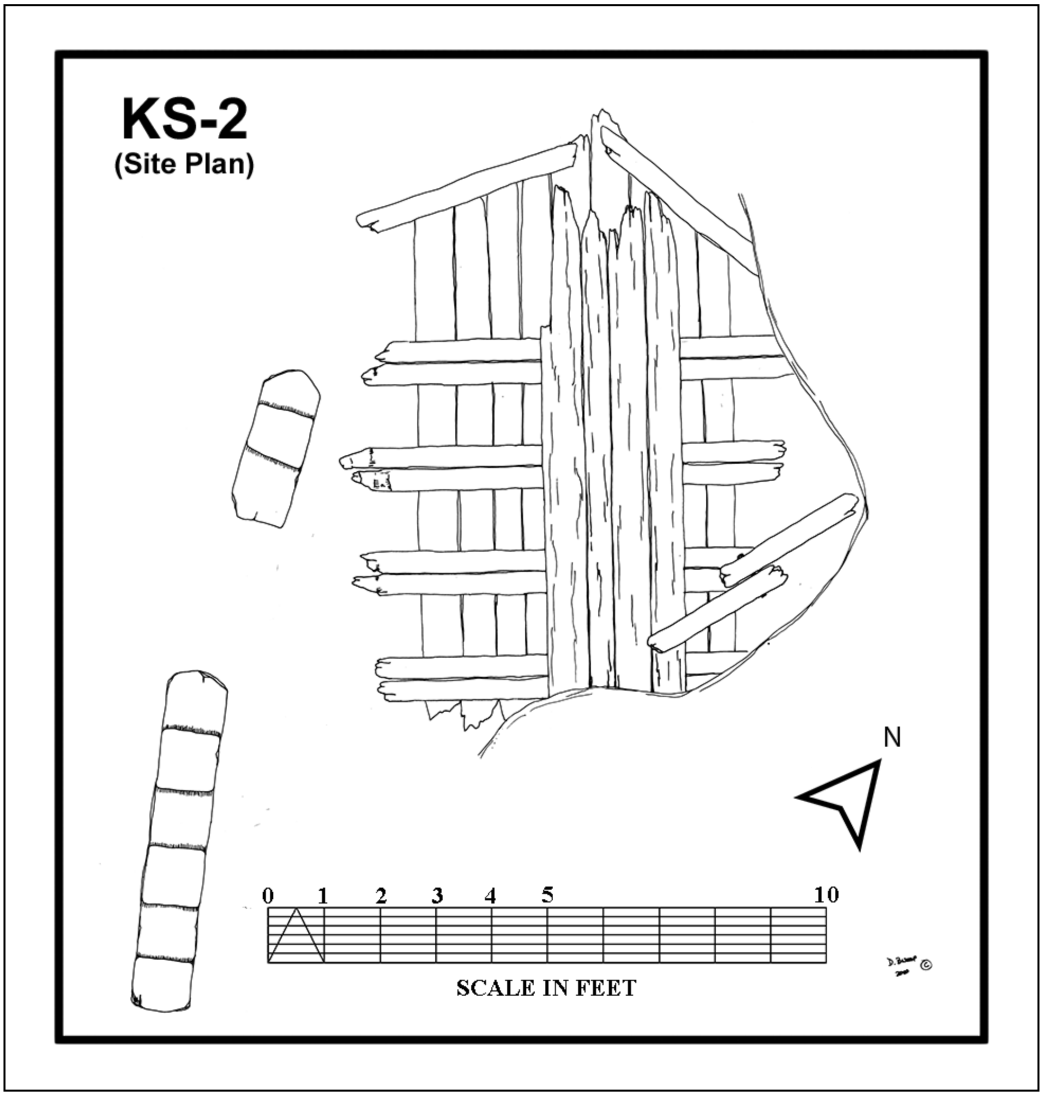

Figure 92 KS-2 site plan. (Drawn by author)

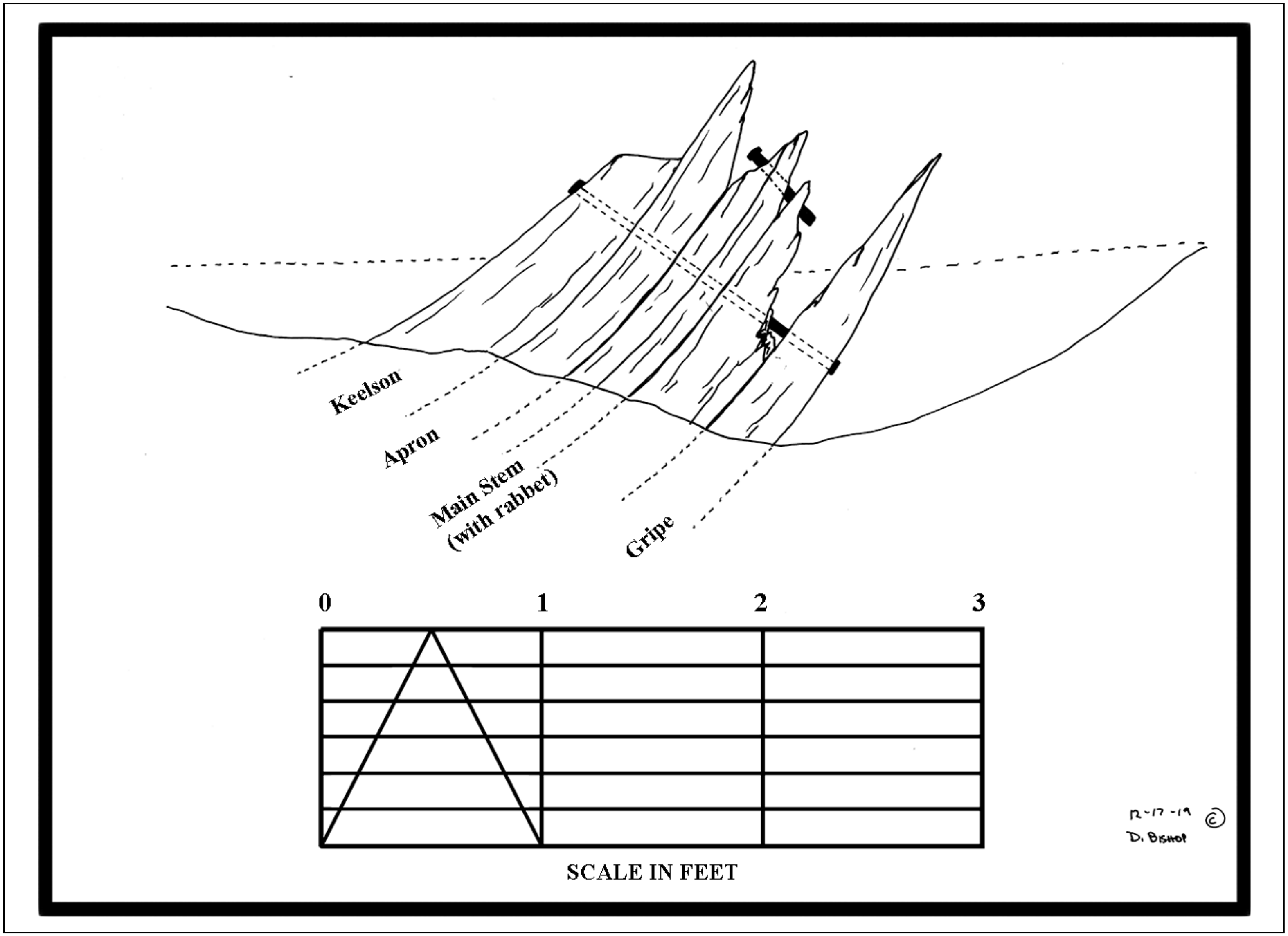

Figure 93 KS-1's stem assembly. (Drawn by author)

Two of the most perplexing timbers found at the King's Shipyard site were large, crenellated timbers roughly 2.5 feet and 6 feet (0.8 m and 1.8 m) long found on the southern side of KS-2 (see Figures 92 and 94). They each are around 1 foot sided and have a maximum molded dimension of 6.5 inches (16.5). The gaps between the raised portions are roughly 13 inches (33 cm) long and, at these locations, the molded dimension ranges from 4 to 4.5 inches (10.2–11.4 cm). No fasteners were felt on these timbers, but that does not mean they were not there. These peculiar timbers, despite the lack of identified fasteners, are believed to be some type of keelson or longitudinal structural component (and to have originally formed a single timber). The crenellated shape is believed to have been cut to fit over the framing components on the flat-bottomed boat. If KS-2 is a radeau, two or three of these timbers could have run parallel to each other longitudinally in the vessel. A better understanding of this vessel's construction is possible only with further excavation.

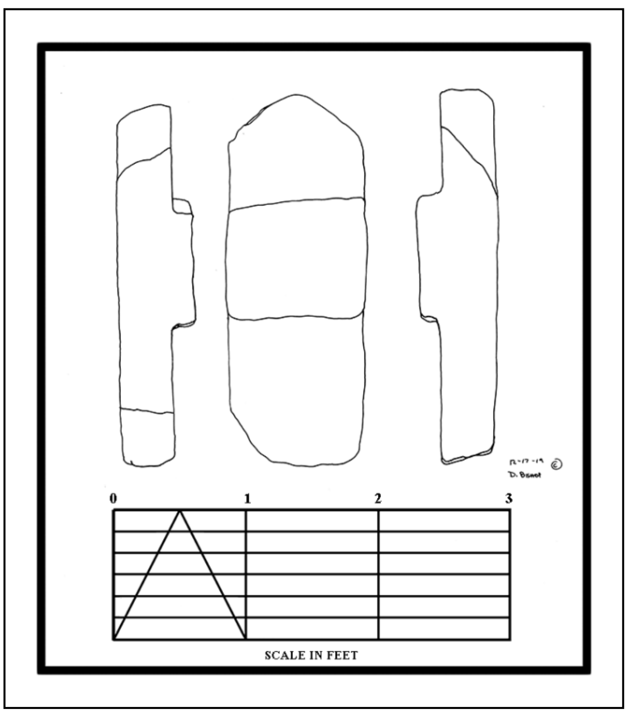

Figure 94 One of KS-2's crenellated timbers. (Drawn by author)

Stern and Keel

Excavations at the stern of KS-1 revealed a sternpost, a gudgeon, a stern knee, and deadwood (see Figure 95). The sternpost is surprisingly vertical, being raked at 87 degrees. It is unknown whether this was an actual construction trait or a result of the vessel having settled into the lake bottom, pitched slightly forward.[242] The sternpost has a maximum molded dimension of 8 inches (20.3 cm) and a maximum sided dimension of 5 inches (12.7 cm). The bearding line to the aft face of the sternpost is 5 inches (12.7 cm). The forward face of the sternpost is 3 inches (7.6 cm) sided and tapers to 2.5 inches (6.3 cm) at the rabbet lines. Interestingly, this is the only vessel of the seven examined in this chapter that has a false sternpost attached to the aft face of the main post. This false sternpost is 2 inches (5.1 cm) molded and 4 inches (10.2 cm) sided, but its aft face is curved.

The excavation of the sternpost revealed a wrought iron gudgeon 44 inches (111.8 cm) below the eroded top of the sternpost, but the bottom of the sternpost was not located. It is believed that the bottom of the sternpost and the top of the keel are located around 12 inches (30.5 cm) deeper in the sediment. The gudgeon's arms are 2.5 inches (6.3 cm) wide, and its inner diameter to accept the pintle is around 1.5 inches (3.8 cm).

Another unique feature of this vessel's stern assembly was small sheet-lead patches, or "tingles," that were secured over the stern hood ends of the outer hull planking to stop leaks. The patches, ranging from 1.57 to 1.96 inches (4–5 cm) wide and from 4.33 to 7.9 inches (11–20 cm) long, each have a center groove that was pushed into the sternpost and hull planking seam (at the bearding line). Tingles that had fallen away from the seam were recovered during the survey.[243]

[242] The only way to determine the pitch of the vessel is with further excavation.
[243] Tingles are typically found on vessels that are aging (and leaking). This type of repair is more efficient and less costly than recalking a vessel's seams.

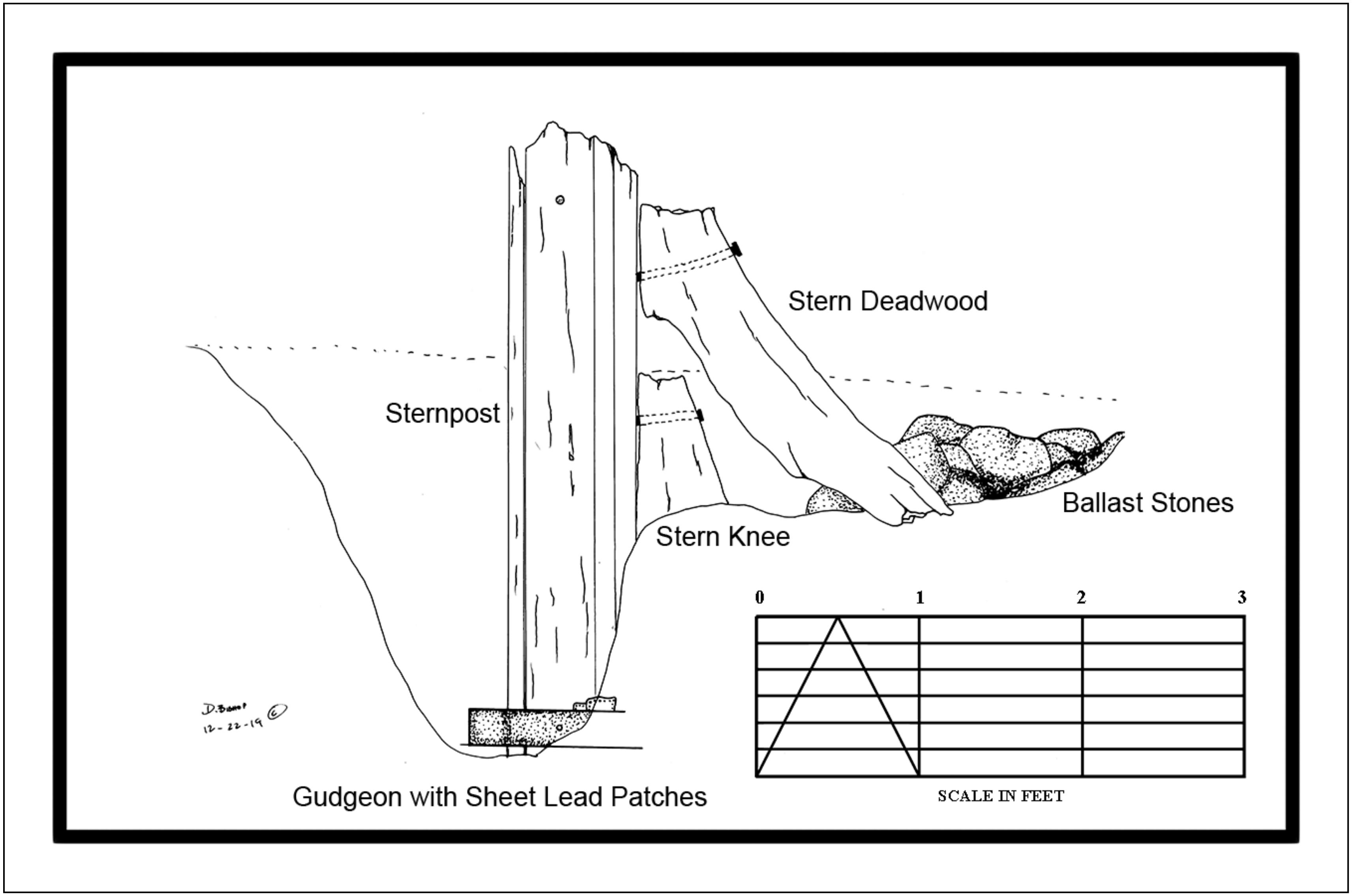

Figure 95 KS-1's stern assembly. (Drawn by author)

We did not extensively excavate inboard of the stern assembly. Less than a foot below the sediment line, we encountered ballast stones piled on top of the stern knee and possible deadwood. Only the top ten inches of the stern knee were exposed. The knee is roughly 6 inches (15.2 cm) sided and measures 7 inches (17.8 cm) at the lowest available molded dimension. It tapers to 3 inches (7.6 cm) molded at its top and was secured with a square drift bolt.

Above the knee, a peculiarly shaped timber was fastened to the sternpost with a 1-inch-diameter (2.5 cm) bolt (which was one of the few iron fasteners observed that had a circular cross-section). This timber is believed to be one of a number of deadwood components that was installed above the stern knee. Its remains are 31 inches (78.7 cm) long and roughly 4 inches (10.2 cm) in its molded and sided dimensions (it was quite eroded).

As mentioned, the keel on KS-1 was not observed because the excavation pits at the bow and stern did not go deep enough to reveal it. However, we can estimate its sided and molded dimensions from the stem and sternpost scantlings. The keel is estimated to be around 6 inches (15.2 cm) sided near the bow and tapers to 5 inches (12.7 cm) at the forward edge of the sternpost. Its molded dimension would have been at least 7 inches (17.8 cm) but is projected to be closer to 8 or 9 inches (20.3 or 22.9 cm).

Frames and Fasteners

The framing components were among the most noteworthy features of the two possible French-built vessels. Even though KS-2 is flat-bottomed and a completely different type of vessel than KS-1, it has nearly identical framing scantlings, spacing, and fasteners used to secure the frames to one another. This suggests that these two vessels were likely built by the same shipwright around the same time (possibly René-Nicholas Levasseur at Saint-Jean in 1758).

Because we did not excavate inboard inside KS-1 to a great extent, we do not know the construction of these frames beneath the sediment. Future archaeological work at this site should focus especially on these frames. From what we could record at the sediment line, we learned that every frame is fully articulated and laterally fastened. It is possible that these frame pairs were double framed, meaning that each floor's corresponding futtock may have additionally crossed the centerline of the vessel. What is certain, however, is that their components (at least all the futtocks) are fastened together and that the frames were likely pre-erected on the keel before the any planking was installed.

We recorded the tips of thirty frame pairs that stuck up out of the sediment along the starboard side of KS-1 (see Figure 96). Based on their spacing pattern, we believe that there were actually thirty-three to thirty-four frame pairs for this vessel—the additional three to four frame pairs were below the sediment line and thus unnoticed during the survey. We counted what we believed were four canted half frame pairs in the bow and possibly only one canted frame pair in the stern. I generated a basic and preliminary set of hull lines from the locations of the frame tips above the sediment and where a roughly 2-foot (0.6 m) section of a single frame's curve was recorded (15 feet [4.6 m] from the bow). See Figures 97 and 98 for the section curve and conjectural hull lines of KS-1.

The framing components in both vessels were fastened together using unusual 1-inch (2.5 cm) square double-clenched iron nails (see Figure 62). This fastener methodology, commonly recognized as being part of a Mediterranean building tradition,[244] adds to the speculation that KS-1 and KS-2 were French built. In addition, nearly all the other iron fasteners that were used in these vessels have square cross-sections, further supporting that these vessels were built in a different tradition than *Boscawen*, *Duke of Cumberland*, and the other British sloops.

[244] McCarthy, *Ships' Fastenings: From Sewn Boat to Steamship*, 81–82.

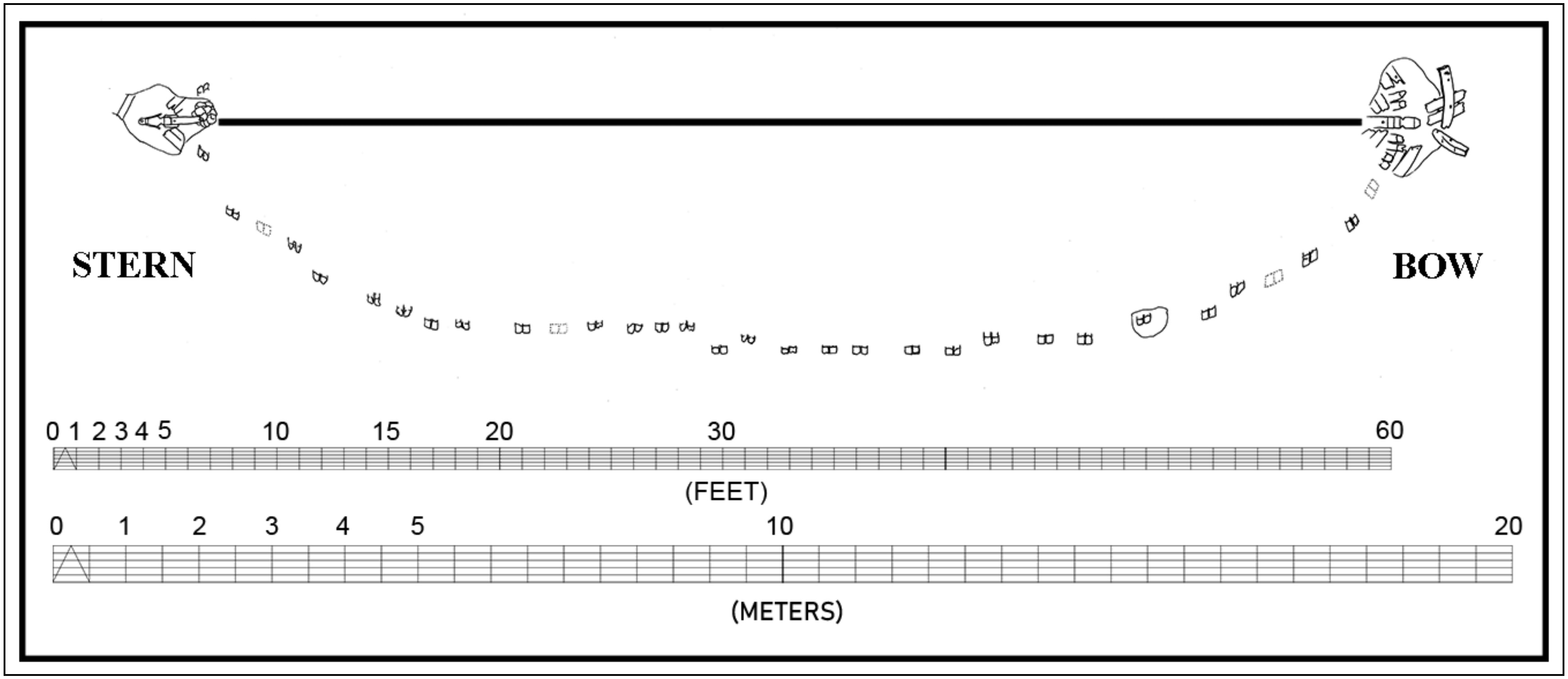

Figure 96 KS-1 site plan and frame tip locations. (Drawn by author)

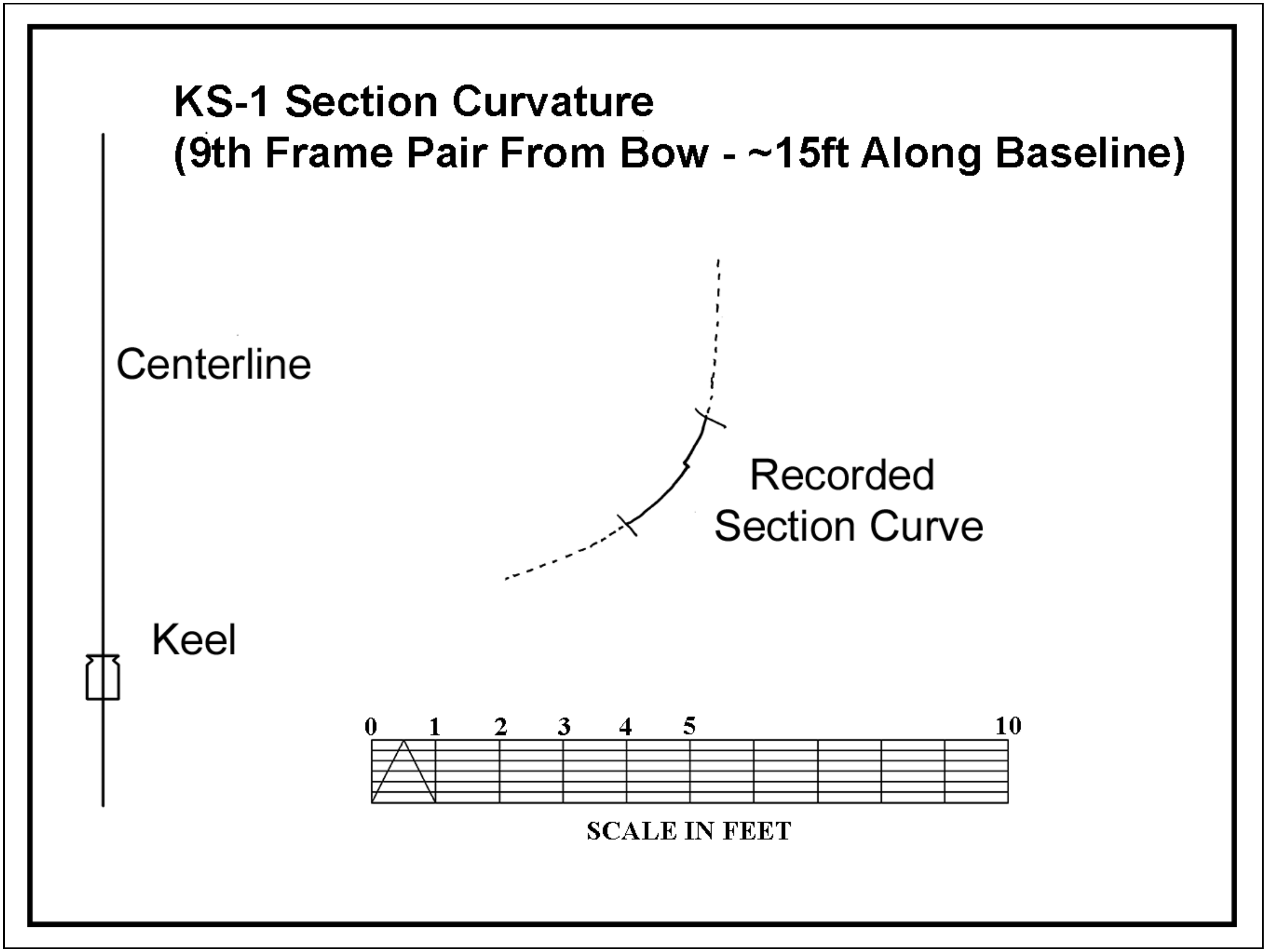

Figure 97 KS-1's recorded frame curvature. (Drawn by author)

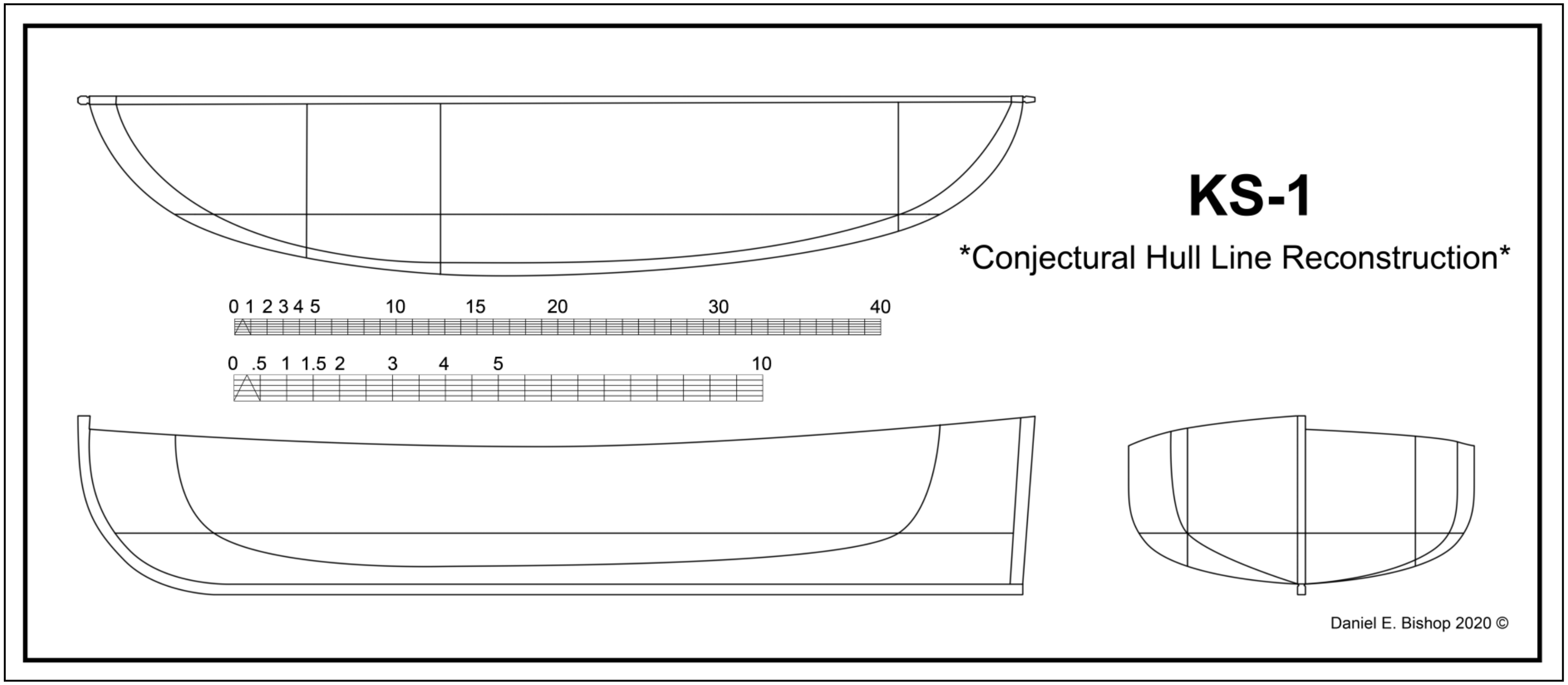

Figure 98 Conjectural reconstruction of KS-1's hull lines. (Drawn by author)

Each of these paired frames is spaced apart, on average, 13 to 14 inches (33–35.6 cm), and each of the framing components is 4 to 5 inches (10.2–12.7 cm) molded and sided. These framing scantling and spacing dimensions are nearly identical to those seen on KS-2 and correspond to the spacing of the mortises in the crenellated timber—another reason why we believe that particular timber fit over these frame pairs as a keelson or a longitudinal support.

Ceiling and External Hull Planking

Not many of the ceiling or hull planks of KS-1 were recorded, due to most of them being buried beneath the unexcavated sediment. However, for the planks that were recorded, we were able to determine an average thickness of 1.5 inches (3.8 cm) for external hull planks and 1 inch (2.5 cm) for ceiling planking. The widths of these few recorded timbers reveal another divergence from British construction, which is characterized by narrower planks and increased standardization. The recorded outer hull planks of KS-1 are around 7.5 inches (19 cm) wide, and the two ceiling planks that were measured near the bow are 4 inches and 7.5 inches (10.2 and 19.05 cm) wide.

Ballast

During our investigation of the KS-1 stern, we observed numerous ballast stones. It is unclear how many stones remain in the hull or how much ballast this vessel originally carried. When we uncovered the stones, we stopped our excavation of the stern's inboard portion. We did not want to disturb the ballast stones or any artifacts concealed within without taking datum-mapping measurements. This area should be a major priority for any future full-scale excavation of the site.

Tons Burthen and Potential Identity

Although we are, at this moment, unable to determine how much ballast may have been used on KS-1, there are a few other ways to determine vessel size and tons burthen. The principal dimensions of the wreck and a basic hypothetical reconstruction of the hull (generated from the frame tip locations and the stem and stern construction) can reveal important information about its original size and possible identity.

The length between the surviving ends of the sternpost and the stem is 57 feet (17.4 m). The maximum surviving beam of the wreck (between two of the widest frame tips, athwart ship) is around 20 feet (6.1 m). The reconstructed length, breadth, and depth of hold of KS-1 are 60 feet (18.3 m), 22 feet (6.7 m), and 5.5 feet (1.7 m), respectively. Using the same tons burthen equation as done previously, KS-1's tons burthen is calculated as 58 tons.[245]

Using these dimensions and calculated tons burthen, we can consider the vessel's potential identity. These measurements, along with other construction features like the diagnostic square clench bolts, suggest that this vessel is one of the three French sloops captured and raised by Loring and Grant in 1759. Because *Muskelongy*, the last Seven Years' War vessel to be used on Lake Champlain, was likely broken up closer to Saint-Jean (now St. Johns), KS-1 is believed to have been either *Brochette* or *Esturgeon*. All three small French sloops were estimated to be between 50 and 60 feet (15.2–18.3 m) long and to have a similar tonnage.[246] It should be noted that this preliminary identification is not definitive; only through further excavation will we be confident in matching a vessel type, nationality, and name to KS-1.

[245] KS-1's hypothetical length of keel for tonnage is calculated at 45.1 feet (13.7 m); its beam and depth of hold are estimated to be 22 feet (6.7 m) and 5.5 feet (1.7 m), respectively.
[246] Laramie, *By Wind and Iron*, 188.

Interpretation and Comparison of Shipbuilding Traditions

Boscawen and *Duke of Cumberland* appear to have been constructed with almost identical methods and timber scantlings. The only major perceived difference in their hulls is their length. This is unsurprising, as they were consecutively built by the same carpenters and master shipwrights at a singular location and were constructed under the guidance of Royal Navy Captain Joshua Loring. Both vessels have the same reconstructed breadths and a similar hull design. Together, these similarities contributed to my estimation that the vessels also had the same depth of hold.

Many elements of the brig and sloop's construction reveal the efficiency of the King's Shipyard shipwrights. Already having a basic hull plan and timber molds for *Duke of Cumberland*'s mould frames, Loring and his shipwrights likely considered the most logical and expedient way to build *Boscawen* was to build another *Duke of Cumberland*, but with a keel that was 20 feet (6.1 m) shorter.

This approach also seems to have been used to construct the three smaller British sloops from Lake George. The keels of CV-1, CV-2, and the Tuttle Sloop are believed to have been laid down in the same year and constructed under the direction of one shipwright (Colonel Nathaniel Meserve) at a singular location (the southern end of Lake George). Although the Tuttle Sloop is interpreted as being a slightly larger vessel than the other two, most of the timber scantlings and hull features are similar, if not identical.

The three British sloops on Lake George also share similarities with *Boscawen* and *Duke of Cumberland*, including relatively "simple" stem and stern constructions, robust framing scantlings relative to vessel size, framing patterns, and planking techniques.[247] The

[247] Additional comparative analysis is conducted on the framing components of these vessels in Chapter VI.

commonalities seen among the sets of British vessels on the two lakes, designed and built by different shipwrights, could be interpreted as British-specific shipbuilding methodologies.

These British shipbuilding techniques are not observed on the two possible French-built vessels surveyed in the King's Shipyard (see Figure 99 for a side-by-side cross-section framing comparison among KS-1/KS-2, *Boscawen* and *Duke of Cumberland*, and the Tuttle Sloop). The vessels, especially KS-1 and KS-2, appear to have been built to completely different standards than those constructed under the direction of Loring and Meserve. The most notable differences were that every frame was fully articulated and laterally fastened with square clench bolts, the room and space between framing timbers was consistent, and most of the framing timbers were of the same size and the observed planks had similar dimensions). This consistency suggests that more pre-planning went into the design and construction of KS-1 and KS-2 than the distinctly British colonial vessels on Lakes Champlain and George.

All these vessels were built, operated, and decommissioned within a span of five to seven years. They may have had relatively short careers, but all played important roles in the Champlain Valley campaigns of the Seven Years' War. These vessels' archaeological remains provide us with a better understanding of how shipwrights designed and constructed vessels for use on vital inland water highways in northeastern North America. It is important, however, to situate these vessels and their building strategies within a larger eighteenth-century context. The following chapter explores the vessel design, construction methodologies, and timber scantlings of twelve eighteenth-century shipwrecks (including *Boscawen*, *Duke of Cumberland*, and the Tuttle Sloop), and compare them to one another.

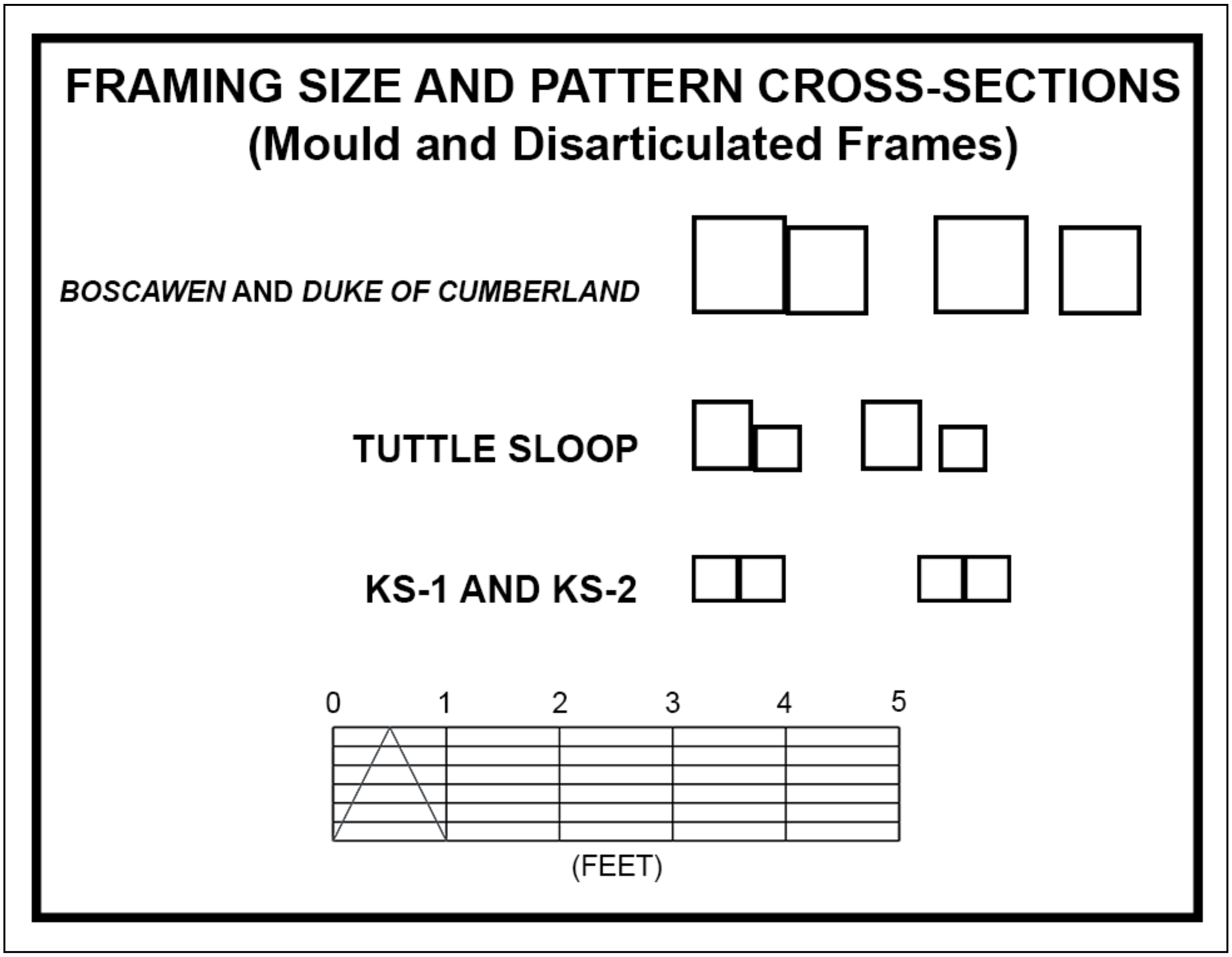

Figure 99 Framing size and pattern cross-section comparison (*Boscawen* and *Duke of Cumberland*, the Tuttle Sloop, and KS-1 and KS-2). (Drawn by author)

CHAPTER VI

BRITISH-AMERICAN FRAMING AND HULL DESIGN: EIGHTEENTH-CENTURY NORTHEASTERN NORTH AMERICA

The eighteenth century was a period of increased trade and intense conflict in both Europe and North America. Both trade and war, especially during the mid- and late-eighteenth century, were heavily influenced by the shipping industry and developments in shipbuilding. As France and Britain populated and vied for control over northeastern North America, shipbuilding strategies, and even the ships themselves, were brought into new geographic contexts and often acquired novel characteristics. Shipbuilders, utilizing different timber species, endeavored to design and build ships able to perform well within their specific environments, such as the Great Lakes and other inland bodies of fresh water or the harsh North Atlantic coast.

It is important to investigate all aspects of ship construction and outfitting (including planking, fasteners, and rigging), but the internal structures, particularly the frames, often reveal the most about a vessel's characteristics and intended use. Analyzing the frames of a vessel—their material, pattern, spacing, and measurements—can illuminate how shipwrights responded to material availability, conceived a vessel's design, and implemented a building sequence. With a large enough dataset, it is possible that an examination of framing strategies can also reveal larger trends in ship construction during a historical period.

Studies of eighteenth-century shipbuilding are complicated by the lack of archaeological information and syntheses of construction trends. Analyses based on limited archaeological data or on literary evidence alone can lead to misinterpretations and incorrect conclusions. This chapter examines the framing of twelve vessels built during the mid- and late eighteenth century in northeastern North America. These vessels include the Terence Bay Wreck, *Boscawen, Duke of Cumberland,* the Tuttle Sloop,[248] the Readers Point Wreck, NBHSS UAD SW#1 and #2,[249] the Phinney Site (*Diligent*), the privateer *Defence,* the Devereaux Cove Vessel, the World Trade Center (WTC) Wreck, and the schooner *Nancy* (see Table 6 for an overview of vessel dimensions and Table 7 for the molded and sided dimensions for floors and first futtocks).

Investigating vessels that originated from a defined geographical context can highlight regional characteristics of ship construction. Here, I examine how certain aspects of shipbuilding in northeastern North America, originally interpreted as methods used primarily to save time and material, may in fact be more than mere shipbuilding shortcuts. Rather, these techniques may represent foundational methods of ship construction significant to this region. But to begin, we must consider the historical context for shipbuilding in the American colonies in general.

[248] To avoid skewing the dataset, this chapter uses the Tuttle Sloop as a general representation of the three colonial Lake George sloops (i.e., the Tuttle Sloop, CV-1, and CV-2) because much of their information is comparable.
[249] These are the "New Bedford Harbor Superfund Site Unanticipated Discovery Shipwrecks" (NBHSS UAD SW#1 and #2) found in the Acushnet River, New Bedford, Massachusetts, in December 2018.

Table 6 Overview of Vessel Dimensions

Vessel Name	**Date Built**	**Location Built**	**Length of Keel***	**Vessel Length (overall)†**	**Vessel Breadth (overall)†**	**Length-to-Beam Ratio**	**Tons Burthen**
The Terence Bay Wreck	Pre-1750	New England/ Massachusetts	55 feet† (19.8 m)	70 feet† (21.3 m)	18 feet† (5.5 m)	3.9:1	100–120
Boscawen	1759	Lake Champlain	59.75 feet (18.2 m)	78 feet (23.8 m)	24.33 feet (7.4 m)	3.2:1	130
Duke of Cumberland	1759	Lake Champlain	80 feet (24.4 m)	100 feet (30.5 m)	24.33 feet (7.4 m)	4.1:1	185
The Tuttle Sloop	1756	Lake George	43.5 feet (13.3 m)	55 feet (16.8 m)	14 feet (4.3 m)	3.9:1	30
The Readers Point Wreck	Pre-1765	New England	42.5 feet (12.9 m)	60 feet (18.3 m)	18 feet (5.5 m)	3.3:1	70–100†
NBHSS UAD SW#1	Pre-1778	Massachusetts	56.6 feet (17.3 m)	70 feet (21.3 m)	22 feet (6.7 m)	3.2:1	100–110†
NBHSS UAD SW#2	Pre-1778	Massachusetts	50.4 (15.4 m)	60 feet (18.3 m)	18 feet (5.5 m)	3.3:1	90–100†
The Phinney Site (*Diligent*)	1776	Boston	79 feet (24.1 m)	100 feet† (30.5 m)	24.67 feet (7.5 m)	4:1	220–236†
Defence	1779	Massachusetts	65 feet† (19.8 m)	85 feet† (25.9 m)	24 feet† (7.3 m)	3.5:1	170
The Devereaux Cove Vessel	Pre-1779	New England	45.5 feet† (13.9 m)	60 feet† (18.3 m)	18 feet† (5.5 m)	3.3:1	>80
The WTC Wreck	Pre-1785	New England	45 feet† (13.7 m)	60 feet† (18.3 m)	20 feet† (6.1 m)	3:1	~80
Nancy	1789	Lake Ontario	59.75 feet (18.2 m)	~78 feet† (23.8 m)	~24 feet† (7.3 m)	3.2:1	100–120

* Length of Keel is the full length of the keel timber(s).
† Value is more heavily estimated (based on the remaining archaeological evidence or on historical documentation).

Table 7 Molded and Sided Dimensions of Floors and Futtocks

Vessel Name	Floors (molded range)	Floors (molded avg.)	Floors (sided range)	Floors (sided avg.)	Floors (molded-to-sided ratio, taken from individual floors)	First Futtocks (molded range)	First Futtocks (molded avg.)	First Futtocks (sided range)	First Futtocks (sided avg.)	Futtocks (molded-to-sided ratio, taken from individual futtocks)
The Terence Bay Wreck	—	6 inches (15.2 cm)	—	8 inches (20.3 cm)	0.75:1*	—	5 inches* (12.7 cm)	—	7 inches* (17.8 cm)	0.71:1
Boscawen	8–15 inches (20.3–38.1 cm)	10.65 inches (27 cm)	7–12.5 inches (17.8–31.7 cm)	9.92 inches (25.2 cm)	1.07:1	8–10.5 inches (20.32–26.67 cm)	9.63 inches (24.5 cm)	6–10 inches (15.24–25.4 cm)	8.26 inches (21 cm)	1.16:1
Duke of Cumberland†	8–15 inches (20.3–38.1 cm)	10.65 inches (27.05 cm)	7–12.5 inches (17.8–31.7 cm)	9.92 inches (25.2 cm)	1.07:1	8–10.5 inches (20.32–26.67 cm)	9.63 inches (24.5 cm)	6–10 inches (15.2–25.4 cm)	8.26 inches (21 cm)	1.16:1
The Tuttle Sloop‡	—	7.5 inches (19 cm)	6–7 inches (15.2–17.8 cm)	6.5 inches (16.5 cm)	1.15:1	4–5 inches (10.16–12.7 cm)	5 inches (12.7 cm)	5–6 inches (12.7–15.2 cm)	5 inches (12.7 cm)	~1:1*
The Readers Point Wreck	8.5–13.5 inches (21.5–34.3 cm)	10 inches (25.4 cm)	7.25-12.25 inches (18.5–31 cm)	9.5 inches (24.1 cm)	1.05:1	6–10.5 inches (15.3–26.6 cm)	8.25 inches (21 cm)	7.25–10.4 inches (18.4–26.4 cm)	8.8 inches (22.3 cm)	~0.94:1*
NBHSS UAD SW#1	—	9.4 inches (23.9 cm)	6.7–10.2 inches (17–25.9 cm)	8.45 inches (21.5 cm)	1.14:1	8–9.5 inches (20.3–24.1 cm)	8.75 inches (22.2 cm)	5–9 inches (12.7–22.9 cm)	7 inches (17.8 cm)	1.25:1
NBHSS UAD SW#2	7.9–12.6 inches (20.1–32 cm)	10.25 inches (26 cm)	5.9–9.1 inches (15–23.1 cm)	7.5 inches (19.1 cm)	1.35:1	4.7–6.3 inches (11.9–16 cm)	5.5 inches (14 cm)	6.3–7.9 inches (16–20.1 cm)	7.1 inches (18 cm)	0.77:1*
Phinney Site (*Diligent*)	—	7.87 inches (20 cm)	—	9.45 inches (24 cm)	0.83:1*	—	7.87 inches (20 cm)	—	8.2 inches (21 cm)	0.96:1*
Defence	9–15 inches (22.9–38.1 cm)	12 inches (30.5 cm)	—	8 inches* (20.3 cm)	1.5:1	—	8 inches (20.3 cm)	—	8 inches (20.3 cm)	1:1
The Devereaux Cove Vessel	—	5 inches* (12.7 cm)	10.5–11.5 inches (26.7–29.2 cm)	11.25 inches (28.6 cm)	0.44:1*	—	5.5 inches* (14 cm)	10.5–11.75 inches (26.7–29.8 cm)	10.75 inches (27.3 cm)	0.51:1*
The WTC Wreck	4.5–6.4 inches (11.4–16.2 cm)	5.5 inches (14 cm)	4.5-6.4 inches (11.4–16.2 cm)	5.75 inches (14.6 cm)	1:1	—	5.2 inches (13.2 cm)	—	5.2 inches (13.2 cm)	1:1
Nancy	7.5–9 inches (19–22.9 cm)	8.25 inches (21 cm)	8–9 inches (20.3–22.9 cm)	8.5 inches (21.6 cm)	1:1	8 inches (20.3 cm)	8 inches (20.3 cm)	8 inches (20.3 cm)	8 inches (20.3 cm)	1:1

* Value skewed by lack of timber preservation/reporting.
† *Duke of Cumberland*'s framing scantlings are duplicated from *Boscawen* (because the molded and sided dimensions of the framing components along the centerline were unobservable).
‡ The Tuttle Sloop's framing scantling are a combination of the data derived from the photogrammetry point cloud and the CV-1 and CV-2 sites (because the molded and sided dimensions of the framing components along the centerline were unobservable).

Eighteenth-Century Shipbuilding in the British Colonies

In the seventeenth and eighteenth centuries, Britain's northern and southern colonies on the eastern seaboard of North America differed in their shipping industries. The South boomed with raw materials and cash crops and quickly became a locus for European merchants, especially the British and French. On the other hand, the northern colonies dominated the fishing and timber trade. They established their own routes to the West Indies and capitalized on trade among the other American colonies.[250] During this time, northern colonial shipbuilders took advantage of the abundant supply of timber and iron ore within their regions.[251]

This vast, ready supply of timber allowed colonial builders to construct vessels in less time than their British counterparts. In doing so, they often used green, unseasoned wood, which caused their vessels to deteriorate faster.[252] This lower standard of timber usage in the colonies ultimately caused the British Royal Navy Board to prefer warships built in the British Isles. However, the naval preference for home-built ships did not stop British merchants from using economical colonial-built vessels. England's chronic timber shortages in the eighteenth century induced the Navy Board to recognize the benefits of using colonial forests for warship construction.[253]

Due to the prejudice against colonial American-built vessels, most Royal Navy warships were constructed at shipyards in England, a division that reinforced the separation of British and colonial shipbuilding practices. The most significant difference was that the colonies had fewer

[250] Davis, *The Rise of the English Shipping Industry*, 267–269, 291; Goldenberg, *Shipbuilding*, 30.
[251] White and red oak were the primary hardwoods utilized in eighteenth-century shipbuilding, but other species such as pine, maple, beech, and birch were used as well. VanHorn, "Eighteenth-Century Colonial American Merchant Ship Construction," 13–14.
[252] Goldenberg, *Shipbuilding*, 31–33, 57, 71; Gwyn, "Shipbuilding for the Royal Navy," 22–23.
[253] Albion, *Forests and Seapower*; Knight, "New England Forests." The timber problem in England was partially alleviated with the colonial timber trade, but the British still preferred either their own or Baltic sources over American forests.

regulations and training requirements for their shipwrights.[254] The majority of vessels built in colonial America were merchant ships constructed in private shipyards. Most of the later colonial shipwrights acquired training and learned construction practices in these private yards,[255] allowing for certain construction methodologies to become established in colonial shipbuilding.

Colonial Shipbuilding and Shipwrights: Royal Navy versus Private Yards

Royal Navy dockyards in the eighteenth century were individually much larger and employed many more carpenters than the private yards of colonial America, even though only six major yards operated in England during this time. On the other hand, there were hundreds of private yards in England—as well as in the colonies where inexpensive land allowed a shipwright to afford a private yard. Colonial shipwrights did not require the immense facilities like the naval yards in England in order to begin building their own vessels—all they needed was a parcel of shoreline and their shipwright's tools.[256]

Royal yards were known for producing well-built vessels (typically warships) but were notorious for long building times and being more expensive due to wood availability. Private yards, whether colonial or in Britain, primarily built merchant vessels and were in constant commercial competition with one another. Vessels produced from these yards were typically built quickly and often with lower-quality materials. Many of the craftsmen in private yards in England moved from yard to yard in search of work because the demand for skilled labor was low, especially in the early eighteenth century.[257]

[254] Goldenberg, *Shipbuilding*, 54–61.
[255] VanHorn, "Eighteenth-Century Colonial American Merchant Ship Construction," 19–23.
[256] Goldenberg, *Shipbuilding*, 69.
[257] Goldenberg, *Shipbuilding*, 54–55.

In England, master shipwrights relied on and often exploited apprentices for physical labor. Compared with private yards, royal dockyards relied heavily on unskilled laborers who were often put to work sawing timbers by hand, since sawmills were rare in England until the late eighteenth century. In the colonies, however, the demand for skilled labor meant that apprenticeships were less common and their terms not as formal as those in England. Many of these colonial apprenticeships were in the form of indentured servitude for three to eight years, or sometimes until the apprentice turned twenty-one years old. Shipbuilding in the northern colonies tended to be a familial affair; records indicate that some of these occupational dynasties extended over five generations. This was not the case in the southern colonies, where sons of shipwrights did not always continue in the family trade. In colonial America, shipwrights and yard owners could buy labor (either indentured servants or slaves) to offset an increased demand for workers, but due to the higher costs of purchasing a slave, only wealthy yard owners could afford this type of labor.[258]

The number of workers in a shipyard fluctuated greatly over the course of a vessel's construction, and employment as a carpenter was never static due to the different tasks needed to be completed at any given time. For instance, master shipwrights occasionally hired sawyers to cut more complex timbers that the sawmill could not. After that job was finished, the sawyers moved on. Also, the work was highly seasonal, especially at northern dockyards. Carpenters, shipwrights, and other yard workers knew this and often sought employment in multiple yards at the same time.[259]

Colonial American shipwrights, unlike their English counterparts, also had greater opportunities to advance economically, socially, and politically. This is likely due to the wider

[258] Goldenberg, *Shipbuilding*, 56–59, 75, 68.
[259] Goldenberg, *Shipbuilding*, 71.

opportunities available to them in the colonies, as well as their central role in the maritime economy and their ties to wealthy mercantile families.[260] These merchant family connections helped shipwrights gain steady work, leading to even more prominence in the community.

Local merchants often engaged a colonial shipwright to build a vessel under contract. The merchants supplied or at least guaranteed funds and sometimes materials at the beginning of construction. They also occasionally took on the responsibility of finding tradesmen to provide materials and manufacture elements needed for building and fitting a vessel.

Merchants requiring a new ship typically supplied the shipwright with the principal dimensions of the intended vessel, the type of rig required for the vessel's operation, and specified whether the vessel was to have a "plain" or "elaborate" finish. The shipwright largely dictated the hull design and the construction method, but there were exceptions to this on occasion.[261]

Shipwrights were usually paid with a combination of currency and mercantile goods. This system could lead to disagreements with merchant owners if they tried to offload unsold/spoiled goods to the builders. After an initial payment and the vessel's size and type were agreed upon, the merchant and shipwright signed a basic contract.

Colonial American shipwrights built mostly merchant vessels, and many of these were smaller hulls rigged as sloops, schooners, brigs, and snows. If vessels built in private yards were intended for naval careers, they often shared many hull characteristics with their commercial counterparts, especially in their ability to transport large quantities of supplies.

[260] Goldenberg, *Shipbuilding*, 76.
[261] Goldenberg, *Shipbuilding*, 82.

French Shipbuilding in Colonial Canada

To understand colonial shipbuilding more fully, we must also consider colonial French shipwrights and shipbuilding practices in New France. According to Réal Brisson, a historian of colonial New France, it was not until the latter half of the seventeenth century that craftsmen began to identify themselves as "ship carpenters."[262] In fact, only six French carpenters specifically known for shipbuilding emigrated to New France in the seventeenth century.[263] By the eighteenth century, the numerous French terms that had earlier been used to describe the people who built vessels and other wooden structures[264] were consolidated in French texts, but the distinction between "carpenter" and "builder" (and a master craftsman of either type) and, importantly, the term *charpentier de navires* (shipwright) were retained.[265]

By the early 1700s, carpenters in New France seem to have acquired enough skills—through direct training, as a result of experiences with skilled craftsmen from Europe, or because they were spurred on by competition—to fill the needs of their local economy. At this time, most of the carpenters in New France were building only small vernacular craft to navigate inland waterways and for use in coastal fishing.[266] Many vessels used in Canada, especially in the seventeenth and early eighteenth centuries were sent from France to Canada as kits or in parts

[262] Brisson, "Les 100 premières années," 14–15. (Original Text: Il faut attendre la deuxième moitié du XVIIe siècle pour identifier les premiers artisans à pratiquer la charpenterie navale en Nouvelle-France. Auparavant, pas un seul artisan canadien ne se réclame de cette profession).
[263] Brisson, "Les 100 premières années," 17.
[264] Some of the various terms used were: *charpentier de bâtiments* (building/vessel carpenter); *charpentier de navires* (ship carpenter/shipwright); *charpentier de navires et de maisons* (carpenter of ships and houses); *charpentiers de barques* (boat carpenters); *charpentier de chaloupes* (small boat/rowboat carpenter); and *charpentier de vaisseaux* (vessel carpenter). Brisson, "Les 100 premières années," 51–52.
[265] Brisson, "Les 100 premières années," 52–53.
[266] Brisson, "Les 100 premières années," 54–55. Many of these vessels were specialized, flat-bottomed work boats.

that were ready to assemble. These types of craft were easier to assemble with untrained and unskilled labor than a typical scratch-built vessel.[267]

By the early eighteenth century, prominent shipbuilding families began to emerge as knowledge and contracts were passed from generation to generation. These families, like those of the northeastern British colonies, began to establish monopolies on both shipbuilding knowledge and skilled workers. There were no shipbuilding trade schools in Canada like there were in France. Instead, carpenters relied on familial education and apprenticeships to gain shipbuilding knowledge.[268] The permanent royal shipyard established at Quebec in 1739, however, did provide more formalized training for shipwrights and a more diverse demand for vessels.[269]

There are many parallels between French Canadian and British colonial shipbuilding in North America. The great demand for labor in Canada meant that the cost of hiring a carpenter or shipwright was much higher than in France. In addition, Canadian shipwrights and carpenters were expected to have a more diverse set of skills (including caulking, patching, fairing, etc.) than their French counterparts, because specialized tasks relating to ship construction had yet to be established as separate jobs in the colonies.[270] Like its counterpart in the British colonies, shipbuilding in Canada was highly seasonal and somewhat unstable: a carpenter could rarely count on a six-day work week, and few vessels were built during the winter months.

During the eighteenth century, the private shipbuilding sector far outpaced royal shipyard production. Between 1739 and 1759, royal shipyards in Canada constructed 15 warships (around

[267] Brisson, "Les 100 premières années," 205. The explorer La Salle's *La Belle* was one such vessel intended to be sent in pieces across the Atlantic in the hull of *Le Joly* and assembled later, but ended up being constructed in France. Bruseth and Turner, *From a Watery Grave*, 73. The remains of *La Belle* were discovered in the mid-1990s, and Texas A&M University's Conservation Research Laboratory conserved the entire hull and all of its artifacts.
[268] Brisson, "Les 100 premières années," 104. The only issue with these modes of knowledge transmission is that they are more difficult to track down in the historical texts and are often not recorded in the first place.
[269] Brisson, "Les 100 premières années," 105.
[270] Brisson, "Les 100 premières années," 168.

6,500 tons combined), while twenty years earlier (1722–1742), private yards produced 115 vessels (for a total of 11,500 tons).[271] Even though private yards were building more vessels, wartime often slowed their production. Royal dockyards (especially during the eighteenth century) were therefore considered to provide more stable employment for Canadian carpenters and shipwrights.[272]

As the eighteenth century progressed, shipyards and the maritime industry in Canada saw an increase in professionalism. With Canadian literacy on the rise, shipbuilding knowledge could more easily be shared, which in turn led to slightly higher professional success. In addition, Canadian carpenters began to standardize some of their methods for sourcing timber and construction. Between 1720 and 1740, carpenters started using jigs to represent hull curvatures and dimensions. These jigs not only helped carpenters and shipwrights construct frame sections in the shipyard but also aided them in identifying the best compass timber in the forest for a particular vessel and contract.[273]

Distinct trends and transitions in Canadian shipbuilding are evident over the seventeenth and eighteenth centuries. In the seventeenth century, shipbuilding was isolated and sporadic, and the vessel types that were constructed suggest the lack of specialized shipbuilding knowledge.[274] As the eighteenth century progressed, Canadian shipbuilding began to take on traits and practices from the outside world, especially as more shipwrights migrated from France to Canada and brought about increased professionalism.

The Anglo–French conflicts of the mid-eighteenth century shaped New France and the northern British colonies. Not only did wartime affect the balance between royal and private

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[271] Brisson, "Les 100 premières années," 179–181.
[272] Brisson, "Les 100 premières années," 182.
[273] Brisson, "Les 100 premières années," 212.
[274] Brisson, "Les 100 premières années," 54–55.

shipyard production but it also brought about more standardized shipbuilding methodologies. As both Canadian and British colonists became more literate, some had access to another form of shipbuilding knowledge: treatises. The increased literacy rate, however, did not necessarily mean that all colonial shipwrights and carpenters read these works.

Eighteenth-Century Shipbuilding Treatises and Other Literary Evidence

The question of whether eighteenth-century shipbuilding treatises were widely distributed and consulted by shipwrights has been debated among scholars.[275] Although a few colonial American shipwrights assuredly had access to the more popular English treatises, most of these craftsmen likely relied on shipbuilding knowledge acquired from past employers and from the projects they worked on.

A shipwright under contract by a merchant needed to draft plans after being informed of the vessel's intended size. The complexity of plans varied dramatically, from basic sketches with approximate frame stations to more extensive ship plans with precisely calculated curvatures. Treatises of the eighteenth century largely documented the basics of hull design, focusing on two methods of frame design, rather than on construction techniques.

Two primary methods (besides the "by eye" method) were used to design frame stations for a vessel during the eighteenth century. The shapes of frames designed on paper were dictated by either the sweep or the whole molding methods. The sweep method utilized arcs from circles (radii of varying sizes along the length of the hull, working out from the midship section) to create proper hull shape. The frame shapes worked out on paper were then expanded to full scale and used to generate each frame individually.

[275] Goldenberg, *Shipbuilding*, 86.

The whole molding method also began with the midship section (which was typically drawn with a series of sweeps). The shipwright then created a full-sized two-piece mold to replicate the station shape. This process was repeated for other section shapes over the length of the hull. The whole molding method was less accurate than using drafted lines but was considerably faster, as the molds could be created at the shipyard for use. Shipwrights kept these molds for future contracts and used them for reference rather than relying on the methods described in shipbuilding treatises, a practice that perpetuated the hoarding of shipbuilding knowledge at this time. Shipwrights and yards guarded their building techniques and traditions and were often hesitant to change what they considered dependable designs.

William Sutherland wrote some of the earliest and most important treatises on ship design and construction during the eighteenth century, his most well known being *The Ship-builders Assistant*, published in 1711 (reprinted in 1726). This treatise included essays on five topics: physics, regulation of timber pricing, ship construction, calculating tonnage, and the proportions of rigging elements.

In addition to working as a master carpenter and inspector for a royal dockyard, Sutherland came from a long line of shipwrights and carpenters. His main goal in writing this treatise was to provide young, inexperienced carpenters with the knowledge to design and build vessels. Although his work was not intended for more experienced shipwrights, he wanted his essays to be useful to others involved in the construction of a vessel; thus, his essays also discuss elements of calculating vessel tonnage, pricing timber, and rigging.[276]

In his third essay, "Rules for Building the Hull of any Sort of Ships," Sutherland provided a general overview of the construction sequence for building ships and focused largely on framing. He explained that the keel was laid first, followed by the stem, apron, sternpost, and

[276] VanHorn, "Eighteenth-Century Colonial American Merchant Ship Construction," 44–45.

transom. The floors of the master (fully articulated) frames were then attached to the keel. Intermediate floors were installed after the master frame floors were properly aligned. Half frames (either square or canted frames located in the bow and stern) were added next. The notched keelson was fitted over and fastened through the floors with bolts. Futtocks and top timbers of the master frames were then installed, followed by a breadth ribband and wale for lateral support.[277]

Although Sutherland did not outline the subsequent steps in the building sequence, he did include some additional information on the spacing of frames. He recommended that framing timbers should be of similar dimension and spaced evenly to avoid timber imbalance. He also advocated having some space between the floors and lower futtocks to avoid timber rot.[278] Overall, this treatise sheds only a small amount of light on vessel construction of the period, likely due to its intended readership.

It was not until 1754 that the next shipbuilding treatise was published.[279] Similar to Sutherland's, Mungo Murray's treatise did not provide an in-depth description of the specifics of an entire vessel's construction. Rather, Murray focused more on the theoretical side of ship design and whole molding for framing.[280] He documented how he formed the frames first on paper, transferred the shapes to full-scale molds, and then used those molds to cut out the framing timbers. This process, along with the use of canted frames in the bow and stern, reduced the amount of compass timber needed to frame a vessel. This was particularly important in

[277] Sutherland, *The Ship-builders Assistant*, 25–28, and VanHorn, "Eighteenth-Century Colonial American Merchant Ship Construction," 45–47.
[278] Sutherland, *The Ship-builders Assistant*, 35, 39.
[279] Murray, *A Treatise on Ship-Building.*
[280] A large portion of Murray’s treatise discusses his thoughts on the geometric proportions of hull sections and his use of trigonometric calculations when designing hulls.

England because by this time, many naturally curved trees in the forests (especially the royal forests) had already been harvested or were set aside for other, important vessels.

The one aspect of framing methodology that Murray covered is how the floors were laid in first and attached to the keel. Next, the futtocks were fitted and laterally fastened to the floors. The remaining futtocks and top timbers were then fitted to the heels of floors and other corresponding futtocks (with no gaps between). This design and construction methodology is quite different from Sutherland's.[281]

The next major treatise on shipbuilding was Marmaduke Stalkartt's *Naval Architecture: Or the Rudiments and Rules of Ship-building* published in 1781. Stalkartt's treatise is largely a theoretical work (without practical testing) and illustrates how vessels of varying sizes were designed on paper.[282] The only significant elements of ship construction recommended in his treatise were that the canted frames should be fitted in the bow and stern (to provide strength at these areas), and that the first futtocks should butt against the keel.

Only a few other treatises were written in the eighteenth century; for the most part, these were not widely distributed (especially in the colonies) and they focused more on elements of seamanship and vessel operation rather than on ship design and construction.[283]

In addition to treatises, some of most detailed information on eighteenth-century English ship design and construction was written in 1737 by French shipwright Blaise Ollivier.[284] Ollivier documented the shipbuilding practices at the Woolwich and Deptford shipyards in England. He noticed that Woolwich shipwrights were constructing ships using a method of

[281] Murray, *A Treatise on Ship-Building*, 142–144, 164; VanHorn, "Eighteenth-Century Colonial American Merchant Ship Construction," 49–50.
[282] The primary design practice covered in this treatise was the use of sweep—where each of the vessel's frames were predrawn on paper.
[283] Hutchinson, *A Treatise of Naval Architecture* (1777); Chapman, *Architectura Navalis Mercatoria* (1768); Roberts, *The Shipbuilder's Repository, or a Treatise on Marine Architecture* (1788).
[284] Roberts, *18th Century Shipbuilding*. Blaise Ollivier's observations were never published during the eighteenth century.

master framing. However, after the floors were inserted and master frames were fully articulated (i.e., their framing components were laterally fastened), Ollivier observed that some shipwrights used a different method of installing first and third futtocks. These futtocks were fastened to one another (but not to their floors and second futtocks) and installed after most of the hull planking was added. This was primarily due to the tight spacing between floors. Ollivier criticized such tight framing and believed that English ships were overly built, expensive, and were "no more weatherly nor [would] sail any faster" than their previous ships.[285]

Overall, shipwrights in eighteenth-century North America had limited access to these shipbuilding treatises. The literacy rate in the American colonies during the mid-eighteenth century was around 60 percent. Even if shipwrights were to obtain and read a treatise, the information and techniques illustrated within could be outdated by the time a reprinted copy was obtained[286] (and as mentioned, many shipwrights would be hesitant to deviate from their own working methods). Sometimes, significant portions of the practical information on ship design were left out of a treatise. It is unknown whether this information was thought to be innate knowledge or whether it was omitted in an effort to hoard shipbuilding knowledge.

Although these treatises provide theoretical information surrounding ship design and construction in England, it is the tangible evidence of colonial shipbuilding resulting from archaeological investigations that reveals the actual techniques used by colonial shipwrights to design and build vessels.

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[285] Roberts, *18th Century Shipbuilding*, 66, 184; VanHorn, "Eighteenth-Century Colonial American Merchant Ship Construction," 59.
[286] VanHorn, "Eighteenth-Century Colonial American Merchant Ship Construction," 60.

Archaeological Examples of Northeastern North American-Built Vessels and Their Framing

The Terence Bay Wreck (Pre-1750)

Between 1980 and 1983, the Underwater Archaeology Society of Nova Scotia (UASNS) located and surveyed the remains of a schooner in Terence Bay, Halifax, Nova Scotia. Most of the survey was conducted by John Carter and Trevor Kenchington, who published a short article in the Society for Historical Archaeology's sixteenth conference proceedings.[287] This shipwreck was dated to the mid-eighteenth century using several artifacts removed from the site in the 1970s[288] and two English coins recovered during the survey. The UASNS spent around thirty-five days surveying the site. During this time, they conducted minimally invasive excavations only near main features and sections amidships. Most of the information on the vessel's construction was derived from the port side of the hull, as this was the only side preserved (see Figure 100 for the Terence Bay Wreck site plan). From these remains, the archaeologists estimated that the vessel was close to 70 feet (21.34 m) long. The artifacts and numerous fish bones recovered suggest that this vessel was a fishing schooner built in New England. Despite extensive colonial fishing activity in this region, the Terence Bay Wreck is still—nearly forty years after its discovery—the only mid-eighteenth-century fishing schooner located in Canadian waters. Hence, this vessel's remains are vital to understanding ship construction within this geographical and spatial context.

The Terence Bay Wreck's fifty-three recorded framing timbers were made of white oak.[289] Of these, only two of the frames were articulated; their components (floors, futtocks, and top timbers) were fastened laterally. These frames could have served as the master frames during

[287] Carter and Kenchington, "The Terence Bay Wreck."
[288] Recreational divers removed a bottle and two spoons. Carter and Kenchington, "The Terence Bay Wreck," 14–15.
[289] The authors did not clarify how many were futtocks. Carter and Kenchington, "The Terence Bay Wreck," 20.

the construction process. In her master's thesis, Kellie M. VanHorn argued that because only two were observed, it is unlikely that these articulated frames were mould or master frames.[290] However, it is possible that more of these laterally fastened frames were simply overlooked during the limited survey.[291] If this vessel was typical of its era, floors of the schooner were likely to be fastened to the keel with through-bolts. It is unfortunate that this could not be observed, as the keel was not preserved. The schooner's floors, of which only the port heads were observed, were 6 inches (15.24 cm) molded and 8 inches (20.32 cm) sided on average.[292]

The rest of the framing timbers were reported to be disarticulated and independently fastened to the outer hull planking. This finding demonstrates that the frames were installed after sufficient planking was attached. Many of the futtocks consisted of timbers too small and roughly shaped to be squared off and thus retained their natural, curved surfaces. The orientation of the first futtocks in relation to the floors (whether they were forward or aft of the floors) was not recorded during the survey.[293] The top timbers (above deck level) were approximately 5 inches (12.7 cm) molded and 7 inches (17.78 cm) sided. These top timbers formed the bulwark stanchions. Since the dimensions of the first futtocks were not reported, the dimensions of the top timbers were used in Table 7.

The Terence Bay Wreck also had canted stern frames. Both VanHorn and Carter and Kenchington remarked that these timbers deviated from the "typical cant frame pattern" because they "were placed at various angles away from the sternpost."[294] According to Carter and Kenchington's illustrated stern section, however, this does not appear to be the case. The canted

[290] VanHorn, "Eighteenth-Century Colonial American Merchant Ship Construction," 181.
[291] At times, the excavators could not distinguish between treenails and wood knots. Carter and Kenchington, "The Terence Bay Wreck," 17.
[292] Carter and Kenchington, "The Terence Bay Wreck," 16–17.
[293] If such regular orientation existed, it is unclear whether the pattern shifted near amidships.
[294] VanHorn, "Eighteenth-Century Colonial American Merchant Ship Construction," 81; Carter and Kenchington, "The Terence Bay Wreck," 17.

stern frames, while roughly hewn and deteriorated, reflect the typical pattern observed on other eighteenth-century vessels.[295]

VanHorn reported that the average space between the schooner's frames was 2 inches (5.08 cm).[296] I believe that this measurement represented the distance between the faces of futtocks and floors. For the purposes of this study, the distance between floors on center is approximated at 20 inches (50.8 cm) using VanHorn's measurement and the site plan.

[295] Morris et al., "The Comparative Analysis," 128–131.
[296] VanHorn, "Eighteenth-Century Colonial American Merchant Ship Construction," 81.

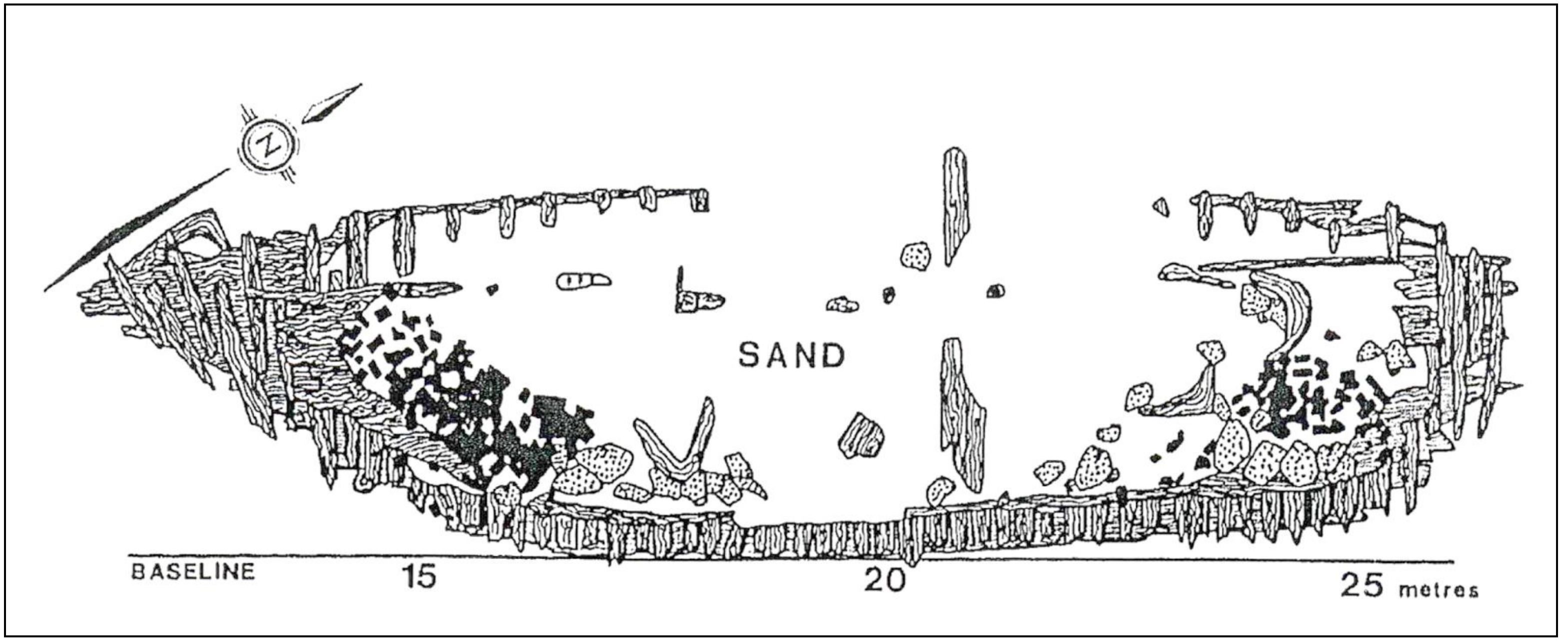

Figure 100 The Terence Bay Wreck site plan. (From Carter and Kenchington, "The Terence Bay Wreck," 16)

HM Sloop Boscawen *and* Duke of Cumberland *(1759)*[297]

Boscawen and *Duke of Cumberland* were built during the Seven Years' War as part of the British campaign to counter the French in the Champlain Valley. In an incredible feat of ship construction in the fall of 1759, the roughly 78-foot-long (23.77 m) sloop and 100-foot-long (30.48 m) brig, built under the direction of Royal Navy Captain Joshua Loring, were ready for action in less than three weeks. In 1984 and 1985, *Boscawen* was excavated and recorded (see Figure 101 for *Boscawen*'s site plan).[298] In 2018, I examined *Duke of Cumberland*'s design and construction using my historical photograph photogrammetry methodology. Because the two vessels share extremely similar construction features and timber scantlings, they are discussed together here.

[297] Information on *Boscawen* and *Duke of Cumberland*'s framing covered in Chapter V is presented again here to familiarize readers of their scantlings and construction features and to better situate the framing components in this comparative setting.
[298] Crisman, "The Construction of the *Boscawen*," 357–369.

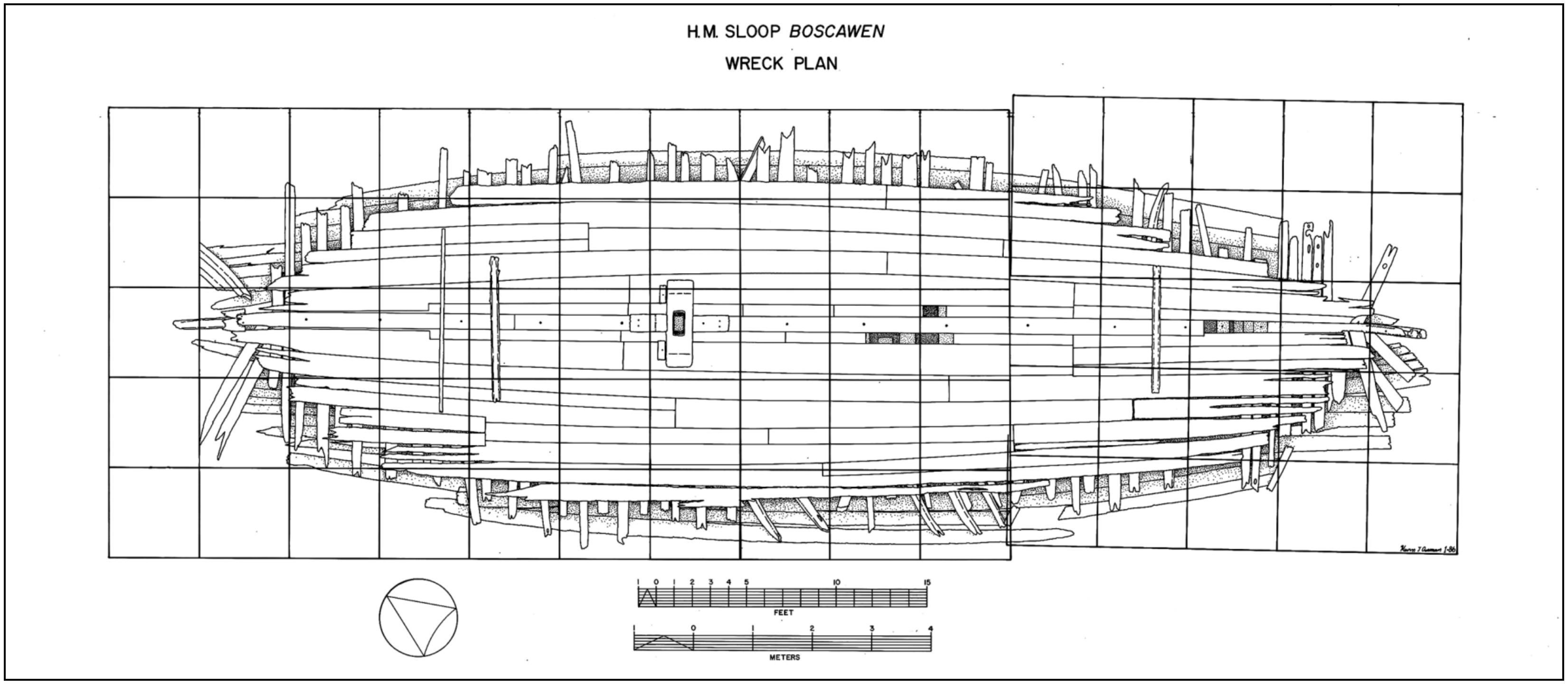

Figure 101 *Boscawen* site plan. (Drawn by Kevin Crisman)

Boscawen has two pairs of canted half frames and fillers in its bow, twenty-six square frames, and six half frames with fillers at its stern. The dimensions and spacing of the sloop's floors are irregular, a possible byproduct of hasty construction. Along the keel, the floors are spaced between 19.5 and 28.5 inches (49.53–72.39 cm) apart on their centers, averaging 25.75 inches (65.4 cm). The floors' molded dimensions range from 8 to 15 inches (20.32–38.1 cm), averaging around 10.5 inches (26.67 cm) at the keel. Their sided dimensions along the vessel's centerline are between 7 and 12.5 inches (31.75 cm), for an average of near 10 inches (25.4 cm). These floors narrow up to an inch (2.54 cm) in their sided dimensions and by roughly 5 inches (12.7 cm) in their molded dimensions over their 6-foot (1.83 m) arms. There is also evidence of the carpenters not "finishing," or square-cutting, *Boscawen*'s floors, leaving the rounded log surface and even bark on these timbers. This was likely done to save time during construction.

The futtocks also vary considerably in their spacing and dimensions. The bases of *Boscawen*'s first futtocks are 8 to 10.5 inches (20.32–26.67 cm) molded, for an average of 9.5 inches (24.13 cm), and are 6 to 10 inches (15.24–25.4 cm) sided, averaging between 8 and 9 inches (20.32–22.86 cm). These timbers narrow over their 9- to 10-foot (2.74–3.05 m) lengths up to 3 inches (7.62 cm) in their sided dimensions and upwards of 6 inches (15.24 cm) in their molded dimensions. For the non-mould frames, the futtocks and their corresponding floors have 1.5 to 6.5 inches (3.81–16.51 cm) between them, for an average of 4 inches (10.16 cm).

Futtocks typically do not cross a vessel's centerline or extend to be above the keel. Yet three futtock pairs at *Boscawen*'s ends breech the keel plane by a few inches (Frames 14, H, and I). This may have been done to better strengthen the sloop's ends (especially for the two bow futtocks, which nest into the apron) or, regarding the futtocks near the stern, it may have been an inconsequential oversight. All the other futtocks were installed outboard of the keel, anywhere between 1 and 11.5 inches (2.54–27.94 cm), for an average of around 7 inches (17.78 cm).

Only broken and fragmentary second futtocks remain on *Boscawen*. The surviving second futtocks have partial lengths of around 6 feet (1.83 m). They have average molded and sided dimensions of 7 to 8 inches (17.78–20.32 cm), which taper as they curve outboard and upward. The heels of the second futtocks were installed anywhere between 2 and 4 inches (5.08–10.16 cm) away from the heads of the floors. This gap could be evidence of a speedy build process but it might also have been planned in order to help internal framing timbers dry out if they ever got wet (see Figure 102 for an isometric illustration of *Boscawen*'s framing construction).

Boscawen's two canted half frames at its bow do not cross the keel; instead, they butt against the keelson and the forward-most floor. These two half frames are 5.5 to 7 inches (13.97–17.78 cm) molded and 6 to 8 inches (15.24–20.32 cm) sided. In the stern, *Boscawen* has six half frames that fit against that deadwood above the stern knee. These frames are canted slightly aft to accommodate the rising and narrowing of the stern. These timbers are between 7 and 8 inches (17.78–20.32 cm) molded and between 7 and 10 inches (17.78–25.4 cm) sided, with an average of 2 inches (5.08 cm) of space between them.

It is unfortunate that *Duke of Cumberland*'s framing components (especially its floors) are mostly hidden in the historical photographs beneath the ceiling planking. However, the visible elements of *Duke of Cumberland*'s frames appear to emulate the size, spacing, and patterns seen in *Boscawen*'s hull. The average dimensions of the visible floors recorded from the scale-constrained photogrammetry model are around 8 to 10 inches (20.32–25.4 cm) sided and molded. Master frames, canted bow and stern frames, and disarticulated futtocks all appear to be represented in Figures 7–15. It was difficult to ascertain *Duke of Cumberland*'s exact number of frames from the historical photographs, but by cross-referencing multiple images, thirty-five square frames and four to five canted bow and stern half frames are visible (see Figures 9–11, 13, and 15).

For both *Boscawen* and *Duke of Cumberland*, a 1-inch (2.54 cm) drift bolt was used to fasten the keelson, floor, and keel on every other floor. In *Boscawen*, however, the aft-most three floors were all fastened with such a bolt. After Frame H in *Boscawen*'s bow, every fourth frame is a master frame, or mould frame (for a total of six), and these were used to help dictate the shape of the hull. Of interest is that the bolting pattern skips these mould frames. Also, only one of the mould frames' floors on the port side (Frame 4) was noted by the 1980s archaeological team to be laterally fastened with a treenail to its corresponding first futtock.[299] The other mould frames' floors lack (or were not observed to have) floor-to-first futtock treenails.[300] However, each of the mould frames' first and second futtocks were laterally fastened together with treenails.[301] One aspect of the futtock placement that is consistent is where they were installed in relation to their floor: forward of the midship frame, futtocks were installed aft of their corresponding floor timber; aft of the midship frame, futtocks were placed forward of their associated floors. This consistency, however, is noticeable only for the mould frames.

[299] Only the framing components (their curves and scantlings) on the port side were recorded by the archaeological team. This was done because the vessel listed slightly to port, causing better preservation of the timbers there.
[300] Only one floor–futtock pair on the port side (Frame D) was noted as not having any lateral fasteners securing them together. The archaeologists did not record lateral fasteners among the remaining four mould frame pairs, but this does not mean that the pairs were not laterally fastened.
[301] These treenails were often left long, sometimes extending 6 inches (15.24 cm) out from their futtocks. Leaving treenails untrimmed like this saved carpenters time during the construction process.

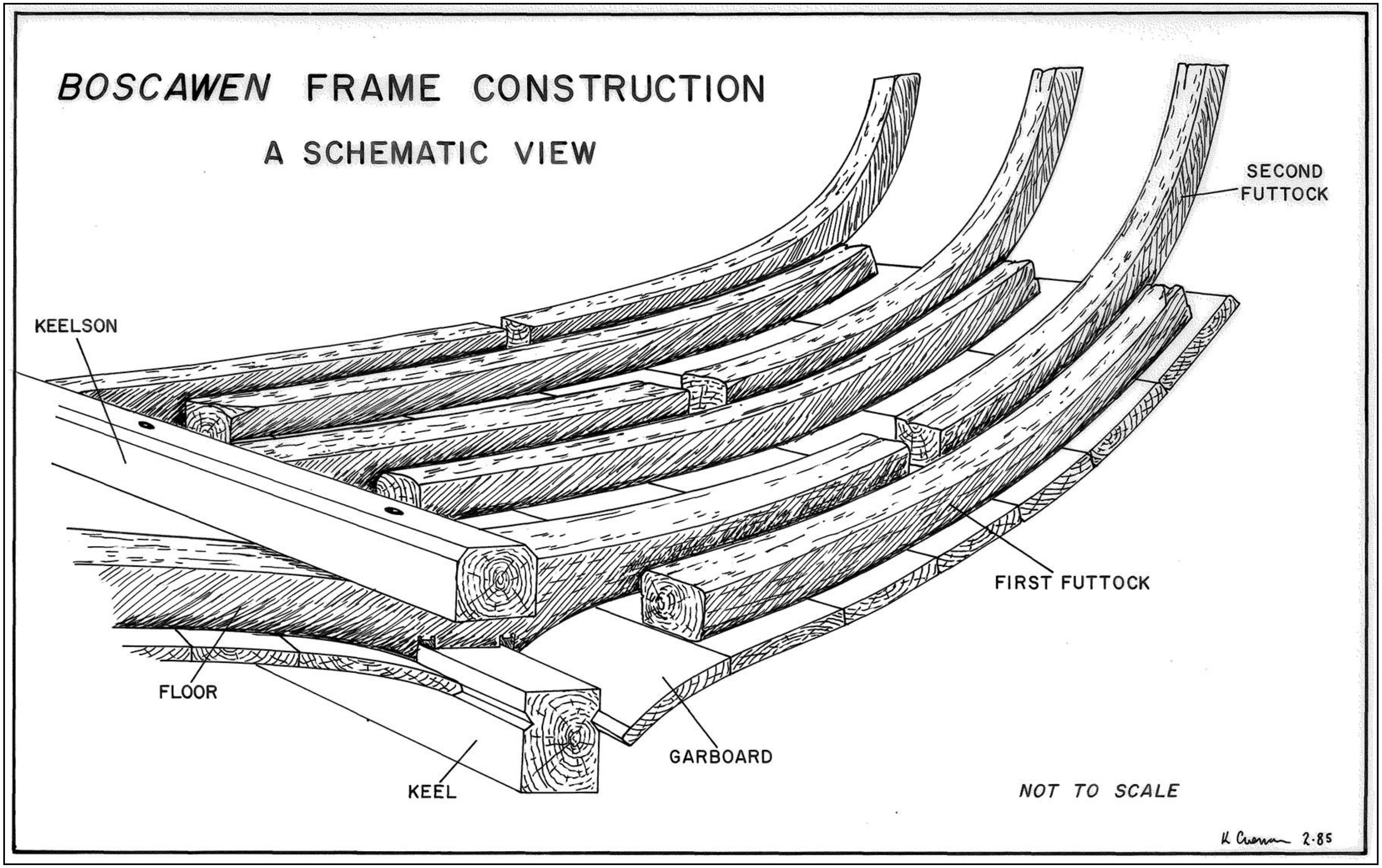

Figure 102 An isometric view of *Boscawen*'s frame construction. (Drawn by Kevin Crisman)

Being built on an inland lake, the frames of both the brig and sloop seem to be close enough to ensure a sturdy hull but wide enough to facilitate air circulation between framing components to counter rot. The framing methodology (i.e., disarticulated frame components fastened only to the hull) necessitated the installation of closer-spaced frames. The inconsistent spacing and dimensions and the lack of lateral fastening of *Boscawen*'s frames are thought to be indicative of the sloop's hasty construction.[302] This framing methodology must be compared to that of other vessels if we are to understand how it fits within a larger colonial shipbuilding tradition.

The Tuttle Sloop (1756)[303]

The Tuttle Sloop was likely one of the sloops used on Lake George during the Seven Years' War. It was raised in 1903 by William Tuttle and photographed by Albert N. Thompson and is presumed to have been burned in a beach-cleaning effort in the 1920s. In 2020, I used my historical photograph photogrammetry methodology on the surviving images to create a scale-constrained 3D point cloud of the vessel. Historical documents and the vessel's estimated tonnage and its association with the other two colonial sloops documented in Lake George in 1998 and 2000 lead us to believe that this vessel was the 30-ton sloop named *Earl of Loudoun*, launched in 1757.

Using the port side of the vessel,[304] the number of frames tallied around twenty-six, with three or four of them being stern half frames. No bow or stern canted half frames were observed

[302] Crisman, "The Construction of the Boscawen," 361; VanHorn, "Eighteenth-Century Colonial American Merchant Ship Construction," 131.
[303] The information on the Tuttle Sloop's framing components (seen in Chapter V) is presented again here to familiarize readers of their scantlings and construction features and to better situate them in this comparative setting.
[304] The port side was selected because the four photographs used to create the photogrammetric point cloud showed this side more clearly than the starboard side. Subsequently, the port side was also used to generate the hypothetical hull lines.

in the photographs. It is likely that they fell away (or were forcibly removed) when the sloop was raised. Because most of the external and ceiling planking survived up to the heads of the floors, it was more difficult to take measurements of those timbers specifically. Instead, much of the information on frame spacing is derived from the first futtocks.

The heads of the floors that were visible enough for recording were 6 to 7 inches (15.24 7.78 cm) sided and 4 to 5 inches (10.16–12.7 cm) molded at their heads. Frames were spaced around 18 inches (45.72 cm) apart on their centers, leaving 11.5 inches (29.21 cm) between them, on average. The first futtocks had sided dimensions between 5 and 6 inches (12.7–15.24 cm) and were 4 to 5 inches (10.16–12.7 cm) molded near their heads.

The Tuttle Sloop's pattern of framing echoes what is seen elsewhere in the eighteenth century: futtocks forward of midships were installed aft of their associated floors, and the futtocks aft of midships were installed forward of their associated floors. In Figures 16 and 17, eroded lateral treenail holes are visible toward the stern, and in Figure 18, we see three frames on the starboard side where floors and futtocks are laterally fastened with treenails. The pattern is hard to discern, but these articulated frames appear to be installed every fourth frame.

The Readers Point Wreck (Pre-1765)

In 1991 and 1992, Texas A&M University and the Institute of Nautical Archaeology conducted an underwater survey of St. Ann's Bay, Jamaica. During this survey, the archaeological team excavated test sections from the remains of an eighteenth-century sloop. Later, in 1994, archaeologists returned to conduct a full excavation and analysis of the sloop's artifacts and construction. The remains of the vessel suggest that this was a sloop around 60 feet

(18.28 m) in length and 18 feet (5.48 m) in breadth and could carry roughly 100 tons (see Figure 103 for the Readers Point Wreck site plan).[305]

Although the vessel's remains were discovered in Jamaica, the primary wood species used in the sloop's construction (white oak and maple) suggest that it was built in New England.[306] All of the framing components of the Readers Point Wreck were made from white oak. Of the twenty-three frames, nine were articulated and fastened together with treenails. These articulated frames were installed every second floor near the bow and stern (in the locations of greatest curvature) and every third floor near amidships. Each of the sloop's floors was fastened to the keel with a single iron drift bolt and had the dimensions of 8.5 to 13.5 inches (21.59–34.29 cm) molded and 7.25 to 12.25 inches (18.41–31.11 cm) sided.[307]

After the master frames and floors were installed, the first runs of strakes were added. First futtocks were then attached to the hull planking with treenails in between the floors and master frames. This alternating process of planking and futtock installation probably continued up to the sheer line of the vessel. Seventy-seven first and second futtocks were preserved from the sloop (forty-nine on the starboard side and twenty-eight on the port side). The first futtocks' dimensions ranged from 6 to 10.5 inches (15.24–26.67 cm) molded and from 7.25 to 10.4 inches (18.41–26.42 cm) sided. The second futtocks measured 3.6 to 8.5 inches (9.14–21.59 cm) molded and 4.75 to 8.75 inches (12.06–22.22 cm) sided.[308]

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[305] Its length-to-beam ratio is 3.3:1.

[306] Cook, "The Readers Point Vessel," 58–60. The observed timber repairs in the Readers Point Wreck were often made with tropical woods, pointing to its long career in the West Indies after being built in the northern American colonies.

[307] Cook, "The Readers Point Vessel," 51–52.

[308] Cook, "The Readers Point Vessel," 51–53; VanHorn, "Eighteenth-Century Colonial American Merchant Ship Construction," 87–8.

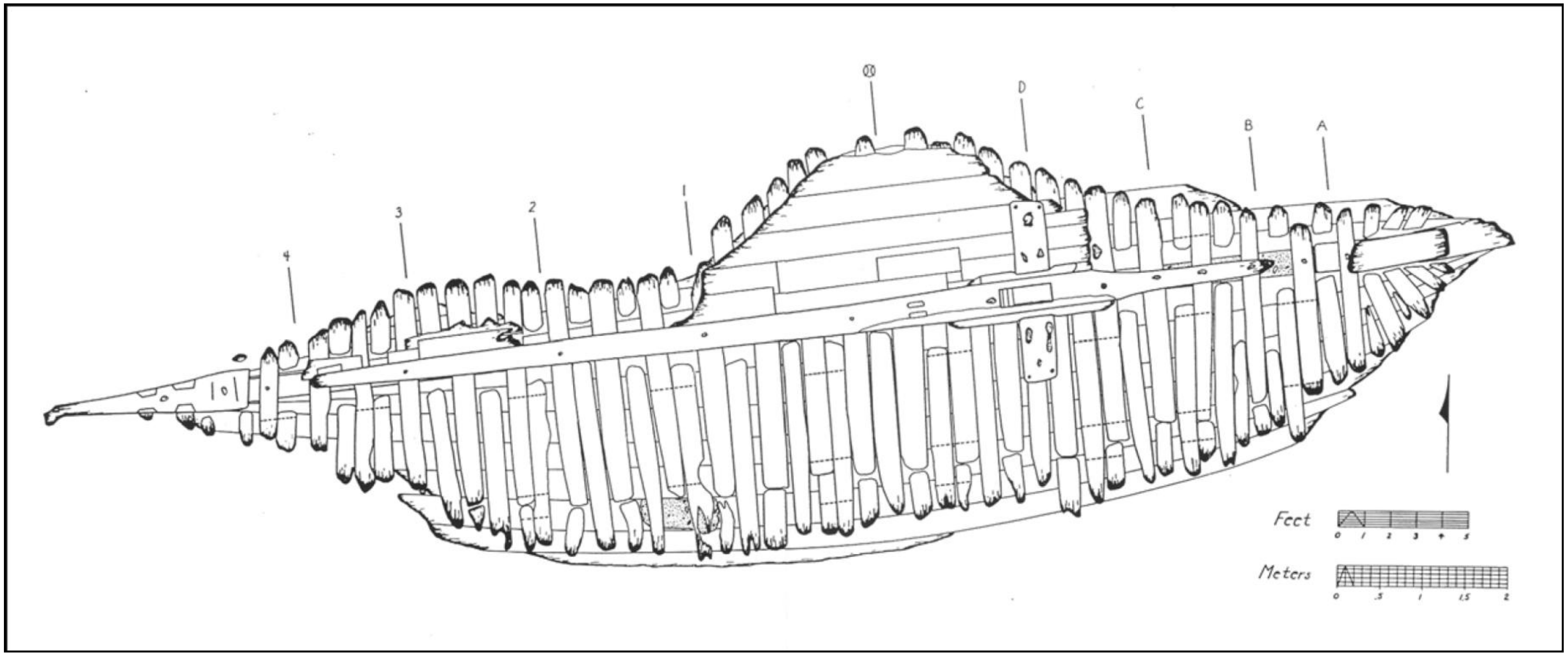

Figure 103 The Readers Point Wreck site plan. (From Cook, "The Readers Point Vessel," 107)

Framing was also observed in the bow and stern. The stern had poor preservation, preventing the recording of framing timbers. However, four notches in the sides of the stern knee suggest that half frames existed at one time. In the bow, nine of the original twelve canted frames were present (six on each side). These frames were fastened only to the outer hull planking (with treenails) and not butted against the stem's apron. Some of these cant frames were wedge-shaped to fit between adjacent frames.[309]

Like the floors in the Terence Bay Wreck, those of the Readers Point Wreck were spaced moderately close and were 22 inches (55.88 cm) apart on center. This provided around 2 to 3 inches (5.08–7.62 cm) of space between futtocks and floors. Forward of amidships, futtocks were installed aft of their respective floors.[310] This orientation reverses aft of the midships frame. The tight framing pattern can be observed in the site plan (Figure 103).

NBHSS UAD SW#1 (Pre-1778)

In 2009, during an underwater archaeological survey of the New Bedford Harbor Superfund Site (NBHSS), a number of eighteenth- and nineteenth-century vessels were discovered, documented, and removed as part of a predredge debris removal effort in the Acushnet River in New Bedford, Massachusetts. Most of the archaeological investigation and recording of these wrecks took place over nearly a decade, between 2009 and 2018, by archaeologist David S. Robinson. NBHSS Unanticipated Discovery Shipwreck #1 (NBHSS UAD SW#1) is believed to be one of the many eighteenth-century coastal traders that were

[309] Cook, "The Readers Point Vessel," 51.
[310] Cook, "The Readers Point Vessel," 51–53; VanHorn, "Eighteenth-Century Colonial American Merchant Ship Construction," 87–88.

burned by British forces during the 1778 attack on New Bedford Harbor, which included the upper Acushnet River.[311]

The remains of NBHSS UAD SW#1 suggest that it was originally around 70 feet (21.34 m) long with a 22-foot (6.7 m) beam, and had an estimated tons burthen of around 100 to 110 tons. Wood samples taken from various parts of the hull reveal that NBHSS UAD SW#1 was predominantly made of white oak, but its keel was made of hickory (see Figure 104 for a basic 3D reassembly of its major components).

Fifteen floors from the stern half of the vessel were surveyed and recovered. Using evidence from drift bolt locations on the keel (because every floor was observed to have been secured to the keel) and fastener markings on the garboard strakes, archaeologists estimated that the original number of floors would have been close to thirty. At the time of recording, the floors had an average molded dimension of 9.4 inches (23.88 cm) and ranged in their sided dimensions from 6.7 to 10.2 inches (17.02–25.91 cm) for an average of 8.2 inches (20.9 cm). The longest single floor timber arm recorded was 5.5 feet (1.68 m) long. The floors were spaced around 22 inches (55.88 cm) apart on their centers and had nearly 16 inches (40.64 cm) between them (where a futtock would be installed). The forward-most three floors (near amidships) all had bottom fillers, or chocks, that would increase the molded height of the floor closest to the keel.[312]

The slight diversity in the molded and sided dimensions of futtocks recovered from the site caused archaeologists to interpret these timbers as first, second, and third futtocks. The surviving lengths of these futtock remains were between 3.5 and 5.6 feet (1.07–1.71 m). The three groupings of futtock dimensions (interpreted as the three different types of futtocks) are as

[311] Robinson, "Marine Archaeological Documentation and Assessment," 33, 48.
[312] This would likely have been done to increase the structural strength of these timbers or to reduce the amount of curve needed in a floor timber (thereby reserving the more drastic compass timbers for the ends). Robinson, "Marine Archaeological Documentation and Assessment," 30–31.

follows: the largest futtocks (the first futtocks) were around 9.5 inches (24.13 cm) molded and 9 inches (22.86 cm) sided; the next-largest futtocks (the possible second futtocks) were 8 inches (20.32 cm) molded and 7 inches (17.78 cm) sided; the smallest and possible third futtocks were roughly 8.5 inches (21.59 cm) molded and 5 inches (12.7 cm) sided.[313]

In addition to the floors and their corresponding futtocks, archaeologists recorded three badly fragmented canted half frames near the bow. Not much data were recovered from these disarticulated timbers, which measured slightly over 2 feet (0.61 m) long.

Due to the fragmentary state of the hull remains, no definitive data were generated from the pattern or spacing of the framing components (particularly for the futtocks). Despite reporting otherwise, two floors have clear evidence of treenails and were originally laterally fastened to their corresponding first futtocks. Their locations along the keel suggest that mould frames were installed every fifth or sixth frame. Only a few of the smaller (interpreted as upper) futtocks had any evidence of these types of fastenings. This suggests that the builders used regular mould frames to dictate hull shape and installed intermediary frames as they planked the vessel.

[313] Robinson, "Marine Archaeological Documentation and Assessment," 30–31.

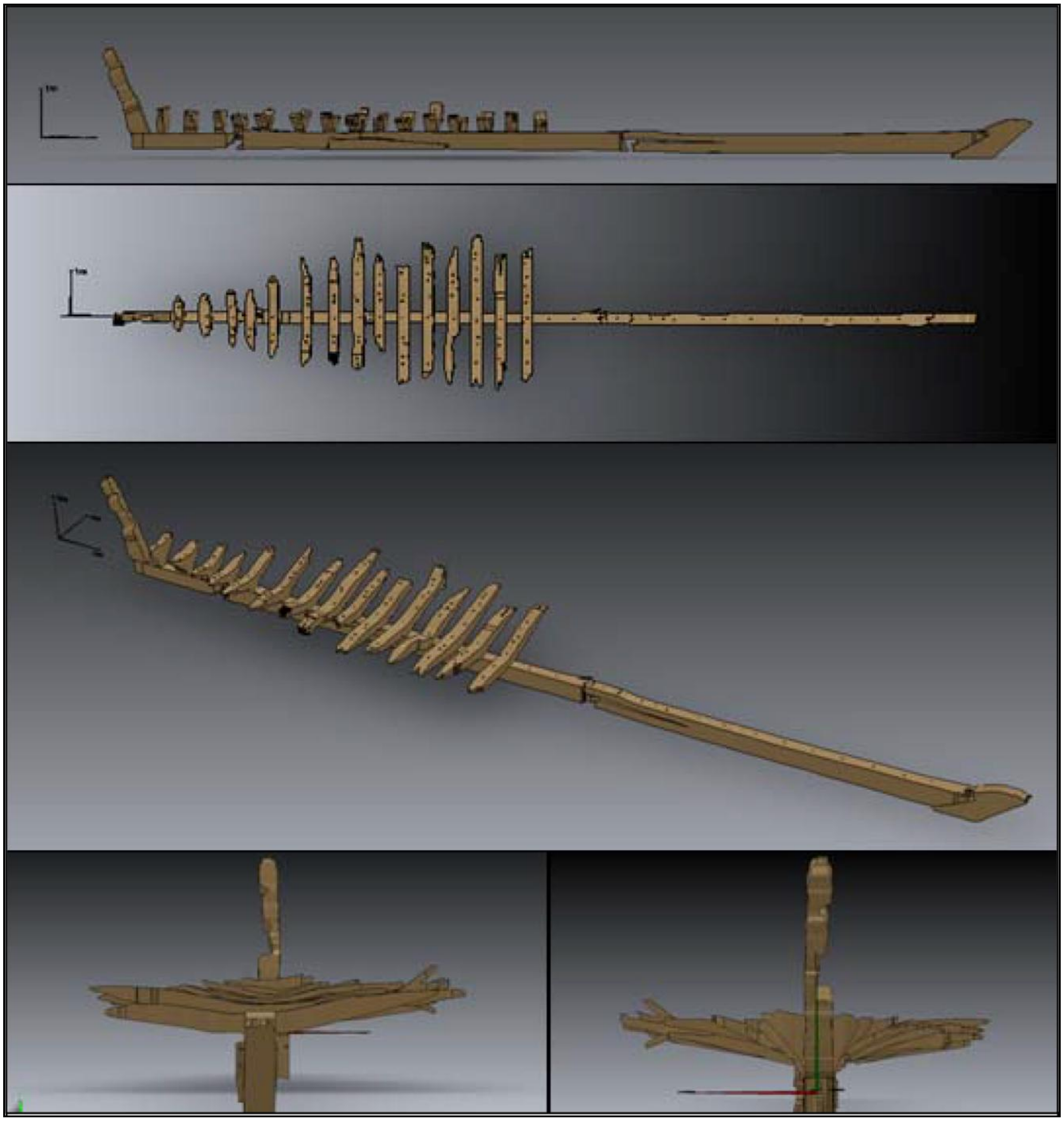

Figure 104 NBHSS UAD SW#1 3D model. (Fig. 2-7 from Robinson, "Marine Archaeological Documentation and Assessment," 3D model by Jake Piskura)

NBHSS UAD SW#2 (Pre-1778)

NBHSS UAD SW#2 is another shipwreck that was discovered, documented, and removed from the NBHSS in the Acushnet River in 2009. The archaeological recording of this vessel took place between July 2017 and September 2018 by David S. Robinson & Associates, Inc. Like NBHSS UAD SW#1, this vessel was identified as an eighteenth-century coastal trader burned by British forces during the 1778 attack on New Bedford Harbor.[314]

NBHSS UAD SW#2 was a slightly smaller vessel than NBHSS UAD SW#1 and may have been closer to 60 feet (18.29 m) long, with an 18-foot (5.49 m) beam. This vessel's tons burthen was estimated to be around 90 to 100 tons. Although NBHSS UAD SW#2's hull components were not evaluated for wood species, they were likely fashioned from white oak (see Figure 105 for a 3D reassembly of its major components).

Only ten of NBHSS UAD SW#2's floors (toward the stern) survived for archaeological recording during this project. As they did for NBHSS UAD SW#1, the archaeologists used drift bolt locations on the keel and fastener locations on the garboard strakes to estimate that NBHSS UAD SW#2 would have had around twenty-three floors. At the time of recording, the surviving floors were 8.8 inches (22.35 cm) molded, on average, and ranged in their sided dimensions between 5.9 and 9.1 inches (14.99–23.11 cm), for an average of 8.6 inches (21.84 cm). The floors were placed around 20 to 22 inches (50.8–55.88 cm) apart on centers and had nearly 14.5 inches (36.83 cm) of space between them. The longest floor (closest to midships) had a single arm length of around 4 feet (1.22 m) and, unlike NBHSS UAD SW#1, no bottom fillers (chocks) were observed.[315]

[314] Robinson, "Marine Archaeological Investigation," 28.
[315] Robinson, "Marine Archaeological Investigation," 21.

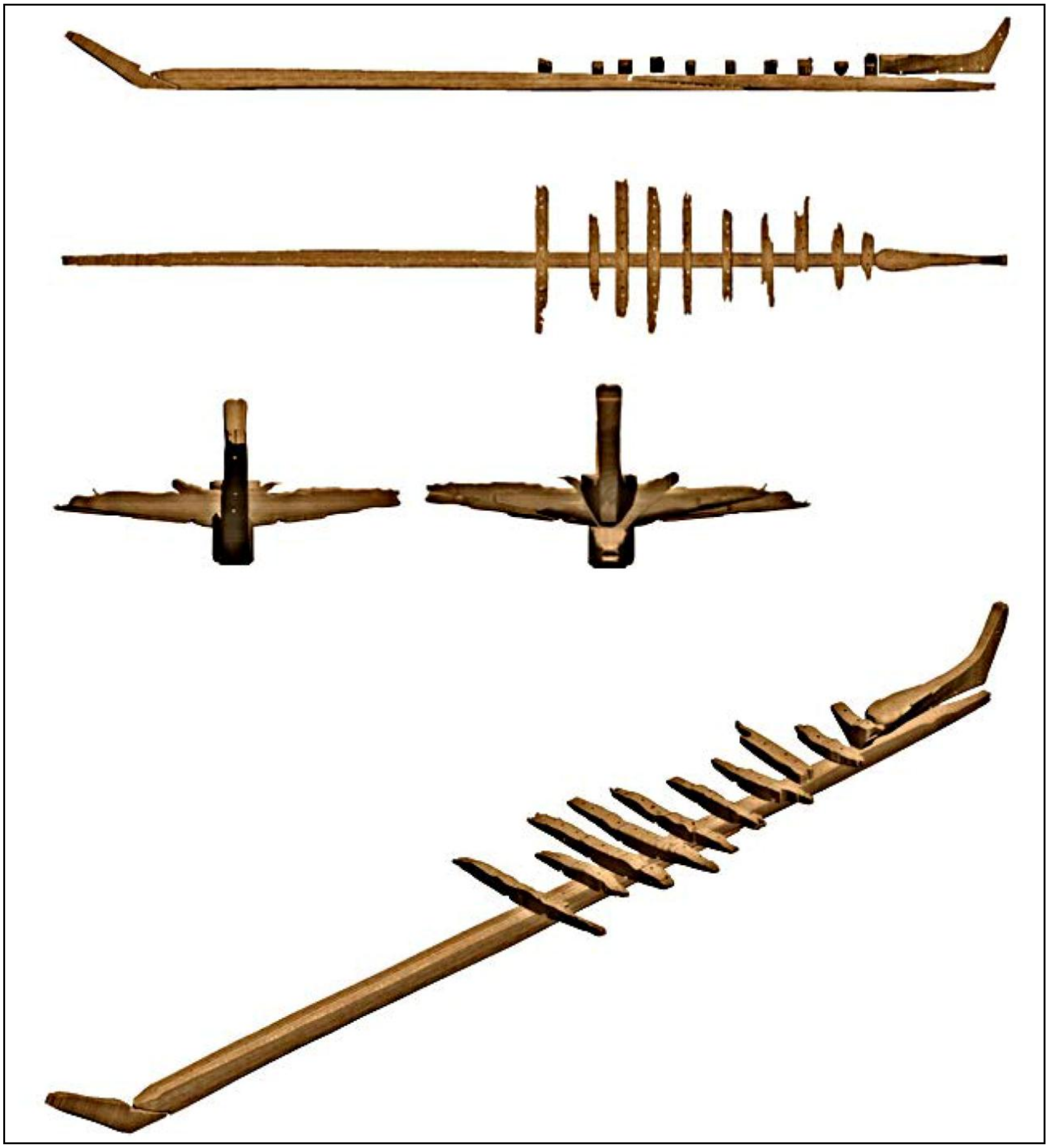

Figure 105 NBHSS UAD SW#2 3D model. (Fig. 10 from Robinson, "Marine Archaeological Investigation," 3D model by Jake Piskura)

Only six partially preserved futtocks were recorded and recovered during this project. The futtocks were roughly 3 feet (0.91 m) long and their molded and sided dimensions ranged from 4.7 to 6.3 inches (11.94-–16 cm) and 6.3 to 8 inches (16–20.32 cm), respectively. These futtocks were found disarticulated from other framing and hull components.

Even though no stern half frames were recovered, evidence of their construction exists on the stern knee. Two 3-inch (7.62 cm) molded, 6-inch (15.24 cm) sided, and 1- to 2-inch (2.54–5.08 cm) deep notches were cut into either side of the stern knee. These would have accepted the heel ends of the stern half frames. No canted frames were observed from this wreck, and the archaeologists proposed that this vessel may not have had canted frames at all.[316]

NBHSS UAD SW#2's observed framing patterns contrast with the larger vessel found previously at the New Bedford site (NBHSS UAD SW#1). Of the ten floors recorded, only two showed signs of being fully articulated mould frames that were laterally fastened to their associated futtocks. The spacing and location of these two mould frames suggests that before the planking was installed, as many as four mould frames may have been erected, one on every fourth frame.

*The Phinney Site/ME 054-004 (*Diligent*, 1776)*

In 2000 and 2001, researchers from the Underwater Archaeology Branch of the US Naval Historical Center (NHC), under the direction of Robert Neyland and Barbara Voulgaris, investigated a shipwreck site in the Penobscot River near Brewer, Maine. The site, ME 054-004, also known as the "Phinney Site," is believed to be where one vessel was scuttled during the

[316] Robinson, "Marine Archaeological Investigation," 27.

Penobscot Expedition in 1779.[317] The NHC identified this vessel, based on the site dimensions and construction features, as the Continental brig *Diligent*. The 1776-built brig had an overall length of around 100 feet; a beam of 24 feet, 8 inches; and a tons burthen between 210 and 236 tons (see Figure 106 for an archaeological site plan).[318]

The archaeological team recorded twenty-four visible floors out of an estimated thirty to thirty-two that may still be present beneath the sediment line. Floors averaged 7.87 inches (20 cm) molded and 9.45 inches (24 cm) sided, and the longest floor's single arm measured 6.3 feet (1.92 m) long. The floor timbers were installed roughly 22 inches apart on centers and had 12.6 inches of space between them. Nearly every other floor was secured to the keel and keelson with a drift bolt; however, three consecutive floors on either extremity of the vessel were secured this way.

The archaeological team recorded what they believed were first, second, and third white oak futtocks at the Phinney Site. First futtocks were 7.87 inches (20 cm) molded and 8.2 inches (21 cm) sided. Second futtocks directly butted the floor heads and were 7.87 inches (20 cm) molded and 7.48 inches (19 cm) sided. Only one futtock from this site is interpreted as a third futtock; it was 7.87 inches (20 cm) sided and 35.43 inches (90 cm) long.[319] It appears that nearly all the first futtocks had wedge-shaped top filler timbers to increase their molded dimension.

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[317] The Penobscot Expedition took place in July and August of 1779. The American fleet consisted of around forty-three Continental Navy ships, privateers, and unarmed transports that set out from Massachusetts to attack a British fortification in Penobscot Bay, Maine. Royal Navy vessels in the bay captured a number of the privateers and forced the rest of the Americans to flee up the Penobscot River and scuttle their vessels.

[318] The beam measurement was taken from historical records and reported in Hunter, "The Penobscot Expedition Archaeological Project," 118. The other values are my own estimations and calculations because *Diligent*'s length measurement, provided by Hunter, was a "length on deck" of 88 feet, 5.75 inches (not overall length), and the tonnage value of 236 provided by him was labeled as "tons displacement" and not tons burthen.

[319] No molded dimension was reported.

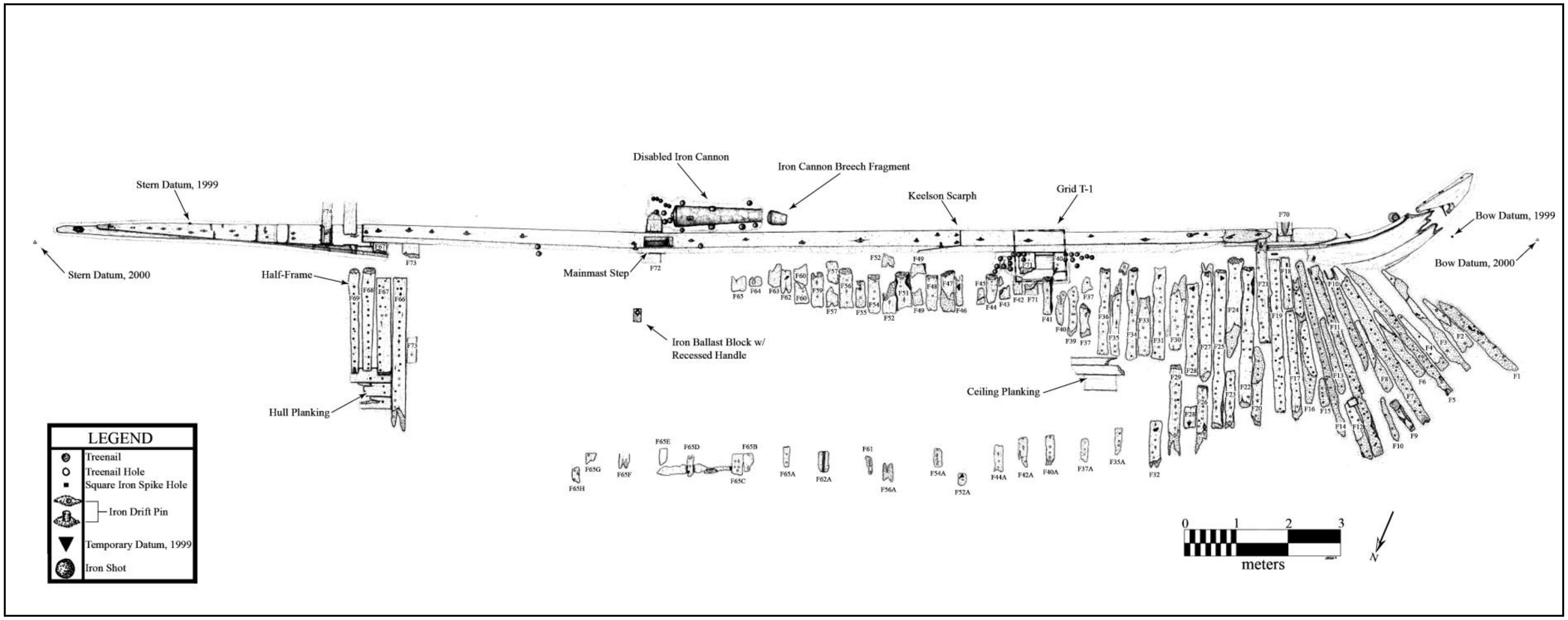

Figure 106 The Phinney Site wreck plan. (After Fig. 8 from Hunter, "The Penobscot Expedition Archaeological Project," 40)

The team also observed sixteen canted bow frames with fillers and one square half frame. The longest canted frame was 12.66 feet (3.86 m) long; on average, these frames were 7.87 inches (20 cm) molded and 19 inches (7.48 cm) sided. The longest filler frame (installed between canted frames) was 5.05 feet (1.54 m) long. The filler frames' molded and sided dimensions were varied and difficult to measure due to their tapered shapes. The heel of the one square half frame, located at the stern, would have originally fit into a notch in the stern deadwood. This timber was roughly 6.56 feet (2 m) long, 6.69 inches (17 cm) molded, and 10.24 inches (26 cm) sided.

Since the bow portion of the vessel at the Phinney Site remained buried during recording, interpretations of the framing pattern and construction are limited. The archaeological team noted that there was "some indication that the vessel's builders incorporated the use of master frames and whole moulding during the construction process";[320] however, evidence for this was not specified in the report. The only observable framing pattern that the archaeological team reported was that the vessel's futtocks were installed aft of their associated floors in the stern portion of the vessel. In addition, they remarked on the uniformity of framing timber dimensions and spacing and suggested that this vessel was well built.[321] The archaeological team's assessment posits that this vessel's construction was not rushed, as was the case for many of the other vessels included in this study.

The Privateer Defence *(1779)*

In 1972, a sonar survey of Stockton Harbor (Penobscot Bay, Maine) revealed the remains of a 16-gun brig from the Revolutionary Era. Due to the site's value as a resource for both eighteenth-century ship construction and its historical significance, as it was thought to be a

[320] Hunter, "The Penobscot Expedition Archaeological Project," 116.
[321] Hunter, "The Penobscot Expedition Archaeological Project," 50.

vessel from the disastrous Penobscot Expedition, archaeologists from the Maine State Museum and the Institute of Nautical Archaeology surveyed and conducted five summers of excavations, completing the work in 1981.[322] Nearly 40 percent of the vessel was preserved. David C. Switzer, one of the lead archaeologists on the project, determined that the brig would originally have been over 80 feet (24.38 m) in length with a 22.1 feet (6.74 m) beam (see Figure 107 for *Defence*'s site plan).[323]

Defence's frames were constructed of white oak, as were most of the other hull timbers. The excavators noted a total of nine master frames, spaced 4 to 5 feet (1.22–1.52 m) apart on center. These frames consisted of heavy floors, first futtocks, and upper futtocks, which were laterally fastened with treenails. Floors were approximately 9 inches (22.86 cm) molded toward the bow and 15 inches (38.1 cm) molded aft of amidships.[324] The floors of the articulated frames were bolted through the keel.[325]

No other floors were installed between *Defence*'s master frames. The rest of the frames consisted of half frames, which butted up against the keel, along with corresponding disarticulated first and upper futtocks. Many of these timbers retained their naturally rounded shapes and some had bark still attached to them. These framing components were fastened to the outer hull planking with octagonal treenails after sufficient planking was installed. The first futtocks were 8 inches (20.32 cm) molded and sided, and the upper futtocks' average molded and sided dimensions were 8 inches (20.32 cm) and 4 to 5.5 inches (10.16–13.97 cm), respectively.[326] Framing components were "spaced fairly evenly" between master frames, with

[322] Feldman, "Hull Construction," 74–75.
[323] Switzer, "The Excavation of the Privateer *Defence*," 50.
[324] Sided dimensions were not reported.
[325] Switzer, "Nautical Archaeology in Penobscot Bay," 90–101; VanHorn, "Eighteenth-Century Colonial American Merchant Ship Construction," 114.
[326] Dimensions of the half frames were not included. From the site plan, they seem to be the same size as the first futtocks. Switzer, "Nautical Archaeology in Penobscot Bay," 95–99.

only about 5 inches (12.7 cm) between components.[327] The spacing of half frames to the mould frames is estimated to be 25 to 28 inches (63.5–71.12 cm) apart on centers.[328]

Radial cant frames supported the bow structure. Each side of the vessel had eight full cant frames that were fastened to both the outer hull planking and apron with treenails.[329] Although no tapered fillers were reported between the cant frames, the site plan would suggest that the first three cant frames' heels butted against the fourth frame's forward face (instead of the apron on the centerline of the vessel).

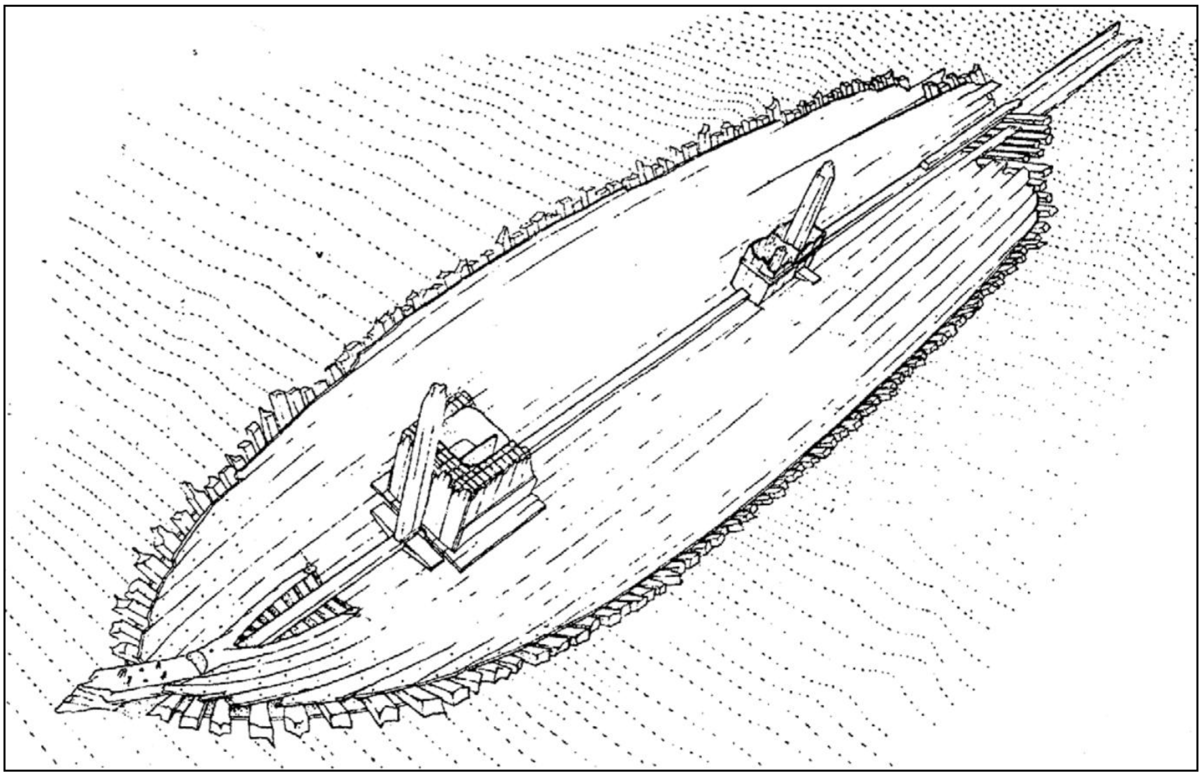

Figure 107 The *Defence* wreck site. (From Switzer, "The Excavation of the Privateer *Defence*," 49)

[327] This measurement was taken near the eroded heads of the futtocks, which were 4.75 inches (12.06 cm) sided on average. This means that the space between floors was likely 14.75 inches (37.46 cm) or that the floors were installed 22.75 inches (57.78 cm) apart on centers.
[328] For the purpose of the robustness calculation, later in this chapter, I use the spacing between half frames and mould frames as an equivalent to average frame spacing. Feldman, "Hull Construction," 75, 78.
[329] Feldman, "Hull Construction," 77, 79.

The Devereaux Cove Vessel (Pre-1779)

The Devereaux Cove Project, conducted in 2000, was a phase II archaeological survey of a wooden vessel that was partly buried beneath the sediment near the low-tide waterline, in Devereaux Cove, Stockton Springs, Maine. At the time, the exposed and heavily eroded hull remains were roughly 52 feet (15.85 m) long and 12 feet (3.65 m) wide. The archaeological measurements and the mix of red and white oak construction suggest that this was a privately built New England sloop used in coastal trade that had principal dimensions closer to 60 feet (18.29 m) long and 18 feet (5.49 m) wide (see Figure 108 for its site plan).[330]

Of the forty-seven framing components recorded in 2000, twenty-one were identified as floors. The full molded dimensions of the floors were difficult to obtain, due to the thick mud between the already tightly spaced framing components. However, the team was able to record a few floors with molded dimensions of around 5 inches (12.7 cm). The sided dimensions of the floors were much more accessible and averaged 11.25 inches (28.57 cm). The average length of a floor's surviving single arm was around 5 feet (1.52 m). The floors were spaced an average of 22 inches (55.88 cm) apart on centers, with 10.75 inches (27.3 cm) of space between them.[331]

Twenty-five first futtocks were observed on the Devereaux Cove Vessel. The archaeological team experienced similar molded-dimension recording issues for first futtocks: the limited number they were able to record were 5.5 inches (13.97 cm) molded. In addition, due to the constraints of their investigation, only one wedge-shaped bottom filler timber was observed to be connected to a first futtock; without further excavation, it is unknown whether others were installed below the remaining futtocks. The first futtocks, however, ranged in their sided dimensions from 10 to 11.75 inches (25.4–29.84 cm), averaging 10.75 inches (27.3 cm).

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[330] Green, "The Devereaux Cove Vessel," 4, 142.
[331] Green, "The Devereaux Cove Vessel," 116–118.

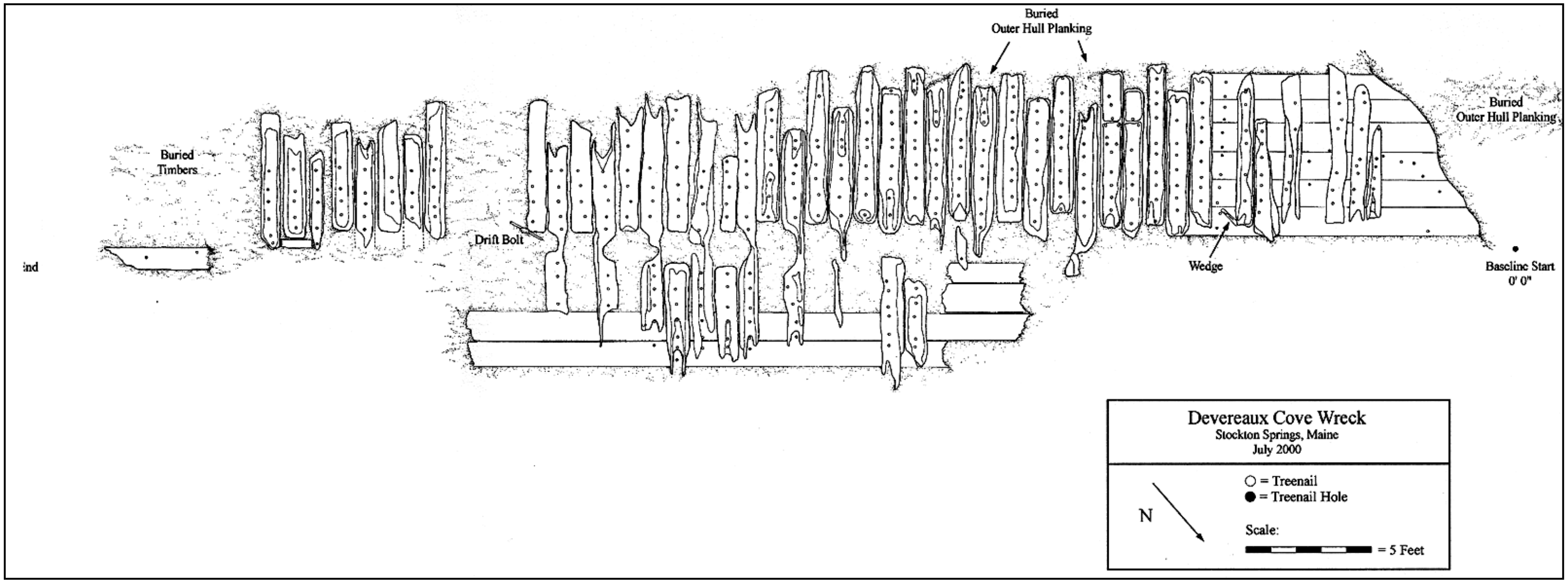

Figure 108 The Devereaux Cove Vessel site plan. (Fig. 14 from Green, "The Devereaux Cove Vessel," 115)

These futtocks were offset around 2.25 inches from where the keelson had previously been installed. No canted or square half frames in either the bow or the stern were observed by the archaeological team. This does not mean that they did not exist in the vessel before deposition.[332]

As for framing patterns, the floor-to-futtock positions are hard to discern due to the lack of identifiable ends. However, the visible floor–futtock pairs all share the same orientation: the futtock is uniformly installed on a single side of its associate floor. The archaeological team observed only one mould frame, a laterally fastened floor–futtock pair. This was due to the tight frame spacing and thick mud that hindered their investigation of the vertical faces of the framing components. It is assumed that additional mould frames were used in the construction of this vessel.

The WTC Wreck (Pre-1785)

During the 2010 construction of a new tower and memorial center at the WTC site in Lower Manhattan, the cultural resource management firm AKRF Inc. discovered the hull remains of a historical wooden ship. Archival research and dendrochronological analysis revealed that this vessel was most likely built either in the late 1770s or early 1780s. In the years of analysis since the vessel's excavation, the vessel type has yet to be definitively identified. The preliminary estimations of the vessel's dimensions are 50 to 60 feet (15.24–18.29 m) in length with a beam of approximately 20 feet (6.1 m). Scholars previously thought that the hull shape was similar to that of a Hudson River sloop, but its rounded stern seems to resist this

[332] Green, "The Devereaux Cove Vessel," 118–122.

classification.[333] It is hoped that the ongoing construction of a scale wooden model of the vessel and the conservation of WTC's hull timbers at Texas A&M University will reveal further insight.

Because a large portion of the wreck forward of amidships was destroyed during previous modern construction projects, most of the framing analysis focused on the components toward the stern. All the frames recovered in the 2010 excavation were made of white oak. AKRF Inc. archaeologists believed that only three master frames remained. Upon further analysis, only two of those were master frames, but an additional two master frames were identified. These frames were labeled 10, 14, 18, and 23 (as seen in Figure 109).[334] Master frames 10, 14, and 18 were installed every fourth frame, with Frame 23 (possibly the midship frame, or near amidships) installed at the fifth frame forward of Frame 18 and spaced roughly 6.5 feet (1.98 m) apart on center. The master frames' floors were each fastened to the keel with a single drift bolt and attached to the first and upper futtocks with iron nails.[335]

The floors were spaced, on average, 17.7 inches (44.96 cm) apart on center and were bolted to the keel. Most of the floors were roughly square in cross-section, ranging from 4.5 to 6.4 inches (11.43–16.26 cm) for both molded and sided dimensions. Each of the floors had an associated first futtock that was attached only to the outer hull planking with iron nails. Futtocks were installed after enough strakes were secured to the master frames. The futtocks were nearly the same size as the floors, averaging 5.2 inches (13.21 cm) square.[336]

[333] Dostal, "Laser Scanning as a Methodology," 17–20; Pappalardo et al., "World Trade Center," 8:6.
[334] Dostal, "Laser Scanning as a Methodology," 23–24.
[335] Dostal, "Laser Scanning as a Methodology," 26.
[336] Dostal, "Laser Scanning as a Methodology," 220; Pappalardo et al., "World Trade Center," 6:7–9.

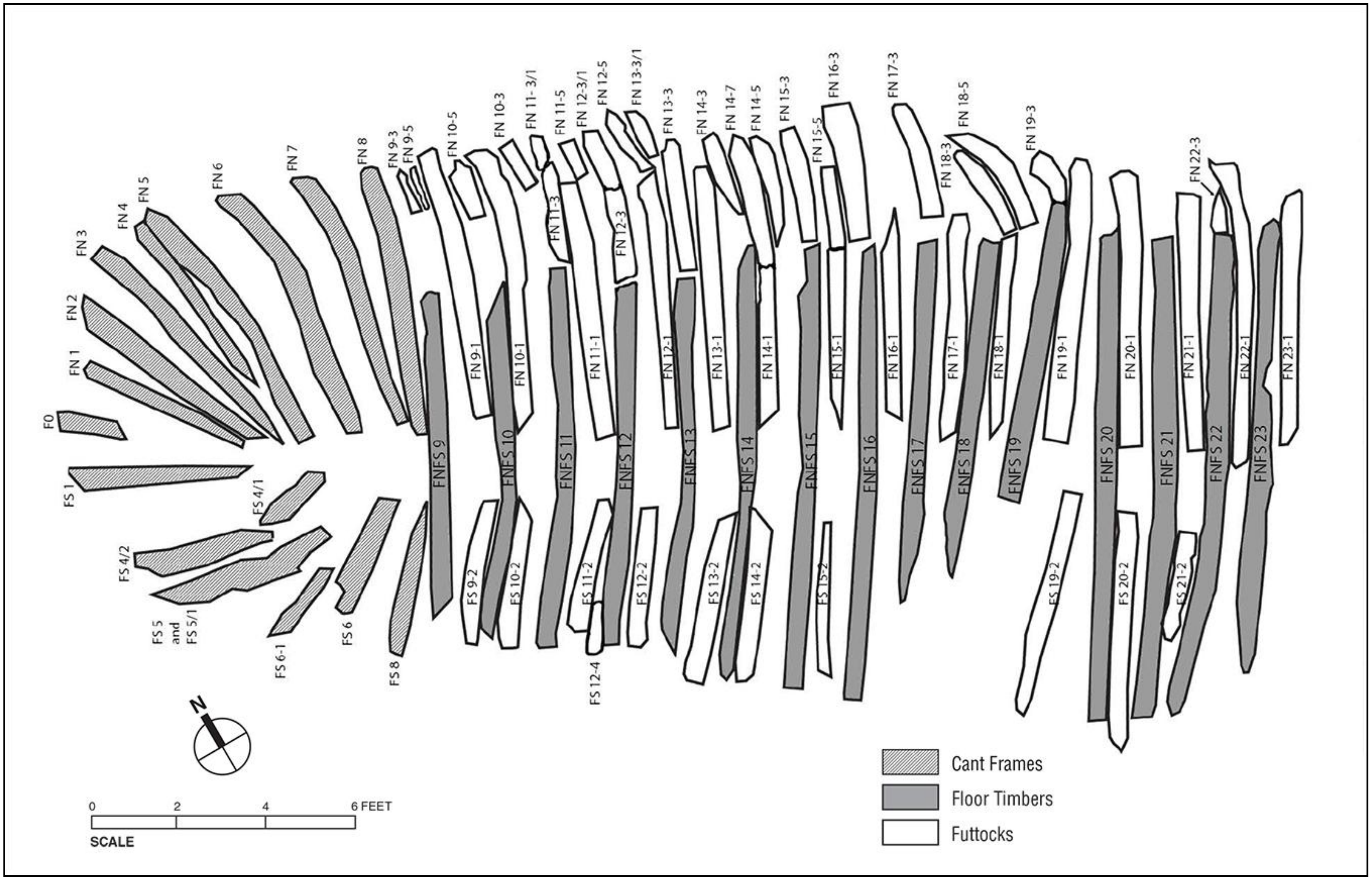

Figure 109 The WTC Wreck framing plan. (Fig. 6-9 from Pappalardo et al., "World Trade Center," in Appendix)

The WTC Wreck had radial cant frames in both the bow and the stern. Due to the poor preservation of the bow, only fragments of nine cant frames were recovered (mostly from the starboard side). In the stern, closely spaced cant frames with filler timbers were recorded. The stern cant frames on the port side were better preserved and noted as abutting the keel. Most of these timbers were roughly square: they ranged from 3.5 to 6 inches (8.89–15.24 cm) molded and 3.25 to 6.5 inches (8.25–16.51 cm) sided.[337]

The Schooner Nancy *(1789)*

The eighteenth-century British schooner *Nancy* was launched from the shipyard in Detroit, Michigan, in 1789. The schooner was initially used in the British fur trading industry in the Great Lakes area but was later hired by the British military as a transport vessel. During the War of 1812, *Nancy* burned to the waterline and sank in the shallows of the Nottawasaga River, in Ontario, Canada. *Nancy*'s hull remained there until 1927 when the schooner was raised and placed on display at the Nancy Island Historic Site. Graduate students from Texas A&M University, led by Chris Sabick, recorded and analyzed *Nancy*'s remains in 1997. The archaeological team used the preserved dimensions, literary evidence, and measurements from other contemporary vessels to estimate *Nancy*'s length and beam at 68 feet (20.73 m) and 22 feet (6.7 m), respectively (see Figure 110 for *Nancy*'s framing plan).[338]

The schooner's floors and some of the futtocks were constructed of white oak, whereas other futtocks and top timbers were of red cedar.[339] Twenty-five of the original twenty-eight floors were preserved. On average, these floors were spaced 25 inches (63.5 cm) apart on

[337] Pappalardo et al., "World Trade Center," 6:7.
[338] Sabick, "His Majesty's Hired Transport Schooner *Nancy*," 19–64, 108–124.
[339] Sabick, "His Majesty's Hired Transport Schooner *Nancy*," 20–21; Cruikshank, "The John Richardson Letters," 27. Most of *Nancy*'s timbers originated from the Great Lakes region.

centers. Their roughly square dimensions ranged from 9 inches (22.86 cm) molded and sided to 7.5 inches (19.05 cm) molded and 8 inches (20.32 cm) sided. Ten of these floors were components of articulated master frames. These frames were spaced approximately 75 inches (190.5 cm) apart on centers, or on every third frame. Master frame components were fastened together with both treenails and iron bolts. Sabick suspected that later in *Nancy*'s career, its master frames' wooden fasteners were either replaced or reinforced with the iron bolts.[340] Most of the floors were bolted to the keel. Sabick noted how this construction method was slightly unusual, in that all of the bolt heads were recessed into the underside of the keel by nearly 2 inches (5.08 cm). These recessed cavities were then, at some point, plugged with treenails. VanHorn interpreted this construction practice as possible evidence of a false keel or as a precautionary measure to protect the bolt heads from damage.[341]

The first futtocks of the remaining frames (i.e., the non-master, or "regular," frames) were disarticulated from their respective floors. They were, on average, 8 inches (20.32 cm) molded and sided at their heels, ranging from 7 to 10 inches (17.78–25.4 cm) from the sides of the keel. Poor preservation of the second and third futtocks prevented the team from acquiring exact measurements. Despite this, Sabick reported that their molded and sided dimensions were similar in size to the first futtocks. The second and third futtocks were diagonally scarfed to their respective floor or first futtock and fastened to the hull planking.[342] It is speculated that these upper futtocks were placed during the same construction sequence as the first futtocks; that is, after master frames, floors, and sufficient hull strakes were in place. The first futtocks aft of amidships were placed forward of their floors. This pattern is reversed forward of amidships.

[340] Sabick, "His Majesty's Hired Transport Schooner *Nancy,*" 92–93. The wooden fasteners were horizontal, whereas the iron bolts were driven into the components at an angle.
[341] VanHorn, "Eighteenth-Century Colonial American Merchant Ship Construction," 119.
[342] Sabick, "His Majesty's Hired Transport Schooner *Nancy,*" 95, 121.

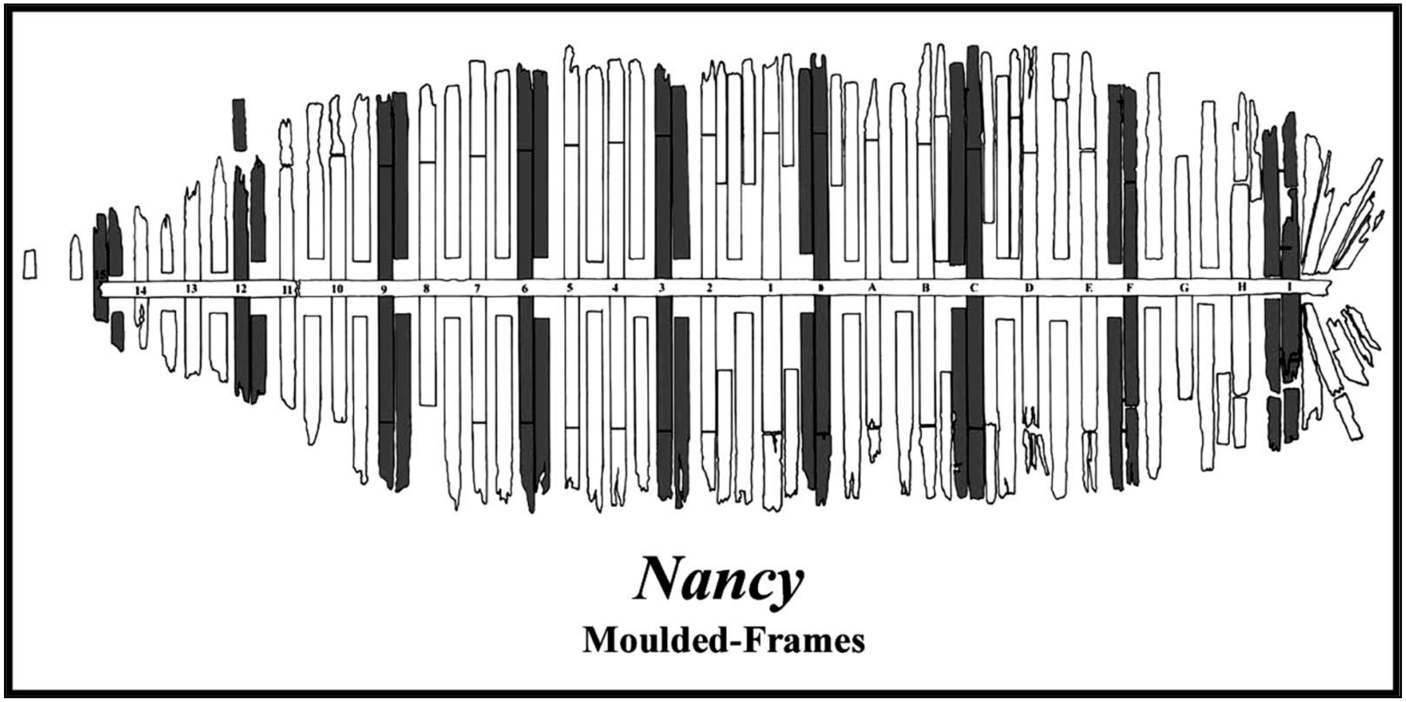

Figure 110 *Nancy*'s framing plan with mould frames highlighted. (After Fig. 21 from Sabick, "His Majesty's Hired Transport Schooner *Nancy*," 94)

Sabick also documented four pairs of radial cant frames in the bow of the schooner. The aftermost two were tapered filler cant frames. The first full cant frames (immediately forward of the tapered cant frames) were seated into notches in the apron. The remaining two pairs were only butted against the apron.

In addition to the master, regular, and cant frames, Sabick recorded framing timbers that did not follow the general framing pattern. Although some of these fillers are as large as the futtocks, they are not attached to any framing components other than the hull.[343] Most of these fillers are located slightly forward of amidships.[344] *Nancy* is the only vessel in this study that utilized this shipbuilding practice. Further comparisons among these vessels could reveal motivations for construction decisions such as these.

Framing: Comparative Analysis and Discussion

Most comparative analyses that evaluate the frames of wooden vessels do so through a limited perspective. Upon closely examining framing details, scholars often remark that a vessel has "heavier" or "lighter" framing or that one vessel's frames are more heavily built than another's.[345] However, the attribute of being "heavily built" is never quantified in these studies: archaeologists attach this subjective label to a vessel with only a few loosely connected measurements to support their claim (e.g., average frame/floor spacing on centers, and average floors' sided and molded dimensions). Although it is important to examine these independent measurements, they should be examined together with other aspects of frame construction (such

[343] It is likely that the fillers were installed during a later rebuild of the vessel.
[344] Sabick, "His Majesty's Hired Transport Schooner *Nancy*," 97.
[345] Morris et al., "The Comparative Analysis"; VanHorn, "Eighteenth-Century Colonial American Merchant Ship Construction," 180–191; and Robinson, "Marine Archaeological Investigation," 25–28.

as component materials, futtock size, vessel size, etc.) to get a complete picture of a vessel's framing.

Material

The primary wood for ship construction in eighteenth-century northeastern North America was white oak. North American white oak was similar to English oak species; their strength and resistance to decay were preferred traits for a ship's timbers. The vessels examined in this study (except the Devereaux Cove Vessel and the schooner *Nancy*) utilized white oak floors and futtocks. According to historical documents, some of *Nancy*'s futtocks and top timbers were made of red cedar,[346] and some of the first futtocks as well as other timbers from the Devereaux Cove Vessel were fashioned from red oak.[347] This demonstrates that shipbuilders in northeastern North America exploited local wood species that may have been considered less preferable to white oak—either as a conscious decision or out of necessity due to the lack of access to white oak.[348] Regardless, determining hull timber wood species is beneficial to archaeological analysis. In the case of the Readers Point Wreck (found in Jamaica), its white oak timbers helped archaeologists determine that the vessel was likely built in New England.

Vessel and Timber Dimensions

Analysis of frame dimensions relative to vessel size can shed light on how shipwrights conceived of a vessel's durability and internal strength. It seems that shipwrights favored floors with molded dimensions roughly equal to or larger than their sided dimensions (near the

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[346] Sabick, "His Majesty's Hired Transport Schooner *Nancy*," 20–21; Cruikshank, "The John Richardson Letters," 27.
[347] Green, "The Devereaux Cove Vessel," 119–120.
[348] Although cedar was considered an adequate shipbuilding wood and has rot resistant characteristics, white oak was generally preferred for use as structural timbers in vessels.

centerline of the vessel) possibly because this would maximize lateral timber strength within a hull. Three of the twelve vessels in this study—the Terence Bay Wreck, the Phinney Site (*Diligent*), and the Devereaux Cove Vessel—appear to be exceptions to this strategy; however, they all had poor floor preservation, and their dimensions were not measured in the same places as the other wrecks.[349] See Table 6 for a list of the framing component measurements.

An examination of the framing timber dimensions reveals that all but three vessels in the study (i.e., not including the Terence Bay Wreck, the WTC Wreck, and the Devereaux Cove Vessel) had floors that were at least 7.5 inches (19 cm) and at most 15 inches (34.3 cm) molded. Futtocks generally have smaller dimensions than floors. The minimum and maximum molded dimensions of first futtocks of these vessels were between 5 and 10.5 inches (12.7–26.67 cm), respectively.

The reason why the Terence Bay Wreck, the WTC Wreck, and the Devereaux Cove Vessel are excluded above is that their frames were either uniquely small (relative to the other vessels) or that poor preservation and archaeological recording biased these measurements. The WTC Wreck's floors, at only 4.5 to 6 inches (11.4–16.2 cm) molded and sided,[350] were roughly half the dimension of the floors on comparably sized vessels. However, the roughly square cross-sections of the WTC Wreck's floors and futtocks did resemble those of most of the other vessels.

It is important to understand how shipwrights determined floor timber size in relation to the size of the vessel. Calculating the ratio of a vessel's floor size to its keel length provides insight into the vessel's structural strength and facilitates comparison among multiple vessels.[351]

[349] The Terence Bay Wreck's framing components measured 6 inches (15.2 cm) at their eroded heads (floors often tapered as they moved away from the keel), so this measurement should be taken as a minimum value.
[350] Dostal, "Laser Scanning as a Methodology," 220; Pappalardo et al., "World Trade Center," 6:7–9.
[351] For floor size, the average floor cross-section area (i.e., average molded and sided dimensions, multiplied) near the centerline was used. Keel length was chosen to best represent vessel size because most of these vessels' keels had survived. It was determined that the quantitative data would be more meaningful if an actual measured timber (that correlated well to vessel size) was used instead of the estimated values of overall vessel length and breadth.

These ratios are displayed in their decimal forms in Table 8. The higher the value, the larger the floors, relative to the vessel's keel length. Ratios of first futtocks to keel length are also calculated (see Table 9).

Overall, there are several noticeable trends. Floor size, relative to keel length, slightly decreases in the late eighteenth-century vessels. Due to the small sample size, however, it is unclear whether this trend is representative within an even wider context of northeastern North America. Another noticeable correlation is that the larger vessels, like the brigs *Duke of Cumberland* and the Phinney Site (*Diligent*), had slightly skewed floor-to-keel ratios. Even though the framing components of these vessels were "typically sized," they are perceived as being smaller relative to the vessel's length. These larger vessels' framing component dimensions are limited by tree size: a small vessel like the Readers Point Wreck is easier to build with large framing timbers relative to its hull size compared to a constructing a large vessel using proportionately large frames.

Table 8 Floor Dimensions, Spacing, Floor-to-Keel Ratio, and Floor Robustness

Vessel Name	**Floors Sided (avg.)**	**Avg. Frame Spacing (on centers)**	**Frame Spacing Value**	**Floors Molded (avg.)**	**Floor Cross-Section**	**Length of Keel**	**Floor-to-Keel Ratio**	**Floor Robustness**
The Terence Bay Wreck	8 inches (20.3 cm)	20 inches (50.8 cm)	**0.40**	6 inches (15.2 cm)	48 inches (121.9 cm)	660 inches (1676.4 cm)	**0.07**	**0.029**
Boscawen	9.92 inches (25.2 cm)	25.73 inches (65.3 cm)	**0.39**	10.65 inches (27 cm)	105.65 inches (268.3 cm)	717 inches (1821.2 cm)	**0.15**	**0.057**
Duke of Cumberland	9.92 inches (25.2 cm)	25.73 inches (65.3 cm)	**0.39**	10.65 inches (27 cm)	105.65 inches (268.3 cm)	960 inches (2438.4 cm)	**0.11**	**0.042**
The Tuttle Sloop	6.5 inches (16.5 cm)	18 inches (45.7 cm)	**0.36**	7.5 inches (19 cm)	48.75 inches (123.8 cm)	522 inches (1325.9 cm)	**0.09**	**0.034**
The Readers Point Wreck	9.5 inches (24.1 cm)	22 inches (55.9 cm)	**0.43**	10 inches (25.4 cm)	95 inches (241.3 cm)	510 inches (1295.4 cm)	**0.19**	**0.080**
NBHSS UAD SW#1	8.45 inches (21.5 cm)	22 inches (55.9 cm)	**0.38**	9.4 inches (23.9 cm)	79.43 inches (201.7 cm)	679.2 inches (1725.2 cm)	**0.12**	**0.045**
NBHSS UAD SW#2	7.5 inches (19 cm)	22.4 inches (56.9 cm)	**0.33**	10.25 inches (26 cm)	76.88 inches (195.3 cm)	604.8 inches (1536.2 cm)	**0.13**	**0.043**
The Phinney Site (*Diligent*)	9.45 inches (24 cm)	22 inches (55.9 cm)	**0.43**	7.87 inches (20 cm)	74.37 inches (188.9 cm)	948 inches (2407.9 cm)	**0.08**	**0.034**
Defence	8 inches (20.3 cm)	26.5 inches (67.3 cm)	**0.30**	12 inches (30.5 cm)	96 inches (243.8 cm)	780 inches (1981.2 cm)	**0.12**	**0.037**
The Devereaux Cove Vessel	11.25 inches (28.6 cm)	22 inches (55.9 cm)	**0.51**	5 inches* (12.7 cm)	61.88 inches (157.2 cm)	546 inches (1386.8 cm)	**0.11**	**0.058**
The WTC Wreck	5.75 inches (14.6 cm)	17.7 inches (45 cm)	**0.32**	5.5 inches (14 cm)	31.63 inches (80.3 cm)	540 inches (1371.6 cm)	**0.06**	**0.019**
Nancy	8.5 inches (21.6 cm)	25 inches (63.5 cm)	**0.34**	8.25 inches (21 cm)	70.13 inches (178.1 cm)	717 inches (1821.2 cm)	**0.10**	**0.033**

* Value skewed by lack of timber preservation/reporting.

Table 9 Futtock Dimensions, Spacing, Futtock-to-Keel Ratio, and Futtock Robustness

Vessel Name	Futtocks Sided (avg.)	Avg. Distance Between Floors (space)	Futtock Room-to-Space Ratio	Futtocks Molded (avg.)	Futtock Cross-Section	Length of Keel	Futtock-to-Keel Ratio	Futtock Robustness
The Terence Bay Wreck	7 inches* (17.8 cm)	12 inches (30.5 cm)	**0.58**	5 inches* (12.7 cm)	35 inches (88.9 cm)	660 inches (1676.4 cm)	**0.05**	**0.031**
Boscawen	8.26 inches (21 cm)	15.73 inches (39.9 cm)	**0.53**	9.63 inches (24.5 cm)	79.54 inches (202 cm)	717 inches (1821.2 cm)	**0.11**	**0.058**
Duke of Cumberland	8.26 inches (21 cm)	15.73 inches (39.9 cm)	**0.53**	9.63 inches (24.5 cm)	79.54 inches (202 cm)	960 inches (2438.4 cm)	**0.08**	**0.044**
The Tuttle Sloop	5 inches (12.7 cm)	11.5 inches (29.2 cm)	**0.43**	5 inches (12.7 cm)	25 inches (63.5 cm)	522 inches (1325.9 cm)	**0.05**	**0.021**
The Readers Point Wreck	8.8 inches (22.3 cm)	12.5 inches (31.7 cm)	**0.70**	8.25 inches (21 cm)	72.6 inches (184.4 cm)	510 inches (1295.4 cm)	**0.14**	**0.100**
NBHSS UAD SW#1	7 inches (17.8 cm)	13.55 inches (34.4 cm)	**0.52**	8.75 inches (22.2 cm)	61.25 inches (155.6 cm)	679.2 inches (1725.2 cm)	**0.09**	**0.047**
NBHSS UAD SW#2	7.1 inches (18 cm)	14.5 inches (36.8 cm)	**0.49**	5.5 inches (14 cm)	39.05 inches (99.2 cm)	604.8 inches (1536.2 cm)	**0.06**	**0.032**
The Phinney Site (*Diligent*)	8.2 inches (21 cm)	12.6 inches (32 cm)	**0.65**	7.87 inches (20 cm)	64.53 inches (163.9 cm)	948 inches (2407.9 cm)	**0.07**	**0.044**
Defence	8 inches (20.3 cm)	18.5 inches (47 cm)	**0.43**	8 inches (20.3 cm)	64 inches (162.6 cm)	780 inches (1981.2 cm)	**0.08**	**0.035**
The Devereaux Cove Vessel	10.75 inches (27.3 cm)	10.75 inches (27.3 cm)	**1.00**	5.5 inches* (14 cm)	59.12 inches (150.2 cm)	546 inches (1386.8 cm)	**0.11**	**0.108**
The WTC Wreck	5.2 inches (13.2 cm)	12.25 inches (31.1 cm)	**0.42**	5.2 inches (13.2 cm)	27.04 inches (68.7 cm)	540 inches (1371.6 cm)	**0.05**	**0.021**
Nancy	8 inches (20.3 cm)	16.5 inches (41.9 cm)	**0.48**	8 inches (20.3 cm)	64 inches (162.6 cm)	717 inches (1821.2 cm)	**0.09**	**0.043**

* Value skewed by lack of timber preservation/reporting.

It is interesting to note that six of the twelve vessels in this regional study (the Terence Bay Wreck, *Boscawen*, *Duke of Cumberland*, the Readers Point Wreck, NBHSS UAD SW#2, and *Defence*) had considerable variation in their framing timber dimensions. When there was a substantial variation in the dimensions of a vessels' floors, the more substantial floors were located either around or aft of amidships. (The other six vessels in the study had timbers of relatively consistent size or lacked a more detailed analysis of their framing components in their original studies.) A possible explanation for this finding is that shipwrights placed these substantial floors to alter a vessel's longitudinal trim. It is preferable to have a vessel trimmed slightly to the stern because this would increase vessel stability and maneuverability.[352] However, the placement of these larger floors is more likely a result of the narrowing of the stern. When using floors (and not half frames), it makes more sense to have as large a molded dimension along the centerline as possible in order to increase strength in one of the narrowest places in the hull.

Framing Patterns and Spacing

The pattern, spacing, and density of frames can also reveal how shipwrights understood frame placement in relation to a vessel's structural soundness. Eighteenth-century vessels had various types of frames. Master, or mould, frames acted as guides for other framing components and as attachment points for initial planking. Regular frames (either full or half frames) "filled out" the run of the hull between master frames. Canted half frames were usually installed in the bow but could also be utilized in the stern. Wedged-shaped filler pieces were often used between canted bow or stern frames, and squared fillers were sometimes placed in the run of the hull

[352] See Owen, *Aids to Stability*, 38–39, for more information on vessel stability and trim.

between upper framing components. It is important to examine the distance between frames (taken at the floors) and note how this distance relates to vessel size.[353]

Table 8 demonstrates just how similar the average frame spacing is among all twelve vessels in this regional study, with a few exceptions: floors were spaced a little closer in the ocean-going vessels compared to most of the lake-going vessels. The relatively tight framing on the Tuttle Sloop and the WTC Wreck was likely due to the smaller dimensions of their framing components: the shipwrights needed to offset the reduced strength of the smaller frames by installing more of them.

The most noticeable trend seen in the average frame spacing of all twelve vessels is that nearly half of their floors were spaced around 22 inches (55.88 cm) apart on their centers. In fact, the average frame spacing for all twelve vessels is 22.42 inches (56.95 cm).[354] This value, when compared with the individual frame spacing on each of the vessels, demonstrates the possibility of a common or standard practice in spacing floors for vessels built in northeastern North America. However, more data are needed to validate these speculations.

Scholars have presented theories on the "framing evolution" of the eighteenth century.[355] Morris et al. investigated the frame spacing and pattern of nine vessels. All but one of the vessels in that study (i.e., the Readers Point Wreck) were "southern built." These vessels were all constructed between the late seventeenth century and the mid-nineteenth century, but six of the nine were built after 1772, which may have skewed their interpretation slightly.[356] Morris et al. observed that over the course of the eighteenth century, spacing between frames began to

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[353] As seen in the site plans of each shipwreck, the ends are often poorly preserved.
[354] It should be noted that the privateer *Defence* had half frames and futtocks between its mould frames. For the purposes of this study, the spacing between half frames and mould frames was used to generate its average frame spacing value.
[355] Morris et al., "The Comparative Analysis," 125–133.
[356] Morris et al., "The Comparative Analysis," 126.

increase and the components of individual frames (floors and their associated futtocks) moved closer together.[357]

Separating the lake-going vessels from the ocean-going ones, the frame spacing data for the northeastern North American vessels in the present study do not seem to substantiate Morris et al.'s claim that frames were becoming more tightly spaced over time. Even if we add in the four lake-going craft, the average frame spacing remains relatively consistent, as seen in Table 8. In addition, the spacing between regular (non-mould) frames and their first futtocks does not noticeably increase or decrease throughout the period for these northeastern vessels (as seen by the open space comparison in Table 10 and Figure 111 in Appendix A).[358]

Table 10 Average Open Space Between Two Frames

Vessel Name	**Average Open Space Between Two Frames**
The Terence Bay Wreck	5 inches (12.7 cm)
Boscawen	7.47 inches (19 cm)
Duke of Cumberland	7.47 inches (19 cm)
The Tuttle Sloop	6.5 inches (16.5 cm)
The Readers Point Wreck	3.7 inches (9.4 cm)
NBHSS UAD SW#1	6.55 inches (16.6 cm)
NBHSS UAD SW#2	7.4 inches (18.8 cm)
The Phinney Site (*Diligent*)	4.4 inches (11.2 cm)
Defence	10.5 inches (26.7 cm)
The Devereaux Cove Vessel	0 inches (0 cm)
The WTC Wreck	7.05 inches (17.9 cm)
Nancy	8.5 inches (21.6 cm)

[357] Morris et al., "The Comparative Analysis," 132.
[358] "Open space" refers to the collective longitudinal area that is unoccupied by framing components between two adjacent floors.

Another important aspect of frame pattern is the placement of the first futtock in relation to its floor. According to Morris et al., "convention says that the first futtock is forward of the floor forward of the midship bend (master couple). Aft of this couple, the first would fall abaft the floor."[359] Morris et al. did not observe this convention in their archaeological data, however. For the majority of the twelve vessels in the present study,[360] the frames that were forward of amidships all had futtocks aft of their associated floors,[361] and the frames that were aft of amidships, or those nearer to the stern, had futtocks forward of their associated floors. Because these vessels all seem to follow this pattern, the placement of the first futtocks does not currently offer any insight into the shipbuilding traditions specific to northeastern North America.

Lastly, Morris et al. observed canted frames on most of the wrecks in their study.[362] The authors identified a developmental shift in framing at the bow—that is, the transition from square bow frames to various types of canted frames—as the eighteenth century progressed.[363] All of the vessels in the present study, except those with poor bow preservation, had preserved radial cant frames in their bows, exhibiting the latest pattern in Morris et al.'s typology.[364] The Terence Bay Wreck likely had canted bow frames, but poor preservation prevented archaeologists from recording this.[365] No apparent pattern was observed in these wrecks' canted frame usage. Additional data and further comparisons among American and European practices may reveal regionally specific traditions.

[359] Morris et al., "The Comparative Analysis," 127.
[360] A couple of the vessels' floor-to-futtock placement patterns were not identifiable due to how disarticulated the hulls were during archaeological recording.
[361] The orientation of the first futtocks for the other vessels was not able to be determined.
[362] Some of the vessels did not have identifiable or observed canted frames (but this does not mean that they were built without them). These particular vessels were largely disturbed and disarticulated, which prevents further analysis on these components.
[363] Morris et al., "The Comparative Analysis," 129.
[364] Some also had canted filler frames in between the full frames.
[365] Carter and Kenchington, "The Terence Bay Wreck," 13–26.

Framing Robustness Relative to the Vessel Size (a more nuanced comparison)

As mentioned at the beginning of this section, most studies that evaluate framing compare individual frame measurements (or loosely related frame measurements) to one another. I believe that we should use a more comprehensive approach when interpreting whether a vessel's framing is "heavy" or "light" and propose a more nuanced method—one that allows us to use multiple aspects of a vessel's framing components to calculate its "framing robustness." The method employs a standardized equation to generate a single value that quantifies a vessel's framing robustness, thus allowing comparisons to be made more easily among multiple vessels. It should be stated that such a value cannot fully correlate to how "heavily built" a vessel is, because fastener types/amounts and the inherent quality of the material used to construct the frames are not taken into account.[366]

What the calculation does consider are floor size, futtock size, spacing of framing components, and vessel size. The resulting "Framing Robustness Value" is a combination of two simple components: the robustness of a vessel's floors in relation to the length of the keel and the robustness of a vessel's futtocks in relation to the length of keel.

The robustness of a vessel's floors is calculated as follows: Divide the vessel's average floor sided dimension by the average frame spacing (floor spacing apart on centers) to get the "Floor Spacing Value." Multiply the average floor molded and sided dimensions together to get the "Floor Cross-Section." Divide the Floor Cross-Section by the overall length of the keel to get the "Floor-to-Keel Ratio." "Floor Robustness" is the product of the Floor Spacing Value and the

[366] These values are much too complex to quantify here. I am hoping that this simplified "Framing Robustness Value" will encourage more objective and straightforward analyses of vessel framing than has previously been done.

Floor-to-Keel Ratio.[367] These measurements and calculations for the twelve vessels can be found in Table 8.

The robustness of a vessel's futtocks is calculated as follows: Divide the average futtock sided dimension by the average space between floors to get the "Futtock Room-to-Space Ratio." Multiply the average futtock molded and sided dimensions together to get the "Futtock Cross-Section." Divide the Futtock Cross-Section by the overall length of the keel; the result is the "Futtock-to-Keel Ratio." "Futtock Robustness" is the product of the Futtock Room-to-Space Ratio and the Futtock-to-Keel Ratio.[368] These measurements and calculations for the twelve vessels can be found in Table 9.

The Framing Robustness Value is simply the sum of a vessel's Floor Robustness and Futtock Robustness values. The larger the Framing Robustness Value, the more robust the framing components are in relation to the vessel's size. See Table 11 for the framing robustness values for the vessels in this study. Table 12 displays different arrangements of the twelve vessels, depending on which particular parameters were used to analyze them. This table demonstrates that using isolated factors to examine framing (as previous scholarship has done) incorrectly skews the data and shows how a collective interpretation of framing can more accurately reflect a vessel's overall framing robustness.

One can see in Table 12 that if one only uses the floors' dimensions or average frame spacing to evaluate the "heaviness" or "lightness" of a vessel's framing, the results will be varied and more difficult to accurately compare to one another. According to the average floor molded and sided dimensions as well as the average frame spacing, one might interpret the Readers Point Wreck as a "lighter-built" vessel. However, when looking at its framing as a whole, the Readers

[367] The larger the value, the more robust a vessel’s floors are (relative to the vessel's size).
[368] The larger the value, the more robust a vessel’s futtocks are (relative to the vessel's size).

Point Wreck is the most robustly framed vessel relative to its size. On the other end, one may have previously interpreted the Terence Bay Wreck as being a "middling-built" vessel, when it actually is one of the least robustly framed vessels of the twelve.

The same hesitancy should be acknowledged when evaluating vessels based on the floor or futtock robustness alone—these individual components do not represent the vessel's framing as a whole. Using only floor robustness, one may have concluded that NBHSS UAD SW#2 was more robustly framed than it was. Its futtocks were actually the fourth smallest, relative to its length of keel.

Table 11 Framing Robustness Values

Vessel Name	Floor Robustness	Futtock Robustness	Framing Robustness
The Terence Bay Wreck	0.029	0.031	**0.060**
Boscawen	0.057	0.058	**0.115**
Duke of Cumberland	0.042	0.044	**0.086**
The Tuttle Sloop	0.034	0.021	**0.055**
The Readers Point Wreck	0.080	0.100	**0.181**
NBHSS UAD SW#1	0.045	0.047	**0.092**
NBHSS UAD SW#2	0.043	0.032	**0.074**
The Phinney Site (*Diligent*)	0.034	0.044	**0.078**
Defence	0.037	0.035	**0.073**
The Devereaux Cove Vessel	0.058	0.108	**0.166**
The WTC Wreck	0.019	0.021	**0.040**
Nancy	0.033	0.043	**0.077**

Table 12 Vessels Ranked to Demonstrate Variance Resulting from Separate Factor Analysis when Evaluating Framing Robustness

Avg. Floor Molded (smallest to largest)	Avg. Floor Sided (smallest to largest)	Open Space (most to least)	Avg. Frame Spacing (widest to tightest	Floor Robustness (least to most)	Futtock Robustness (least to most)	Framing Robustness (least to most)
The WTC Wreck	The WTC Wreck	*Defence*	*Defence*	The WTC Wreck	The Tuttle Sloop	The WTC Wreck
The Devereaux Cove Vessel	The Tuttle Sloop	*Nancy*	*Boscawen*	The Terence Bay Wreck	The WTC Wreck	The Tuttle Sloop
The Terence Bay Wreck	NBHSS UAD SW#2	*Boscawen*	*Duke of Cumberland*	*Nancy*	The Terence Bay Wreck	The Terence Bay Wreck
The Tuttle Sloop	The Terence Bay Wreck	*Duke of Cumberland*	*Nancy*	The Phinney Site (*Diligent*)	NBHSS UAD SW#2	*Defence*
The Phinney Site (*Diligent*)	*Defence*	NBHSS UAD SW#2	NBHSS UAD SW#2	The Tuttle Sloop	*Defence*	NBHSS UAD SW#2
Nancy	NBHSS UAD SW#1	The WTC Wreck	The Readers Point Wreck	*Defence*	*Nancy*	*Nancy*
NBHSS UAD SW#1	*Nancy*	NBHSS UAD SW#1	NBHSS UAD SW#1	*Duke of Cumberland*	*Duke of Cumberland*	The Phinney Site (*Diligent*)
The Readers Point Wreck	The Phinney Site (*Diligent*)	The Tuttle Sloop	The Phinney Site (*Diligent*)	NBHSS UAD SW#2	The Phinney Site (*Diligent*)	*Duke of Cumberland*
NBHSS UAD SW#2	The Readers Point Wreck	The Terence Bay Wreck	The Devereaux Cove Vessel	NBHSS UAD SW#1	NBHSS UAD SW#1	NBHSS UAD SW#1
Boscawen	*Boscawen*	The Phinney Site (*Diligent*)	The Terence Bay Wreck	*Boscawen*	*Boscawen*	*Boscawen*
Duke of Cumberland	*Duke of Cumberland*	The Readers Point Wreck	The Tuttle Sloop	The Devereaux Cove Vessel	The Readers Point Wreck	The Devereaux Cove Vessel
Defence	The Devereaux Cove Vessel	The Devereaux Cove Vessel	The WTC Wreck	The Readers Point Wreck	The Devereaux Cove Vessel	The Readers Point Wreck

Overall, we can see in Tables 11 and 12 that of the twelve vessels, the Readers Point Wreck was the most robustly framed and that the WTC Wreck was the least robustly framed for their size. However, there are no discernible trends in this study's Framing Robustness Values: we do not see increases or decreases in robustness at different times during the eighteenth century, between military and mercantile craft, or between lake-going and ocean-going vessels. It seems that framing decisions were made on an individual basis for each vessel.

It should be stated again that the Framing Robustness Value should not be used to interpret vessel durability or strength. Those concepts would rely on fastener sizes, types, and amounts, as well as overall quality of build, which is much more difficult to quantify. Importantly, the Framing Robustness Value, which represents framing timber sizes and spacing relative to a vessel's keel length, provides scholars with a quantifiable way to compare vessels.

Construction Sequence

The positioning of framing components and how they were attached to the vessel are important in understanding construction sequence. Historical literary evidence suggests that the use of master frames and disarticulated intermediary framing components was a common practice in the eighteenth century. Yet, most of the treatises and first-hand observations noted that the first and third futtocks were typically scarfed to one another but spaced away from the floors and second futtocks, which were also scarfed together. This construction sequence is interpreted as follows: After laying down the keel and fitting the end posts, the articulated master frames, floors, and keelson were installed and garboards and plank strakes were attached up to the ends of the floors. After the initial strakes were in place, the first futtocks with their scarfed upper futtocks were fastened to the hull between the floors. The twelve vessels of the present study, however, seem to deviate from this practice, as no futtocks were scarfed to other framing components. Ultimately, the archaeological evidence suggests a somewhat different construction sequence for these vessels.

All twelve of the vessels in this study had some evidence of laterally fastened framing components. Not all of these were interpreted as "fully" articulated mould frames, which would have guided hull shape and the runs of planking. The articulated frames in the Terence Bay Wreck were interpreted as non-mould frames due to there being only two. However, as mentioned earlier, it is likely that other laterally fastened frames went unnoticed because the excavators could not always distinguish between treenails and wood knots.[369] In *Boscawen*, only one of the mould frames' floors on the port side (Frame 4) was observed to be laterally fastened to its corresponding first futtock with a treenail.[370] The other mould frames' floors were not noted as having floor-to-first futtock treenails.[371] However, each of the mould frames' first and second futtocks were laterally fastened together with treenails.[372] It is possible that the excavators, similar to those working on the Terence Bay Wreck, overlooked the floor-to-first futtock fasteners due to the incredibly poor visibility at the site. For the Devereaux Cove Vessel and the Phinney Site (*Diligent*), the archaeological teams were unable to excavate these vessels to better investigate potential mould frames, but they found evidence of lateral fastening on framing components.[373] All four of these vessels likely had floor-to-futtock fasteners for regular mould frames, but if they did not, it would reveal a separate (third) construction sequence.

[369] Carter and Kenchington, "The Terence Bay Wreck," 17.
[370] As noted earlier, only the framing components (their curves and scantlings) on the port side were recorded by the archaeological team.
[371] Only one floor–futtock pair on the port side (Frame D) was noted as not having any lateral fasteners securing them together. The archaeologists did not record lateral fasteners among the remaining four pairs, but this does not mean that they did not have them.
[372] These treenails were often left long, sometimes extending 6 inches (15.24 cm) out from its futtock. Leaving treenails untrimmed like this would save carpenters time during the construction process.
[373] Hunter, "The Penobscot Expedition Archaeological Project," 58.

The Three Construction Sequence Possibilities

The first sequence begins with installing the floors and fully articulated mould frames along the keel after the stem and stern assemblies are secured. The garboards and initial strakes are then attached to the floors and mould frames (up to the heads of the floors). Following this, the intermediary first futtocks (for the non-mould frames) are fastened to the hull planking.[374] More strakes are attached to the master frames and the newly erected first futtocks' upper ends. After this, the heels of the second futtocks are secured to the hull planking above the floor heads and adjacent to the first futtocks. This pattern continued until the sides are fully planked and framed.

Alternatively, after the floors and mould frames are installed, the entire hull is planked (from garboards to caprails). The intermediary framing components are secured to the hull planking either during or after the planking process.

The third possible construction method (the sequence for the four vessels that may not have relied on mould frames, including *Boscawen*) would have started similarly after the stem and stern assemblies were constructed by installing all the floors on the keel. This time, however, only one or two fully articulated (laterally fastened) frames would have been erected. At this stage, the carpenters likely would have used ribbands to help visualize and mould the intended shape of the hull. Hereafter, the method would echo the first sequence: planking out to the heads of the floors, adding first futtocks, installing more planking, followed by second futtocks, and so on. This third method would have relied more on ribbands and "by eye" shaping of the hull.

Nevertheless, all twelve vessels appear to have been built using one of these three similar methods. The nature of these sequences—alternating the planking and framing (or installing

[374] In the case of *Defence*, this is also when its intermediary half frames and their associated first futtocks were installed.

them at the same time)—is a more efficient way to construct a vessel than the preplanned, mathematically designed hull construction methods that were more prevalent in England and especially used in the royal shipyards.[375] Regardless of which specific sequence was used, this general practice of vessel construction appears to be its own shipbuilding tradition, one that is related to but separate from its English counterpart. Additional research should be conducted on other eighteenth-century vessels built in North America, as well as from other regions, to substantiate this hypothesis.

Location, Date, and Speed of Build

It is important to understand the specific historical and geographical context in which vessels were built. Unfortunately, without historical documentation or large databases of dendrochronology for many eighteenth-century wrecks in North America, much of this analysis is impossible. For six of the shipwrecks within this study—the Tuttle Sloop, *Boscawen*, *Duke of Cumberland*, *Defence*, the Phinney Site (*Diligent*), and *Nancy*—historical records exist to confirm their identities and situate them within their appropriate contexts. Most of these vessels were built for military use and were hastily built. Speedy construction is evidenced by some of these vessels' framing components still bearing outer tree bark.[376] It is possible that the construction methodology of alternating the installation of planking and framing was chosen specifically to reduce build times but it might also have been the more commonly used method, which just happened to save time.

[375] Using this alternative building method (using disarticulated futtocks, installing frames and planks roughly at the same time, and designing frame curvatures "by eye") enabled carpenters to be more efficient by not square-cutting or laterally fastening framing components, thus allowing the building force to complete different tasks simultaneously.
[376] Crisman, "The Construction of the *Boscawen*," 61–64; Feldman, "'Hull Construction," 76.

On the other hand, *Nancy* was not built quickly, relative to *Boscawen* and *Defence*. Constructed in four months, it was considered by its owner to be a "perfect masterpiece of workmanship and beauty."[377] It is also interesting to note that the crew who built *Nancy* were not a part of an established American shipyard: the "three frenchmen, three englishmen, or rather irishmen [*sic*], good tractable fellows, and the Master Carpenter" were employed by shipyard owner John Richardson.[378] Although the identity of the master carpenter remains unknown, Richardson suggested in one of his letters that the master carpenter wanted to "distinguish himself" for future work.[379] The longer duration of the build, along with an ambitious shipwright, is likely the reason for *Nancy*'s twenty-five-year life span, which was relatively long for a merchant-built vessel.[380]

Boscawen, *Duke of Cumberland*, and the Tuttle Sloop were built for naval service on a freshwater lake. This was likely taken into consideration during the construction process, as evidenced by their slightly wider-spaced frames. Examining vessel framing robustness in Table 11, one may notice how *Boscawen* is one of the more robustly framed vessels, despite its lake environment. It is difficult to determine the exact reason why Loring decided to build *Boscawen* so robustly. Perhaps he wanted the sloop to be extra weatherly or better able to withstand French cannon fire. It could be that Loring did not wish to take the time to reduce timber size, or perhaps this was the only way he and the shipwright knew to build vessels. It could also be that in an effort to save time by "recycling" *Duke of Cumberland*'s timber molds, they simply built the sloop with the brig's timber dimensions.

[377] Sabick, "His Majesty's Hired Transport Schooner *Nancy*," 21; Cruikshank, "The John Richardson Papers," 23–27.
[378] Cruikshank, "The John Richardson Papers," 23–27; Sabick, "His Majesty's Hired Transport Schooner *Nancy*," 20.
[379] Cruikshank, "The John Richardson Letters," 27.
[380] *Nancy*'s life span would have been even longer had it survived through the war.

What we can be certain of is that many factors contributed to the manner in which *Boscawen* and the other eleven vessels of this study were designed and built. No single element, such as environment, intended purpose, material availability, or shipwright knowledge, can solely be responsible for the construction of a vessel. Rather, the shipwrights who built these eighteenth-century vessels took all these factors into account, making it difficult to confidently identify specific building trends in this relatively small dataset.

CHAPTER VII

CONCLUSIONS AND AVENUES FOR FUTURE RESEARCH

Boscawen is believed to be one of the oldest sailing vessels in and around Lake Champlain and is among only a handful of military vessels from the mid-eighteenth century that have been excavated in North America. In this dissertation, I consider how colonial shipwrights designed, built, and rigged these early sailing vessels for use on Lake Champlain, including those built by the British and possibly the French for the same conflict. These vessels are *Boscawen*, *Duke of Cumberland*, the Tuttle Sloop, CV-1 and -2, and KS-1 and -2. Because of the limited number of shipwreck excavations from the period and region, I can draw only tentative conclusions about noticeable shipbuilding trends and differences in building traditions and practices. Still, this study is useful for adding to our overall knowledge of eighteenth-century shipbuilding for Lake Champlain and vessels built in northeastern North America. My new photogrammetry methodology to recover 3D data from historical photographs (discussed in Chapter III) allows us to learn even more about other important "lost" vessels that may have eluded previous academic study.

In addition, I put *Boscawen* and the other local Seven Years' War vessels in context with others that were built later in the eighteenth century for use on different inland and coastal waterways in northeastern North America. These vessels include the Terence Bay Wreck, the Readers Point Vessel, NBHSS UAD SW#1 and SW#2, the Phinney Site (*Diligent*), the Devereaux Cove Vessel, the Revolutionary War privateer *Defence*, the WTC Wreck, and the transport schooner *Nancy*.

The analysis of frames from fifteen of the vessels in this study reveals how shipwrights from northeastern of North America conceived of framing dimension, patterns, and construction sequence in their vessels. It is hoped that this comparative study forms a framework for future research that has the potential to shed light on how shipbuilding practices developed in different temporal, geographical, and operational contexts. Employing my new framing robustness equation in vessel comparisons, we can more accurately evaluate the relationship between vessel size and framing dimensions and spacing. Ultimately, the equation provides us with another tool to help understand a shipwright's decision-making process.

The Seven Years' War Vessels on Lakes Champlain and George

Despite the limited number of vessels examined, there still are some observable ship construction trends and design elements among the Seven Years' War vessels built for use on Lakes Champlain and George. First, *Boscawen* and *Duke of Cumberland* appear to be nearly identical, other than in their lengths. This is unsurprising, for the two vessels were consecutively built by the same carpenters at the same shipyard and constructed under the guidance of Captain Joshua Loring. However, their hull similarities may have been more than a consequence of carpenter building practices and material availability. Rather, as I have posited in Chapter V, it may have been a strategy to expedite the construction of *Boscawen*. Evidence of efficiency and cutting corners is seen in many elements of the brig's and sloop's construction as well as in *Boscawen*'s rig (i.e., not squaring some of the framing components, irregular frame spacing, and its conglomerate of rigging components).

These same tactics and building conditions seem to have been present for the construction of the three small British sloops from Lake George. The Tuttle Sloop is somewhat larger than the other two sloops, but all three share commonalities in their scantlings, frame spacing, and construction methods. In addition, they all have been interpreted as being built under the direction of the same shipwright (Colonel Nathaniel Meserve) at the same location and around the same time.

In looking at these five vessels together, their similar stem and stern constructions, framing scantlings relative to vessel size, framing patterns, and planking strategies could all be interpreted as evidence for a possible British shipbuilding trend.

This shipbuilding strategy is even more noticeable when comparing the British-built vessels with the two possible French-built vessels (KS-1 and KS-2) surveyed in the King's Shipyard. The possible French vessels appear to have been constructed in a completely different shipbuilding tradition. The most notable differences were the use of square clench bolts to laterally fasten every frame pair in the hull and the consistency of the room and space of framing components. In addition, KS-1's Frame Robustness Value (0.015) was considerably lower than *Boscawen*'s (0.115) and the other British-built vessels.

Shipbuilding Trends Seen in Northeastern North American Vessels

The most noticeable trend seen among the northeastern North American vessels in this study is their comparable average frame spacing. The average frame spacing for the twelve vessels considered in the comparative framing analysis in Chapter VI is 22.42 inches (56.95 cm).[381] This value, when compared with individual frame spacing values for each vessel, many of which were 22 inches (55.88 cm), demonstrates the probability of a standardized shipbuilding practice used for the spacing of frames in vessels built in northeastern North America. Even one

[381] The spacing between half frames and mould frames for *Defence* was used to generate this vessel's average frame spacing value.

of the possible French sloops (KS-1) had an average frame spacing of 22.5 inches (57.1 cm). However, more data are needed to validate this hypothesis.

In addition, all of the vessels in this framing analysis share similarities in construction methodologies (although *Defence* was built with half frames between its mould frames). The vessels all have evidence of laterally fastened mould frames and independent framing components between them (i.e., floors and futtocks were fastened only to the hull planking), which suggests that the carpenters alternated between framing and planking after mould floors were installed.

In previous comparative studies, archaeologists have applied seemingly subjective labels such as "heavier built" and "lighter built" when evaluating vessel framing. They do not enumerate how those descriptors were determined or provide any quantifiable means for cross-vessel comparison.[382] I have proposed that archaeologists could better compare and evaluate vessels by examining multiple framing components (including average frame spacing, space between floors, floor and futtock dimensions, and vessel size) simultaneously, using my framing robustness calculation. As seen in Chapter VI, the resulting Framing Robustness Value allows more meaningful and quantifiable comparisons among vessels; however, it does not equate to overall vessel strength or hull durability, which depends on a multitude of factors that are more difficult to quantify.

Factors that Influence Ship Design and Construction

The construction methodologies used in *Boscawen* and the other vessels analyzed in the dissertation were influenced by a variety of factors, including environment, intended purpose,

[382] Morris et al., "The Comparative Analysis"; VanHorn, "Eighteenth-Century Colonial American Merchant Ship Construction," 180–191; Robinson, "Marine Archaeological Investigation," 25–28.

time and material availability, and shipwright knowledge. These variables make identifying shipbuilding trends within this relatively small dataset difficult. However, using *Boscawen* as an example, this multifaceted building influence is very apparent.

The environment of Lake Champlain (a narrow inland body of water with predominant north and south winds) partly dictated the designs and rigs of the vessels that Loring was tasked with building and fitting, and certainly influenced the shape of *Boscawen*'s boxier hull and its "reduced" sloop rig. The hull shape and rig were also influenced by the vessel's intended purpose as an armed military transport, which would be crewed by soldiers inexperienced in operating square sails and topsails.

It took only about three weeks to build *Boscawen*. Elements observed in its framing could be interpreted as shipbuilding shortcuts to save time. But it is unwise to hastily categorize construction methodologies such as leaving bark on framing timbers and using disarticulated futtocks between mould frames as mere shortcuts. Indeed, these techniques could save time and material, but they might also have been part of the shipbuilding tradition the carpenters and shipwrights were trained in. We do not know whether the unfinished timbers were "left" that way to achieve an intended molded or sided dimension or whether the shipwright's use of nonsquared timbers typified an acceptable standard.

Avenues for Future Archaeological Research

While this dissertation reports on and analyzes important data from a total of sixteen vessels, there is still much to learn about the building traditions and construction methodologies of vessels from built in northeastern North America. It will be important for subsequent academic research to consider the construction and design of the vessels examined here within larger regional and temporal contexts to better understand the transmission of shipbuilding knowledge and the building traditions specific to colonial America.

Although *Boscawen* was excavated for two seasons, researchers returning to the site could learn much more from this wreck. Archaeologists could record more data at the stem and stern assemblies, record additional frame curvatures (on both the port and starboard sides), and digitally record and map the hull with new technologies such as 3D sonar imaging.

The other two vessels that remain at the King's Shipyard site (KS-1 and KS-2) require dedicated long-term projects to excavate them fully. After the 2019 survey, we know that these vessels possess important information that would greatly benefit the field. These wrecks may be some of the oldest and only colonial French warships ever to be documented. Studying the artifacts on board would provide a unique opportunity to compare them with *Boscawen*'s, and an examination of hull construction features (including frame curvatures and dimensions, a mast step, possible deck remains, and other internal components) would be invaluable.

Scholars could pursue further archival research on the individual carpenters and shipwrights employed by General Amherst and led by Loring; their backgrounds and previous employments may reveal important information about the shipbuilding traditions they were exposed to and trained in. Additional research into *Boscawen*'s rig and hull, including its hypothetical sail area, sailing speed, and hull and rig stability could also be pursued.

There is a tendency in the field to overlook sites that have been "lost" to bad practices, historical enthusiasm, or neglect. We live in a world where politics and bureaucracy are beginning to limit the type and scope of fieldwork we are able to conduct. If we cannot acquire new data from the field, we must look to the archives and revisit material thought to be useless or a "lost cause"—and find new ways of divining information from it. My photogrammetry methodology can help retrieve such data from the archives. By learning from and building on the information that new techniques like this can provide, it is hoped that the field will advance and grow in new directions.

We must also continue to push for in-depth archaeological field investigations of early to mid-eighteenth-century British and French colonial American watercraft. Government entities and legal owners of these cultural heritage sites (here and abroad) must continually reevaluate how their vessels, and the information they could provide, are actively protected and studied—before they are destroyed by criminal looting or the variable and ever-changing local and global climates (both environmental and political). We must move forward through cooperation and action in order to learn from, appreciate, and protect our collective cultural heritage.

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APPENDIX A

"SCANTLING TABLES FOR *BOSCAWEN* AND OTHER COLONIAL-ERA NORTH AMERICAN VESSELS"

Table 1. Comparative Scantlings of All Vessels Discussed

Category	Vessel Name													
	Boscawen	***Duke of Cumberland****	**The Tuttle Sloop***	**CV-1 and CV-2**	**KS-1**	**The Terence Bay Wreck**	**The Readers Point Wreck**	**NBHSS UAD SW#1**	**NBHSS UAD SW#2**	**The Phinney Site (*Diligent*)**	***Defence***	**Devereaux Cove Vessel**	**The WTC Wreck**	***Nancy***
Location Built	Lake Champlain	Lake Champlain	Lake George	Lake George	Lake Champlain	Massachusetts	Massachusetts	Massachusetts	Massachusetts	Boston	Massachusetts	New England	New England	Lake Ontario
Vessel Type	Sloop	Brig	Sloop	Sloop	Sloop?	Fishing	West Indies Trade	Coastal Trader	Coastal Trader	Brig	Brig/Privateer	Troop Transport	Sloop/Coastal Trader	Lake Trader
Year Built	1759	1759	1756–1757	1756–1757	1758–1759	Pre-1750	Pre-1765	Pre-1778	Pre-1778	1776	1779	Pre-1779	Pre-1785	1789
Tons Burthen	130 tons	185 tons	30 tons	20 tons?	58 tons	100–120 tons	70–100 tons	100–110 tons	90–100 tons	220–236 tons	170 tons	>80 tons	~80 tons	100–120 tons
Length Overall	78 feet (23.8 m)	~100 feet (30.5 m)	54 feet (16.46 m)	—	60 feet (18.3 m)	70 feet (21.3 m)	60 feet (18.3 m)	70 feet (21.3 m)	60 feet (18.3 m)	100 feet (30.5 m)	85 feet (25.9 m)	60 feet (18.3 m)	60 feet (18.3 m)	78 feet (23.8 m)
Maximum Beam	24.33 feet (7.4 m)	24.33 feet (7.4 m)	14 feet (4.27 m)	—	22 feet (6.7 m)	18 feet (5.5 m)	18 feet (5.5 m)	22 feet (6.7 m)	18 feet (5.5 m)	24.67 feet (7.5 m)	24 feet (7.3 m)	18 feet (5.5 m)	20 feet (6.1 m)	24 feet (7.3 m)
Length-to-Beam Ratio	3.2:1	4.1:1	3.8:1	—	2.7:1	3.9:1	3.3:1	3.2:1	3.3:1	4:01	3.5:1	3.3:1	3:01	3.2:1
Depth of Hold	9 feet (2.7 m)	9 feet (2.7 m)	5.5 feet (1.6 m)	—	5.5 feet (1.7 m)	—	—	—	—	10.83 feet (3.3 m)	—	—	—	7.5 feet (2.3 m)
Keel Length	59.75 feet (18.2 m)	80 feet (24.4 m)	43.5 feet (13.7 m)	—	~50 feet (15.2 m)	55 feet (19.8 m)	42.5 feet (12.9 m)	56.6 feet (17.3 m)	50.4 feet (15.4 m)	79 feet (24.1 m)	65 feet (19.8 m)	45.5 feet (13.9 m)	45 feet (13.7 m)	59.75 feet (18.2 m)
Keel Molded	12 inches (35.5 cm)	12 inches (35.5 cm)	~8–9 inches (20.3–22.9 cm)	~8 inches (20.3 cm)	~8–9 inches (20.3–22.9 cm)	—	10.9 inches (27.68 cm)	11.5–16 inches (29.2–40.6 cm)	9.4–13.8 inches (23.9–35.1 cm)	15 inches (38 cm)	15 inches (38.1 cm)	—	9.12 inches (23.2 cm)	12–14.75 inches (30.5-37.5 cm)
Keel Sided	10.5 inches (26.7 cm), narrows to 6 inches (15.24 cm)	11 inches (27.9 cm)	6 inches (15.2 cm)	6.5 inches (16.5 cm)	~6 inches (15.2 cm)	—	9.6 inches (24.4 cm)	8.2–10 inches (20.8–25.4 cm)	8.7–11 inches (22.1–27.9 cm)	15.7 (40 cm)	8 inches (20.3 cm)	—	6.75 inches (17.1 cm)	8-9.5 inches (20.3–24.1 cm)
Keelson Length (total)	53.1 feet (16.2 m)	72 feet (21.9 m)	34–35 feet (10.4–10.7 m)	—	—	—	—	—	—	57.4 feet (17.5 m)	—	—	—	53 feet (16.1 m)
Keelson Molded (max.)	10 inches (25.4 cm)	10 inches (25.4 cm)	~9 inches (22.9 cm)	6 inches (15.2 cm)	—	—	9.6 inches (24.4 cm)	—	—	14.6 inches (37 cm)	12 inches (30.5 cm)	—	6 inches (15.2 cm)	12 inches (30.5 cm)
Keelson Sided (max.)	11 inches (27.9 cm)	10 inches (25.4 cm)	~9 inches (22.9 cm)	7.5 inches (19 cm)	—	—	10.9 inches (27.68 cm)	—	—	10.24 inches (26 cm)	13.5 inches (34.3 cm)	~14 inches (35.6 cm)	10.5 (26.7 cm)	9 inches (22.9 cm)
Floor Molded (avg.)	10.65 inches (27 cm)	10.65 inches (27 cm)	7.5 inches (19 cm)	7.5 inches (19 cm)	4–5 inches (10.2–12.7cm)	6 inches (15.2 cm)	10 inches (23.9 cm)	9.4 inches (23.9 cm)	10.25 inches (26 cm)	7.87 inches (20 cm)	12 inches (30.5 cm)	5 inches (12.7 cm)	5.5 inches (14 cm)	8.25 inches (21 cm)
Floor Sided (avg.)	9.92 inches (25.2 cm)	9.92 inches (25.2 cm)	6.5 inches (16.5 cm)	6 inches (15.2 cm)	4–5 inches (10.2–12.7 cm)	8 inches (20.3 cm)	9.5 inches (24.1 cm)	8.45 inches (21.5 cm)	7.5 inches (19.1 cm)	9.45 inches (24 cm)	8 inches (20.3 cm)	11.25 inches (28.6 cm)	5.75 inches (14.6 cm)	8.5 inches (21.6 cm)
Futtock Molded (avg.)	9.63 inches (24.5 cm)	9.63 inches (24.5 cm)	5 inches (12.7 cm)	~7.5 inches (19 cm)	4–5 inches (10.2–12.7 cm)	5 inches (12.7 inches)	8.25 inches (21 cm)	8.75 inches (22.2 cm)	5.5 inches (14 cm)	7.87 inches (20 cm)	8 inches (20.3 cm)	5.5 inches (14 cm)	5.2 inches (13.2 cm)	8 inches (20.3 cm)
Futtock Sided (avg.)	8.26 inches (21 cm)	8.26 inches (21 cm)	5 inches (12.7 cm)	~6 inches (15.2 cm)	4–5 inches (10.2–12.7 cm)	7 inches (17.8 cm)	8.8 inches (22.3 cm)	7 inches (17.8 cm)	7.1 inches (18 cm)	8.2 inches (21 cm)	8 inches (20.3 cm)	10.75 inches (27.3 cm)	5.2 inches (13.2 cm)	8 inches (20.3 cm)
Futtock Offset Keel (avg.)	6.16 inches (15.6 cm)	6.16 inches (15.6 cm)	—	9 inches (22.9 cm)	—	—	12 inches (30.5 cm)	—	—	—	13.5 inches (34.3 cm)	—	4–9 inches (10.2–22.9 cm)	7–10 inches (17.8–25.4 cm)
Average Frame Spacing	25.73 inches (65.3 cm)	25.73 inches (65.3 cm)	18 inches (45.7 cm)	12–15 inches (30.5–38.1 cm)	—	20 inches (50.8 cm)	22 inches (55.9 cm)	22 inches (55.9 cm)	22.4 inches (56.9 cm)	22 inches (55.9 cm)	26.5 inches (67.3 cm)	22 inches (55.9 cm)	17.7 inches (45 cm)	25 inches (63.5 cm)
Average Space Between Frames	15.73 inches (39.9 cm)	15.73 inches (39.9 cm)	11.5 inches (29.2 cm)	6–9 inches (15.2–22.9 cm)	13–14 inches (33–35.6 cm)	12 inches (30.5 cm)	12.5 inches (31.7 cm)	13.55 inches (34.4 cm)	14.5 inches (36.8 cm)	12.6 inches (32 cm)	18.5 inches (47 cm)	10.75 inches (27.3 cm)	12.25 inches (31.1 cm)	16.5 inches (41.9 cm)
Floor Robustness	0.057	0.042	0.034	—	0.007	0.029	0.08	0.045	0.043	0.034	0.037	0.058	0.019	0.033
Futtock Robustness	0.057	0.044	0.021	—	0.008	0.031	0.1	0.047	0.032	0.044	0.035	0.108	0.021	0.043
Framing Robustness Value	0.115	0.086	0.055	—	0.015	0.06	0.18	0.092	0.074	0.078	0.073	0.166	0.04	0.077
External Planking Thickness	2 inches (5.1 cm)	2 inches (5.1 cm)	1.5 inches (3.8 cm)	1.5 inches (3.8 cm)	1.5 inches (3.8 cm)	2 inches (5.1 cm)	2 inches (5.1 cm)	2 inches (5.1 cm)	2 inches (5.1 cm)	1.4 inches (3.5 cm)	2–2.5 inches (5.1–6.3 cm)	2.5–3 inches (6.3–7.6 cm)	1.5 inches (3.8 cm)	2 inches (5.1 cm)
Ceiling Planking Thickness	1.5–2 inches (3.8–5.1 cm)	2 inches (5.1 cm)	1.5 inches (3.8 cm)	1.5 inches (3.8 cm)	1 inch (2.5 cm)	2 inches (5.1 cm)	2 inches (5.1 cm)	—	—	—	—	—	0.87 inches (2.2 cm)	1.5 inches (3.8 cm)
Planking Fasteners	Iron nails and treenails	Iron nails and treenails	Iron nails and Treenails	Iron nails and treenails	Iron nails	Iron fasteners and treenails	Iron fasteners and treenails	Iron fasteners and treenails	Iron fasteners and treenails	Treenails	Iron fasteners and treenails	Treenails	Iron nails	Iron nails and treenails
Lateral Framing Fasteners (mould frames only)	Treenails	Treenails	Treenails	Treenails?	Iron square clench bolts	—	Treenails	Treenails	Treenails	—	Treenails	—	—	Treenails

* Values and information provided here are generated from photogrammetric models and associated historical and archaeological data.

Table 3 *Boscawen*'s Individual Floor Dimensions and Spacing

Frame Number (bow to stern)	Molded (taken near centerline)	Sided (taken near centerline)	Frame to Frame	Frame Spacing on Centers	Space Between
J	8.5 inches (21.6 cm)	8 inches (20.3 cm)	J - I	19.5 inches (49.5 cm)	12 inches (30.5 cm)
I	9.5 inches (24.1 cm)	7 inches (17.8 cm)	I - H	23.25 inches (59 cm)	14.75 inches (37.5 cm)
H	8 inches (20.3 cm)	10 inches (25.4 cm)	H - G	23.25 inches (59 cm)	13.25 inches (33.7 cm)
G	8 inches (20.3 cm)	10 inches (25.4 cm)	G - F	28.5 inches (72.4 cm)	18 inches (45.7 cm)
F	11.5 inches (29.2 cm)	11 inches (27.9 cm)	F - E	25.5 inches (64.8 cm)	15 inches (38.1 cm)
E	11 inches (27.9 cm)	10 inches (25.4 cm)	E - D	28.5 inches (72.4 cm)	18.25 inches (46.4 cm)
D	10.5 inches (26.7 cm)	10.5 inches (26.7 cm)	D - C	26 inches (66 cm)	16 inches (40.6 cm)
C	9.5 inches (24.1 cm)	9.5 inches (24.1 cm)	C - B	26.25 inches (66.7 cm)	16.25 inches (41.3 cm)
B	10 inches (25.4 cm)	10.5 inches (26.7 cm)	B - A	26.75 inches (67.9 cm)	17 inches (43.2 cm)
A	10 inches (25.4 cm)	9 inches (22.9 cm)	A - ꝏ	28 inches (71.1 cm)	18.5 inches (47 cm)
ꝏ	—	10 inches (25.4 cm)	ꝏ - 1	27.5 inches (69.8 cm)	17 inches (43.2 cm)
1	—	11 inches (27.9 cm)	1 - 2	24.5 inches (62.2 cm)	15.5 inches (39.4 cm)
2	11 inches (27.9 cm)	7 inches (17.8 cm)	2 - 3	26.5 inches (67.3 cm)	17 inches (43.2 cm)
3	—	12 inches (30.5 cm)	3 - 4	27.75 inches (70.5 cm)	16.25 inches (41.3 cm)
4	10.5 inches (26.7 cm)	11 inches (27.9 cm)	4 - 5	25 inches (63.5 cm)	15.5 inches (39.4 cm)
5	11 inches (27.9 cm)	8 inches (20.3 cm)	5 - 6	27.5 inches (69.8 cm)	18 inches (45.7 cm)
6	11 inches (27.9 cm)	11 inches (27.9 cm)	6 - 7	27.5 inches (69.8 cm)	16.5 inches (41.9 cm)
7	—	11 inches (27.9 cm)	7 - 8	28.5 inches (72.4 cm)	17 inches (43.2 cm)
8	—	12 inches (30.5 cm)	8 - 9	26.75 inches (67.9 cm)	15 inches (38.1 cm)
9	11 inches (27.9 cm)	11.5 inches (29.2 cm)	9 - 10	28 inches (71.1 cm)	17 inches (43.2 cm)
10	12 inches (30.5 cm)	10.5 inches (26.7 cm)	10 - 11	23.5 inches (59.7 cm)	12 inches (30.5 cm)
11	12 inches (30.5 cm)	12.5 inches (31.7 cm)	11 - 12	27.25 inches (29.2 cm)	16.5 inches (41.9 cm)
12	12 inches (30.5 cm)	9 inches (22.9 cm)	12 - 13	22 inches (55.9 cm)	14 inches (35.6 cm)
13	—	7 inches (17.8 cm)	13 - 14	21.5 inches (54.6 cm)	12.5 inches (31.7 cm)
14	15 inches (38.1 cm)	11 inches (27.9 cm)	14 - 15	24 inches (61 cm)	14.5 inches (36.8 cm)
15	11 inches (27.9 cm)	8 inches (20.3 cm)	—	—	—
AVERAGE FLOOR	**10.65 inches (27 cm)**	**9.92 inches (25.2 cm)**	**AVERAGE SPACING**	**25.73 inches (65.3 cm)**	**15.73 inches (39.9 cm)**

Table 4 *Boscawen*'s Individual First Futtock Dimensions and Spacing

Frame Number (bow to stern)	Molded (taken near centerline)	Sided (taken near centerline)	Space to Corresponding Frame*	Space to Next/Previous Frame*	Offset from Keel
J	—	8 inches (20.3 cm)	2 inches (5.1 cm)	2 inches (5.1 cm)	8 inches (20.3 cm)
I	10.5 inches (26.7 cm)	10 inches (25.4 cm)	3 inches (7.6 cm)	0 inches (0 cm)	–1.25 inches (–3.2 cm)
H	10.5 inches (26.7 cm)	8 inches (20.3 cm)	0 inches (0 cm)	5.5 inches (14 cm)	–1.25 inches (–3.2 cm)
G	—	9 inches (22.9 cm)	6.5 inches (16.5 cm)	2.5 inches (6.3 cm)	8.5 inches (21.6 cm)
F	10 inches (25.4 cm)	8 inches (20.3 cm)	3.25 inches (8.2 cm)	3.5 inches (8.9 cm)	3.5 inches (8.9 cm)
E	—	9 inches (22.9 cm)	2.5 inches (6.3 cm)	6 inches (15.2 cm)	11 inches (27.9 cm)
D	10 inches (25.4 cm)	9 inches (22.9 cm)	0 inches (0 cm)	7.5 inches (19 cm)	10 inches (25.4 cm)
C	9.5 inches (24.1 cm)	9.5 inches (24.1 cm)	3.5 inches (8.9 cm)	2.5 inches (6.3 cm)	11 inches (27.9 cm)
B	—	9 inches (22.9 cm)	5 inches (12.7 cm)	3 inches (7.6 cm)	9 inches (22.9 cm)
A	—	8.5 inches (21.6 cm)	3.5 inches (8.9 cm)	4 inches (10.2 cm)	11.5 inches (29.2 cm)
⊗	10 inches (25.4 cm)	7 inches (17.8 cm)	0 inches (0 cm)	10 inches (25.4 cm)	5.75 inches (14.6 cm)
1	—	—	—	—	—
2	9 inches (22.9 cm)	8.5 inches (21.6 cm)	4 inches (10.2 cm)	3 inches (7.6 cm)	5.5 inches (14 cm)
3	9 inches (22.9 cm)	9 inches (22.9 cm)	3.5 inches (8.9 cm)	3 inches (7.6 cm)	6 inches (15.2 cm)
4	10 inches (25.4 cm)	6 inches (15.2 cm)	0 inches (0 cm)	9 inches (22.9 cm)	6.5 inches (16.5 cm)
5	10 inches (25.4 cm)	9.5 inches (24.1 cm)	4.25 inches (10.8 cm)	1 inch (2.5 cm)	8 inches (20.3 cm)
6	10 inches (25.4 cm)	9 inches (22.9 cm)	4 inches (10.2 cm)	5 inches (12.7 cm)	5.5 inches (14 cm)
7	10.5 inches (26.7 cm)	8 inches (20.3 cm)	6 inches (15.2 cm)	2 inches (5.1 cm)	7 inches (17.8 cm)
8	—	9.5 inches (24.1 cm)	0 inches (0 cm)	7.5 inches (19 cm)	7 inches (17.8 cm)
9	—	6 inches (15.2 cm)	8 inches (20.3 cm)	1 inch (2.5 cm)	6.5 inches (16.5 cm)
10	—	8 inches (20.3 cm)	6 inches (15.2 cm)	3 inches (7.6 cm)	8.5 inches (21.6 cm)
11	8 inches (20.3 cm)	9 inches (22.9 cm)	1.25 inches (3.2 cm)	1.25 inches (3.2 cm)	8 inches (20.3 cm)
12	8.5 inches (21.6 cm)	8 inches (20.3 cm)	0 inches (0 cm)	8.5 inches (21.6 cm)	1 inch (2.5 cm)
13	—	6.5 inches (16.5 cm)	4.5 inches (11.4 cm)	2 inches (5.1 cm)	1 inch (2.5 cm)
14	—	6.5 inches (16.5 cm)	2.5 inches (6.3 cm)	3 inches (7.6 cm)	–1.25 inches (–3.2 cm)
15	9 inches (22.9 cm)	8 inches (20.3 cm)	5 inches (12.7 cm)	1.75 inches (4.4 cm)	9 inches (22.9 cm)
AVERAGE FUTTOCK	**9.63 inches (24.5 cm)**	**8.26 inches (21 cm)**	**3.13 inches (7.9 cm)**	**3.9 inches (9.9 cm)**	**6.16 inches (15.6 cm)**

*Framing pattern shifts at Frame 16 (midship frame). After the midship frame, futtocks were installed forward of their corresponding frame.

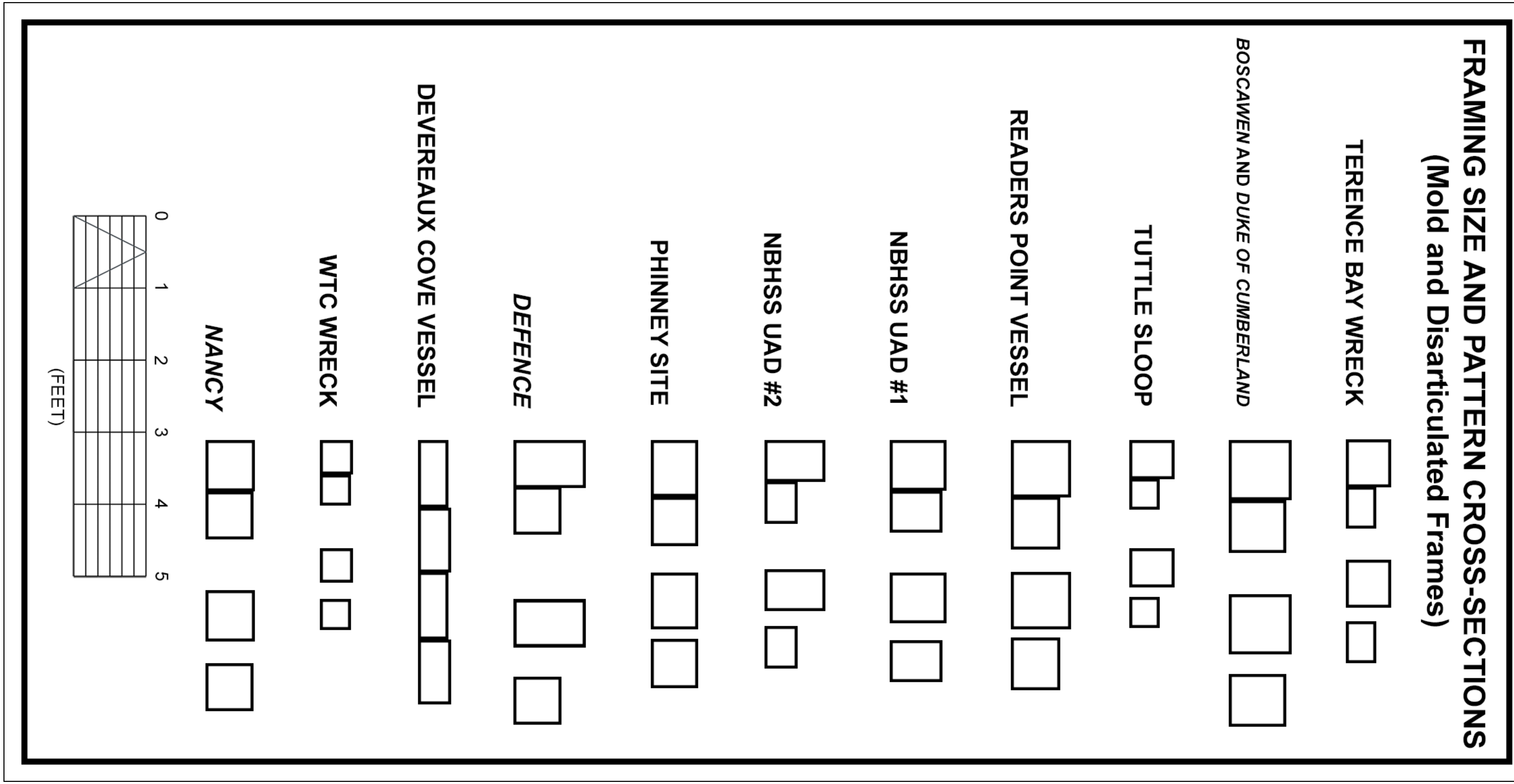

Figure 111 Framing size and pattern cross-sections.