THE LAST SCHOONERS: THE TWO-MASTED SCHOONER *KATIE ECCLES* AND THE DECLINE OF SAIL ON LAKE ONTARIO

A Dissertation

by

BENJAMIN MURRAY IOSET

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Chair of Committee,	Christopher Dostal
Committee Members,	Kevin Crisman
	Felipe Castro
	Brian Rouleau
Head of Department,	Darryl de Ruiter

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ABSTRACT

The last quarter of the 19th century witnessed the increasing industrialization of the Great Lakes region and the emergence of the modern Great Lakes transportation system, a system which would ultimately supplant the sailing commerce which defined freight transport on the lakes throughout most of the 19th century. While steamboats were introduced to the Great Lakes as early as 1817, competition between sail and steam was limited before the middle of the 19th century, with sail and steam occupying separate economic roles in the emerging regional economy. The introduction of novel steam-propulsion technologies and more efficient steamship designs intended for carrying freights from the 1840s and 1850s brought sail and steam into direct competition.

By the early 1880s, the momentum within shipping on the Great Lakes had decidedly begun to shift toward steamships as increasingly efficient steamships and means of handling bulk freights lowered freight rates and shifted shipping markets towards bulk low-cost, low profit per ton transport, all of which favored steam. By the 1880s, Lake Ontario's sailing fleets had been largely relegated from the profitable inter-lake trade to local trading confined within Lake Ontario and the Upper St. Lawrence and by 1900 had become almost entirely reliant on the transport of a single commodity, anthracite coal. In this local role, sailing vessels persisted for another 30 years.

In 2019 the author directed the Last Schooner Project, photogrammetrically documenting and surveying the wreck of the two-masted schooner *Katie Eccles* which was among the last schooners in operation on Lake Ontario. This survey produced

significant information regarding the changes that sailing vessels underwent in their final years, as well as the specialized role such vessels possessed in Lake Ontario's intra-lake trade in which sailing commerce on the Great Lakes spent its final years.

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INTRODUCTION

On the evening of 26 August 1925, a crowd of onlookers gathered along the waterfront of Oswego, New York to view a remarkable sight that would have passed unnoticed some 20 years prior. The sails of three schooners had appeared upon the lake and were running into Oswego before a northeasterly breeze.

As the day's last light waned, the two-masted schooners, or "fore-and-afters," *Lyman M. Davis* and *Mary A. Daryaw*, and the three-masted schooner, or "three-and-after," *Julia B. Merrill* slipped in past the lighthouse and outer harbor piers under their canvas. The youngest of these schooners, *Lyman M. Davis*, was in its fifty-second season on the lakes and though it remained in service for another six years, all of the schooners were much diminished from the trim vessels they had once been, as noted by the *Oswego Palladium-Times:*

> "Steam from a donkey boiler forward now hoists the patched sails and browned canvas of the present-day sailing ships. Their decks are smirched with coal dust, no longer do owners or crew take pride in brightwork and varnished masts. They serve another purpose still, but the days of fast passage are gone, as likewise are the days when skippers took their ships to sea regardless of the wind. Now the schooners that are left to go to sea only with fair winds and rising glass, for hulls are weak and

> leaky, and caulking has a way of pulling out in a seaway and some say, are kept afloat only by steam siphons (*Oswego Palladium-Times* 1925)."

These schooners, built in the 1860s and 1870s at the height of sailing commerce on the Lakes, were three of only four remaining sailing vessels on Lake Ontario. 50 years before, 75 sail could be sighted simultaneously in and about the harbor carrying Oswego's thriving commerce throughout the Great Lakes (Snider 1931).

Beneath the romanticism and nostalgia which has so often characterized literature on the waning years of sail, the journalist hinted at some of the struggles besetting these remaining vessels in their struggle for financial viability in the coal trade with Canada. This late-August trip, entering what was once the height of the profitable season, was likely to be their last of the season as they laid up, anticipating work stoppages in the anthracite fields of Pennsylvania. Their livelihood was now solely dependent on the anthracite industry, which had been particularly unstable throughout the 1920s. The end of 1925 and beginning of 1926 would be a crucial for the anthracite industry, and the precipitous collapse of anthracite markets, thereafter, would leave these schooners dependent on a declining industry (Karanek 1974:60-61). By the beginning of the 1932 season, *Lyman M. Davis*, the last lake-built schooner still operating under sail was not fitted out at the beginning of the season (Oswego *Palladium-Times* 1932)[1].

By 1925, sailing commerce on the Great Lakes had been waning for more than half a century, though the recognized dates for the transition between sail and steam have varied between 1868 and 1885 (Lewis 2015:346). Throughout the 19th century, the Great Lakes developed from a sparsely settled maritime frontier into an inland extension of the Atlantic maritime world forming, along with the St. Lawrence River, a corridor for navigation some 2,300 mi. (3,701 km) into the interior, into the heartland of the American and Canadian nations. It was soon among the most heavily trafficked waterways in the world. (Jensen 2019:5-6). For most of the century, it was sailing vessels, rather than steamers that dominated the lakes, and which carried the greater proportion of their commerce (Lewis 2015:347). For nearly four decades after the introduction of steam navigation to the lakes, sail and steam vessels plied their respective trades with only limited competition. Steam vessels, being inefficient bulk freight carriers with high construction and operating costs were uneconomical in bulk freighting but were ideally suited for passenger and package freight service. In contrast, sailing vessels dominated the transport of freights until the last quarter of the 19th century (Lewis 2015:365-366).

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[1] The *Lyman M. Davis*, which remained in commission through the end of the 1931 shipping season, was the last commercial schooner built on the Great Lakes to operate under sail. The three-masted schooner *Our Son*, has been incorrected identified as such, though the *Davis* remained in commission for more than a year after the loss of *Our Son* on 26 September 1930 (Karamanski 2001:223).

It was only after the mid-19th century that advancements in the efficiency of steam propulsion and the introduction of hull designs better suited for bulk freight carrying that steam began to displace sailing vessels. By the late-1870s and 1880s, steam had surpassed sail in both overall numbers of registered vessels as well as aggregate tonnage, and while sail tonnage remained consistent throughout the last decades of the century, the number of vessels operating under sail declined (Lewis 2015:374).

While the development of bulk carriers, and particularly steel vessels from the later 1880s, has been widely studied (e.g. Labadie 1989:26-29; Devendorf 1995; Rodger 2003, Dappert 2006), the circumstances that resulted in the emergence of the modern bulk freight transport system of the Great Lakes in which sailing vessels were increasingly uncompetitive and unprofitable predate their introduction. The movement of the freight transport economy towards an industrially-arranged transportation system characterized by high-volume, low-profit freight transport was brought about by developments in steam barges and bulk carriers, as well as the adoption of novel management approaches, new mechanized methods of handling loose bulk freights, and in the widespread employment of towing. Within this economy, re-oriented towards steam, sailing vessels were disadvantaged and thereafter began to decline in numbers.

The history of this last generation of lake sailing vessels and their prolonged disappearance has been widely overlooked due to contemporary focus on the development of steam vessels and particularly bulk carriers. While it is perhaps true that the motive forces which rendered sail obsolete were largely developments within steam technology and shipbuilding, this narrative acknowledges only a portion of the story, a portion in which steam is portrayed as dynamic and sailing vessels as static and unchanging in the face of increasing marginalization.

In reality, sailing vessels were dynamic and adaptable, undergoing numerous changes to continue to compete with steam. Though often met with initial hesitancy, novel marine technologies brought about extensive changes in not only the vessels themselves but also their operations and life aboard for their crews. These innovations and their implementation aboard sailing vessels have received very little comment from maritime historians or archaeologists alike. Their histories, like that of the vessels themselves, have largely been relegated to obscurity by a contemporary fascination with the steam vessels which came to dominate the lake's economy.

This dissertation will discuss what developments precipitated the decline of sail, particularly on Lake Ontario, and what conditions allowed and were exploited by sailing vessel owners and masters to keep their ships in service. As the potential scope of these questions is vast, I will attempt, insofar as is possible, to restrict the discussion towards only those developments on the Great Lakes which had direct implications for Lake Ontario carriers.

I will argue that, in contrast to the idea of sailing vessels as rigidly unchanging and conservative, the persistence of some sailing vessels was in large part due to innovations and the adaptability of these vessels and their crews. The economic viability of sail commerce varied considerably throughout the lakes, and sailing vessels changed in nearly all aspects of vessel operation, maintenance, equipage, and management in response to their increasingly marginalized position. The high adaptability of sailing vessels enabled them to persist within trades for which they had not been intended.

I will further argue that the unique economic environment afforded to Lake Ontario, and the variegation of commerce on Lake Ontario between the inter-lake forwarding trades, primarily concentrated on the forwarding of grain and other commodities to lake terminals on Lake Ontario and Lake Erie for transshipment eastward, and local trading between ports on Lake Ontario itself. These differences resulted in vastly varying experiences between vessels employed primarily in one role or the other.

Jay C. Martin, focusing on the broader Great Lakes economy, maintains the differentiation of Great Lakes transportation between "international" and "coastwise" trades to characterize these differing roles (Martin 1995:19-20). Martin defines the coastwise trade as "sailing between two ports (often on the same lake) in the same country with no intermediate stops at foreign ports," while international trade is characterized as having been over longer distances and by larger vessels. Martin subsumes inter-lake trading, transmitting two or more lakes within this international trade. These categories are problematic as commerce of vastly disparate character including both inter-lake and local trade would thus be aggregated. The majority of freight tonnage carried in American vessels on the lakes was between Upper Lake ports and the terminals within the United States, and thus much of the long-distance, interlake trade was actually coastwise. In contrast, many Canadian vessels were engaged in importing American commodities along nearly the same routes or within the same lake and would be characterized as international trade (Martin 1995:19-20).

Martin's distinction, seemingly derived from contemporary customs reporting, is problematic when studying Lake Ontario alongside the other Great Lakes due to the intensively and uniquely international character of its local trade. Though Lake Ontario's share of the lake trade was the smallest among the lakes, it was disproportionately important in the international trade (Ford 2018:87). In 1892, Oswego ranked 46th among Great Lakes ports in domestic cargo receipts, while it ranked 3rd in the United States in the value of its imports and exports. Nearly all of this international trade was carried by local vessels operating primarily on Lake Ontario (Brock 1892:XXIX,26-29).

A more relevant distinction can be made between short-distance trading, often confined within a single lake, employed in whatever local charters were available at the time, and those employed in the inter-lake trade (Meverden and Thomsen 2010:5-7).

While the restrictions imposed by the Welland Canal across the Niagara Peninsula between Lakes Ontario and Erie, limited the effectiveness of competition from steam vessels on Lake Ontario, subsequent improvements would increasingly disadvantage sailing vessels. The effects of competition from what Bradley Rodgers refers to as "the bulk carrier system" were most acutely and immediately experienced among sailing vessels in the inter-lake trade, as freight rates plummeted rapidly with the increasing efficiency of bulk freight handling and bulk freight carriers (Mansfield 1899:535; Rodgers 2003:37). By the end of the 19th century, the ascendency of steam was apparent to all. The effects of competition were first felt in the American sailing fleet, which was reliant on inter-lake forwarding trade, primarily in grain. These vessels disappeared rapidly as steam competition reduced freight rates, while Canadian vessels, driven from the inter-lake trade, were largely relegated into local trading on Lake Ontario.

Lake Ontario's smaller scale of economy, the low operating cost of sailing vessels, and the comparatively high price of anthracite coal, as well as a lack of improvements to many lakeports, combined to create an economic environment that enabled the persistence of sail longer than elsewhere in the Great Lakes. Amidst the increasing marginalization of its role in the coal trade with declining demand and labor instability, increasing maintenance costs, and aging hulls, stretched long past their anticipated service lives, sailing commerce came to an end by 1931 (Oswego *Palladium-Times* 1932; Karamanski 2001:223).

As a result of these changing roles and pressures upon sail operators and owners, sailing vessels underwent extensive changes throughout the late-19th century and early decades of the 20th century. This dissertation will utilize historical and archaeological records to examine how sailing vessels were adapted to remain viable in the years after steam had surpassed sail in aggregate tonnage and number of vessels. Accordingly, it will discuss the archaeological remains of one such vessel, the *Katie Eccles*, inquiring what construction techniques were employed, how hull designs were adapted to local commercial conditions, and how these vessels changed throughout their lifespans to adapt to an increasingly economically uncompetitive position.

The end of sail has received only passing comment from most historians of the Great Lakes, and no work has been entirely dedicated to discussing this transition from the perspective of the sailing vessels and those sailing them. This obscurity is, in part, the result of contemporary historian's concentration on the emergence of the modern bulk freighting system and massive bulk carrier designs, which were, by the end of the 19th century, more important statistically to the economy of the Great Lakes.

In attempting to reconstruct the history of the decline of sail, the annual reports of the Bureau of Statistics on the *Commerce and Navigation of the United States* and *Report on the Internal Commerce of the United States* and the U.S. Census Bureau's report *Transportation by Water* provide intermittent statistical insights into the commerce of Lake Ontario and the composition of its shipping fleets (Straus 1908). These sources cover the topic to the turn of the 20th century and figure prominently as sources for the foundational historical works: J.B. Mansfield's *History of the Great Lakes* (1899) and James C. Mills' *Our Inland Seas* (1910), which cover the transition up to the dates of their publications. While these histories extensively discuss the economic role and development of Great Lakes sailing vessels, their principal emphasis is upon the growth of the Great Lakes economy. Therefore, as sail's statistical importance to the lake trade diminished from the 1870s, so too did the centrality of sail in these author's narratives. The principal focus on the inter-lake commodities trade in these works meant that as sailing vessels were relegated to local trading, they were increasingly overlooked in favor of steam vessels.

Recent histories such as Jay C. Martin's social history of lake sailing vessels *Sailing the Freshwater Seas* and Theodore Kamanski's *Schooner Passage* discussed the decline of sail. This is particularly true of Martin, although it was beyond the scope of his work to discuss the changes that the vessels themselves underwent in more than a passing manner (Martin 1995; Karamanski 2001). Ben Ford's maritime cultural landscape study of Lake Ontario, while influential for its historical background for Lake Ontario and for being among the only works focusing on Lake Ontario, does not discuss the details of sailing vessels, nor their operations on the lake beyond the broader historical trends (Ford 2018).

The column *Schooner Days*, published in the *Evening Telegram* of Toronto between 1931 and 1954, authored by C.H. J. Snider, provided valuable though anecdotal and often second-hand information regarding life aboard lake vessels, particularly for Canadian vessels on Lake Ontario in the last quarter of the 19th century and early-20th century. Similarly, amateur historian Willis Metcalfe is the principal source for Canadian vessels operating out of Prince Edward County and the Bay of Quinte.

While there remain large gaps in our knowledge of wooden shipbuilding on the lakes, archaeological investigations have narrowed these considerably. Ships and their archaeological remains are the material products of the social, cultural, and historical contexts that produced them, reflecting the economic decisions and enterprise by the owner, the technology and craftsmanship of the shipwright, and the work of those working aboard it. Vessels influenced thousands of individuals throughout their lifespan, their influence extending far beyond those immediately involved in their ownership and direct operation. Furthermore, the vessel itself was the result of innumerable, intentional decisions, the results of which are preserved, if imperfectly, within the archaeological record. Accordingly, the remains of these vessels are communicative and invaluable sources of historical information not only for the ship itself but for contemporary maritime culture and social context in which the ships were built and operated (Steffy 1994:5).

Though Lake Ontario is underrepresented within the historical literature of the Great Lakes, Lake Ontario's sailing fleet features prominently among the assemblage of archaeologically investigated shipwrecks throughout the Great Lakes, attesting to the intensity of Lake Ontario's commercial enterprises. Lake Ontario built or owned commercial vessels that have been the subject of archaeological studies include the barkentines *Montgomery* and *Sligo*, the canal schooners *Bermuda*, *Daniel Lyons,* and *Kate Kelly, Northerner*, *Walter B. Allen,* and *J.S. Williams* (Labadie 1989:35-42; Monk 2003; Meverden *et al.* 2006; Rodgers *et al.* 2006; Meverden and Thomsen 2010:101-115; Meverden *et al.* 2012:60-79; Thomsen *et al.* 2019:51-76). Another mid-19th-century schooner on Lake Ontario, the CityPlace schooner, has recently been documented by nautical archaeologists from Texas A&M University (Herbst 2019).

Archaeological investigations of Great Lakes steam vessels have provided substantial information on shipbuilding techniques and advances in steamship design throughout the 19th century. These investigations have provided important contextual information for developments within steam vessels that ultimately transformed the Great

Lakes transport economy, and, over the latter half of the 19th century, transformed steam vessels into efficient, high-volume, low-cost carriers that would supplant sailing vessels. Investigations of the sidewheel steamboat *Anthony Wayne* and the early propeller-driven steamboat *Indiana* provide insight into the early development of steam propulsion and shipbuilding (Robinson 1999; Krueger 2012). The subsequent development of steam barges is elaborated in Dina Baziill's study of the steam barge *Joys* as well as the Wisconsin Historical Society's surveys of *Grace Patterson* (Bazzill 2007; Thomsen *et al.* 2019:77-86). Bradley Rodgers and Claire Dappert had produced studies of the bulk freight carriers *City of Glasgow* and *Monohansett*, while the Wisconsin Historical Society and National Park Service's Submerged Cultural Resource Unit surveys provide numerous additional examples of this important vessel type (Labadie 1989; Cooper and Jensen 1995; Rodgers 2003; Dappert 2006; Meverden and Thomsen 2013:46-62; Thomsen *et al.* 2019:29-50). This archaeological information is supplemented by substantial secondary literature concerning steamship development and changing trends in the management and operation of steamship lines involved in bulk freighting (Mills, R. 2002; Jensen 2019). Taken together, this literature provides a clear picture of the development of freighting steam vessels on the lakes.

Lake Ontario, and particularly Eastern Lake Ontario, contains an unrivaled wreck assemblage from the Canadian sailing fleet of the early 20th century, many of which are remarkably well-preserved and often intact. These shipwrecks provide an ideal opportunity to improve our understanding of these vessels, their operational histories, and the changes that such vessels underwent in the waning years of sail as sailing vessels struggled to remain economically viable.

Among the located and identified vessels in the Eastern basin of the lake are the schooners *Abbie L. Andrews* (1873-1920), *City of Sheboygan* (1871-1915), *George A. Marsh* (1882-1917), *Hattie Hutt* (1888-) *Horace L. Taber* (1867-1922), *Katie Eccles* (1877-1922), *Oliver Mowat* (1873-1921), *William Jamieson* (1878-1923) and the scow schooner *Maggie L.* (1889-1929). In addition to this shipwreck assemblage, the *Sligo* (1860-1918), *Julia B. Merrill* (1872-1931), *Lyman M. Davis* (1873-1934) lie off Toronto at the western end of Lake Ontario. With the limited historical information regarding the vessels themselves, this assemblage of well-preserved vessels from this important transitionary period provides an ideal opportunity for archaeological research and study of the development of hull forms on the Great Lakes. The exceptional preservation afforded by Lake Ontario's fresh, cold waters allows reconstruction and analysis of such hulls with minimal conjecture by the reconstructionist and comprises an invaluable archaeological record of these last sailing vessels.

The Last Schooners Project 2019-2020

The Last Schooners Project was conceived as a multi-year archaeological project documenting the remains and focusing on vessels lost between 1920 and 1931, the final decade of commercial sail on Lake Ontario. It sought to provide a more complete understanding of these sailing vessels, their operations, and the changes that these vessels underwent in their final years.

The *Katie Eccles*, a two-masted schooner built in 1877, which spent its entire career on Lake Ontario before being lost in November 1922, was selected as the focus of the 2019 pilot season. *Katie Eccles*' operational history is typical of Canadian vessels that engaged in trading on Lake Ontario in the last quarter of the 19th and first three decades of the 20th centuries. Such schooners performed an important role in integrating Canadian lakeshore communities with wider markets and have seldom been the subject of archaeological studies. The *Eccles* was selected on account of its accessibility and exceptional state of preservation, which would provide an ideal test of the proposed methodology for site recording and reconstruction.

The *Katie Eccles*' well-preserved and nearly complete remains were located in 1985 off Prince Edward County in Lake Ontario's eastern basin. Though the location has been publicly accessible since 2002, no archaeological investigations were undertaken to document the shipwreck before 2019. The research objectives for the pilot season were to produce a 1:1 scale-constrained photo model of the site which allowed remote study, analysis, and reconstruction, to establish a photographic record of the site, and to generate a site plan from orthophotos produced from the photo model.

The 2019 field season focused primarily on the documentation of the hull of *Katie Eccles* by video recording the site to produce a three-dimensional photo model. This video would form the basis for analysis and interpretation of shipbuilding techniques, while the photo model provided the basis for measurements and a reconstruction of the hull's form as a set of ship lines. Furthermore, the pilot season sought to document the ship's machinery as well as the remains of its spars and rigging to the extent allowed by permitting restrictions and the project's remote access approach.

While diving operations possess certain advantages for the archaeologist, provincial regulatory restrictions on scientific diving combined with planning and budgetary limitations made diving operations unfeasible for the 2019 season. The survey was conducted remotely using a Teledyne Seabotix LBV-150-2 remotely operated underwater vehicle, provided by the Institute of Nautical Archaeology. Structure from Motion (SfM) photogrammetry provided an ideal means of remote site recording. SfM photogrammetry generates three-dimensional photo models using the Exchangeable Image File Data (EXIF) of each photograph, which allows the software to automatically identify shared points from pixel data appearing in multiple overlapping photographs. Provided that a point appears in three or more overlapping photographs, the software is able to estimate the positions of the camera, and calculate the positions of the shared pixels, forming a point cloud representing the geometry of the subject. The 3D models created using SfM allow for the site to be digitally revisited and analyzed which allowed analysis post-season. This record was supplemented by the two-dimensional video taken of the site which would be used to generate the photo model. SfM photogrammetry thus simultaneously allowed the accurate mapping and production of a scaled, measurable photo model which simultaneously recorded the as-preserved form of the hull, providing the basis for a reconstruction of the hull form.

As the scale-constrained photo model accurately represents both the measurements of the hull as well as its preserved form, the transverse sections of the hull, taken at measured intervals in Rhino3D, a three-dimensional modeling software, formed the basis for a set of reconstructed ship lines for *Katie Eccles* from which analysis of the hull can be made (Yamafune 2016, Yamafune *et al.* 2017:716-720).

As the project was initially planned with a broader scope of inquiry into the archaeology of the Lake Ontario sailing fleet, plans for the 2019 field season originally included the documentation of the three-masted schooner *Oliver Mowat*. While the *Oliver Mowat* was to be the secondary focus of the 2019 season as a representative of three-masted schooners originally engaged in the inter-lake trade, no work was conducted at that site due to a delay in receipt of the permit in 2019 (the result of ongoing revisions of permitting restrictions on sites potentially containing human remains).

A second field season was planned for June 2020 to revisit the *Katie Eccles* and to survey the *Mowat,* however, the imposition of travel restrictions on the United States and Canadian border and the restriction of Texas A&M University research travel due to the COVID-19 pandemic necessitated the cancellation of further data gathering. Despite the 2020 cancellation, the 2019 season produced sufficient data to accomplish the principal research objectives of the project, albeit on a constrained scale, focusing on the archaeology *Katie Eccles.* Historical insights derived from archival and historical research into the *Oliver Mowat* have been retained in adapted form, as this schooner's history was particularly communicative of changes undergone by Canadian vessels engaged in the inter-lake trade, but which ended their careers confined to Lake Ontario alone.

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CHAPTER II

THE LAKE ONTARIO SAILING FLEET, 1815-1932

The inland position of the Great Lakes gives the impression of inland seas, isolated from the influence and communication with the Atlantic. In fact, the settlement and subsequent development of the Great Lakes throughout the 19th century was defined by efforts to integrate the lakes with the Atlantic, forming a maritime frontier of the Atlantic in the interior of the continent. These efforts involved overcoming obstacles impeding movement between the lakes, forming a continuously navigable chain beginning at the St. Lawrence Estuary and extending to the head on Lake Superior (Jensen 2019:15).

With a surface area of 7,340 mi^2. (18,960 km^2), Lake Ontario (Figures 1 and 2) is the smallest of the Great Lakes. The lake is drained by the St. Lawrence River, which runs more than 300 mi. (482 km) to the Gulf of St. Lawrence and the Atlantic, forming a natural corridor of communication into the interior, though it required multiple portages around the rapids on the river. The head of Lake Ontario is connected by the Niagara River to Lake Erie, and by extension, the Upper Great Lakes. Navigation along this river was prevented by the 326 ft (99 m) high Niagara Falls formed by the Niagara Escarpment, the single greatest obstacle to navigation between lakes (U.S. Environmental Protection Agency 2020). This was overcome by the construction of the Welland Canal in the early 19th century.

During the 19th century, Lake Ontario witnessed the smallest share of the commerce of the Great Lakes due to the constraint on navigation imposed by the transit

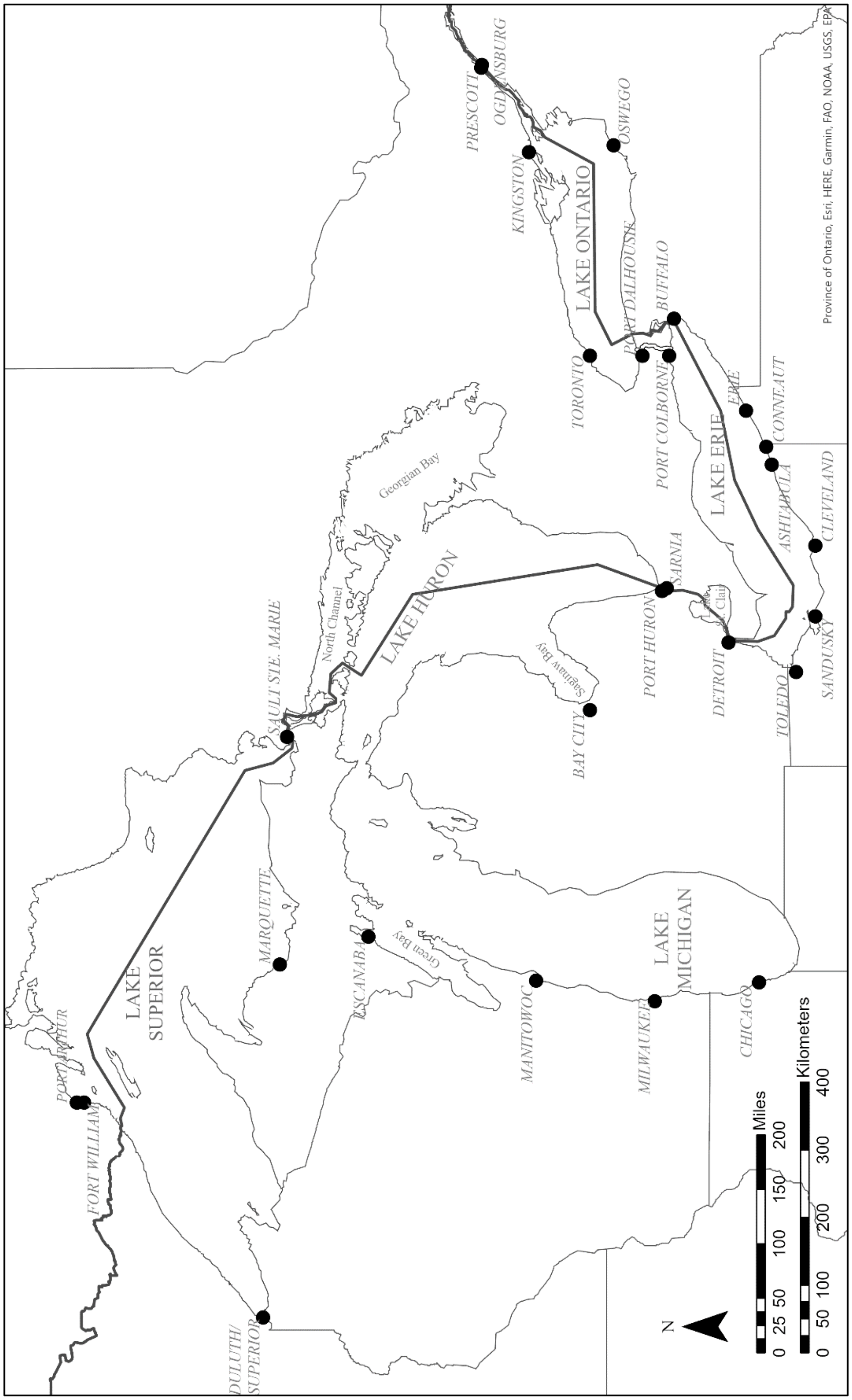

Figure 1. Map of the Great Lakes (ESRI, 2021.)

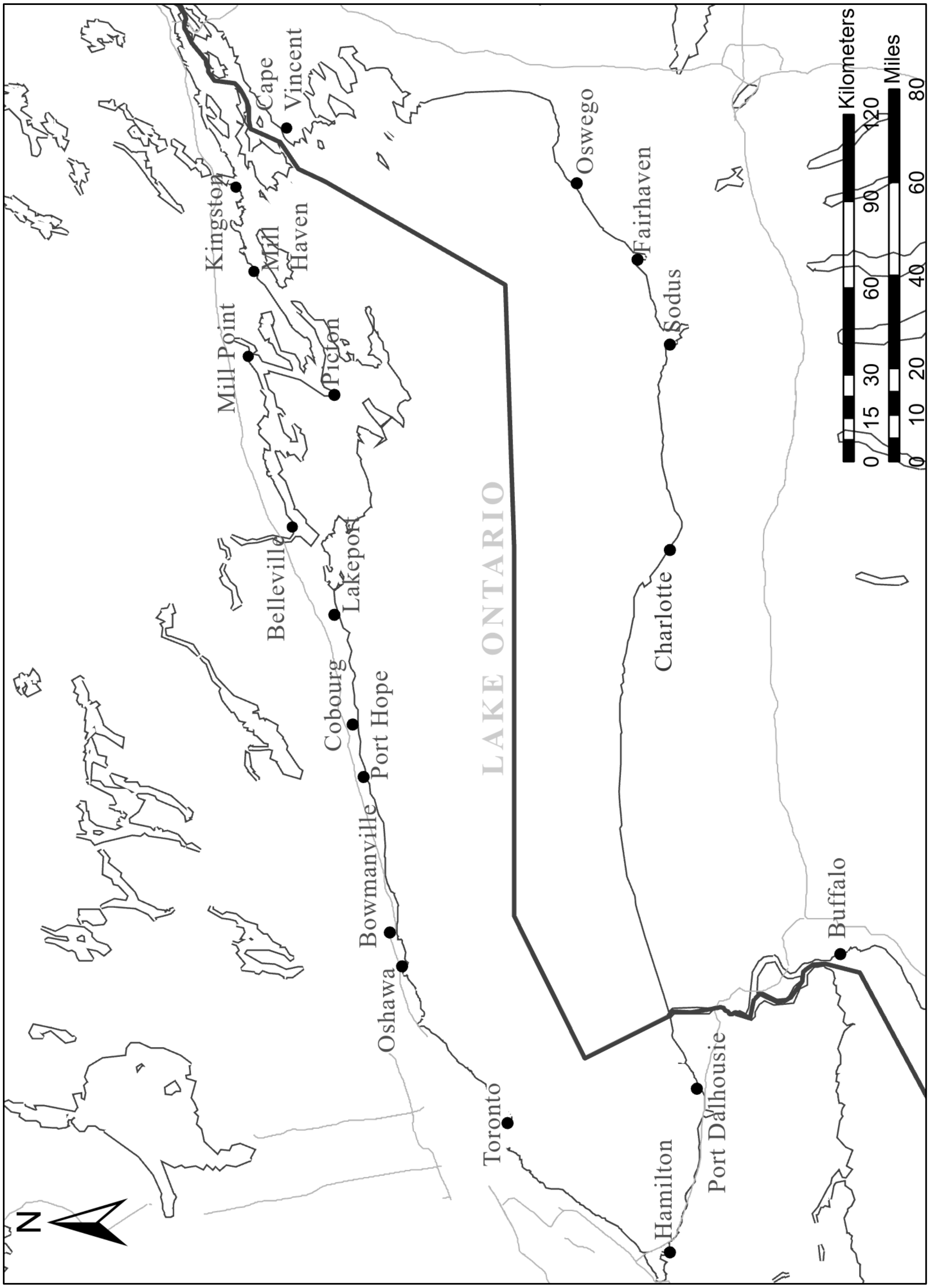

Figure 2. Map of Lake Ontario (ESRI, 2021.)

of

of the Welland Canal. As the commerce on the Upper Lakes thrived, recurring cycles of obsolescence and improvement in the canals and inadequate coordination between the St. Lawrence and Welland Canals periodically insulated the lake from developments within the transportation economy and shipping of the Upper Lakes (Ford 2018:87).

The result was a commercial environment unique to the Great Lakes, its economy characterized by intensive participation in the inter-lake trade, primarily in carrying grain to forwarding ports on Lake Ontario by way of the Welland Canal, alongside a thriving local commerce which possessed a distinctly international character not present elsewhere within the lakes (Brock 1892:XXIX,26-29; Ford 2018:78). While this international commerce underwent successive reorientations with protectionist restrictions, changes in the forwarding trade, and shifts in the commodities carried. This international commerce provided the last refuge of sailing commerce on the Great Lakes.

Though the constraints imposed by the canals limited the size of vessels transiting directly between Lakes Ontario and Erie, many of the developments that influenced the trajectory of Lake Ontario's commerce were driven by commerce on the Upper Lakes.

The Pre-Canal Commerce of Lake Ontario, 1815-1825

Almost immediately after the cessation of the War of 1812 between the United States and Britain at the end of the winter of 1814-1815, a resurgence of civilian shipping began, reviving commerce that was devastated by the war and the preceding Embargo Act of 1807. As early as April 1815, less than two months after the ratification of the Treaty of Ghent returned tranquility to its waters, regular commerce and sailing packet service had been reestablished on Lake Ontario (Ford 2018:85-86). This commerce remained relatively small scale due to the constraints to direct navigation with the Lower St. Lawrence and the comparatively small but growing population within the region. According to Ben Ford, American trade on Lake Ontario did not exceed a total aggregate value of $3.6 million annually, while Canadian commerce may have attained twice this sum in the years immediately following 1815 (Ford 2018:85-86).

In British Canada, this trade followed the St. Lawrence River before reaching Lake Ontario at Kingston then continuing west to Niagara. Arriving at the outlet of the Niagara River, a portage was required over the Niagara Escarpment before reaching the Upper Niagara River above the falls with Lake Erie at its head. In the United States, the primary corridor of movement into the lake region followed an inland riverine route along the Hudson River north to the to the Mohawk River above Albany. The route then went westward on the Mohawk River before portaging to Fish Creek. It proceeded down Fish Creek and across Oneida Lake to the Oneida and Oswego Rivers, requiring a portage around the falls above Oswego before reaching Lake Ontario at Oswego. Goods and passengers were then forwarded west to the Niagara portage on the lake. While both routes required several portages and therefore incurred additional costs, these waterborne routes offered the most cost-effective avenues of commerce within the region.

The reestablishment of regular commerce encouraged riskier investment in steamboats, which had both higher initial and operating costs. The first operational steamboat on the lakes was *Ontario,* constructed at Sacket’s Harbor, New York for the Ontario Steamboat Company of Joseph Smyth and Associates of Albany, under license granted by Harris Fulton and William Cutting, the heirs to the Fulton and Livingston monopoly on steam navigation in New York State. *Ontario* made its first voyage under steam in April 1817, being placed into packet service between Ogdensburg and Niagara (Palmer 1988:7). The Canadian steamboat *Frontenac*, built by competing Upper Canadian interests at Ernestown, Ontario, was launched without machinery in September 1816, but delays in the arrival and installation of its machinery, manufactured by Boulton and Watt in England, meant that *Frontenac* would not sail under steam power until 17 May 1817, a mere nine days after the *Ontario* (Kingston Gazette 1817; Mansfield 1899:587-588; Lewis 1987/2000; Ford 2018:107-108). By 1818, steam had spread to Lake Erie with the launching of *Walk-in-the-Water* at Black Rock, New York on the Upper Niagara River (Mansfield 1899:593).

Steam vessels were slow in arriving on Lake Ontario, as steamboats had navigated the St. Lawrence River since 1809 and on the Hudson by 1807. Yet by 1819, Canada's *Frontenac* was joined by *Queen Charlotte* and *Dalhousie,* vastly outstripping American aggregate steam tonnage. In 1826 there were two American steamers on Lake Ontario, while seven were in operation in Canada (Niles 1826:87). The initial development of the American steam fleet on Lake Ontario was impeded by the New York State Legislature's grant of a monopoly on steam navigation in state waters awarded in 1798 to Robert Livingston and 1803 to Livingston and Robert Fulton for 20 years. In 1824 the monopoly was eliminated by the United States Supreme Court's decision of *Gibbon v. Ogden* as being opposed to the Constitutionally appointed authority of Congress over interstate commerce (New York State 1803; Mansfield

1899:394). With the monopoly removed, American steam tonnage on the lakes began a period of growth.

In 1817 both Canadian and American steamboats had been placed into packet service on the Upper St. Lawrence and Lake Ontario. Packet lines, commonly arranged on a cooperative agreement among independent vessel owners, provided regularly scheduled and reliable service to most major ports on Lake Ontario. The profitability of packet service depended on its reliability and high passenger numbers, rather than the capacity of the individual vessel at a single stage of its voyage, as these packets were advertised to sail regardless of their passenger fares (Still *et al.* 1993:68; Lewis 2019:135). Sailing vessels were rapidly supplanted in passenger traffic by the establishment of regularly scheduled steamboat lines, but it would be nearly a half-century before steam began to make inroads into freighting. Though steamboats were ideally suited for passenger and packet freight, they proved inefficient and unprofitable carriers, apart from high value, easily handled packaged goods, which were taken aboard alongside passengers.

Foremost among the issues that precluded early sidewheel steamboats' participation in freighting was the inefficient arrangement of hull and machinery. H. A, Musham noted that the heavy construction scantlings and structural components needed to distribute the weight of machinery reduced the interior volume of the hull by as much as 15 to 20 percent. The placement of the machinery amidships, where the hull possessed its greatest capacity, occupied a significant portion of the space below and above the main deck and reduced space needed for the already-limited passenger accommodations. This limitation of revenue-generating hull capacity was further aggravated by the necessity to set aside space for fuel storage. A steamboat might consume as much as 40 cords of wood per day, and with each cord taking up 128 cubic ft. (3.62 m^3), 5120 cubic ft. (144.8 m^3) of space aboard would be needed to sustain operation for one day. The limited revenue-generating space that remained in the hull, required steamboats specialize in passengers and package freight (Musham 1957:89-90; Krueger 2012:44).

The high costs of construction and operation of steamboats further reinforced this specialization. In 1840 a steamboat operating on a regular schedule might incur expenses of $140 every day including the wages of the crew. A single downbound trip between Chicago and Buffalo might cost between $200 and $600 in fuel alone (Mills 1910:120). The *Anthony Wayne* consumed 40 cords of wood daily, meaning a daily expenditure of $80 and a round-trip fuel expenditure between Buffalo and Chicago of $1,220 at the same rates (Krueger 2012:44-45).

An 1819 article appearing in the *Rochester Telegraph* listed 51 American vessels on Lake Ontario with an aggregate of 2,531 tons, exclusive of undecked vessels (*Rochester Telegraph* 1819). Of these 51 vessels, there were 47 schooners, 1 sloop, and 3 steamers. Most of the schooners were between 25 and 85 tons, though the largest measured 130 tons. Hezekiah Niles reported that there were 30 to 40 Canadian sailing vessels over 30-40 tons in 1826 (Niles 1826:87). In 1819, total shipping on Lake Ontario was approximately 4,500 tons of which 14 percent was steam tonnage (Lewis 2015:349).

This limited number of vessels was sufficient to carry the modest commerce along what remained a largely undeveloped frontier.

The Erie Canal

The opening of the Erie Canal on 26 October 1825, eight years after its construction had begun, was a concerted effort by the State of New York and New York City to control the trade of the Great Lakes by providing a more efficient alternative to the long St. Lawrence route to the Gulf of St. Lawrence. The complete canal stretched 363 mi. (584 km) between Buffalo on Lake Erie and the Hudson River above Albany, requiring passage of 83 locks each measuring 90 ft. (27.4 m) in length, 15 ft. (4.6 m) wide, and 4 ft. (1.2 m) deep (Croil 1898:280-281).

The establishment of uninterrupted water transport between Lake Erie and the Upper Lakes and the Hudson tidewater brought about a collapse of distance between the region and the Atlantic world, the implications of which are nearly impossible to overstate for the economic development of the Great Lakes. Regular, reliable, and cost-effective transportation reduced time and costs of movement between the regions.

Before the opening of the Erie Canal, the cost of transportation of commodities originating in the Great Lakes to markets on the East Coast and Europe often exceeded the market value of the goods themselves. In 1810 bulk grain was valued at ¢50 per bushel on the Great Lakes and could be sold for 75 cents in New York City. Transportation costs for a bushel of grain between Oswego to New York City amounted to 75 cents. Lower transport costs diverted downbound trade to the St. Lawrence and markets at Montreal and Quebec City (MacGill 1917:82-83). In 1824, on the eve of the opening of the Erie Canal, transporting a ton of freight overland between Buffalo to Albany cost $100.00. With the opening of the canal, freight rates declined precipitously, allowing transport of the same ton at a rate of $8.84 by 1830. As traffic on the canal increased and the canal was enlarged, rates continued to reduce. By 1834, rates reached $7.15 and by 1842 $5.93 per ton (Mansfield 1899:186; Lenihan 1987:24).

For heavy bulk goods moving westward to Lake Erie by way of Lake Ontario, costs were somewhat higher due to the necessity of portage across the Niagara escarpment, which imposed an additional cost of $10 per ton in 1800. The opening of the Erie Canal and the low costs of transportation along it meant that the eastbound commodities of the Upper Lakes, rather than being directed to established Lake Ontario forwarders and down the St. Lawrence, was instead directed to Buffalo and along the inland canal corridor, effectively bypassing Lake Ontario (Ford 2018:99).

This canal also redirected the trajectory of westward migration to the Great Lakes region, with most migrants arriving by way of the Erie Canal and then continuing westward aboard steamboats. Lake Ontario received a steady inflow of immigrants, most arriving from Lower Canada along the St. Lawrence, providing steady business for Canadian and American steam packets between Montreal and the head of Lake Ontario. This increase in demand for packet service brought about a rapid proliferation of steamboats on both Lake Erie and Lake Ontario, with packet services extending regular service throughout the lakes, apart from Lake Superior.

Access to markets outside the Great Lakes and the acceleration of population growth in the region resulted in a rapid growth of demand for transportation on the lakes, and of tonnage following the opening of the Erie Canal and those which followed. In 1830 aggregate tonnage of all lake shipping was 7,728 tons, by 1860 this had grown to 450,726 tons. This exponential expansion of demand for tonnage meant that aggregate tonnage for both sail and steam experienced exponential growth with only limited competition over package freights (Ford 2018:87).

The First and Second Welland Canal Era 1829-1881

The opening of the Erie Canal was a significant setback for commercial interests reliant on Lake Ontario and the St. Lawrence River, with most commercial traffic being diverted to the Erie Canal, bypassing Lake Ontario. Canadian and American businessmen and shippers tied to Lake Ontario and the St. Lawrence proposed the construction of a canal traversing the Niagara Peninsula and ascending the escarpment (Zercher 1935:6; Willoughby 1956: 165; Ford 2018:99)

Initial efforts towards this canal were begun largely by the efforts of local mill-owner William H. Merritt and an interested group of millers who sought to create a feeder canal to supply their mills with running water. With the input of other parties invested in commerce, the plans were soon expanded for the construction of a ship canal. In 1824 the Welland Canal Company was incorporated by the Provincial Legislature of Upper Canada. The provincial legislature was reluctant to pay for the canal’s construction, and the canal was mostly funded by private investors with only limited financial assistance from the legislature. Between November 1824 and 30 November 1829, 27 mi. (43.45 km) of canal was constructed following Twelve-Mile Creek at Port

Dalhousie southward to Dick’s Creek, the Niagara Escarpment, and then south to the Welland River, with the upper terminus on the Niagara River. The 330 ft. (100.6 m) elevation of the Niagara Escarpment was divided between 40 wooden locks measuring 110 ft. (33.5m) long, 22 ft. (6.7 m) in width, and an 8 ft. depth (2.4 m) (Willoughby 1956:158-165).

Though not completed until 1829, the first upbound passage of the canal was accomplished on 27 November 1828 by the Canadian schooner *Annie and Jane* of York followed by the American schooner *R.H. Boughton* of Youngstown, New York (Cuthbertson 1931:220). The need to tow vessels against the current of the Niagara River to reach Lake Erie made it apparent that bypassing the Niagara River as the canal’s upper terminus was necessary and by 1833 the southern terminus of the canal was redirected to Port Colborne on Lake Erie (Ford 2018:102).

The eager anticipation of the opening of the Welland Canal was not confined to Canadian interests, and the principal beneficiary of the canal was arguably the port of Oswego. Of the initial $80,000 capitalization of the Welland Canal Company approved by the provincial legislature, half was provided by American investors (Willoughby 1956:161-162). In 1839, when the company’s capitalization was increased by the legislature, concern over the possibility of American shareholders purchasing a controlling interest in the canal led the Upper Canadian government to limit American-held shares to one-quarter of the capitalization. The opening of the Welland Canal initially benefited American forwarders more than the Canadians due to the need for transsshipment on the St. Lawrence, which delayed the full benefits of the canal to Canadian shippers for some years (Willoughby 1956:165-166).

Investments by American commercial interests on Lake Ontario were not confined to the Welland Canal. Oswego businessmen, intent on recapturing the port's former centrality in the forwarding trade formed the Oswego Canal Corporation to construct a canal along the Oswego River that would intersect with the Erie Canal near the town of Salina, New York. Construction of the canal began almost immediately, eventually being taken over by New York State and was completed on 28 April 1829 (O'Connor 2010:6).

The openings of the Oswego and Welland Canals, though not restoring Oswego's control of American forwarding, had much of its anticipated effect in restoring commerce. This Welland-Oswego-Erie Canal route provided forwarders with several advantages over the Buffalo-Erie Canal route. The Oswego route bypassed 125 mi. (201 km) of the Upper Division of the Erie Canal and some 28 locks, along with the congestion it entailed. Furthermore, the comparatively high tolls on the Erie Canal encouraged the Welland to Oswego route as the cheaper alternative to Buffalo. By bypassing tolls on the upper end of the Erie Canal, the Oswego route offered shippers an estimated savings of $4 per ton in 1840 (*Oswego Palladium* 1841).

Oswego's commerce expanded rapidly following the opening of the Oswego Canal. Between 1830 and 1848 tonnage arriving and clearing annually increased from 6,910 to 188,919 tons with an increase in the value of Oswego's commerce from $277,000 to $18,166,907. The port of Oswego's enrolled tonnage increased between

1830 and 1848 from 521 to 21,079 tons. By 1853 18 percent of goods eastbound on the Erie Canal were sent by way of Oswego and the Oswego Canal (O’Connor 2010:7; Ford 2018:100).

Canadian commercial interests, attempted to reestablish the St. Lawrence River as the principal outlet for lake shipping by advocating for and receiving support for the construction of a series of canals to bypass the rapids between Prescott and Montreal. The Rideau Canal was completed in 1832. Though intended to support the British garrison at Kingston, the Rideau Canal route was used primarily by upbound traffic avoiding the current on the St. Lawrence by following the Ottawa River from Montreal to Ottawa, where the canal connected to Lake Ontario by way of the Cataraqui River. Once at Kingston, most eastbound vessels proceeded down the St. Lawrence River to Montreal (Croil 1898:264; Gilmore 1956:249).

From the outset, the efficiency of the Canadian canals suffered from a lack of coordination of the lock dimensions, in part due to the lack of a unified government between Upper and Lower Canada (Ford 2018:101-102). Efforts to improve the St. Lawrence River began with the construction of the Lachine Canal between 1821 and 1825, bypassing the Lachine Rapids at Montreal. Initially, the Lachine Locks measured 100 ft. (30.5 m) long by 20 ft. (6.1 m) wide and 4 ½ ft. (1.4 m) deep and required later enlargement to the dimensions of the locks within the Welland Canal. By 1842, the rapids above Montreal were bypassed by the Beauharnois Canal. The Cornwall Canal was completed in 1847, having been begun in 1834. The opening of the Galop and Williamsburg Canals in 1847, which had been under construction since 1844, completed the canal system bypassing all rapids on the St. Lawrence River (Croil 1898:264-265; Gilmore 1956:249).

The completed canal system, referred to as the St. Lawrence Canal, achieved unified lock dimensions by 1848 of 200 ft. (61 m) long by 55 ft. (16.8 m) wide and 9 ft. (2.7 m) deep and included 53 locks totaling more than 551 ¼ ft. (168 m) of elevation gain and 71 mi. (114 km) of canal (Croil 1898:264-265; Ford 2018:101).

By 1840, the increasing size of vessels and the increased demand for shipping tonnage meant that the First Welland Canal locks were too small and required both replacement and enlargement. In 1841, the government of Upper Canada purchased all privately held shares in the Welland Canal Company and took over the operations of the canal. The improvements to the canal included the enlargement of the locks to a minimum dimension of 150 ft. (45.7 m) long, 26 ½ ft. (8.1 m) wide and 9 ft. (2.7 m) deep, with the elimination of 13 locks, bringing the total number of locks to 27. These lock dimensions allowed passage by vessels with a capacity of between 20,000 and 25,000 bushels (Mansfield 1899:229-231).

Even after the enlargement of the Welland Canal, the lock dimensions of the St. Lawrence Canal exceeded those of the Second Welland Canal. Therefore, vessels built to the dimensions of the St. Lawrence Canal could transit the St. Lawrence to Lake Ontario but were unable to transit the Welland Canal. These limitations imposed by the Welland locks, before their enlargement in 1884, limited the efficiency and scale of commerce with the Upper Lakes, factors which tended to favor the smaller sailing vessels comprising the majority of vessels trading by way of the First Welland Canal.

Before 1841, all vessels transiting the Welland Canal were sailing vessels (Musham 1957:91; Lenihan 1987:51).

The unique requirements of lake navigation and the restrictions imposed by canals had a central role in the development of Great Lakes sailing vessels, particularly the sailing canal vessels, which emerged as a dominant type in the inter-lake trade in the years between 1844 and 1881. The development of a distinct Great Lakes wooden shipbuilding tradition was the result of diverging requirements for navigation on the lakes as opposed to those for navigation on the Atlantic. The confined, shallow waters of rivers and the many riverine harbors on the lakes necessitated vessels with both a shallow draught as well as good weatherliness and seakeeping capabilities when sailing to windward, all while maintaining sufficient carrying capacity.

At the turn of the 18th and 19th centuries, the majority of ships built on the Great Lakes were standing-keel vessels, that is possessing a conventional keel. They relied on a relatively steep deadrise, and the hull's draught to provide lateral resistance to the hull, reducing the vessel's leeway, particularly when sailing on a beam reach or when beating to windward (Snider 1932a).

Navigation into the frequently shoal ridden, unimproved riverine ports that predominated throughout the lakes or confined rivers necessitated vessels with shallow draughts. The St. Clair Flats, which limited passage between Lakes Huron and Erie, averaged between 8 and 11 ft. (2.4-3.4 m) deep, and reportedly fell to as low as 6 ft. (1.82 m) depth during periods of low lake levels (*Monthly Nautical Magazine and Quarterly Review* 1854:9-16). The standing keel possessed inherent limitations in shoal-draft vessels. If a vessel's permanent draught was decreased by reducing its deadrise and depth of hold, this was accompanied by a correlative loss of lateral resistance, a loss of overall volume of the hull, and increased leeway.

The centerboard, introduced to the lakes in the early 19th century, overcame these limitations. The centerboard consisted of a board, pivoting on a pin in its lower forward face, that was lowered or raised through a slot along the centerline or offset along the keel. When lowered, it temporarily increased the lateral resistance of the hull without permanently increasing its draught. When retracted the centerboard pivoted into a watertight case constructed atop the keel, with the centerboard's leading-edge flush with the underside of the keel (Barkhausen 1990:9-15). The centerboard was the successor to the short-lived slide-keel, or daggerboard, in which a keel board fitted within a watertight case was raised and lowered vertically within a slot in the centerline of the keel. The keel board was raised and lowered by a series of purchases but frequently bound within the cases due to the considerable lateral pressure on the board while underway (Barkhausen 1990:5-8). The centerboard alleviated the issues of manipulating the keel boards and were rapidly adopted on lake vessels by 1840.

The introduction of the centerboard was accompanied by changes to hull design. The lateral resistance handily afforded by the centerboard enabled hulls to be built with a nearly flat deadrise, a low turn of the bilge, and vertical sides, resulting in a fuller hull form with a substantially increased capacity when compared to standing-keelers of similar dimensions and draughts. As the locks of the First Welland Canal restricted draught to 8 ft. (2.4 m), and later 9 ft. (2.7 m) after the construction of the improved

Second Canal, a standing-keel schooner with a deadweight capacity of 300 tons when loaded to a depth of 15 ft. (4.57 m) would be unable to transit the canal when fully loaded, making the vessel inefficient and likely unprofitable for routes that required transiting the canal. Snider notes that a similarly dimensioned centerboard schooner might possess a capacity of as much as 700 tons with the same draught, and a vessel of the same tonnage would possess a maximum draught of 9 ft. (2.7 m) (Snider 1932a; Barkhausen 1990:14-15). The expansion of capacity enabled by the adoption of the centerboard and fuller hull forms provided vessel owners and operators an immense economic incentive to adopt these innovations.

These adaptations in the hull were paralleled in alterations to their means of propulsion, the rigging. The confined waters and prevailing easterly winds on the lakes necessitated a rig with favorable downwind characteristics while running, primarily on downbound passages, and that could be easily handled in confined waters, sailed well to windward, and which could be handled by a minimal crew (Cuthbertson 1931:227). By the mid-18th century fore-and-aft rigs were preferred for merchant vessels on the lakes. In the first half of the 19th century, many ship owners on the lakes attempted to attain the benefits of both square and fore-and-aft rigs by adopting brigantine rigs, with a square-rigged foremast and a fore-and-aft rigged mainmast, or barkentines rigs with a square-rigged foremast and two or more fore-and-aft rigged masts. The larger crew required to work the square sails and the resulting higher expenditure on wages resulted in these rigs becoming less common after the 1860s (Cuthbertson 1931:230; Pott 2001:13).

The schooner rig was the most common rig in use on commercial sailing vessels throughout the 19th century, first with two masts, and later, with three-masted variations becoming common by mid-century. Both two and three-masted rigs were adopted extensively for use on the lakes (Ford 2018:86-87).

In two-masted lake schooners, the foremast and mainmast were stepped farther forward and aft respectively than on vessels constructed for the Atlantic. This allowed more efficient loading, unloading, and the carriage of deck loads, a rare practice on the Atlantic but common on the lakes, within the more open waist afforded by this arrangement. On Atlantic schooners, the mainsail had the largest sail area and was footed by a boom projecting well outboard of the counter. On the lakes, the relative sail area of the mainsail was reduced with the main boom being shortened to prevent entanglements while transiting locks, while the area of the foresail was increased. The placement of the largest sail inboard made the sails easier to handle at the expense of some performance to windward. While this tended to move the sail plan’s center of effort forward, this was offset by the introduction of the centerboard and an increase in the length of the jib boom and bowsprit, and a proportional increase in the area of the headsails (Snider 1934).

Three-masted schooners were increasingly common on the lakes from the late 1840s and became the predominant rig among larger commercial sailing vessels due to their ease of handling. In the three-masted schooner, the division of the sail area between three masts and smaller constituent sails made the handling of individual sails more manageable than two-masted schooners of comparable size. This allowed vessel owners to take advantage of greater economies of scale by building larger vessels without proportionally increasing the crew complement and wage costs. Whereas it was common practice on the Atlantic to rig all masts in a schooner the same height, lakers typically had a mainmast slightly taller than either the fore or mizzen masts. As in two-masted lake schooners, the fore and mizzen masts were stepped farther forward and aft than on contemporary Atlantic vessels. This meant that the mizzenmast, rather than being stepped on deck forward of the cabin, was stepped within the aft cabin. The length of the mizzen boom was also reduced to limit its overhang outboard of the counter (Snider 1934). In the first half of the 19th century, both rigs were commonly paired with a square topsail on the foremast. While the square topsail became uncommon by the 1870s, the topsail was retained in the form of the raftee, or raffee, a boom-footed topsail comprised of two triangular halves on either side of the mast that could be raised independently without the need to go aloft (Snider 1934; Bennet 2001:129).

By the 1840s, a distinct shipbuilding tradition on the lakes had developed that remained the basis for the construction of wooden sailing vessels to the end of the 19^{th} century. This tradition was characterized by a centerboard lowered through a slot in the centerline of the keel, a flat or nearly flat deadrise, a long, parallel mid-body, a sternpost set at 90 degrees to the keel, a shortened transom overhang, a proportionally lower freeboard amidships, and a proportionally longer and narrower length to breadth ratio.

The constraints imposed by the Welland Canal imposed unique requirements on vessels employed in the inter-lake forwarding trade with Lake Ontario, principally carrying grain. For the period of the First and Second Welland Canals, this commerce was controlled by sailing vessels designed specifically for trade through the canal. These sailing canal vessels, popular with vessel owners throughout the Great Lakes, were particularly prominent among Lake Ontario's sailing fleet due to the dependency of Lake Ontario on trade through the Welland Canal.

Sailing canallers were designed to maximize the deadweight capacity of the hull while remaining within the maximum dimensions imposed by the Welland Locks. As such, in the period of the Second Welland Canal, these vessels necessarily could not exceed 150 ft. (45.7 m) long, 26 ½ ft. wide, and 9 ft. (2.7 m) in draught (Mansfield 1899:229-231). The extent to which vessel owners sought to maximize the size of their vessels within these dimensions resulted in the emergence of moderate canallers, which commonly were approximately 136 ft. (41.5 m) long, 23 ½ ft. in breadth, and 9 ft. (2.7 m) depth of hold, and later extreme canallers, typically measuring up to 145 ft. (44.2 m) long, 26 ft. (7.9 m) in-breath and 10 ft. (3 m) deep. The capacity of the hull was maximized with flat floors, a sharp, low turn of the bilge, and straight, vertical sides. In addition to imposing restrictions on the overall measurements of canallers, maximizing capacity necessitated full ends and minimal overhangs. Accordingly most canallers were designed with a vertical stem and bluff bow and a vertical sternpost with a short counter overhang. The need to prevent overhangs that might foul in lock gates resulted in the use of folding davits at the stern, shortened mizzen booms, shortened or folding bowsprits and jib booms, and head rigs which were typically highly steeved. Furthermore, several alterations were made to the sail plan, with the foresail, mainsail, and mizzen sail all having a lower peak and shorter luff, giving the rig a more squared and short appearance (Cuthbertson 1931:235; Monk 2003:43-65).

Sailing canallers proved to be excellent, economical vessels to operate, resulting in their widespread proliferation and popularity with vessel owners throughout the lakes. In 1862, 755 sailing vessels of "canal size" were in service throughout the Great Lakes (Labadie 1989:21). Kimberly Monk proposes a lesser number with approximately 500 built between 1846 and 1880 (Monk 2003:48,63). These designs, which were oriented towards the extremes of economic efficiency, were not without their compromises. In 1877 the *Chicago Inter-Ocean* noted that among losses of vessels along with all hands that year, canallers accounted for 90 percent of such losses (*Chicago Inter-Ocean* 1877). Losses among canallers were prevalent enough that the United States government convened an inquest to investigate the cause. The inquiry concluded that boxy, full hull forms rather than constructional defects likely contributed to the losses. The perceived unseaworthiness of the full hull was further compounded by the absence of shifting boards between stanchions along the centerline of the holds, allowing loose cargoes to shift readily, as well as the tendency for canallers to be unstable when overloaded (Mansfield 1899:293; Monk 2003:62-65).

The era of the First Welland Canal witnessed innovations aboard steamboats which presaged the emergence of steam-propelled bulk carriers and steam barges and the transformation of freight transportation on the lakes in the latter half of the 19th century. The introduction of high-pressure steam engines in 1825 eliminated the need for heavy framing to support the vertically mounted cylinders of the low-pressure engines. The original configuration was thought to be necessary to prevent wear of the pistons against cylinder walls, which would prevent the formation of a vacuum in the cylinder and the functioning of the engine (Lewis 1997:4). The weight of the vertically mounted cylinder was supported on a heavy wooden framework, raising the vessel's center of gravity and decreasing stability. Furthermore, the heavy point-loading on the hull of such machinery necessitated heavy construction to alleviate this stress, increasing draft and decreasing available revenue-generating volume within the hull. The need for such a framework was eliminated by the use of high-pressure steam engines (Lewis 1997:4). While high-pressure engines and boilers provided greater efficiency, increased horsepower output, were more easily maintained, and significantly reduced weight with the horizontal mounting of the cylinders, the weakness of wrought iron high-pressure boilers and their potential for explosions resulted in their slow acceptance. This was particularly true of Canadian shipbuilders (Lewis 1997:8-9). Beginning in the 1830s, there was a proliferation of boiler designs incorporating multiple, smaller internal flues, resulted in a considerable improvement in the efficiency of heat transmission from the firebox and flues to the boiler chamber (Lewis 1997:6).

The 1840s witnessed the introduction of the first propellers in the waters of the Upper St. Lawrence River and Lake Ontario. In 1840, George Sanderson of Brockville, Ontario and Donald Murray of Montreal, Quebec, partners in the Rideau and St. Lawrence River forwarding firm Sanderson and Murray, requested the opinion of Captain James Van Cleeve on the Ericsson propeller and direct drive system while the latter was visiting New York City where the device was on display by its inventor John

Ericsson. Van Cleeve met with Ericsson, inspected the device, sent his overwhelming approval to Murray and Sanderson, and contracted with Ericsson to construct a vessel by the end of the following year employing Ericsson's propeller on Lake Ontario. In exchange for testing the invention, Van Cleeve received half interest in the patent for the Ericsson propeller's use on the lakes (Mansfield 1899:403-404; Musham 1957:92; Neilson 1987:4-8).

By late spring 1841, Sanderson and Murray built a small propeller towboat, the *Ericsson*, at Brockville, Ontario. Between 10 and 21 June 1841, *Ericsson* towed barges to Montreal, returning up the Ottawa River and Rideau Canal route to Kingston before continuing to Brockville down the St. Lawrence, becoming the first propeller-driven vessel on Lake Ontario. By the end of Summer 1841, two more propellers were in service on the Rideau and Upper St. Lawrence River (Neilson 1987:4-8).

In December 1840, Van Cleeve and associates contracted with shipwright Sylvester Doolittle of Oswego to modify a schooner then on the stocks to be used with Ericsson's propeller. In November 1841, this vessel, the *Vandalia*, was completed, becoming the first propeller designed for service on the Great Lakes (Musham 1957:92). *Vandalia* was outfitted with two propellers mounted individually on shafts astride the sternpost. It was not until 1843 with the launch of the propeller *Porter* that a single propeller and shaft through the sternpost was introduced (Mills. J.C. 1910:129). Many of the aspirations of Oswego shippers for the propeller rested in its having been designed to transit the Welland Canal, therefore allowing the extension of Oswego's steam packet service through the Welland Canal to the Upper Lakes. On its first trip of 1842, *Vandalia* became the first steamboat to transit the Welland Canal, opening the way for the inter-lake packet service from Lake Ontario (Musham 1957:98).

The *Vandalia*'s success resulted in the launching of seven more propellers by the end of 1843 (Mansfield 1899:403-404). By 1853, 53 propellers were plying the lakes. By 1854, 97 propellers were listed on American registries above the Welland Canal with another 14 in Canadian registers (Ericson 1969:200; Neilson 1987:4-8). While the first propellers were employed in packet service, the first propeller intended entirely for freight cargoes, specifically for package freight, the *Sampson*, was launched in 1843 (Lenihan 1987:54).

The application of Ericsson's propeller possessed several significant advantages which would later allow steam competition with sail in bulk freights. The positioning of the propellers below the waterline provided greater efficiency and resulted in reduced fuel consumption. Furthermore, this position of the propeller proved more protected than comparatively exposed sidewheel steamers (Mills, J.C. 1910:130). Almost as importantly, the *Vandalia*'s machinery weighted only 15 tons and occupied only 17ft. (5.18 m) in the aft extremity of the hull, entirely below the main deck. This more efficient arrangement of interior space of the hull resulted in increased revenue and potential profits (*Oswego County Whig* 1841; Mansfield 1899:403-404).

The period of the Second Welland Canal, between 1841 and 1884 was the height of Great Lakes sailing commerce and of Lake Ontario's commercial prosperity, with both American and Canadian vessels engaged intensively in the inter-lake forwarding trade from Upper Lakes ports by way of the Welland Canal. While United States law restricted foreign vessels from carrying domestic cargoes between United States ports, thus excluding Canadian vessels from carrying American grain to the American terminals at Buffalo and Oswego, both American and Canadian vessels carried vast quantities of grain to the other nation's terminals from their own ports (Martin 1995:23). For Canadian vessels, much of this trade, particularly in grain and lumber to American ports was carried by trading vessels which were largely confined to Lake Ontario.

The commerce undertaken by Lake Ontario vessel owners was not confined to the Great Lakes and St. Lawrence forwarders alone. By 1848, improvements on the St. Lawrence Canal increased the locks to 200 ft. (61 m) long by 55 ft. (16.8 m) wide and 9 ft. (2.7 m) deep allowing passage of larger lake vessels to the Lower St. Lawrence River and, ultimately to the Atlantic. From that year forward, a small number of vessels sailed annually from the Great Lakes, primarily from Canadian ports on Lake Ontario, to oceanic ports, primarily in Europe. C. H. J. Snider lists some 54 sailing vessels from the Great Lakes that undertook such voyages, though before 1856 and 1857, when the Crimean War raised prices substantially throughout Europe, such voyages were rare (Snider 1932b; Ford 2018:88). While Snider notes that many of these vessels only made a single voyage at the outset of their careers before returning to the lakes, other lake vessels were sold in Europe, a more efficient alternative for European shipowners than importing lumber to construct ships (Brown 1961:4-8).

The Port of Oswego and Trade

For much of the era of the Second Welland Canal, the commercial enterprise of Lake Ontario is perhaps best represented by the ports of Oswego and Kingston, Ontario.

Following the opening of the Oswego and Welland Canals, the city of Oswego was ideally situated astride multiple corridors of commerce, with access to the Erie Canal by way of the Oswego Canal, and on the shores of Lake Ontario along the inter-lake route to the St. Lawrence River. The value of Oswego's forwarding trade had increased steadily since the opening of the canals (O'Connor 2010:6-7).

With the repeal of British corn laws and the resulting reduction of artificially elevated grain prices in Britain, Canadian merchants had less incentive to export grain along the Kingston-Montreal route to European markets. Instead, a significant portion of this trade was directed southward to Oswego, where it was transshipped to canal boats and taken down the Erie Canal. Oswego soon emerged as the principal importer of Canadian grain on the Great Lakes. In 1851, Oswego's foreign trade was larger than all other American ports on the Great Lakes together (*Oswego Daily Times* 1851). In that year, Oswego imported 260,874 barrels of flour and 1,094,444 bushels of wheat, nearly 200,000 bushels more than Buffalo which led domestic grain receipts overall (*Oswego Daily Times* 1851).

The commercial interests of Oswego were furthered by the 1854 Treaty of Reciprocity, which removed tariffs on the importation of Canadian commodities. Oswego, the only port on Lake Ontario with a canal connection to the Erie Canal was the natural beneficiary of importation of Canadian commodities particularly in Canadian grain and lumber (Ford 2018:100). In spite of the financial panic of 1857, which was followed by a slow recovery, the period between 1855 and 1866 was a thriving period in the international trade on Lake Ontario. This period of reciprocity came to an end in

1865 when the treaty was annulled by the United States (O'Connor 2010:8-9; Ford 2018:77-78).

The benefits of reciprocity for Oswego's foreign trade had been immediate, with Oswego experiencing an annual increase in the value of its foreign trade of $9 million in the first year of reciprocity (O'Connor 2010:9). By 1856, the grain trade of Oswego reached its peak, with Oswego importing 18,646,955 bushels that year, supporting numerous forwarding firms, flour mills, and malt houses. Nearly all of the grain arrived aboard sailing vessels (O'Connor 2010:8; Ford 2018:78).

Surpassing Oswego's grain forwarding and flour milling trade were its lumber imports from Canadian ports on Lake Ontario, and to a lesser degree, from the Upper Lakes. This commerce supplied all manner of woodworking industries that developed in the port including numerous lumber mills, lumber forwarding firms, and shipbuilders. Most lumber received at Oswego was imported from lumber ports on the north shore of Lake Ontario and the Bay of Quinte, most prominently Belleville, Napanee, Mill Haven, and Trenton (Palmer 1984:30).

Much of the arriving lumber was transshipped to canal boats for forwarding down the canals, with the bypassing of the Upper Erie Canal offering shippers a savings of between $1.00 and 1.50 per thousand board feet of lumber in 1849 (*Oswego Commercial Times* 1850). A substantial portion was finished in local mills before being shipped to Canadian markets or as an upbound freight to ports on the Upper Lakes. (O'Connor 2010:7-8; Palmer 1984:36).

Oswego's lumber imports totaled 19,650,997 board feet in 1840. By 1850, Oswego was the leading importer of lumber on the Great Lakes, importing 50,685,682 board feet of lumber from Canadian ports. Oswego's lumber imports continued to increase in the subsequent decades. By 1873, lumber imports reached 298,881,000 board feet (Palmer 1984:32). In 1870 lumber comprised 95 percent of Oswego's business (Palmer 1984:35). The financial depression beginning with the Panic of 1873 brought a recession in the lumber trade, which was slow to recover throughout the 1870s. Though receipts again reached 214,323,000 board feet in 1882, the lumber trade never again attained its pre-recession scale, and thereafter, steadily declined (Palmer 1984:37). Though lumber receipts continued on a limited scale until 1928, the trade was effectively ended by the McKinley Tariff of 1890 (O'Connor 2010:11).

Accompanying the lumber trade, Oswego possessed a thriving shipbuilding industry at the height of its commercial prosperity. Between 1835 and the 1870s, the shipbuilding industry of Oswego employed between 600 and 700 workers as ship carpenters, joiners, sailmakers, and smiths (*Oswego Palladium* 1888). That industry reached its height in the early 1870s, declining rapidly in the later 1870s due to the local depletion of lumber resources. By October 1880, only 15 to 25 workers were employed in repairing vessels in the remaining yards (*Oswego Palladium* 1880b).

Throughout the mid-19th century, Oswego possessed a large sailing fleet, primarily employed in the inter-lake grain trade with the Upper Lakes. On 22 April 1866, at the height of the grain trade on the lakes, some 73 sailing vessels were registered out of Oswego (*Oswego Palladium* 1916). In the winter of 1868 and 1869, some 77 vessels were laid up in winter quarters at the harbor (*Oswego Commercial Advertiser and Time* 1868). By 1870, some 876 vessels, the vast majority of which were canal boats, were registered at the Port of Oswego with an aggregate 100,040 tons (Brock 1892:XIV-XV). In 1880, there were 56 schooners registered out of Oswego. The majority of these vessels were held in fleets operated by a relatively small number of owners, each owning between two and six schooners. At least 16 were independently owned. The operations of these vessels were not restricted to routes calling at Oswego. The fleet of Thomas S. Mott, among the largest of Oswego with six vessels, spent the opening months of the 1880 season hauling iron ore between Escanaba and Marquette, Michigan on Lakes Michigan and Superior, to foundries at Cleveland and Chicago (*Oswego Palladium* 1880a).

The sailing fleet of Oswego began to decline with the recession of the 1870s and the lowering of grain rates that followed. By 1891, only 15 vessels with an aggregate of 4,091 tons remained at Oswego. While 19 steam vessels appeared on the registry rolls, sail still dominated the majority of aggregate tonnage, at 4,091 tons against 3,856 tons in steam, suggesting that many of these steam vessels were small vessels, likely tugboats (Brock 1892:XV). By the turn of the century, Oswego's prominence as a ship-owning port had vanished and nearly all of its commerce was carried by Canadian vessels.

No other port along the New York shore of Lake Ontario would rival Oswego in the intensity of its maritime activity in the 19th century. Charlotte, the port of Rochester, New York, situated on the Genesee River, lacked Oswego's beneficial position as a transshipment port and received far less traffic. Though Charlotte was a prominent port for packet lines on Lake Ontario in the first half of the 19th century, it did not develop lake commerce to nearly the same extent, its commercial interests being directed towards its position along the Erie Canal (McKelvey 1954:12; McKelvey 1955:272). At its height in 1855, the value of Rochester's imports by lake reached $1,534,000, while in the same year its exports totaled only $774,000 (McKelvey 1955:274-275). In 1870 Rochester's registers listed 27,305 tons of shipping in comparison to Oswego's 100,040 tons (Brock 1892:14).

The Port of Kingston and Its Forwarding Trade

Across the border, Canadian inter-lake commerce was linked to grain forwarding down the St. Lawrence and Rideau Canals to Montreal and Quebec City, as well as exports to Oswego. The direction of the movement of grain was largely shaped by American protectionist legislation, prohibiting foreign vessels from participating in the transport of domestic goods between American ports (Martin 1995:23). While Canadian grain could be exported to Oswego from Canadian ports on both the Upper Lakes and Lake Ontario, imports of American grain, which comprised the majority of the downbound Canadian traffic through the Welland Canal before the 1890s, necessarily went to the elevators at Kingston from where it was transshipped and forwarded to Montreal or Quebec City on the St. Lawrence River. The majority of grain arriving at the elevators at Kingston before the last decades of the 19th century, whether from within Lake Ontario or by way of the Welland Canal, arrived aboard sailing vessels.

While the terminals for grain-laden vessels were restricted by nationality and where it had taken on its cargo, vessels of both nations participated in carrying grain to

Kingston forwarders, with American schooners frequently delivering American grain to Kingston. Vessel owners were not particularly concerned about where their vessels offloaded as long as they were at profitable (Thomsen and Zant 2015:84).

The grain forwarding trade was controlled by several prominent firms including the St. Lawrence and Chicago Forwarding Company of Toronto, the Kingston and Montreal Forwarding Co, and the Montreal Transportation Company, which came to be one of the largest shipping corporations in Canada (Duerkop 2017:3-4). These companies invested considerable sums in expanding Kingston's elevator capacity and harbor. In 1887, Kingston received government support to make improvements to increase the minimum depth of Kingston Harbor to 12 ft. (3.6 m), allowing the largest vessels transiting the Third Welland Canal, which possessed capacities of up to 100,000 bushels, to call there (Preston 1955:24-29).

The Calvin Company was among the most important businesses in Kingston and among the only commercial interests diversified outside of the grain trade (Preston 1955:28). The firm, founded by Dexter Dileno Calvin of Cape Vincent and initially named Calvin and Cook, established a timber rafting operation on company-owned Garden Island, just southeast of Kingston. In 1855, the firm was renamed Calvin and Breck, when Ira Breck became partner. Calvin and Breck, later renamed the Calvin Company, had diversified interests in ship owning, shipbuilding, a towing and wrecking company, and in timber and grain forwarding. In 1914, the Calvin Company was purchased by the Montreal Transportation Company, further consolidating that company’s control of forwarding on the St. Lawrence (Snider 1938; Bascom 1972; Duerkop 2017:5; Ford 2018:83-85).

In contrast to the American shore, the Canadian side of Lake Ontario possessed a thriving trading economy within the confines of Lake Ontario and the Upper St. Lawrence, integrating them into wider markets and to the forwarding commerce centered on Kingston and Oswego. Lakeshore communities along the north shore, isolated until the arrival of rail lines, looked towards the lake throughout the century (Ford 2018:106-107). Many of these communities developed considerable sailing fleets of their own, forming a vital economic link between themselves and markets for the products which they produced.

The towns arrayed along the Bay of Quinte, the nearly enclosed bay between the north shore and Prince Edward County, developed into the center of the lumber industry of Canada and supported substantial traffic in lumber transport. Belleville and Trenton, situated at the mouths of the Rivers Moira and Trent, as well as the mill town of Mill Point (now Deseronto) and Napanee on the Napanee River, which possessed riverine connections to the interior, rafted lumber down these rivers to their mills for processing and shipment (Metcalfe 1968:7-8,233).

The towns on the Bay of Quinte, Prince Edward County, and the north shore, provided substantial quantities of grain for the elevators of Kingston and Oswego. Metcalfe notes that smaller trading schooners might complete as many as three trips every week between the Bay of Quinte and Oswego when rates were high (Metcalfe 1968:26).

The Emergence of the Bulk Freighting System

The late 1850s and 1860s were a formative period in the emergence of the modern Great lakes freighting economy, and the design of steam vessels developed rapidly into well-built, profitable, and efficient bulk freight carriers.

The completion of major railroad lines along the St. Lawrence River and Lake Ontario, including the Canadian Grand Trunk Railroad in 1856, the Great Western Railway between Niagara, Toronto, and Windsor in 1856, and the Baltimore and Ohio connections between New York, New England and Lake Ontario at Ogdensburg, Oswego and Cape Vincent by 1852 established reliable, regularly scheduled year-round service that paralleled the steamboat packet routes (Ford 2018:114). The completion of these rail connections had little negative effect on the lake forwarding trade, as transport by water offered significantly lower freight rates per ton than was possible by rail. The increased ability to move freights to lake ports as branch lines were extended, would prove beneficial for lake commerce.

For many steam packet lines, rail competition was devastating, attracting an increasing share of passenger fares and package freight tonnage. The Panic of 1857 brought a precipitous reduction in demand for freights, an excess of available tonnage, and the resulting collapse of freight rates which was disastrous for vessel owners, forcing many vessels into idleness (Lewis 2019:145). Aggregate tonnage and investment in sailing vessels were seemingly less impacted by the economic downturn, and in the years immediately following, as sailing vessels, with their lower construction and operation costs, were widely considered more conservative investments in times of economic volatility (Davidson 1988:249). Nevertheless, many vessel operators were forced out of business in the final years of the 1850s (Mansfield 1899:1:191,677-679).

This excess of idling tonnage, available at prices significantly below their pre-1857 values, led John R. Noyes of Buffalo to purchase several large steamboats, cut them down into barges, then tow them in line behind a steam tug (Mansfield 1899:403,517,520). Furthermore, the relatively short serviceable lifespan of wooden vessels meant that in most ports there was always inexpensive sail tonnage available for purchase that could be towed behind a steamship.

Such towed vessels, typically sailing vessels, were initially fully crewed and remained rigged. However, once the efficacy of towing had been proven, crews were rapidly reduced aboard the tows to minimize expenses on wages. Later schooners under tow were typically manned by two to three crewmen employed in steering the vessel, management of towing lines, working the pumps, assisting in the docking of the vessel, and working the rig (Rodgers and Green 2003:28-29; Rodgers *et al.* 2006:13; Bazzill 2007:2-3). To reduce the required crew, most of these sailing vessels were cut down, their topmasts and gaff topsails removed, as well as bowsprits and jib booms, leaving only the forestaysail, foresail, and mainsail to handle the vessel should the towline part or need to be cast off, and used while underway under tow to alleviate some strain on the towing hawsers and consumption of fuel by the towing vessel (Mills, J. 1910:187-188; Rodgers *et al.* 2006:12-13).

This system of operations offered several distinct advantages to vessel owners over independent operation. By towing between two and six barges in line astern of a single tug or steam barge, the steam operator could increase the capacity being moved by an individual steam vessel without commensurate increases in construction or operating costs. Furthermore, individual barges could be left along the tow's route to be unloaded and retrieved on the return (Jensen 2019:176). Demand for shipping tonnage with the opening of continuous navigation to Lake Superior with the completion of the St. Mary's River Locks, combined with depressed freight rates and the realization of the efficiencies offered by towing barges led to the rise of propellers intended specifically for freighting.

Steam barges represented a transition in construction method between schooners and bulk freight carriers of latter years. Steam barges were designed as single-decked propellers with an elongated, unobstructed deck amidships, all cabins and the pilothouse being situated aft before the 1880s when the pilothouse and some cabins were moved to the bow (Bazzill 2007:32). Internally steam barges were constructed with longitudinal reinforcement similar to those in use on schooners, with a keelson, sister keelson, and assistant keelsons of heavy scantlings, paired with doubled frames and longitudinal ceiling planking. These standard features of schooner construction were paired with steam propulsion machinery situated at the stern (*Detroit Free Press* 1866; Labadie 1989:26; Bazzill 2007:39,56).

The first steam barge, the *Petrel* built at Port Huron, Ohio in 1848, was initially an economic failure due to low demand in the lumber trade for which it was designed. In 1865, steam barges were reintroduced to answer the increased demand in the lumber trade and provided to be efficient and economical carriers in that trade (*Detroit Free Press* 1873). Some 800 steam barges were built and operating on the lakes before 1910

(Bazzill 2007:40). Steam barges soon replaced tugs as towing vessels, allowing operators to further increase their efficiency. Many early steam barges were designed to fit through the Welland Canal and were widely employed in towing barges on the St. Lawrence River, placing steam in direct competition with sailing canallers and increasing the volume of freight being moved by steam on the lake. As steam barges increased in size on Upper Lakes, routes shifted west to provide more profitable economies of scale for larger steam barges which the Welland Canal could not accommodate (Mills, J.C. 1910:17,186).

Steam barges possessed some disadvantages which would be largely overcome by their successors, the bulk freight carriers. The relatively shallow holds of steam barges, intended for the efficient loading and unloading of lumber, reduced the overall capacity of the vessels when carrying freights that could not be carried as deck loads. Furthermore, the comparatively small hatches prevented the use of many mechanical unloading methods (Lenihan 1987:57).

The first wooden bulk freighter, the *R.J. Hackett*, designed in 1868 by Elihu M. Peck at Cleveland and launched in 1869, was intended specifically for the Lake Superior ore trade. The single-decked *Hackett*, at 208 ft. 1 in. (63.42 m) long, 32 ft. 5 in. (9.88 m) breadth, and 12 ft. 6 in. (3.81 m) deep, was designed to maximize capacity within the controlling breadth and draught imposed by the Sault Locks along the St. Mary’s River between Lakes Superior and Huron. The resulting hull had a length to breadth ratio of 6.5:1 and a length to depth ratio of 1:16.7. As wooden shipbuilding techniques improved, wooden bulk carriers approached 300 ft. (91.4 m) in length which was held to be the maximum possible length for wooden vessels due to excessive stresses of hogging and sagging (Dappert 2006:22).

As a result, the hull of the *Hackett* and subsequent bulk carriers, being extremely narrow and shallow for its considerable length, required substantial reinforcement to overcome hogging and sagging stresses exerted at the bow and stern. This was accomplished by the use of a heavy keelson, alongside several rider and assistant keelsons, paired with a heavy flooring system comprised of floor keelsons running parallel to the keel, offset from the centerline, and fastened to the inner face of the floors. Over this was laid two layers of heavy athwartships ceiling planking extending to the bilge, which was reinforced with heavy bilge strakes.

Other aspects of the *Hackett's* and subsequent bulk carrier design were centered on facilitating new methods of mechanized handling of loose freights. Like steam barges, the *Hackett* had a long, unobstructed waist with a continuous hold, accessed through hatches spaced at 24 ft. (7.3 m) centers to allow loading from pocket docks, the chutes of which were situated at 12 ft. (3.6 m) centers. Hatch dimensions were enlarged to allow the use of mechanized unloading devices (Mills, R. 2002:122; Rodgers 2003:8,37; Dappert 2006:8).

The *Hackett*, with its plumb stem, the pilothouse at the extreme bow, cabins at the stern, and fantail stern, established the configuration of subsequent bulk freighters and persists in modern steel bulk freighters on the lakes. Furthermore, the *Hackett's* machinery was moved aft, which increased available space within the hold amidships, but which tended to cause the vessel to settle by the stern when light, resulting in increased strain on the hull amidships (Hall 1884:168; Labadie 1989:26-28; Mills, R. 2002:122; Rodgers 2003:30-34; Dappert 2006:9,50; Bazzill 2007:35-36). Though developed for the specifications of the iron ore trade, bulk carriers proved adaptable and were soon employed in transporting most commodities moving on the Great Lakes.

The economic advantages and efficiencies offered by ever-larger vessels resulted in a rapid increase in the size of bulk carriers beginning in the last quarter of the 19th century. As wooden bulk carriers expanded in length, two-deck variants were introduced, with the additional beams, which were left without planking, stiffening the sides of the hull. By the end of the 19th century, two-decked bulk carriers dominated, both new constructions and retroactive rebuilds of single-deck bulk carriers (Mills, R. 2002:50; Rodgers 2003:8). Other means of mitigating longitudinal stresses and increasing the longitudinal rigidity of these hulls involved the incorporation of iron structural reinforcements including iron basket trusses, diagonal strapping intersecting at right angles, forming a latticework between the frames and the outer hull, and as well as iron strapping along the upper ends of the frames (Labadie 1989:18-118; Rodgers 2003:1,10,29,32; Meverden and Thomsen 2013:47).

While few of these vessels were able to transit the Welland Canal, and therefore, access Lake Ontario, their presence was broadly felt within the economy. These innovations in bulk carriers were integral to the development of what Rodgers called the “integrated bulk carrier system” in the last quarter of the 19th century, a system characterized by mechanization in the storing, handling, and transportation of loose, bulk freights combined with vessels designed for cost-effective, high-volume bulk transport

(Rodger 2003:37). The collective experience among vessel owners was that with the increasing scale of transport, costs were reduced (Mills, R. 2002:3). The rapid increase in steam tonnage and in the efficiency of steam vessels specifically designed for freighting, and the improvements in mechanized handling of bulk freight cargoes, brought about tremendous increases in the tonnage of commodities transported on the lakes, and with it reduced freight rates. The increase in lake tonnage, alongside reduced demand following the Panic of 1873, rendered many sailing vessels unprofitable for several years (Cooper and Jensen 1995:14).

The Third Welland Canal, 1884-1932

By the late 1870s, the Welland Canal was unable to accommodate an increasing number of vessels, despite an 1873 increase in the minimum depth to 12 ft. (3.6 m), imposing additional transshipment requirements and diverting Upper Lakes traffic to the Erie Canal. Mansfield noted that in 1845 nearly all vessels engaged in the grain trade on the Upper Lakes could clear the Welland Canal, but by 1850 some 20 propellers were too large to enter the Welland locks. By 1872, this number had increased to 60 vessels (Mansfield 1899:235).

Between 1881 and 1884, the Canadian Government undertook improvements to the canal, enlarging the locks to 270 ft. (82.3 m) long, 45 ft. (13.7 m) wide, and with a minimum depth of 14 ft. (4.3 m). Despite these improvements, by 1884 the new dimensions were again insufficient to accommodate most bulk carriers operating above the Welland in the 1870s (Labadie 1989:25). However, the expansion of the canal heralded the transition in the Welland Canal trade from sail forwarding to steam canallers and direct shipment between the Upper Lakes and Montreal, effectively eliminating Lake Ontario transhippers' and forwarders' roles in the grain trade.

Again, the enlarged dimensions of the Welland Canal were outpaced by the rapidly increasing scale of bulk carriers operating on the Upper Lakes allowed by improvements on the locks of the St. Mary's River between Lakes Superior and Huron. Between 1855 and 1888, the Soo Locks on the St. Mary's River limited vessel's size to 350 ft. (106.7 m) long by 70 ft. (21.3 m) wide and 12 ft. (3.6 m) draft. As vessel owners sought ever larger and more cost-effective vessels, the limits of wooden construction were reached by the 1880s as bulk carriers approached lengths of 300 ft. (121.6 m) (Dappert 2006:59).

While iron shipbuilding was widely used on the Atlantic by the mid-19th century and was introduced to the Great Lakes as early as the 1840s, it was comparatively rare on the lakes before the 1880s. Iron shipbuilding was first used for merchant vessels on the lakes in 1862 with the construction of the 720-ton propeller *Merchant* built by the Union Dry Dock Company of Buffalo. The first iron bulk carriers on the lakes were: *Alberta* built by C. Connel and Company Ltd. of Whiteinch, Scotland, *Algoma* and *Athabasca* both built by Aitken and Mansell of Glasgow, Scotland, where a thriving iron-working industry was already established. These vessels were brought to Montreal where they were cut in half, the halves being towed through the Welland Canal to be reassembled at Buffalo (Cuthbertson 1931:268). In 1882, the 2,164-ton *Onoko*, built by Globe Ship Building Company of Cleveland, became the first iron bulk carrier constructed on the Great Lakes. *Onoko* was followed by *Spokane* in 1887, the first steel bulk carrier, also constructed by Globe Ship Building.

While iron and steel offered an improved strength to weight ratio, allowed the reduction of scantlings, and offered increased longitudinal strength, its widespread implementation on the lakes was impeded by the increase in costs and the local availability of inexpensive lumber before the 1890s (Labadie 1989:28; Cooper and Jensen 1995:17,29). In 1882, the *Onoko* was completed at the immense cost of $210,000, offering an increased capacity of between 25 and 30 percent over wooden bulkers of comparable dimensions. A wooden bulk carrier and consort barge of comparable capacity could be constructed at 50 and 70 percent of this cost (Meverden and Thomsen 2013:47). The transition to iron and steel construction occurred as a result of exhaustion of available lumber resources, the decreasing cost of steel, and the necessity of increasing hatch dimensions to facilitate mechanical unloading devices beyond what was possible with wooden construction (Cooper and Jensen 1995:19; Mills, R. 2002:3; Dappert 2006:29).

In 1888, the completion of the federally funded Weitzel Lock at Sault Saint Marie expanded the lock dimensions between Lake Huron and Lake Superior to 515 ft. (157 m) long, 80 ft. (24.4 m) wide, and 17 ft. (5.2 m). The opening of the Poe Locks in 1896 with dimensions of 800 ft. (243.8 m) long by 100 ft. (30.5 m) wide and a depth of 24 ft. (7.3 m) and the Davis Lock in 1914 with dimensions of 1,350 ft. (411.5 m), 80 ft. (24.4 m) wide and 21 ft. (6.4 m) deep, effectively removed the upper limit of vessel length for steel shipbuilding on the lakes. The result was a rapid increase in the scale of vessels operating on the Upper Lakes after 1890. In 1890 the longest bulk carriers were 300 ft. (91.4 m) long. By 1894 bulkers had increased to 400 ft. (121.9 m), reaching 500 ft. (152.4 m) only six years later. By 1906, vessels of some 600 ft. (182.9 m) were plying the waters of the Upper Lakes (Labadie 1989:28). The increase in shipping tonnage had an immense impact on the shipping economy. In 1889, some 25,266,974 tons of freight were shipped on the lakes aboard 2,737 American vessels. In 1916, some 125,384,042 tons were carried on the lakes by 2,856 vessels, with only marginally more vessels moving significantly more freight (Larson 1983:56).

The Decline of the Forwarding Trade

As a smaller portion of vessels on the Upper Lakes were able to transit the Welland Canal, Lake Ontario's commerce was again constrained by the necessity of transshipment into smaller vessels, this transshipment occurring at Lake Erie ports. From the 1880s, the improvements in the St. Lawrence Canals meant that the vessels downbound on Lake Ontario did not require transshipment when passing to the St. Lawrence Canals. As a result, Lake Ontario, and its long-established role in transshipment and forwarding was increasingly bypassed in favor of direct transit between Lake Erie transshipment ports and the Lower Saint Lawrence River (Gilmore 1957b:97).

Since 1848, the locks of the St. Lawrence Canals, with controlling dimensions of 200 ft. (61 m) long by 55 ft. (16.8 m) wide and 9 ft. (2.7 m) deep, had allowed lockage of vessels of up to 175 ft. (53.3 m) long, 35 ft. (10.7 m) in breadth and 8 ft. (2.4 m) draught. Though these vessels were able to reach Lake Ontario, the largest vessels of St. Lawrence canal size were still unable to transit the Welland Canal locks (Croil 1898:264-265; Gilmore 1957a:19). From the late 1860s, most steam traffic and grain transport on the canals was conducted by package freighters rather than bulk carriers, while bulk freights were carried in towed barges or aboard sailing vessels (Duerkop 2017:3).

By the 1890s, in anticipation of the expansion of the St. Lawrence Canal, the Montreal Transportation Company began investing in building a fleet of steel canal-sized propellers intended to carry bulk grain from Lake Superior ports directly to Montreal, without the need for transshipment for the St. Lawrence transit (Duerkop 2017:3). Investment in canallers as well as the exponential increase in grain shipments from the Canadian prairies by way of Lake Superior resulted in record shipments to the Kingston elevators. In 1900 Kingston's elevators received 5,400,000 bushels, with the number increasing in 1907 to 19,100,000 bushels (Duerkop 2017:6). The completion of enlargements to the St. Lawrence Canal in 1902 allowed lockage of vessels of up to 256 ft. (78m) length, 44 ft. (13.4 m) breadth, and with draughts of 14 ft. (4.3 m) (Mills, J. 1910:226). The unification of lock dimensions with the Welland Canal permitted bulk freight canallers to pass from the Upper Lakes to the Lower St. Lawrence, without the need for transshipment at Kingston.

Canadian sailing vessels driven out of the inter-lake grain trade sought refuge in the local trading economy, taking whatever charters were available and choosing cargoes as rates became favorable. Grain cargoes were still available in season, carrying grain from lake ports to Kingston or Oswego. As grain shipments increasingly passed directly down the St. Lawrence to Prescott and Montreal, Kingston's once prominent role as a port of transshipment declined. By 1919 the grain-starved elevators at Kingston closed in favor of those at Montreal (Gilmore 1957b:97; Duerkop 2017:6).

American commerce on Lake Ontario fared worse. The abolition of tolls on the Erie Canal in 1883 removed any remaining economic advantages of the Welland-Oswego route, as tolls remained for the passage of the Welland Canal at a rate of $6 per 1000 bushels or 20 cents per ton (Larson 1983:53-54; Meverden and Thomsen 2013:7). In 1884, the Canadian government instituted the partial refunding of tolls paid on grain exports carried in Canadian vessels through the Welland Canal. This reimbursement increased from 10 cents in 1884 to 18 cents by 1892. In response to American protests against the advantages afforded to Canadian vessels, tolls were reduced to 10 cents per ton in 1893 and were eventually abolished in 1903 (Mansfield 1899:239; Mills, J. 1910:229).

This conspired to encourage the use of the Erie Canal rather than the Lake Ontario routes. With the disappearance of the forwarding trade and transshipment business on Lake Ontario, the American sailing fleet, which had been almost entirely dependent on the inter-lake trade, disappeared rapidly. By 1890, Oswego's sailing fleet was reduced to only 12 schooners and disappeared entirely soon thereafter (*Weekly British Whig* 1890).

The international trade within Lake Ontario, consisting primarily of exportation of Canadian commodities to New York ports aboard Canadian vessels, received another serious blow from the McKinley Tariff of 1890. The McKinley Tariff, which went into effect on 1 October 1890, imposed tariffs of between 10 and 35 percent on all commodities being imported into the United States which competed with American-produced commodities (Palmer 1984:37). In 1890, Oswego's barley imports had totaled some 3 million bushels, or approximately one-third of the annual barley imports of the United States. The tariff increased duties on Canadian barley from 10 to 30 cents, resulting in the almost immediate end to the barley trade (Palmer 1986:248). Similar losses in Oswego's imports occurred in all other commodities except for coal, which was an export and therefore exempt from the tariff. The decline of international imports into Oswego was so complete that by 1913 the Oswego Customs District was removed and subsumed in that of Rochester (O'Connor 2010:12; *Oswego Palladium* 1916).

The Coal Trade on Lake Ontario

By the end of the 19th century, most schooners still operating on Lake Ontario were Canadian-owned, and increasingly reliant on the importation of anthracite coal from south shore ports to Canadian consumers and coal merchants.

Anthracite coal, or hard coal, was primarily used as a domestic heating fuel as it was clean-burning (Karanek 1975:207). While bituminous coal, or soft coal, was a principal eastbound cargo on Lake Erie and occasionally carried on Lake Ontario, anthracite coal was the principal commodity being moved on Lake Ontario by the end of the 19th century. While much of the anthracite coal carried on the lakes arrived at Lake Erie ports for upbound shipment, the high market price and limitations of demand for anthracite coal throughout much of the period made the transportation of coal through the Welland Canal unprofitable (Larson 1983:54). While coal was not as profitable, the schooners with their small size and low operating costs were well suited to chartering relatively small coal consignments to Canadian consumers and coal merchants often operated in ports inaccessible or uneconomical for larger vessels or steam vessels with their higher operating costs.

It is perhaps ironic that the dwindling number of sailing vessels remaining on Lake Ontario after the turn of the century owed their employment in transport of coal to the railroads. The expansion of rail connections to the Lake Ontario lakeshore in the late 1860s and 1870s connected the anthracite coal fields of Pennsylvania with the New York lakeports of Oswego, North Fairhaven, Sodus Point, and Charlotte, providing coal sellers with access to, and inexpensive transport to, Canadian consumers.

In 1869, a branch line of the Delaware-Lackawanna and Western Railroad was extended to Oswego, accompanied by the construction of a large coal trestle on the east side of the harbor at the mouth of the Oswego River. This was replaced in 1882 by a larger elevator containing 24 pockets with a combined storage capacity of 9,365 tons. The new trestle, 50 ft. (15.2 m) high, extended some 1,800 ft. (548.6 m) into the harbor, providing sufficient dockage to load eight vessels simultaneously (Saward 1887:567; *Oswego Palladium-Times* 1935). The DLWRR trestle was supplemented by additional trestles managed by the Delaware & Hudson Coal Company and the New York Ontario & Western Railroads, both situated at the mouth of the Oswego River on the east side of the river.

Rochester was extensively connected by rail from the mid-19th century. While the first trestles at Charlotte were constructed in the late 1860s by A.G. Yates, Charlotte's coal trade was slow before the extension of the Delaware-Lackawanna and Western Railroad to Charlotte in 1882. At this time, Yates' trestle was replaced by a new trestle 1000 ft. (304.8 m) long and 45 ft. (13.7 m) high, with a capacity of 3,000 tons divided between 40 pockets (Saward 1887:567).

The ports of North Fairhaven and Sodus Point, on Great Sodus Bay and Little Sodus Bay, would never achieve the same scale of coal commerce. In 1852, the Sodus Point and Southern Railroad Company attempted to connect a spur line with the Pennsylvania Railroad, but the line would not be completed until 1872. In 1874, S.B. Stuart and Company constructed a rail trestle with a pocket capacity amongst 34 pockets of 2,380 tons, capable of loading four vessels simultaneously. With the opening of this trestle, Sodus Point became an exporter of coal. By 1883, this trestle was inadequate for the port's coal business, and it was rebuilt (Saward 1887:567; Larson 1983:55).

In 1871, the port of North Fairhaven was connected to the South-Central Railroad (later taken over by the Lehigh Valley Railroad) forming the northern terminus of the line stretching south to the Wyoming region of Pennsylvania. To facilitate loading vessels, a rail trestle was constructed on the east shore of Little Sodus Bay containing 43 pockets with a combined storage capacity of 3000 tons and was sufficiently long that three vessels of 500 tons could be loaded simultaneously (Saward 1887:567; *Ithaca Journal* 1876).

From their construction until the 1920s, sailing vessels regularly carried loads of coal from these trestles to Canadian ports. In 1889, Charlotte and Oswego loaded 350,000 and 320,260 tons at their trestles respectively. In that same year, Fairhaven and Sodus Point loaded 132,000 and 75,000 tons (Saward 1890:103). The anthracite trade at Oswego and Charlotte seems to have peaked in 1907 with 698,427 and 719,187 tons loaded on lake vessels (Saward 1910:16).

From the 1870s, Canadian sailing vessels carrying grain to Oswego frequently carried coal as a routine return cargo before the 1890 McKinley Tariff. The marginalization of most sailing vessels from the inter-lake trade by the 1890s, the end of the export trade to Oswego, and the declining role of Lake Ontario in the grain forwarding trade, meant that by 1900, coal consignments comprised the only reliable employment for the remaining schooners.

During the 1920s, labor upheavals within the anthracite coal industry, and the centralized control of labor on the anthracite fields of Pennsylvania by the United Mine Workers of America (UMWA) would ultimately bring about the collapse of the anthracite industry after work stoppages in 1920 and 1923 and extended strikes in 1922 and 1925. As labor within the anthracite industry was completely organized under the UMWA, these work stoppages effectively ceased production of anthracite.

In January 1922, contract negotiations between the UMWA and anthracite operators involved disputes over wage scales, labor’s demand for an eight-hour workday, and provisions for union dues to be deducted directly from paychecks known as the checkoff. Anthracite operators gave strong opposition stating that declining demand necessitated decreasing production costs to lower prices and stimulate demand, which required that wages be reduced (Gadsby 1922:932,940). Unwillingness to negotiate resulted in work stoppages beginning 31 March 1922, with the stoppages escalating to a formal strike by 1 July, when virtually all anthracite production ceased (Gadsby 1922:932-944). After a series of failed negotiations, an agreement was reached on 2 September and production resumed (Gadsby 1922:949-950).

The 1923 contract between anthracite operators and the UMWA ensured against strike for two years, leading to optimistic prospects for the remaining schooners on Lake Ontario (*Oswego Daily Times* 1924; Zeiger 1969:254-256). In July 1925, the representatives of the UMWA and anthracite operators met to renegotiate the contract. Amidst opposing and intractable demand for wage increases by labor, reductions by the operators, and the checkoff, and refusal of wage arbitration by the union, negotiations were broken off on 2 August. On 1 September, the UMWA began a formal strike (Karanek 1974:44-47). By mid-October, anthracite stockpiles had begun to disappear, and prices increased in anticipation of shortages. As winter arrived, existing stockpiles had been largely exhausted. In the absence of a reliable supply of anthracite, which had been expensive before the shortages, with which to heat their homes and businesses, many consumers shifted to substitute fuels permanently (Karanek 1974:57,59-60). Negotiations would not reconvene until 29 December. Finally, on 12 February 1926, both parties reached an unremarkable agreement that maintained pre-strike wages and required neither party to submit to compulsory arbitration (Karanek 1974:53-58). The strike lasted 165 days, and while the remainder of the 1920s witnessed no further interruption in work on the anthracite fields, the market losses would never be recovered, and anthracite production and demand declined steadily thereafter (Karanek 1974:60-61).

Though by 1925 attrition and age had reduced the number of remaining schooners to four, the effects for those remaining in operation were devastating. The long-uninsurable schooners had been relegated to comparatively low-value coal, which was less susceptible to water damage from leaks in the aging hulls. Now entirely reliant on the anthracite supply to the lake ports, the remaining schooners were laid up through the summer of 1922 and the fall of 1925 (*Oswego Palladium-Times* 1925). This instability and idling compounded the inability to obtain consistent charters throughout the season, as coal rates fluctuated with market demand (*Oswego Daily Times* 1924). The collapse of anthracite markets following the disruptions of 1925 and early 1926 further exacerbated these issues, ensuring that these schooners would be left without employment within a few years.

The Decline of the Lake Ontario Sailing Fleet

By 1915, there was widespread recognition that the era of the sailing ship had passed (*Cape Vincent Eagle* 1915). The rapid decline of the American wooden shipbuilding on Lake Ontario in the 1870s and of the Canadian industry in the 1880s meant that new vessels had to be obtained from elsewhere to replace worn-out vessels. Building for Lake Ontario vessel owners on the Upper Lakes had begun well before the decline of shipbuilding on Lake Ontario in the 1870s (Meverden and Thomsen 2013:7).

Yet, as Lake Ontario's fleet aged, replacement vessels were increasingly sought from vessels employed in the Lake Michigan lumber trade as the persistence of the Lake Michigan lumber trade to the end of the century, and its subsequent decline with the deforestation of the region, resulted in a surplus of sailing vessels on that lake.

Of the 23 sailing vessels on Lake Ontario that were listed in the *Oswego Palladium* on 26 April 1916, 17 had been purchased from the Upper Lakes and transferred to Canadian owners. These included *Abbie L. Andrews, Arthur, Burt Barnes, Bertie Calkins, Mary A. Daryaw, Grace M. Flier, Ford River, J. B. Kitchen, Maize, Charlie Marshall, George A, Marsh, Julia B. Merrill, Lizzie Metzner, Lyman M. Davis, J. B. Newland, Horace Taber*, and *Theodore Voges* (*Oswego Palladium* 1916). The remaining Canadian-built schooners were *New Dominion, Katie Eccles, William Jamieson, Keewatin*, *Oliver Mowat, Sligo,* and *St. Louis* (*Oswego Palladium* 1916). Several small scow schooners operating on the Upper St. Lawrence and Eastern Basin of Lake Ontario were not listed.

These vessels, retaining little of their value, and typically uninsurable, after having reached the end of their serviceable lives, could seldom be disposed of profitably. The exception was in the years of the First World War, when demand for shipping tonnage increased, allowing the profitable sale of aging schooners out of the Great Lakes. Both the *Arthur* and the *Ford River* were sold in 1917 down the St. Lawrence (Wisconsin Maritime Museum 2021).

By the end of 1921, the sailing fleet had been reduced to six three-masted schooners: *Burt Barnes, Horace L. Taber, J.B. Newlands, Grace M. Flier, Julia B.*

Merrill, and St. Louis, and four two-masted schooners: *Mary A. Daryaw, Katie Eccles, William Jamieson, and Lyman M. Davis* (*Cape Vincent Eagle* 1921). By May of 1923, the fleet had suffered further attrition with the loss of the two-masters *Katie Eccles* on 30 November 1922, its sistership *William Jamieson* on 15 May 1923, and the three-master *Horace L. Taber* in the same storm that had disabled the *Eccles* on 26 November 1922. The fleet was supplemented by the three-masted schooner *Hattie Hutt* which was purchased by Kingston owners from Lake Michigan in that same year (*Oswego Palladium* 1923, *Oswego Daily Times* 1923). Over the following years, the fleet decreased rapidly, and by the time *Mary A. Daryaw* was taken out of commission in 1927, only the *Julia B*, *Merrill*, and *Lyman M. Davis* remained (*Oswego Daily Times* 1924; *Oswego Palladium-Times* 1928).

The last two remaining schooners would share a common ignominious end. *Julia B. Merrill* of Port Hope was then owned by James Peacock and Company, coal sellers of Port Hope and sailed by his son and business partner, Captain William H. Peacock since 1921. Though registered out of Port Hope, it had not operated from Port Hope since 1926, instead having been employed carrying coal to Kingston from New York coal ports (*Daily Times* 1928). *Julia B. Merrill* had begun its career in 1872 at Wenona, Michigan in the shipyard of F.A. Carpenter, and was employed in the Lake Michigan lumber trade. In 1921, it was purchased by James Peacock of Port Hope and Arnold Way of Picton and for use in the Lake Ontario coal trade (Snider 1931). At the end of the 1927 shipping season, the *Merrill* was taken out of commission (*Oswego-Palladium Times* 1928).

In March 1931, while laid up alongside the Port Hope pier, *Merrill* sprung a leak and settled at its moorings. Asked by *Evening Guide* if the vessel would be repaired and placed in service again William Peacock simply stated that, "She has done her bit." The *Merrill* was refloated but would not be placed back into service. Instead, Peacock sold it to D.M. Goudy, the manager of attractions for Sunnyside Park at Toronto, for $350.00 and agreed to deliver the vessel to Toronto by 9 June 1931 (*Evening Guide* 1931a, 1931b). Tied up along the seawall at Sunnyside, Toronto, *Merrill* attracted considerable public interest. C.H.J. Snider's column *Schooner Days* published many of the letters of concerned individuals protesting the destruction of the *Merrill.* Snider, for his part, felt *Merrill* too far gone to repair and preserve, its sheer having severely hogged, and its rotten mizzenmast having been cut down before leaving Port Hope. The outcry came to nothing, and it was burned before a crowd of thousands on 21 July 1931 (Snider 1931).

The demise of *Julia B. Merrill* left *Lyman M. Davis* the sole sailing vessel still operating under canvas on Lake Ontario in 1930, and from September of 1930, the only sailing vessel still in operation under sail on the entirety of the Great Lakes. *Davis* was another Lake Michigan lumber schooner, owned by William Monroe until 1913, when it was transferred to Canadian registry, having been bought by the Graham Brothers of Kincardine, Ontario for the Lake Huron lumber trade. In 1919, it was sold to John McCullough and Cephus H. Spencer of Napanee who operated it in the coal trade. In 1927, *Davis* was purchased by Captain Henry Daryaw, who sailed the vessel until 1931 (Oswego Palladium-Times 1928; Palmer 1983:41). In 1931, it had taken 20 coal charters, primarily between Oswego, Kingston, and the Bay of Quinte. This apparent abundance of charters was likely due to the absence of significant competition for smaller consignments. In 1931, the 53-year-old schooner was not returned to service, ending the era of commercial sail on the Great Lakes (Oswego Palladium-Times 1932).

In 1933, it was purchased by D.M. Goudy with the intention of staging a similar spectacle to the end of the *Julia B. Merrill*, and the vessel was moored alongside the Sunnyside Pier, with a banner stretched between its lower mastheads stating "Come Bid Me Farewell."

The announcement of the plans to burn the *Davis* elicited widespread public concern given a public platform in C.H.J. Snider's column Schooner Days. Snider coordinated the effort to save the vessel, inspecting the vessel's condition and the feasibility of repairing it, which he believed would require recalking but not drydocking (Snider 1933a).

Snider's solicitation of letters on behalf of the *Lyman Davis* received a massive response in correspondence and petitions from throughout Ontario and *Davis* received nearly l7,000 visitors in August (Snider 1933a). The efforts to save *Davis* were helped considerably by Mayor William J. Steward who wrote a letter to D.M. Goudy, who agreed to defer the issue until the following summer (Snider 1933b). On 23 September 1933, Snider declared that the *Davis* had been saved for that year and though he expressed optimism for efforts the following year he noted it was "only a reprieve not an ending (Snider 1933c).

On 2 February 1934, Sunnyside announced 24 May as the new date for the burning, an event which was to be the central event of the early season at Sunnyside

(*Oswego Palladium* 1934). Amidst protest from many members of the public, the date was again delayed, and Goudy offered to sell the *Davis* if a reasonable offer could be made for the schooner. Amidst the financial hardships of the Great Depression, fund drives failed to gather sufficient funds to save it.

On the evening of 29 June 1934, the *Davis*, its spars tarred, its decks piled with wood and doused in coal oil, was towed several hundred yards offshore, and with tens of thousands looking on, was set alight. The fires spread rapidly through the incendiary-filled ship, igniting fireworks on the decks. For the next hour, it burned. Shortly before 2:00 a.m., the burning hulk was towed into deeper water in the Outer Bay and a dynamite charge was set off on its bottom, the hull disappearing within minutes, ending the era of commercial sail on the Great Lakes (*Oswego Palladium*-Times 1934; Toronto *Telegram* 1934; Palmer 1983:43).

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CHAPTER III

THE LAST SCHOONERS PROJECT 2019 - METHODOLOGY

Between 13 to 19 June 2019, the author directed the pilot season of the Last Schooners Project, remotely surveying the wreck of the *Katie Eccles* off Prince Edward County, Ontario. The research team made a total of eight dives on the wreck with the LBV-150-2 remotely operated underwater vehicle (ROV). A remote-access-based approach to site documentation was employed due to provincial regulations restricting the use of open-circuit SCUBA at depths exceeding 30.5 m (100 ft), which precluded diver access to the site, which lies in 108 ft. (32.9 m) within the funding available for the pilot project.

On June 14, an orientation dive on the *Eccles* had to be aborted soon after the ROV reached the bottom due to building wind and waves at the exposed mooring. The following day access to the site was prevented by unsettled weather. On 16 and 17 June, the team made seven dives on the site recording nearly eight hours of video and capturing 5,178 timed still photographs. While the internal camera of the LBV-150-2 was utilized in the piloting of the ROV, it was not recorded due to its low resolution, which was insufficient for photogrammetric recording. Digital video was recorded with a GoPro Hero 7 mounted externally to the frame of the LBV-150-2 as well as a GoPro Hero 3/3+ which could be alternated between video and timed stills. The GoPro Hero 7 video files were shot in an aspect ratio of 1440 by 1080 at 20-30 frames per second with wide-angle and low-light settings enabled. The use of *Agisoft Metashape* did not necessitate pre-calibration of the cameras, due to *Metashape's* use of adaptive calibration, which corrects for distortions resulting from refraction algorithmically (Yamafune *et* al. 2017:705; Shortis 2019:24). Individual dive times were limited to approximately one hour based on our estimates of the battery life of the GoPro cameras in cold water temperatures at depth.

The *Eccles'* hull was recorded with repeated passes at depth intervals of approximately 1 m, with cameras oriented perpendicularly to the centerline of the hull as the ROV panned around it. This was repeated until complete video coverage of the hull was achieved. This footage was supplemented by top-down video recording on repeated passes parallel to and at regular offsets from the centerline. Each dive was planned to record a specific section of the site and to ensure lateral overlap with the areas recorded in the preceding and following dives. For photo modeling in *Agisoft Metashape,* successive photos should possess vertical and horizontal overlaps of 60 and 80 percent respectively (Agisoft 2018:2). The use of extracted video stills allowed the ROV operator to ensure sufficient lateral overlaps between successive still frames, though this resulted in some loss of resolution along the edges within the rendered photo model due to motion blurring in some frames (Yamafune et al. 2017:714-715).

While a survey of the *Oliver Mowat* with similar methodologies and research questions was planned for 2019, delays in the processing and receipt of the permit precluded any fieldwork at that site.

Generating the Photo Model in *Agisoft Metashape*

Still frames were extracted directly in *Agisoft Metashape Professional Edition* with the "Import Video" function. Only those still-frames extracted from video taken at a top-down angle required correction for brightness and contrast in Adobe Photoshop before being imported into *Metashape*. The extracted frames were then grouped in chunks encompassing the port side, the bow, the starboard bow to amidships, the stern, the deck, and the starboard quarter with overlap between chunks to enable alignment into a unified photo model. This chunk-based approach to modeling was necessitated by the large quantity of data and the extended processing times that would be involved in producing a unified model. After sorting into chunks, photos were reviewed to exclude any low-quality images.

Once the still frames had been grouped into chunks, the "Align Photos" command was used to generate a sparse point cloud before rendering the dense point cloud. As no masks were used to exclude the water column in the photos, extensive filtering was needed to eliminate extraneous points resulting from water column within the dense point cloud. As considerable noise was present, the "Filter by confidence" and "Filter by selection" functions were used to filter out these points. The remaining noise was manually selected and removed.

The chunks were then aligned using a series of manually selected points along the overlapping margins of the chunks. After alignment, the "Build mesh," command was run, forming a unified mesh of the site. With the unified mesh complete, the "Build texture" function was used to overlay the mesh with photorealistic textures.

The principal difficulty in producing a unified site photo model from the on-site video was the limited overlap between sections of the hull recorded on separate dives. Structure from motion photogrammetry requires that a point appears in a minimum of three overlapping photographs to reconstruct the position of the camera. The intact and complex three-dimensionality of the *Katie Eccles* made obtaining sufficient overlap difficult along narrow features such as the bulwarks. This was largely the result of the recording methods employed, in which the LBV-150 was slewed around the hull. This focus on one side of the hull in a dive and the resumption of recording where we had left off on the next dive resulted in a limited overlap of the areas of the hull covered between dives, though the individual lateral overlap between photographs was not a concern due to the use of video stills rather than still photographs. When still frames were imported into *Metashape*, there were often insufficient overlapping surfaces visible to automatically align and join the chunks properly along the bulwarks. To correct this alignment, markers were manually inserted to identify shared points to assist the alignment of the chunks, substantially increasing the time needed to render the photo model.

The resulting model accurately represented the three-dimensional geometry of the site but lacked any information with which to constrain its scale (Yamafune 2016:29; Yamafune *et al.* 2017:710). Scaling measurements were taken from identifiable features throughout the site utilizing a metric scaling bar attached to the lower side of the LBV-150-2's frame during the final dive. Scaling measurements were limited to a length of 15 cm. Markers were added to the photo model to mark the endpoints of these measurements and the known distances between them were entered to constrain the photo model to actual scale. When scaling the model, the limited length of these measurements resulted in a higher standard deviation of scaling accuracy across the site. To constrain this deviation, the maximum breadth of the hull recorded in the Eccles 1877 registration was used to scale the model athwart the forehatch. However, the possibility of errors in the vessel measurements listed in the Eccles registration documents introduces the potential for error (Library and Archives of Canada [LAC] 1877).

Without access to a working-class ROV, some techniques that might have expedited processing and improved the quality of data were impossible, including the temporary placement of scale bars or coded targets on-site. When placed throughout the site, the coded targets, provided by Agisoft, are recognized in *Metashape* and function as control points to assist the alignment of the point network. Kotaro Yamafune notes that this method significantly increases the percentage of photos that aligned when contrasted with the same photos without recognition of the targets (Yamafune 2016:20-21,23). Furthermore, the placement of multiple scaling bars throughout the site would provide a better means of introducing scale measurements and limiting the deviation of scale within the model across the site.

Agisoft Metashape allows the processing and rendering of orthophotos, a two-dimensional orthogonal image generated from the photo model (Yamafune et al. 2017:715). As the basis for generating a site plan, orthophotos were rendered for the top-down plan view, as well as for the bow, stern, starboard, and port elevations. These orthophotos provided the basis of the site plans which were traced from the orthophotos by hand. While this process was perhaps more laborious than alternative digital methods for generating site plans from the orthophotos, drawing by-hand possesses numerous benefits for the archaeological interpretation of the site, during the process of drawing (Yamafune et al. 2017:716).

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CHAPTER IV

THE THREE-MASTED SCHOONER *OLIVER MOWAT*

Throughout much of the 19th century, the inter-lake grain trade from grain ports, first on Lakes Erie and Michigan, and later Lake Superior, was central to Lake Ontario's commerce. Kingston and Oswego, as the easternmost major terminals of the grain trade on the lakes, transshipped and forwarded vast quantities of grain eastward down the St. Lawrence River and Erie Canal.

Though only one vessel, *Oliver Mowat*'s 48-year operational history is illustrative of the role of sailing vessels in importing bulk grain from American ports on the Upper Lakes to Kingston forwarders and of the transitions to trading within Lake Ontario as sailing vessels were marginalized from the inter-lake commerce.

Among the Canadian schooners on Lake Ontario, *Oliver Mowat* is among the most well-documented vessels. As a long-time member of the Lake Ontario sailing fleet, the *Mowat's* arrivals, clearances, and incidents concerning the schooner appeared frequently in Kingston's *Daily Times,* and *Daily British Whig*. Furthermore, *Mowat* was a favorite of C.H.J. Snider, author of the column "Schooner Days" in Toronto's *Evening Telegram*, who had sailed aboard it in the 1890s. It frequently appeared in his writings, with detailed description of the vessel and its forecastle accommodations, life aboard, and its masters that is absent for most of its contemporaries (*Snider* 1936, 1950).

The inability to access Canadian archives impeded some aspects of this research, including access to the Canada Department of Marine's investigations into the collision between *Keywest* and *Oliver Mowat*, held in the Library and Archives of Canada in Ottawa. Without access to these resources, I have compiled as complete an account as can be made of the *Mowat* under the present circumstances. However, even with these limitations, the *Mowat* provides an informative perspective on the experience of Canadian vessels in the inter-lake trade and their transition into trading in the 1890s.

The Builders and the *Oliver Mowat*

In 1872 or early 1873, shipwright Edward Beaupre, Sr. was approached by the hardware firm of John Fraser and Frederick J. George of Kingston to contract for the construction of a new three-masted schooner with a capacity of 18,000 bushels at a cost of approximately $25,000.

Edward Beaupre was a prominent citizen and city councilman in Portsmouth, Ontario, and a ship carpenter who constructed numerous vessels at Portsmouth, Kingston, and throughout the Bay of Quinte throughout his career. By 1873, when he was 53 years old, Beaupre had built the schooners *Robert Taylor*, *Jessie Conger*, *Annie Minnes*, *Eliza Fisher*, *Annie Falconer*, *John Stevenson*, and the propeller *Hemlock* (*Daily British Whig* 1908b; Wisconsin Maritime Museum 2021).

The Beaupre family was heavily involved in the maritime affairs of Kingston and the Great Lakes. Edward's brothers Peter and Joseph were likewise ship carpenters, while three of his seven sons would obtain master's certificates, and a fourth became a foreman and ship carpenter (*Daily British Whig* 1908b). One of his sons, Edward Beaupre, Jr., who had attained a master's certificate at a young age, was actively

Figure 3. ***Oliver Mowat*** **in the Bay of Quinte (Willis Metcalfe Fonds, Picton Naval Marine Archive).**

involved in his father's shipbuilding business, and was involved in the design and construction of the schooner for George and Fraser from the outset (*Kingston Whig-Standard* 1938).

In 1873, Beaupre established a temporary yard at Millhaven for the construction of the new schooner. The hull taking shape on the stocks was 131 ft. 2 ½ in. (39.98 m) on deck, 25 ft.10 in. (7.89 m) in breadth, and with a 10 ft.8 in. (3.29 m) depth of hold (Figure 3). Its launching, scheduled for 15 July 1873, was widely publicized in local newspapers and was a much-anticipated social event.

When 15 July finally arrived, a delegation, invited by Fraser and George, gathered at Carruthers' Wharf along the Kingston waterfront. Among the delegation was Oliver Mowat, the brother-in-law of Mr. Fraser and the Premier of Ontario, as well as

William Robinson, Member of the Provincial Parliament, Judge J.J. Burrowes of Kingston as well as many other prominent Kingstonians accompanied by their families. At 11:00 that morning everyone departed the wharf aboard Fraser and George's new steam barge *Saxon*, which was constructed the preceding year. Taking advantage of the open deck amidships, an awning was stretched over the deck to accommodate guests for the passage across the Lower Gap with a brief stop at Portsmouth to take on more guests. After a pleasant trip, the *Saxon* arrived at Millhaven around 1:00 p.m., and the delegation disembarked onto the wharf to be greeted by a crowd of more than 2,000 that had gathered at the shipyard and along the waterfront.

At 1:30 p.m., the workmen began knocking out the studding timbers and supports to free the *Mowat* but at 2:00, the appointed hour for the launch, the *Mowat* refused to move on the ways. In the ensuing hours, futile efforts to free the vessel continued while the crowds waited. By 4:15 p.m. the shipwrights were making fast a towing hawser from the *Saxon* to the *Mowat* to pull the schooner off the ways when it finally began to move on its own. Helen Fraser, daughter of Mr. Fraser, christened the vessel and a new pennant was unfurled at the mizzen truck revealing the vessel's name, *Oliver Mowat.*

Mowat was towed to the wharf by the *Saxon*, with many Millhavenites aboard. Without a rudder, the *Mowat* grounded twice and was rapidly freed without sustaining damage before being brought alongside the Davidson and Doran Wharf to be fitted out. At 7:00 p.m. the *Saxon*, and the delegation with it, departed for Kingston arriving at 10:00 after a calm trip, having stopped briefly at Portsmouth and Garden Island to disembark passengers (*Buffalo Commercial Advertiser* 1873; *Daily British Whig* 1873a, 1873b; *Daily News* 1873a, 1873b, 1873c; *Toronto Mail* 1873b).

***Oliver Mowat*'s Operational History**

Edward Beaupre, Jr., who had assisted in the design and construction of the new schooner, was *also* Mowat's master, a position he held until 1882. (*Daily British Whig* 1876, 1882a).

Though grain still comprised the principal eastbound freight on the Great Lakes, lake shipping's control of this commodity's transport was increasingly challenged by rail from 1873 as grain production steadily shifted westwards (Ford 2018:85). Rail transport would only periodically surpass lake carriers in 1881 and 1885. In all other years before 1900, the majority of grain moved on the lakes and increasing overall volume of transport provided potential profits for smaller schooners throughout the 1870s and into the 1880s (Mansfield 1899:530-6).

The *Mowat*'s first trip was upbound to Cleveland, where it took on a return cargo of 16,985 bushels of wheat for the Montreal Transportation Company's elevators at Kingston, arriving 29 August 1873. The *Mowat* made a second trip to Cleveland, a third to Chicago, and multiple trips to Port Dalhousie, the Lake Ontario terminus of the Welland Canal, before laying up for its first winter at the Carruther's Wharf in Kingston (*Daily British Whig* 1873c; *Daily News* 1873d, 1873e, 1873f, 1873g, 1873h, 1873i, 1873j).

Under Fraser and George's ownership and Beaupre's management, *Mowat* was primarily employed importing grain from Lake Erie ports, principally Toledo, to the elevators of the St. Lawrence and Chicago Forwarding Company and the Montreal Transportation Company at Kingston and Toronto. Shorter trips to load grains at Port Dalhousie were also a frequent occurrence (*Daily British Whig* 1874b; *Daily News* 1876b). Up-bound trips were typically made light. In March 1874, one grain cargo was taken from Toledo at a rate of $1.50 per ton, greatly increasing the profitability of the trip (*Daily British Whig* 1874a; *Daily News* 1878a). However, throughout much of the shipping season, no up-bound cargoes were available. Though grain freights provided the highest rates and potential for profit, and though grain freights might have been the rule, for the *Mowat*, freights in coal and lumber or lumber products were periodic exceptions when for these bulk cargoes rates fluctuated and became favorable (*Daily British* Whig 1877; Daily *News* 1874a, 1874b, 1876a, 1876c).

In the years in which Fraser and George owned the vessel, several incidents befell *Mowat*. In late October or early November 1875, *Mowat* was reported aground in Belleville Harbor on the Bay of Quinte, before being freed on 5 November after lightering (*Daily British Whig* 1875a, 1875b). On the evening of 2 December 1876, the *Mowat* attempted to leave Oswego Harbor unassisted and under sail with a southerly wind. As the *Mowat* cleared the harbor entrance, the wind backed to the northeast, driving the *Mowat* towards the breakwater. With the vessel threatening to strike and break up along the western pier just west of the Oswego Lighthouse, it was only through the timely intervention of Captains William Munson and John Budds, the lightkeepers, that lines were made fast to the lighthouse pier, keeping the *Mowat* off the pier until it was towed clear the following morning by the tug *C.P. Morey* (*Daily British Whig* 1876; *Daily News* 1876d).

In April 1878, the *Mowat* was put up for sale due to the insolvency of Fraser and George, likely as a result of the prolonged depression that persisted long after the Panic of 1873 (*Daily News* 1878b). The highest bid for the *Mowat* was made by Dileno D. Calvin and Ira Breck of the Calvin and Breck Company of Kingston. On 26 April, the tug *Traveller* took the *Mowat* to Garden Island, where it was fitted out for the shipping season at Calvin and Breck's yard (*Daily British Whig* 1878).

Calvin and Breck employed the *Mowat* in the grain forwarding trade between Toledo and Kingston, primarily proceeding upbound light and returning with corn, rye, and wheat taken on at Toledo, with occasional trips to Chicago to take on grain (*Daily British Whig* 1879a, 1879b, 1879c, 1879d, 1879e, 1880a, 1880b, 1880d, 1880f; *Daily News* 1878c, 1878d).

At 2:00 p.m. on 24 October 1880, the *Oliver Mowat* cleared from Portsmouth, bound for Chicago with a load of phosphate. The trip was noted in local newspapers due to the unfortunate ordeal of a deckhand named Gouyeau, who hailed from Howe Island. On 2 November, on northern Lake Huron, Gouyeau was out on the bowsprit when the *Mowat* plunged its head into heavy, frigid seas, washing Gouyeau from the bowsprit. Gouyeay narrowly averted being carried overboard and the almost certainty of drowning by clinging to one of the bowsprit shrouds as he was washed past. That same evening, Gouyeau went aloft in the mizzen crosstrees and attempted to shift the tack of the mizzen gaff sail when he fell, striking the cabin roof before plummeting unconscious to the deck. Beaupre tended to Gouyeau, who regained consciousness after half an hour. Believing that his injuries were likely fatal, they put in at Cheboygan, Michigan, and brought the injured hand to the local hospital, where he was found to have fractured his arm and leg. Beaupre took a subscription among the crew, gathering 50 dollars in addition to 22 dollars in owed wages. This sum was entrusted to the attending doctor, who would keep the money despite having agreed to ten dollars as payment for his services. When *Mowat* arrived at Chicago, Beaupre received news that Gouyeau's condition was improving, and had soon convalesced sufficiently to be transferred to the Chicago Marine Hospital (*Daily British Whig* 1880h, 1880i, 1881a, 1881i).

Mowat was still in Chicago on 15 November, too late in the season to return to Kingston on account of the scheduled closure of the Welland Canal. Beaupre instead laid up the *Mowat* in winter quarters at Port Huron, Michigan, after a difficult downbound trip (*Daily British Whig* 1880h). Returning to Kingston from Port Huron the following spring, *Mowat*, while being towed by the tug *Kitty Haight*, fouled and lost its jib-boom and bowsprit while transiting a lock in the Welland Canal (*Daily British Whig* 1881b).

On 19 July 1881, the *Mowat* again made headlines as a result of a mishap entering the Burlington Canal at the entrance to Burlington Bay, the harbor of Hamilton, Ontario. That evening, *Mowat*, running in amidst a gale while upbound light for Burlington, arrived off the entrance to the Burlington channel to find the swing rail bridge closed. Fast approaching the piers of the bridge, Beaupre let go of the best bower anchor to bring the *Mowat* to a halt. When the swing bridge opened, the *Mowat's* anchor had fouled in the Montreal Telegraph Company's cable, blocking the channel, preventing the closure of the bridge and the passage of rail traffic. At around 3:00 a.m., after some three hours, the cable finally gave way and the *Mowat* cleared the bridge (*Daily British Whig* 1881d).

In 1881 the *Mowat* continued operating as it had the previous years, concluding the shipping season with a trip to Chicago, carrying 18,000 bushels of barley up bound, with corn as eastbound return cargo (*Daily British Whig* 1881c, 1881d, 1881f, 1881g, 1881h, 1881j).

Edward Beaupre, Jr. had served as master of *Mowat* for nine seasons when, in March 1882, he left to take a position on the schooner *Grantham*. He was replaced by Captain John Saunders, who had formerly served as the master of the *Eureka* (*Daily British Whig* 1882a).

The expansion of rail connections to Lake Ontario initially benefited schooners. Throughout the 1880s, *Mowat* was intermittently engaged in the export of iron ore from a brief and financially unsuccessful attempt to exploit ore deposits in the vicinity of Godfrey and Bedford, Ontario, north of Kingston (*Daily British Whig* 1880c, 1880e, 1880g, 1881e). In 1882, the *Mowat* received a rate of 45¢ per ton of iron ore for one trip from Kingston to Fairhaven, making iron ore highly profitable for the short trip (*Daily British Whig* 1882h). Less frequently, the *Mowat* was chartered to carry iron ore to Cleveland and Sandusky (*Daily British Whig* 1886a). Return cargoes in coal were common (*Daily British Whig* 1882b, 1882c, 1882d, 1882e, 1882f, 1882g, 1884a). The

Mowat remained active in trafficking grain from Toledo and Chicago and importing grain to Fairhaven (*Daily British Whig* 1883b, 1884b, 1886c).

On 5 December 1882, on its final trip of the season, *Oliver Mowat* again made the local newspapers when it ran the 90 mi. (144 km) between Charlotte and Kingston in a gale in only six hours and 35 minutes, averaging 14 mph. (22.5 kph) throughout the trip. The trip, the fastest then on record, was met with initial disbelief and settled the *Mowat's* reputation as one of the finest schooners then in service on Lake Ontario (*Daily British Whig* 1882i, 1883a).

By the fall of 1887, the *Mowat* was listed as owned by the Folger Brothers of Kingston (Senate of Canada 1889:611). No records indicate the dates at which Folger Brothers purchased or sold it, though in 1883 it was still owned by the Calvin Company, and by 1902 it was owned by John McLellan and William McCann of Bowmanville, Ontario. Under the Folger Brothers, *Mowat* seems to have continued much the same participation in increasingly varied charters both locally and in the inter-lake trade, carrying iron ore to Lake Erie ports with coal return cargoes becoming increasingly common. *Mowat* also engaged in coal traffic between south shore ports and Canadian ports on Lake Ontario (*Daily British Whig* 1887a, 1887b, 1887c, 1887d, 1887e).

On 21 September 1887, while upbound laden with iron ore for Sandusky, the *Mowat* went aground near Charlotte, New York amidst heavy fog, leaving the hull in leaking condition after it was released. The *Daily British Whig* later reported that the navigational error which caused the grounding was the result of a large sailmaker's needle which had found its way into the compass housing, deflecting the indicated heading of the compass. On entering the Welland Canal, Saunders contracted with the Welland Canal authorities to hire a diver, assistants, and their equipment to inspect and conduct repairs on the *Mowat's* bottom, a task which took nearly a day and a half and cost $28.75. Saunders arranged with the clerk to pay the order on his return trip. The *Mowat* continued onto Sandusky where it was unloaded, to find water in the hold. The *Mowat* took on 514 tons of coal for Kingston and on 30 September cleared from Sandusky.

In the early morning hours of 3 October, *Mowat* was caught in a fierce gale between Cleveland and Ashtabula. Heavily laden and with waves washing over the decks, the crew broke out the bulwarks to free the water. After some 20 hours of laboring at the pumps, leaking with 19 in. (0.48 m) of water in the hold, and having blown out its foresail, two jibs, and the main gaff topsail, *Mowat* reached Port Colborne. The gale on 3 October 1887 resulted in the stranding of six vessels, with the loss of six more throughout the Great Lakes along with 26 lives (Mansfield 1899:747).

On the downbound passage through the canal, the *Mowat* was detained at Lock 1 in Port Dalhousie from midnight until daybreak the following day as Saunders, being unable to pay the fees owed for the diver repairs, made arrangements for the forwarding of the bill to Folger Brothers in Kingston for payment before being released. Saunders and Folger Brothers initially refused payment, claiming the price had been excessively high, eventually agreeing to pay the bill on 10 November 1887 (Senate of Canada 1889:610-612). On 7 October the *Mowat* finally arrived in Kingston (*Daily British Whig*

1887f, 1887g, 1887h). In late October, the *Mowat* was placed into the Goble Dry Dock in Oswego for repairs (*Daily British Whig* 1887i).

It seems that 1888 was the first season in which Captain James H. Peacock served as master of the *Mowat*, a position he would hold until the end of 1904 (*Evening Guide* 1931).[2]

The years following 1890 witnessed the *Mowat* increasingly confined to Lake Ontario as well as frequent changes in *Mowat's* ownership. At the end of 1891, the *Mowat* was purchased by William Cann and John McLellan of McLellan & Company, coal merchants from Bowmanville, Ontario. Over the winter of 1891-1892, *Mowat* was rebuilt by William Hickey at Port Hope and relaunched on 31 March 1892. Captain James H. Peacock stayed on as *Mowat's* master under the new owners (*Canadian Statesman* 1892; *Daily British Whig* 1892a).

In 1890, the *Mowat* had made no less than seven trips to Lake Erie, primarily hauling bituminous coal from Sandusky to Kingston and Brockville (*Daily British Whig* 1890a, 1890b, 1890c, 1890d, 1890e, 1890f, 1890g, 1890h, 1890i). The following year the *Mowat* made no fewer than six trips to Lake Erie ports, taking on coal and chemical ore for Lake Ontario ports, though it also conducted numerous trips in the coal and grain trades on Lake Ontario (*Daily British Whig* 1891a, 1891b, 1891c, 1891d, 1891e, 1891f, 1891g, 1891h, 1891i, 1891j). In 1892, under its new owners, the *Mowat* made a single

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[2] Though the dates in which Capt. James Peacock was master of *Mowat*, the *Evening Guide*, 11 March 1931 stated he had served as master of the *Mowat* for 17 years. As Peacock served until early 1905 in this role when he was replaced by George Robertson, 1887-88 are the most likely dates.

trip to Toledo (*Daily British Whig* 1892b). In 1896, *Mowat* took on 19,000 bushels of corn for Kingston at Toledo, after which *Mowat* appears to have never again sailed outside of Lake Ontario and the Upper Saint Lawrence River (*Daily British Whig* 1896).

In 1893, the *Mowat* was chartered for three months by Thomas Myles and Sons, coal merchants from Hamilton, Ontario alongside the *L.D. Bullock*, *W.J. Stauffell*, and *Flora Carveth.* A similar contract was arranged the following year (*Daily British Whig* 1893b, 1894). This coal trade was often supplemented by taking on grain at Toronto or other lake ports for Kingston forwarders before continuing to Oswego light to load coal once again (*Daily British Whig* 1893a, 1898, 1899a, 1899b, 1900).

C.H.J. Snider recorded the competitiveness between schooners engaged in chartering coal to Hamilton consignees, in the mid-1890s. He wrote of a race up the lake between the masters of *Mowat*, *White Oak*, and *Flora Carveth*, with the vessels being towed out of Oswego at night and converging on Burlington Bay two days later. Such competition was often taken to the point of recklessness, with Captain Peacock of the *Mowat* risking and narrowly avoiding a collision between the *White Oak* and *Mowat* which were closing on converging tacks, with neither willing to cede right of way. Arriving first at the docks was a prize in itself for the masters. As Snider noted: “To be first to the dock in those days when coal was unloaded by wooden bucket, hove up by one horse, meant a week’s wages.” A late arrival meant delays waiting for wharfage and unloading, a period during which wages continued to be paid while the ship sat idle, reducing the possibility of profits from that trip (Snider 1932).

In the early years of the 1900s, fewer coal cargoes were reported, while forwarding grain to Kingston remained the foundation of *Mowat's* commerce (*Daily British Whig* 1901, 1902b, 1903a, 1903b, 1903c, 1903d, 1904). On 13 April 1902, the *Mowat*, on its first trip of the season to take on coal, was taken in tow by the *Charlie Ferris* upon arriving at the mouth of the Genesee River at Charlotte. Recent improvements to the Genesee altered the current at the mouth of the river, and as the tug and its tow entered the river, they were caught in the unexpected eddy. The *Mowat* struck a dock, carrying away its jib boom and fore topmast. It was subsequently repaired at the Goble Shipyard in Oswego (*Daily British Whig* 1902a).

In 1905, Captain George Robertson was appointed as master of *Mowat.* In May of that year he purchased 15 shares of the *Mowat* from John McLellan, becoming part-owner alongside McLellan, who had 33 shares and William Cann, who possessed 16 shares (Lewis 2020). Robertson's brief tenure was marred by a series of mishaps culminating in his resignation in 1907.

The month of November 1905 saw a series of catastrophically violent storm systems sweep across the lakes. On 15 November, *Mowat,* having departed Oswego laden with coal for Bowmanville, was caught in a terrific gale and driving snowstorm. No account of the *Mowat's* struggle on the lake was recorded by those aboard, but the *Mowat* ran before it, eventually anchoring off Four-Mile Point at Simcoe Island, south of Kingston, early on the morning of 15 November. There it dragged its anchor a mile and a half northward before reaching a more sheltered anchorage where its anchor held. The schooner *Lizzie Metzner*, mastered by Capt. Henry Daryaw, was likewise caught in the storm. Daryaw related his ordeal to reporters of the *Daily British Whig*. Heavily loaded and with waves continuously washing over the decks, the *Metzner* had threatened to founder. They were only saved by Daryaw's order to break out the bulwarks, freeing the water accumulating on deck. Eventually, *Metzner* joined the *Mowat* at anchor off Four-Mile Point, both schooners remaining there until the following morning when they sailed to Kingston, with *Mowat* in leaking condition (*Daily British Whig* 1905a). Robertson attempted to sell off the coal to avoid making the late season trip up the lake in this leaking state but found no buyers at Kingston for the size of coal loaded (*Daily British Whig* 1905b). Unable to dispose of the cargo, and unable to effect repairs with a full hold, Robertson was compelled to risk a late-season run up the lake.

On 28 November, *Mowat* was en route for Bowmanville when it was again caught in a blinding blizzard with high winds. Unable to find its bearings in the white haze, the *Mowat* went hard ashore on the east side of Bluff Point, approximately 1 ¼ mi. (2 km) east of Oshawa. *Mowat* lay aground with the high following seas striking and washing over the stern and its boat, hanging from the davits, was shattered against the transom, leaving the crew stranded aboard. With waves breaking over the deck, the men sought refuge in the rig, lashing themselves to the masts to await rescue. The stricken vessel was sighted by a passing Grand Trunk Rail Road crew as the train's tracks paralleled the lakeshore. In Oshawa, Mayor Frederick L. Fowke telephoned the Port Hope Life Saving Station, which dispatched its crew to the scene aboard a train provided by the Grand Trunk Railway Company. By the time they arrived, the storm had begun to subside, the lifesaving crew took all six crew off without loss of life. Several days later, the steamer *Donnelly* of the Donnelly Wrecking Company was dispatched to Oshawa and managed to haul *Mowat* off the shore and bring it under tow to Bowmanville. The *Mowat* was initially reported as a total loss, though it was subsequently repaired (*Daily British Whig* 1905c, 1905d; Gourdeau 1906:17-18).

Even at the time, the storm of 27-28 November 1905 was recognized as "historic as being the most severe and general gale that has occurred on the Great Lakes for many years." The storm, the epicenter of which had been on Lake Superior, resulted in the loss or damaging of 20 vessels on Lake Superior, 7 on Lake Michigan, and 12 on Huron, inflicting more than $3,245,000 in losses among steel vessels and $322,000 in wooden vessels, with the loss of 36 sailors (*Buffalo Evening News* 1905; Schneider 1905:4).

On the evening of 18 August the following year, Robertson suffered a broken leg after falling through an open hatchway on the *Mowat*. He was taken ashore at Olcott Beach, New York and was transferred to the Oswego City Hospital (*Daily British Whig* 1906).

The 1907 shipping season began with a further series of misfortunes for *Mowat.* Having left Oswego on 18 April for Bowmanville with a consignment of coal for John McLellan, *Mowat* was caught in a squall, springing a leak and blowing out its headsails. The schooner ran for the shelter of Cape Vincent and had to be towed to Kingston by the tug *Frontenac* that evening, the crew laboring at the pumps through the night. By morning, the leaks were gaining on the pumps and *Mowat* had 3 ft. (0.9 m) of water in its hold. Robertson arranged labor crews to provide relief at the pumps and for the sale and offloading of the coal by the Calvin Company so that the hull could be recaulked

(*Daily British Whig* 1907a). The *Mowat* proceeded to Oswego, where it was re-caulked at the Goble Drydock for $300 (*Daily British Whig* 1907a, 1907b, 1907c).

On 15 May, *Mowat* departed Oswego, again laden with a 545-ton consignment of coal for Bowmanville. The following evening, off Cobourg, the schooner was struck with a sudden squall, blowing out the foresail, the jib topsail, the standing jib, and the raftee. Unable to make Port Hope in the early morning hours of 17 May, the *Mowat* sought shelter at Presque Isle, not arriving in Bowmanville until the afternoon of 19 May. The damages totaled $400, and in consequence of these combined losses, Robertson sold some of his shares to John McLellan, resigning as master and dismissing the crew (*Daily British Whig* 1907d). No records have been found identifying who replaced Robertson as the master for the remainder of 1907.

From 1908, and particularly after 1913, the *Mowat* appeared less frequently in local newspapers. After the departure of Robertson, the *Mowat* went through a rapid succession of masters and owners, for which few sources provide dates of transfer. In 1908 Captain William H. Peacock, son of Captain James H. Peacock and formerly mate of the *Mowat* served as master. The following year, the position was filled by Henry Matthews (*Daily British Whig* 1908d, 1911).

In 1912, Peacock became part-owner of *Mowat*, purchasing 16 shares from Alvina Robertson following the death of George Robertson. For the 1913 shipping season, Captain James Smith of Belleville served as master (*Daily British Whig* 1913b). The following year, William Peacock and William Savage each held 52 shares. In 1915, William Peacock sold eight shares back to both John McLelland and William Cann, with

William Savage being the principal owner with 52, and Peacock with 36 shares (Lewis 2020).

The *Mowat* appears to have been employed forwarding barley to the Montreal Transportation Company's elevators at Kingston and in the importation of coal to Bowmanville for John McLelland, though mentions of the schooner in local newspapers became infrequent (*Daily British Whig*, 1908a, 1908c, 1913a, 1913b).

In January of 1920, William Savage and William Peacock sold all of their shares of the *Mowat* to Captain Thomas Van Dusen of Picton (Green 1920:144). After some 40 years on the lakes, Van Dusen was among the most well-known and well-regarded sailing masters operating on Lake Ontario (*Oswego Palladium* 1921). However, nearly no sources have been found for the *Mowat* for the 1920 and 1921 seasons during which it operated under Van Dusen.

The Loss of the *Oliver Mowat*

At noon on Thursday, 1 September 1921, *Oliver Mowat* cleared Picton light, bound for Oswego where it was to take on coal intended for Picton or Belleville. Five were aboard: Captain Van Dusen, Mate Jacob Corby of Deseronto, George Keegan of Belleville, John Minaker of Picton, and the cook, Carrie McGuigan of Port Hope. *Mowat* had light winds throughout the clear, calm evening which persisted into a cloudless and moonless night. By 10:30 p.m. Mowat was passing south of the head of False Duck Island with the False Duck Light off the port beam. Entering the shipping channel while passing between Main Duck and the Psyche Shoal to the west, slightly before 11:00 p.m., the *Mowat*'s crew sighted an upbound canal propeller off the port side on a converging course, about one mile away (1.6 km). Though reportedly sailing with normal running lights, Van Dusen was unsure if they had been seen, so he waved a flare. The canaller continued on its converging course.

The approaching canaller was the 1748-ton steel-hulled *Keywest*, owned by the Keystone Transportation Company of Montreal. With an inattentive watch being kept aboard *Keywest*, Captain Delos Whitely of Montreal and Mate C.F. Gilfnan remained unaware of the schooner as they rapidly closed on a collision course. The *Mowat* was sighted too late to avert a collision and at 10:57 p.m. *Keywest* struck the *Oliver Mowat* amidships, its bow cutting halfway into the schooner's port side. The *Keywest* maintained forward motion in an attempt to remain embedded in the *Mowat's* side, slowing the inflow of water into the stricken schooner. With *Mowat* settling rapidly, it became apparent to both crews that it was about to sink. The *Keywest* backed clear and began lowering its boats to assist the *Mowat's* crew.

On the *Mowat*, Captain Van Dusen and Mate Corby, both of whom had been on deck at the time of the collision went below to retrieve McGuigan, who had been asleep in the cabin and who could be heard yelling. John Minaker and George Keegan, who had been at the bow, abandoned the settling vessel, Minaker donning a life vest and following Keegan into the water.

Within approximately four minutes of the collision, the *Mowat* foundered suddenly. Unable to find or reach McGuigan, Van Dusen was last seen in the water just as the ship went under. Corby was also seen in the water but disappeared as the sails settled on the water, seemingly carried under when he became entangled in the rigging.

Minaker and Keegan were taken into the *Keywest's* boats, which stood by for some time in the search for any survivors until all hope was abandoned. Keegan and Minaker were taken aboard the *Keywest*, which continued to Port Dalhousie rather than putting in at Kingston to report the incident.

At Port Dalhousie, the accident was reported and the statements of Minaker, Keegan, and Whitely, and Gilfman of *Keywest* were taken by local authorities. Word of the accident and loss of some of the *Mowat's* crew first arrived in Kingston, aboard schooners returning from south shore coal ports on Wednesday, 7 September, six days after the *Mowat's* loss.

The reports aroused outrage among Kingston's maritime community, much of this outrage being directed towards the *Keywest*'s delay in reporting the incident and resulting in a delay of days before news of the crew's fate was known. On the morning of 7 September, the *Mary A. Daryaw*, mastered by Captain Clinton Daryaw of Picton, arriving at Oswego, reported sighting two of the *Mowat's* three masts standing above the surface of the lake south of Main Duck Island.

In the wake of the accident, the Canadian Marine Department convened an investigation into the collision. As the *Mowat's* officers were lost with the vessels, any investigation was directed primarily towards Captain Whitely and First Officer Gilfnan of *Keywest*, who had been detained pending the conclusion of the investigation. On 23 September, the Marine Department's commissioner ruled both vessels at fault, stating that both had kept an indifferent and inadequate watch. Whitely's master's license was suspended for one year and Gilfnan, who was without a certificate, was issued a severe reprimand. Van Dusen was found partially at fault, having kept an inattentive watch. Furthermore, though sailing vessels typically held right of way over steam vessels, Van Dusen had entered the upbound shipping channel, restricting the navigability of the channel out of which the *Keywest* could not safely operate. As a result of the finding of shared culpability, no charges of criminal negligence were brought against *Keywest's* officers.

The *Mowat's* registration was closed on 5 October 1921, its certificate of registry and paperwork having been lost with the schooner (*Cape Vincent Eagle* 1921a, 1921b; *Republican-Journal* 1921; *Oswego Palladium* 1921; *Picton Gazette* 1921).

Conclusions

The *Oliver Mowat* was launched at the height of prosperity in the inter-lake grain trade in 1873. With the high freight rates of the 1860s and early 1870s, the *Mowat* was launched amidst a period of optimism for vessel owners in which schooners brought high returns on investments and could be paid off over the course of only a few seasons. The years immediately following the panic of 1873 and the recession that lasted until the late 1870s proved to be hard times for vessel owners. Fraser and George of Kingston, a seemingly profitable firm for which the *Mowat* was built in 1873, and which had also added the steam barge *Saxon* to its fleet in May of the same year, went into receivership by 1876 (*Toronto Mail* 1873a).

While the first years of the *Mowat's* existence had been difficult years for lake shippers, the *Mowat* remained steadily employed in the inter-lake grain trade, carrying grain for Kingston and Montreal forwarding firms, namely Calvin and Breck and the

Montreal Transportation Company, between Lake Erie and Lake Michigan ports and Kingston. When local freight rates were high, the *Mowat* and many vessels in similar roles accepted local grain charters on Lake Ontario, either carrying grain from Port Dalhousie's elevators or local ports to Kingston.

Nearly all of the Upper Lakes grain carried by the *Mowat* was American, necessitating that it be carried to Canadian ports. This importation of grain to Canadian terminals was the primary direction of the Canadian grain trade before the emergence of the Canadian prairies as centers of grain production in the late 1880s and 1890s. However, by the 1890s, the completion of the Third Welland Canal meant that schooners in the inter-lake trade were competing with increasingly efficient and voluminous steam propellers, which brought about the reduction of freight rates, rendering smaller, less-efficient vessels unprofitable. As increasing competition arose in the inter-lake trade, the *Mowat* withdrew into local trading on Lake Ontario and the Upper St. Lawrence River, where rates were typically higher per tonnage mile and the limited regional economy and limited competition enabled it to operate profitably.

By the 1890s, coal was an increasingly important commodity for Lake Ontario sailing vessels, and coal charters formed the foundation of the *Mowat*'s business by 1900. Despite the decline of the anthracite industry in the 1920s, vessels were able to remain employed as a result of decreasing availability of shipping tonnage as small, low-cost schooners dwindled in number, resulting in reduced competition for the charters. While age and attrition set an expiration for sail commerce on the lake, sailing commerce persisted for nearly a decade after the *Mowat*'s loss albeit at an ever-diminishing scale (*Oswego Palladium-Times* 1932).

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CHAPTER V

THE TWO-MASTED SCHOONER *KATIE ECCLES*

The two-masted schooner *Katie Eccles* was typical of trading schooners operating from Canadian ports between the 1870s and 1931, for it never left the confines of Lake Ontario and the Upper Saint Lawrence. Local trading, which has received comparatively little attention among Great Lakes historians, involved relatively short, frequent trips thus relying on the volume of trade rather than fewer, high-paying trips to remain profitable. The *Eccles'* operational history exemplifies the role of small sailing vessels in integrating lakeshore communities into regional and international markets and their changing roles. On Lake Ontario, these changes increasingly relegated them to less profitable coal transport by the first decade of the 20th century. This shift was accompanied by a reversal of their principal role, the transportation of north shore and Bay of Quinte agricultural products to Kingston forwarders and American markets to importers of a single commodity for local consumption.

Like the *Oliver Mowat,* the *Eccles* was widely known throughout its career of 45 years, with its clearances and calling at various ports chronicled in marine columns of local newspapers among lakeshore communities, providing an exceptional record of the schooner's operational history.

Building the *Katie Eccles*

The two-masted schooner *Katie Eccles* was built at the shipyard of H.B. Rathburn & Sons at Mill Point, Ontario (later Deseronto) at the mouth of the Napanee

Figure 4. The *Katie Eccles* under sail. Date unknown. (Digital image from the Fr. Edward J. Dowling, S.J. Marine Historical Collection, University of Detroit Mercy).

River on the northeast end of the Bay of Quinte (*Daily British Whig* 1878c).[3] The Rathburn yard, an extension of the lumber company H.B. Rathburn & Sons at Mill Point, had been established to construct and maintain the vessels of the Rathburn's lumber fleet (Bowell 1868:312-319). Among the workers listed at the Rathburn & Sons shipyard in 1867 were William Jamieson and his brother Hugh Jamieson (Bowell 1868:312-319).

[3] The *Katie Eccles'* first enrollment (L.A.C., RG-42, C-2471, VOL. 232)) lists 27 July 1877 as the "built date." This most likely represents the date of launching.

William Jamieson, born at Bushmills in County Antrim, Ireland, immigrated to Canada shortly before 1861-1862, settling in Picton, Prince Edward County. William and Hugh soon found work at the H.B. Rathburn and Sons shipyard at Mill Point as ship carpenters (LAC 1861; Bowell 1869:312-319). By 1871, at the age of 27, Jamieson had risen to become a master shipwright overseeing the Rathburn yard (LAC 1871). His brief career extended only from 1871 to 1879 when he retired, but during this time he was a prolific builder. In 1871, Jamieson built his first vessel, the 190 ton schooner *William Elgin,* built from the bottom of the 1853 schooner *Catherine*. Between 1871 and 1877, Jamieson completed no less than 15 vessels at the Rathburn yard (Wisconsin Maritime Museum at Maitowoc 2021).

In 1877, the Rathburn shipyard was contracted for the construction of a schooner of 120 tons by Captain Dexter Eccles, a member of a prominent family of ship owners and sailing masters from Wolfe Island. Eccles had risen to become master and owner of the scow-schooner *Pearl* at the age of 23. In the intervening years, he had owned and operated several other schooners and scow-schooners, his ownership of vessels being characterized by short-term ownership, likely to avoid incurring expenses of rebuilds or extensive refits and depreciation of vessel value with reduction of insurance ratings (*Daily News* 1876a, 1876b; Wisconsin Maritime Museum at Manitowoc 2021).

This new schooner was to be Jamieson's sixteenth vessel. It was relatively small by contemporary standards with a length of the deck of 95 ft. (28.96 m), a breadth of 24 ft. (7.21 m), and a depth of 9 ft. 6 in. (2.89 m). The vessel would have a volume of 121 tons or a capacity of approximately 10,000 bushels, though recorded chartered cargoes rarely filled this capacity and was sufficient for its intended role in the limited-scale local grain trade (LAC 1877)(Figures 4 and 5).

The *Katie Eccles'* Operational History

No identified sources document the *Eccles*' first season afloat, apart from a note that it passed the winter of 1877-1878 at Kingston (*Daily British Whig* 1878a). Likewise, sources for the 1878 and 1879 seasons are scarce but indicate active involvement in the domestic grain forwarding trade along the northern shore of Lake Ontario. On 3 June 1878, the *Eccles* was reported to have arrived at Kingston from Toronto with 8,617 bushels of wheat for the Montreal Transportation Company (*Daily British Whig* 1878b). On 1 October 1878, the Eccles arrived at Kingston with 9,000 bushels of grain from Hay Bay on the Bay of Quinte, consigned to Diamond & Sherwood of Napanee (*Daily News* 1878).

In January 1880 Dexter Eccles sold the *Katie Eccles*, which retained an A1 insurance rating, to Archibald Campbell and Captain Henry Isaac Matthews, both of Colborne, for $8,000.00. This was $500 more than its assessed value the previous year (Morey *et al.* 1879:38). Matthews was appointed as its master (*Daily British Whig* 1880a). Both men were residents of the village of Lakeport, Ontario, a small village intensely involved in maritime affairs that served as the port of Colborne, Ontario. The port of Lakeport consisted only of two long wharves extending into the lake, the western pier, owned by Campbell, as well as a grain elevator and coal sheds situated at the foot of the pier. The Lakeport wharves were exposed from the west, south, and east and their use was impossible in anything but settled weather. Accordingly, vessels registered at

Lakeport wintered in the harbors of Cobourg or Brighton. The *Eccles* wintered 1880-1881 in Brighton, Ontario (*Daily British Whig* 1881a).

In 1883, a Captain Redfearn assumed command of *Katie Eccles*. This was either Charles, Henry, or William Redfearn of Colborne, three brothers, all working as master mariners. No records were found to determine which of them served as the *Eccles'* master (*Daily British Whig* 1883a). Soon after, on 8 May, *Katie Eccles* went ashore near Presque Isle, Prince Edward County, with the steamer *Hiram A. Calvin* being dispatched from Kingston to assist in getting the schooner off the shoal (*Daily British Whig* 1883c). By the time *Calvin* arrived, the *Eccles* had been lightered and refloated (*Daily British Whig* 1883d).

Campbell employed the *Eccles* in both the export of grain to Oswego and the shipment of grains and peas from north shore ports and occasionally from Port Dalhousie or Toronto to Kingston, principally to the Montreal Transportation Company's docks (*Daily British Whig* 1880b, 1880c, 1880d, 1880e, 1880f, 1881b, 1883b; *Oswego Palladium* 1881; *Marine Record* 1885).

Grain cargoes were largely taken on at Colborne, utilizing Campbell's wharf and elevators. The revenues of grain exportation were occasionally supplemented by taking northbound cargoes of coal (*Daily British Whig* 1882b; *Oswego Palladium* 1882).

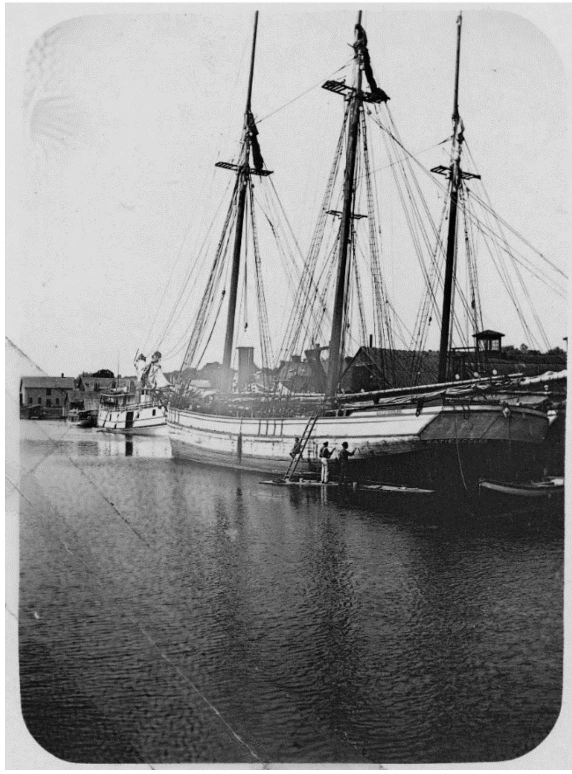

Figure 5. *Katie Eccles* being repainted at Napanee in 1900 (N-1551 – Transportation, schooner *Katie Eccles*, Napanee [1900] – LAHS Collection, Lennox & Addington County Museum, and Archives)

While this Colborne-Kingston-Oswego route seems to typify Campbell's operation of the *Eccles* in the 1880s, the *Eccles* was by no means restricted to grain and coal cargoes. It often took opportunistic cargoes as rates permitted, particularly when the grain trade was slow or at the beginning of the season. Lumber products were commonly carried to New York ports, including rough cut lumber, rail ties, and bundles of wood (*Daily British Whig* 1882a, 1882b, 1886b, 1886c, 1888). Coal was taken as a return cargo (*Daily British Whig*, 1881, 1882b; *Oswego Palladium* 1884).

By 1884, the *Katie Eccles* had been downgraded to an A2 rating by the underwriting inspector and by 1886, its rating had further declined to A2 ½, the ship being valued at $4000 (Polk 1884:89; Taylor 1886:16). To restore its A1 ½ rating, the *Eccles* was rebuilt in 1889, increasing the vessel's value to $5,500 (Taylor 1886:16, 1890:26; Wisconsin Maritime Museum 2021). In late August of that year, the *Eccles* was involved in a minor accident while entering Charlotte Harbor, when it fouled and carried away the topmast of the yacht *Velnette* and then fouled in the rigging of the schooner *Endie*. Captain Davis, the *Eccles'* master, paid $22 in damages to the *Velnette*'s master for the damages (Daily British Whig 1889).

The 1890s brought significant changes to trade on Lake Ontario, altering the *Eccles'* operations. Foremost among these was the passage of the McKinley Tariff Act of 1890. While the pattern of grain exportation to Oswego and shipment to Kingston continued in 1890, principally from Lakeport and Prince Edward County ports, a distinct shift towards carrying grain to Kingston for transshipment occurred in 1891 (*Daily British Whig* 1890). Without available return cargoes from Kingston, the *Eccles* usually returned up the lake light. While this meant less revenue per trip, it significantly reduced the time a vessel idled in port unloading and loading cargoes, allowing more downbound trips with grain per season.

This increased dependence on domestic grain transport placed the *Eccles* and similarly-employed schooners in competition with an expanding Canadian grain fleet of canallers transporting grain products from the western provinces. The *Eccles* encountered issues with this competition as early as May 1886, when the *Eccles,* laden with 7,000 bushels of wheat from Brighton and the grain-laden *Eliza White* were refused wharfage by Kingston forwarders in favor of grain-laden bulk freighters passing through the Welland Canal that provided more grain at less cost per bushel (*Daily British Whig* 1886a).

For the 1892 to 1894 seasons, the *Eccles* was mastered by Captain James Shaw (*Daily British Whig* 1893). On the morning of 25 November 1894, the *Eccles* grounded near Grafton, Ontario in heavy fog and seas, but was refloated without the need for extensive repairs (*Daily British Whig* 1894a, 1894b, 1894c).

On 11 November 1896, Archibald Campbell drowned in Lake Ontario near his Lakeport home. The *Eccles* continued to operate the following year under Captain John McComisky, though the ownership of the vessel in 1897 remains uncertain (*Daily News* 1897).

In 1898, Charles J. McCallum of Cobourg, Ontario purchased *Katie Eccles* (*Daily British Whig* 1898a). That August, it underwent repairs at the Davis Dry dock in Kingston (*Daily British Whig* 1898b). In 1899, Captain Steven H. Taylor of Lakeport was appointed master (*Daily British Whig* 1899). The *Eccles*' operations in the early years of the 1900s began much the same as in the 1890s. In 1901 and 1902, all newspaper sources examined showed the *Eccles* carrying exclusively grain cargoes, these cargoes being insurable as *Katie Eccles* still held an A 2 ½ rating following replacement of some spars in 1901. It retained a value of $2,100 (McMurrich 1902:26). During the season of 1902, the *Eccles* began taking an increasing number of coal cargoes from the New York coal ports (*Daily British Whig* 1902a, 1902 b, 1902c). The 1902 coal strike on the anthracite coal fields of Pennsylvania, which persisted from 12 May to 23 October of that year, resulting in high freight rates for coal shipped late in that season.

However, freight rates and the profit of coal trade were significantly higher, with increases in shipping rates to 50 cents per ton from 25 cents per ton to Kingston or 35 to 45 cents per ton to Belleville and Trenton before the strike (*Daily British Whig* 1902c).

On 7 November, the *Eccles* arrived at Lakeport and was brought alongside the eastern side of the exposed wharf for unloading. As it was preparing to unload, a strong southeasterly wind arose threatening to break the *Eccles* against the pier. The schooner was moved to the western side of the pier only for the wind to shift to the southwest, again threatening to break the vessel against the pier. To save the schooner, the crew bored holes in the bottom, scuttling it alongside the wharf. The following day the Calvin Company's steamer *Chieftain* was dispatched from Kingston to Lakeport to raise the *Eccles*. By Sunday, 9 November the *Eccles* had been towed into Kingston for repairs, entering Davis' Dry Dock on 11 November. Repairs were completed by 19 November with the damages not exceeding $100. The 150 tons of anthracite coal aboard that was brought to Kingston was purchased by R. Crawford and Company (*Daily British Whig* 1902d, 1902e, 1902f, 1902g; *Colborne Chronicle* 1978). The *Eccles* went back into service immediately but was laid up for the winter at Oswego when no consignment of coal for the trip back could be found (*Daily British Whig* 1902h).

The start of the 1903 season found Captain Taylor again in command, he and mate Don I. Matthews traveling to Oswego in mid-March to outfit the vessel for the season (*Enterprise of East Northumberland* 1903a). It would be the first vessel to call at Lakeport that year, carrying a cargo of coal from Oswego, but while preparing to unload coal at the Lakeport pier on 5 April, a southerly wind arose, and the *Eccles* was compelled to sail to the shelter of Cobourg Harbor to unload there (*Enterprise of East Northumberland* 1903a, 1903b, 1903c; *Colborne Chronicle* 1974;).

In early 1904, Charles J. McCallum put the *Katie Eccles* up for sale and entered negotiations with Captain Thomas Sullivan of Kingston and James Hanley of Watertown, New York (*Enterprise of East Northumberland* 1904). The negotiations fell through, and it was instead sold to Captain James Dougherty of Deseronto, formerly master of the steamer *Reliance* (*Daily British Whig* 1904a, 1905b). Dougherty then sold the *Eccles* to Captain Frank Barnhard, who in turn sold it to Captain John McCullough of Napanee and Alexander Foot of Deseronto in December of the same year (*Daily British Whig* 1904b, 1905a, 1905b). The reason for this rapid succession of owners is unknown.

In November 1906, the *Katie Eccles* made headlines again when it was reported to be lost. On 5 November, the *Eccles* departed Oswego for Napanee. The following day it was reported overdue and over the ensuing days, inquiries by telegraph produced no word of the schooner. On 9 November, the *Daily Palladium* reported the *Eccles* lost along with its crew of six. The *Eccles* arrived in Napanee that same day having been delayed by a misunderstanding of its itinerary as it had sailed down the St. Lawrence River (*Daily British Whig* 1906a, 1906b; *Oswego Palladium* 1906).

In late August 1908, McCullough and Foot sold the schooner to Captain Harry T. Mitchell of Newcastle (now Bowmanville), with the intent of using the proceeds of the sale to purchase a steam barge (*Daily British Whig* 1908a, 1908b). Mitchell had become master and owner of the 18-ton schooner *Minnie* of St. Catharine’s, Ontario in 1896, at the age of 17, making a meager income in stone hooking. Stone hooking involved the recovery of large stones from stone banks with a long rake, the stones being lifted onto a scow before being transferred to a schooner which would deliver them to a construction site (Ford 2018:120-121). In 1898, Mitchell sold the *Minnie*, purchasing the sloop *Viking* which he likewise employed in stone hooking until 1906, when he purchased the *Katie Eccles* (Snider 1943a).

During the first decade of the 20th century, sailing vessels became increasingly relegated to coal transport. After 1910, coal cargoes predominated, though the *Eccles* was employed in the grain trade at the beginning of the season and in early fall with the harvest. In 1915, all reported cargoes for the *Eccles* consisted of coal from Oswego (*Oswego Palladium* 1915a, 1915b, 1915c). Furthermore, charters on behalf of forwarding companies declined in favor of individual businesses or consumers chartering directly with the schooner operators. The *Eccles* was employed for much of 1912 carrying coal to the Kingston cotton mill (*Daily British Whig* 1912a, 1912b, 1912c, 1912d, 1912e, 1912f, 1912g). Though the schooner was usually light on the southbound trip across the lake, feldspar was occasionally taken (*Daily British Whig* 1912h, 1913).

On the morning of 20 October 1908, the *Eccles*, having cleared from Kingston for the south shore of Prince Edward Bay, grounded on the Brothers, a series of shoals off the northern end of Amherst Island, southwest of Kingston. It was released by the steamer *Donnelly* (*Daily British Whig* 1908c). In mid-September 1909, the *Eccles* grounded again, this time at Newtonville, near Newcastle while laden with coal from Oswego. It was again released by the *Donnelly*, which towed it into Davis' Dry Dock in

Kingston. The *Eccles* returned to service by 6 October, only to return for further repairs on 13 October (*Buffalo Evening News* 1909; *Daily British Whig* 1909a, 1909b, 1909c, 1909d).

In early August 1911, the *Eccles* was involved in a collision with the small steamer *Jessie Bain* in Kingston Harbor. The *Bain* sustained significant damage to its stern while damage to the *Eccles* was relatively minor (*Daily British Whig* 1911a, 1911b, 1911c). In late September of that year, the *Eccles* went aground near Brighton, Ontario while carrying coal from Sodus to Kingston, but was refloated by 10 October (*Daily British Whig* 1911d, 1911e; *Oswego Palladium* 1911). While laid up during the winter of 1913-1914 at Kingston Harbor, the *Eccles* was given a refit at a cost of more than $100 (*Oswego Palladium* 1914).

Between 1914 and 1922, little information was published regarding *Katie Eccles*, aside from occasional reports of the vessel's arrivals or clearances. All recorded cargoes between 1914 and 1922 were coal taken on at Oswego (*Oswego Palladium* 1915a; *Republican-Journal* 1916).

On 30 July 1921 at 7:15 pm, *Katie Eccles* cleared from Oswego for Port Hope laden with 225 tons of anthracite coal consigned to Brown and Company. That night a northwesterly gale with winds as high as 50 mph. (80 kph) struck Lake Ontario producing heavy seas. By the evening of 31 July, nothing had been heard of the *Eccles*, and it was believed that it may have been lost. Concern at Port Hope was not alleviated until 3:00 p.m. on the afternoon of 1 August, when a telegram arrived from Kingston reporting the *Eccles* had weathered the gale behind Horseshoe Island, off the southwest end of Wolfe Island (*Oswego Palladium* 1921*; Republican-Journal* 1921).

The 1922 shipping season was particularly slow for sail operators on Lake Ontario, who by now were entirely reliant on coal charters. On 31 March 1922, the United Mine Workers of America went on strike in the anthracite fields of Pennsylvania, effectively ceasing the supply of coal to the trestles at Sodus, Oswego, and Fairhaven. The strike persisted throughout the summer, not ending until 2 September 1922 (Gadsby 1922:939-940,950). Unable to obtain coal charters, Mitchell employed the *Eccles* in stone hooking on the shallow stone banks of the Bay of Quinte. Though it was hard labor and provided only meager revenue, the lack of overhead costs made it a potentially profitable means of keeping the schooner in service (Snider 1943a). With the resumption of anthracite production, the coal freights returned in time to take advantage of higher late-season freight rates, and the *Eccles* returned to the coal trade.

The Loss of the Katie Eccles

Several accounts of the loss of the *Katie Eccles* and the events that led up to it have been preserved, though these conflict in many of the details. The principal part of this account is based upon C.H.J. Snider's *Schooner Days* articles of 29 May and 5 June 1943, which was reportedly derived from an interview with Mitchell years after the events. The account, as written by Snider, contains several notable inconsistencies, including the inaccuracy of the dates. Details from conflicting accounts will be noted as they occur. Similar errors concerning the dates of the events are noted in Willis

Metcalfe's retelling of William Markle's account of the storm as a sailor on the *Lyman M. Davis.*

Late November 1922 found the schooners *Mary A. Daryaw, Horace L. Taber, Katie Eccles,* and *Lyman M. Davis* weather-bound in Oswego Harbor for days, awaiting improved conditions to make their final return trip before laying up in winter quarters. The *Katie Eccles* had loaded 180 tons of coal consigned to the Schuster Coal Company of Belleville in the previous days (*Watertown Daily Times* 1922).

The Weather Bureau's daily weather forecast for Sunday, 26 November was unsettled as low-pressure systems centered on the Upper Lakes and western Lake Ontario with variable winds on the eastern end of Lake Ontario (U.S. Dept. of Agriculture Weather Bureau [USWB] 1922c, 1922d). That afternoon the wind shifted from the northwest to the southwest with conditions seemingly improving, and the storm signals were taken down. At 4:00 in the afternoon, with dusk approaching but the weather apparently improving, Mitchell decided to attempt the crossing, sailing out of the harbor before a southwest breeze following the *Lyman Davis,* mastered by John McCullough, who had formerly owned and sailed the *Eccles*.[4] Their departure was followed an hour later by the Kingston-bound *Mary A. Daryaw* and *Horace Taber*, mastered by brothers Frank Daryaw and Henry Daryaw (*Toronto Globe* 1922; USWB 1922a, 1922b, 1922c, 1922d, 1922e, 1922f, 1922g).

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[4] Markle's account conflicts here, stating that the *Lyman Davis* was the last of the vessels to leave Oswego and that it had departed around 1:00 p.m. (Metcalfe 1975:24).

The *Eccles* was severely under-manned, likely due to the scarcity of work in the preceding months, with only three aboard: Captain Harry Mitchell, boy Hugh Hanna of Kingston (also given as Hugh McCullough), and Mary M. Lloyd of Kingston, the ship's cook. As they sailed out of the harbor, Mitchell and McCullough hoisted sails, and Lloyd manned the helm; she, by all accounts, was a competent, albeit unrated, sailor having gained experience during the previous three or four seasons during which she was employed in various vessels as a cook (*Sandy Creek News* 1922a, Snider 1943a, 1943b).

The *Eccles* had run off 5 mi. (8 km) when the rudder became unresponsive to the movements of the wheel. Mitchell brought the *Eccles* about by trimming the sails in an attempt to return to Oswego, but with Oswego directly to windward, and being unable to tack, it became apparent they could not make the harbor. With no anchorages and only leeward shore to the east, Mitchell decided to run for the Canadian shore where they might anchor in the lee of the False Duck Islands or within Prince Edward Bay. Much depended on the location of their landfall, as the False Duck Islands, Timber Island, Main Duck Island, and the shoals extending south and west from the False Ducks all presented potential hazards for the northerly crossing.

Throughout the evening the weather continued to deteriorate, developing into a driving snowstorm by 10:00 p.m., with ice and snow accumulating on deck, and visibility being nearly whited-out. Despite the weather, the *Eccles'* maintained a north-northwesterly course under only its mainsail with a slacked sheet. Two hours later, during an interlude in the snow, the crew sighted a light, eventually concluding that this was the False Ducks Light, warning of the Duckling Shoal (also called Outer False Duck

Shoal or the Gull Bar) extending southwest from False Duck Island with a minimum depth of less than 1 ft. (0.3 m). The crew hoisted all three headsails in an attempt to make the *Eccle*s turn off northward to clear False Duck Island on its northern side where there was sufficient depth to clear the shoal. This had little effect until a westerly shift in the wind pushed the bow to the north and the *Eccles* narrowly averted going ashore passing close by the False Duck Light.

With the False Ducks astern and nearing the lee of Timber Island, the accounts diverge. Snider records that when they reached the lee of Timber Island, the headsails were struck, the mainsail sheeted in, bringing the bow into the wind, and both anchors were thrown over the side in 15 fathoms (90 ft. / 27.4 m). Mitchell recounted that the *Eccles* remained at anchor throughout November 27 and 28 (Snider 1943b; Metcalfe 1975:24). Another account reportedly given by Mitchell said that the *Eccles* stranded on Timber Island after dragging its anchor (*Oswego Palladium* 1922). This was later corroborated by Captain Miller Donnelley (*Daily British Whig* 1922b; *Daily Intelligencer* 1922b, 1922c; *Republican-Journal* 1922a*; Sandy Creek News* 1922a). The account Mitchell provided Snider does not indicate that *Eccles* went aground at any stage of its prolonged struggle between 26 and 28 November.

The *Eccles* was not alone in its peril on the night of 26 November and the early morning of 27 November. The *Lyman M. Davis* had cleared the False Ducks and turned into South Bay, only to go ashore on Waupoos Island, 7 mi. (11.25 km) west-northwest of where the *Eccles* lay at Timber Island. William Markle of Napanee, the *Davis'* mate, climbed out on the jib-boom and stepped from it onto land where he found a farmhouse from which to telephone Kingston to dispatch a salvage tug. Returning to the *Davis*, Markle and McCullough bored a hole in the lazarette with a two-in. (5.08 cm) auger, allowing the water to rise to 4 ft. (1.2 m) in the holds, easing the *Davis'* movements on the shoal and preventing it from breaking up (Metcalfe 1975:24-25).

The *Mary A. Daryaw* and the *Horace Taber* were both driven aground off Four-Mile Point on Simcoe Island, southeast of Kingston. While the *Daryaw* was refloated within two days, the *Horace Taber* went to pieces and quickly became a total loss (*Daily British Whig* 1922a, 1922c; *Daily Intelligencer* 1922a).

With *Katie Eccles* overdue and reports of the grounding of the *Daryaw, Taber,* and *Davis*, concern arose over the safety of the *Eccles* and its crew. On 28 November Captain Miller Donnelly of the Donnelly Wrecking Company and the tugboat *Mary P. Hall* arrived at Waupoos Island and passed a towline to attempt to pull the *Davis* off. After several unsuccessful attempts, the *Hall* began its return to Kingston to retrieve a lighter when Donnelly sighted the *Eccles* at Timber Island. Donnelly reported it being hard aground. The *Hall* was unable to approach the schooner due to the shallow depth of water surrounding it and, having observed smoke rising from the cabin stove-pipe, returned to Kingston assured that the crew was safe onboard (*Daily British Whig* 1922b; *Daily Intelligencer* 1922b, 1922c; *Republican-Journal* 1922a; *Sandy Creek News* 1922a).

With Donnelly's report at Kingston, a telegram was sent to W.E. Schuster of the Schuster Coal Company in Belleville, the consignee of the *Eccles'* cargo, notifying him that the vessel had been found and the crew was safe (*Sandy Creek News* 1922a). The *Davis* was later lightered of its coal and released by the *Hall* (Daily *British Whig* 1922b).

The morning of 29 November dawned clear with a westerly breeze. According to Snider, the *Eccles's* crew believed they might attempt to reach the Upper Gap at the entrance to the Bay of Quinte while the weather remained favorable. While preparing to weigh anchor, a westerly squall arose and within a half-hour the *Katie Eccles* was pitching head-on into the heavy sea while still at anchor. The strain being transferred to the windlass bitts by the chain cable was so great that Mitchell worried that the windlass might be unshipped and pulled overboard. To alleviate the strain, the crew took the chain from the remaining anchor, wrapped it around the foremast, and bent it to the jib sheet bits on the windlass with a towing hawser. The hawser parted on the first rise and the chain rapidly let out through the hawse pipes. Mitchell reported that the hawse pipe was torn loose, the pipe sliding down the chain, yet both hawse pipes remain in place on the wreck today. With the chain threatening to saw through the bolster and planking at the bow, the crew set a double-reefed mainsail to keep the bow into the wind and dropped the remaining anchor only to find their remaining chain was insufficient to hold. The chain parted and the anchor was lost.

By the evening of Wednesday, 29 November, the *Eccles* had begun to drag its remaining anchor and was working off the shoal. With nothing remaining to save the ship, Mitchell decided to abandon the *Eccles*. Lowering the yawl from the davits and securing a painter to the schooner's bow, they boarded from the main chains amidships after gathering many of the provisions that remained aboard. Mitchell was the last to make the leap from the main chains to the yawl (*Daily* Intelligencer 1922c; Snider 1943b). The crew landed the yawl on the western shore of Timber Island, where they built a shelter and a fire on the southern end of the island where it would be visible from Point Traverse. The *Eccles* reportedly remained at anchor throughout the afternoon, until later in the day, having dragged the anchor and now adrift, it disappeared from view. On 30 November, the crew were taken off the island and later taken to Kingston by local fishermen (*Daily* Intelligencer 1922c; *Republican-Journal* 1922b, Snider 1943b).

With the *Eccles* adrift, it was expected that it might go ashore on Amherst Island but by Saturday, 2 December, no report had arrived (*Cape Vincent Eagle* 1922a). By December 7, Mitchell concluded that the vessel had foundered, a great loss to him as it was nearly all he owned (*Cape Vincent Eagle* 1922a). The following season he would serve as master of the *Burt Barnes* (*Oswego Palladium* 1923).

On 5 December, a large section of the upper stern of the *Eccles* drifted ashore in Reid's Bay on the South Shore of Wolfe Island (*Republican-Journal* 1922c). Later in December, Captain Claude W. Cole of Cape Vincent, who was taking the lightkeepers off from Pigeon, False Duck, and Timber Islands located the wreck with its topmasts protruding above the water in what he estimated to be approximately 80 ft. (26.7 m) depth opposite the Upper Gap, between Amherst and Timber Islands. Cole towed part of the mainsail and its boom to Cape Vincent, where it was placed on the Pyke Coal Company's dock and reported the wreck to the Pyke Wrecking Salvage Company (*Cape Vincent Eagle* 1922b, *Sandy Creek News* 1922b). Nothing came of the talk of raising the

Eccles, no salvage efforts seem to have been made, though the masts were taken down to remove them as a hazard to navigation.

The *Katie Eccles* was relocated on 4 August 1985 by Barb Carson and Doug Pettingill while conducting an echo-sounder sonar search for the wreck off the Upper Gap of Prince Edward Bay. In 2002 Carson and Rick Nielsen placed a mooring on the site to allow public access by recreational divers (Barb Carson, 2020, pers. comm). The *Eccles* is presently among the most-visited shipwrecks within the eastern basin of Lake Ontario, yet it remained archaeologically undocumented before the 2019 field season of the Last Schooners Project.

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CHAPTER VI

THE ARCHAEOLOGY OF THE *KATIE ECCLES* PART I- THE HULL

Description of the *Katie Eccles* Site

The remains of the *Katie Eccles* lie in 105 ft. of water (32 m.) within Prince Edward Bay's Upper Gap, 6 mi. south of Amherst Island (9.7 km) and 5.5 mi. (8.9 km) northeast of Timber Island (Figure 6). The wreck rests on relatively featureless mudflats which gradually rise to the west and north. The hull lies on a southeasterly heading and retains an overall preserved length of approximately 126 ft. (38.4 m) including the jib boom and bowsprit, and a length on deck of 95 ft. 6 in. (29.1 m) (Figures 7-9).

The bow rests with a list to port of approximately 3-3.5 degrees, the port side resting embedded in sediment along the turn of the bilge, while the starboard bilge is

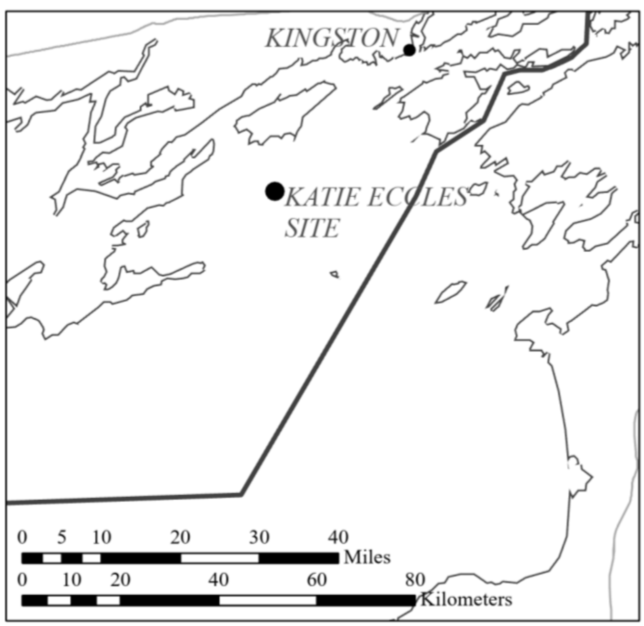

Figure 6. Location of the *Katie Eccles* (By author, 2021)

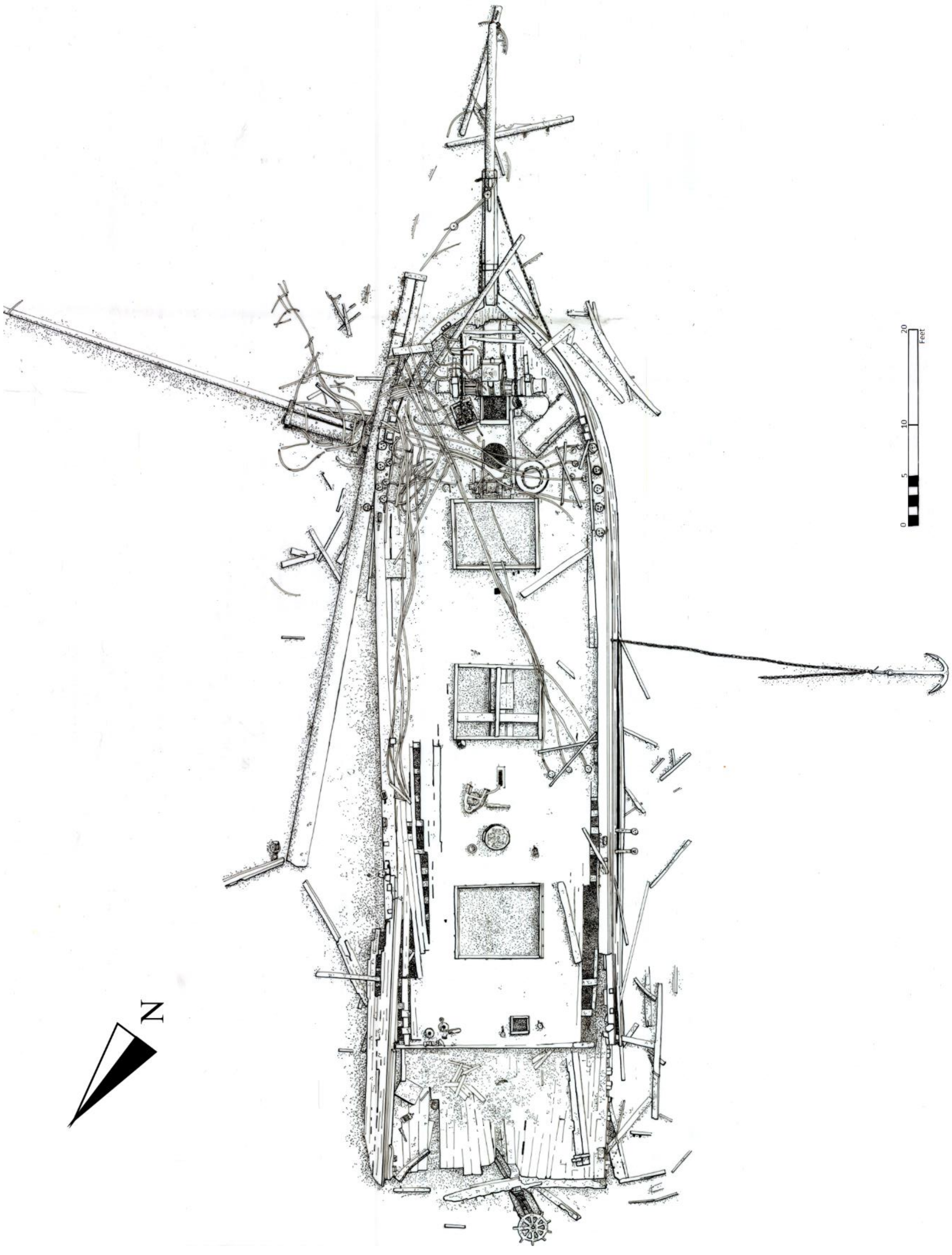

Figure 7 ***Katie Eccles site plan*** **(By author, 2021)**

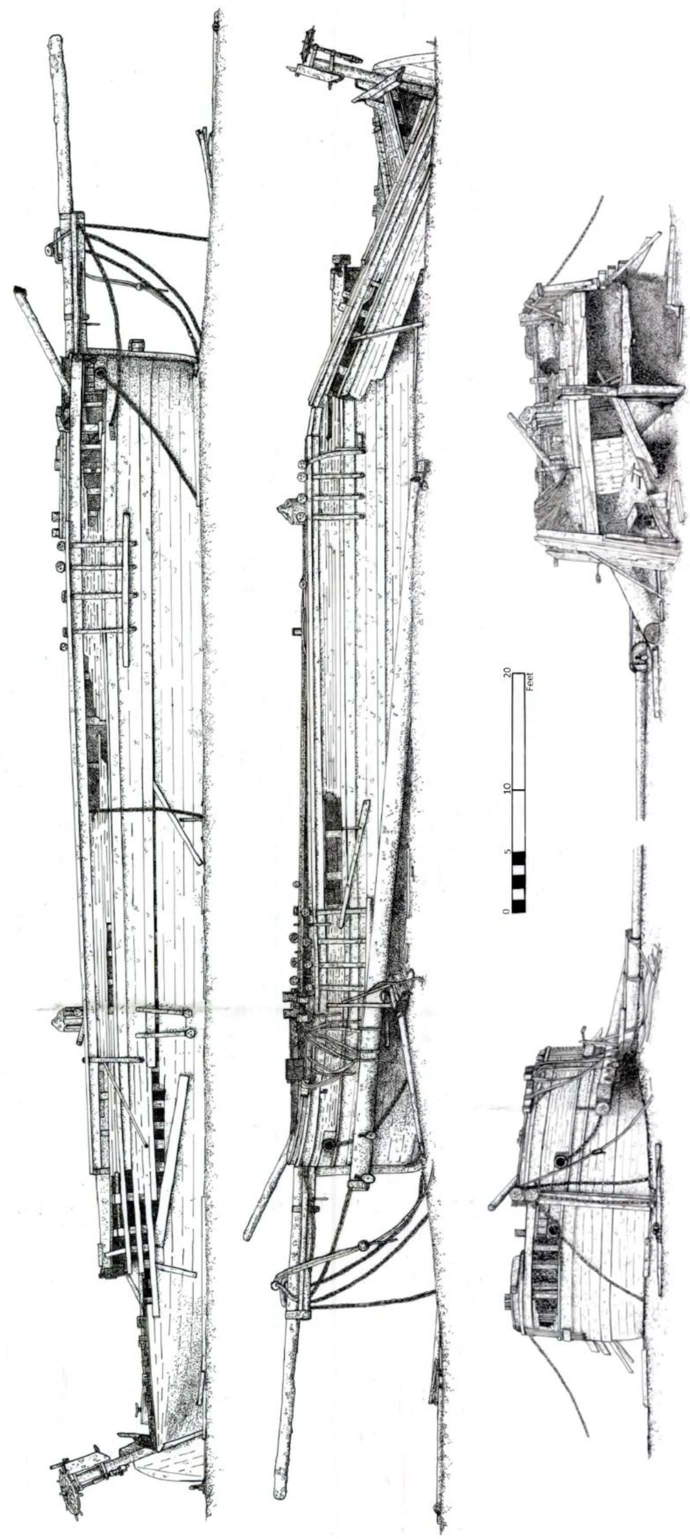

Figure 8. ***Katie Eccles*** **elevation plans (Photo by author, 2021)**

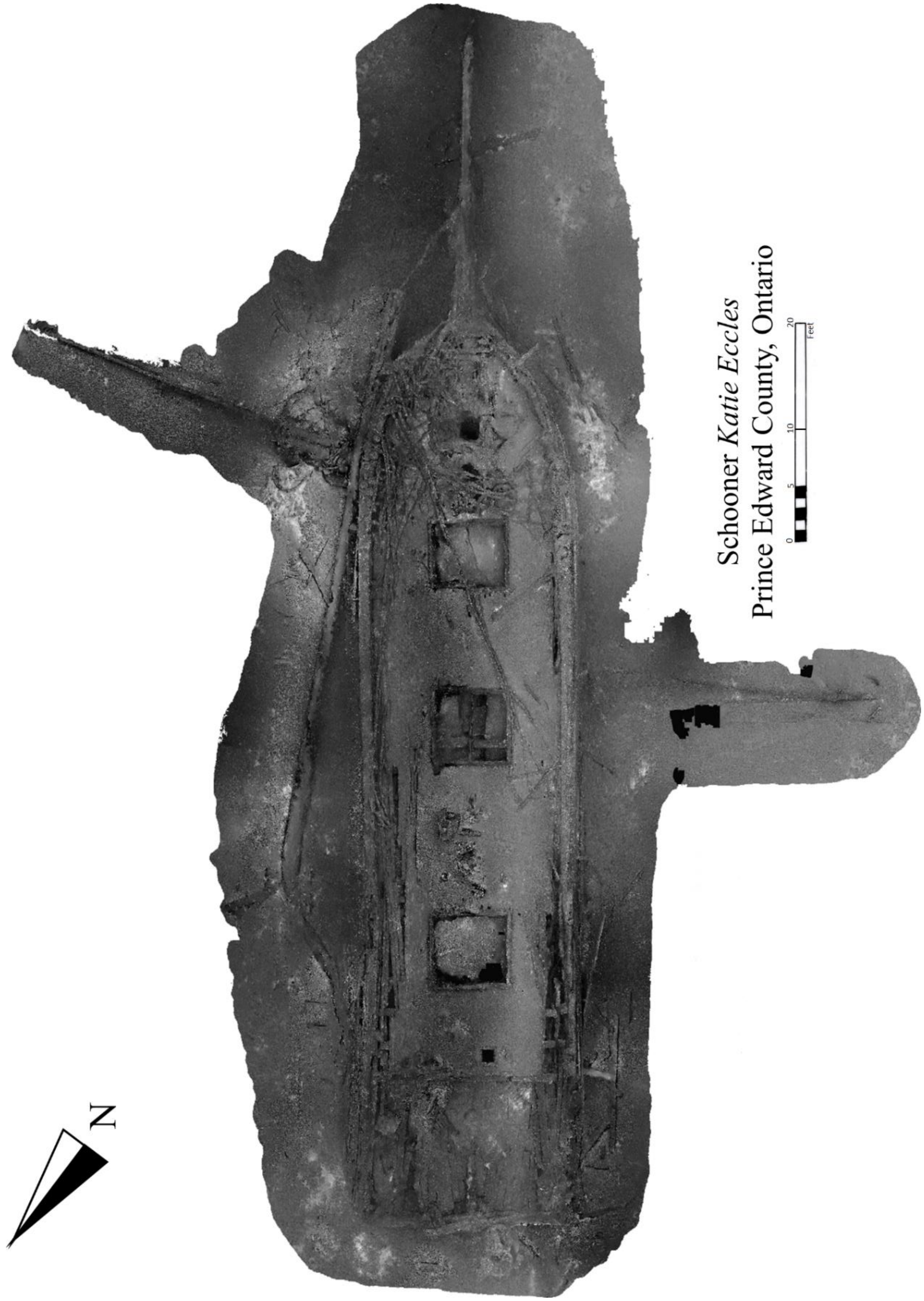

Figure 9. Orthophoto of the Katie Eccles (Photo by author, 2021).

exposed along much of the length of the hull. The stern is more deeply embedded in the bottom and lists to starboard, indicating a possible break in the keel aft of amidships. The hull retains a maximum height of 12 ft. 7 in. (3.84 m) from the bottom at the starboard chock rail, the highest point of the hull.

The *Eccles*' hull is almost entirely intact from the bow to approximately athwart the third (aftermost) hatch. Except for the quarter-deck, the cabin and upper starboard quarter, and several spars, the *Eccles* is a nearly complete archaeological example of a late-19th century lake schooner.

The bow is intact, as is the bowsprit, which remains stepped in the forward face of the pawl post. A large section of the jib boom and its doubling with the bowsprit remains standing. The bowsprit retains its chain shrouds, foot ropes, and bobstays. The martingale, spreader spars, and the outer portion of the jib boom all lie on the lakebed beneath the bowsprit.

Forward of the empty foremast hole the deck retains a purchase-lever, or brake-operated type windlass, and, to starboard, forward of the fore hatch, a vertical boiler lies on its side resting against the bulwarks while its baseplate remains *in situ* just forward of the steam winch along with a possible steam-siphon. Though the forecastle companionway coaming remains intact, the companionway house is not present.

Forward of the forward hatch, the deck, particularly on the port side, is covered by tangled rigging which is draped over the port rail between the port fore chains and the cathead. Between the bow and midships at the mainmast, disruption of the hull is limited to the disarticulation of some deck planking and damage to the bulwarks between the port fore chains and amidships, and at the starboard bow between the starboard hawse pipe and the starboard chock bitts. The starboard chock and cap rail have been detached forward of the cathead to starboard.

The length of the deck is interrupted by three hatch openings in addition to the forecastle companionway hatch. A centerboard case extends from the after-hatch beam of the fore hatch to forward of the mainmast where the deck is pierced by the centerboard pennant chock. The pennant chain runs from the chock to the centerboard winch, which lies on its side on deck to port.

The most significant damage to the extant portions of the hull has been inflicted on the port quarter. A large section of the upper port quarter, 30 ft. (9.15 m) in length and 5ft. 5 in (1.34 m) in height, has broken away. Its forward end remains partially articulated with the rail and deck, sloping aft to the taffrail, which is embedded in the bottom. This section comprises a portion of the bulwark, cap rail, waterway, plank sheer, and two strakes below the planksheer. The port quarter between the upper and lower turns of the bilge has broken off and lies flat on the bottom, partially beneath the upper port quarter. The half frames and planking of the lower turn of the bilge have separated along the sternpost and deadwood and have settled to port. The sternpost, inner post, deadwood, and transom are intact, though with a list to starboard. The starboard quarter is broken off along the upper turn of the bilge, above which the hull is missing.

This localized damage to the stern is most consistent with the *Eccles* having gone down stern first, striking the bottom on its port quarter, disarticulating this portion of the hull from the longitudinal assembly. The transference of this force forward through the hull and the downward momentum of the deck resulted in the compression of the sides and the separation of the deck from the hull along the waterways as it settled. The missing components of the upper part of the stern were likely disarticulated in the impact and subsequently drifted away, as previously noted.

Much rigging remains throughout the site. As noted previously, the bowsprit and jib boom are largely intact. The martingale, spreader spars, and the outer portion of the jib boom all lie on the lakebed beneath the bowsprit. The foretopmast and its doubling with the foremast rest on the lakebed, laying nearly perpendicular to the port side of the bow with the masthead pointed outward. The lower foremast is unaccounted for below the hounds. The mainmast lies off the port side, approximately parallel to the hull, with the masthead pointed forward. This mast overlies the foremast doubling and is thus raised off the lake floor at its head. The wire shrouds of both the fore and mainmast remain attached to the masts at the hounds. The mainmast was broken off above the deck.

A spar, likely the main gaff, lies off the port quarter parallel to the hull. This spar was omitted from the 2019 photo model and site plans due to difficulties in integrating it into the photo model of the hull from which it is separated.

Construction of *Katie Eccles*

The intact state of the *Katie Eccles* proved an impediment to the examination of internal construction features of the hull. Without penetration below decks, penetration of the hull being restricted by the permit, complete or close examination of many constructional features was impossible. Furthermore, approximately 180 tons of coal remain within the hold, eliminating the possibility of observations of the ceiling at and below the bilge, along with the keel, keelson, floors, and first futtocks, all of which remain buried and thus inaccessible.

Construction features were observed wherever the opportunity was presented by the disruption in the hull, namely at the break of the deck aft, where the interior of the hold is visible as far forward as the aft-hatch, along the sides of the deck, at the quarters, and through the hatch openings. While the resulting observations are incomplete, the survey nonetheless produced much information of relevance to the study of shipbuilding techniques and the scantlings employed in the *Eccles.*

Observation of some features was impeded by a thick fouling layer of Dreissena *polymorpha*, the zebra mussel, and Dreissena *rostroformis bugensis*, the Quagga mussel. These invasive species first identified within the Great Lakes in 1988 and 1989 have spread throughout the lakes, proliferating on solid substrates such as shipwrecks. Such Dreissenid fouling possesses far-reaching implications for the preservation of Great Lakes shipwrecks and impedes the observation and study of hull features, further limiting the information that can be obtained by non-disturbance methods (Binnie et al. 2000; U.S. Geological Survey 2019a, 2019b).

Keel and Stem Assemblies

The keel and keelson assemblies could not be observed along most of their lengths. At the forward extremity of the keel, the upper extent of the forefoot is exposed. The forefoot’s lower half is embedded in the bottom. The straight stem extends above

Figure 10. The Eccles' starboard bow looking forward (left) and the port bow (Photo by author, 2021).

the forefoot of approximately 8 ft. 6 in. (2.59 m) along its forward face. The stem is nearly vertical with a 2° forward rake. As the hood ends of the strakes remain seated along the rabbet, the overall dimensions of the stem could not be determined. The external molded dimension from the rabbet line to the forward face of the stem is approximately 1 ft. 5 in. (0.41 m) at the head of the stem, tapering to 1 ft. (0.30 m) at the foot. The forward-sided dimension of the stem could not be reliably measured.

The stem assembly is observable outboard of the rabbet line. The gripe is visible at the foot of what is presumably the false stem (Figure 10). The scarphs attaching the gripe are reinforced by the upper bobstay plate, which is angled upwards at its forward end to clear the stem rabbet. The lower end of the gripe and the outer bobstay play are embedded in the sediment. However, the relatively small radius of the gripe's curvature and that of the rabbet line, and the relatively close spacing of the bobstay plates suggest a hard turn of the straight, near-vertical stem into the forward end of the keel.

Sternpost, Keelson, and Stern Deadwood Assemblies

Though the aft end of the keel and keelson assemblies are not visible, the sternpost and inner post remain in situ, listing slightly to starboard with its heel embedded in the sediment (Figure 11). The sternpost has an exposed length of 7 ft. 6 in. (2.28 m) and had an aft rake of seven degrees. This appears to be, in part, the result of the disarticulation of the starboard quarter and distortion to the stern sustained in the sinking, as indicated by the gap that has opened between the main transom timber and the aftermost half-frames on the starboard quarter.

The aft face of the sternpost is hollowed to fit the forward part of the rudder stock, fitted forward of the rudder body. As the rudder stock did not extend the full length of the rudder, this inletting is evident only in the upper part of the post.

The inner post has an exposed length of 7 ft. (2.13 m) and is bolted to the forward face of the sternpost. The corners of the sternpost and inner post along this joint are chamfered, forming the rabbet with the back rabbet line following the seam between the timbers. The top of the inner post is mortised to receive the main transom timber.

The deadwood is a simple structure (Figure 11), consisting of two diagonally set timbers, one bolted atop of the other. The existence of this sternson is suggested by the 1876 Board of Lake Underwriter’s rules and the necessity of integrating the keelson assembly with the inner post (Dorr 1876:29). The timbers of this diagonal deadwood

Figure 11. (Left) The sternpost, inner post, and rudder stock. (Right) the sternpost and deadwood assembly looking aft (Photo by author, 2021).

could not be measured. Fasteners protruding from the port side of the deadwood indicate where the half-frames have pulled away, their fastenings being pulled through the frames.

Square Frames and Midships Half Frames

The square frames were largely obscured by both the exterior and ceiling planking, but a portion of the framing was visible on the starboard side from the break of the deck as far forward as amidships. Here a split in the hull immediately below the load waterline wale has displaced two strakes, exposing the outer faces of the frames. No frames were observable below the bilge.

The amidships square frames possess an average room of 1 ft. (30.5 cm), with each futtock, sided 6 in. (15.25 cm) at the level of the load waterline wale. Spaces between frames average approximately 8-9 in. (20.3-22.9 cm), with frames set on 21 in. (0.53 m) centers. Here the *Eccles* seems to have been built to adhere to the 1866 Lake Underwriter's rules, which required spacing of frames on 21 in. (0.53 m) centers (Lewis 2000). The molded dimension of the square frames could not be measured, nor could the spacing of the shifts of the butts above and below the level of the bilge be determined.

Between approximately 29 ft. 6 in. and 53 ft. (8.99-16.15 m) along the baseline, measured along the centerline running aft from the forward face of the stem, the presence of the centerboard case prevented continuous floors and first futtocks from crossing the upper face of the keel. Here half-frames would have been stepped into notches cut into the outer molded faces of the pocket pieces in place of floors.

The uppermost futtocks, or top timbers, extended above the covering board at every other frame and served as bulwark stanchions. These top timbers are set in line with the forward half-frame of each pair, spaced on 3 ft. 6 in. (1.06 m) centers, extend approximately 2 ft. 6 in. (0.76 m) above the upper face of the covering board at amidships. All other frames extended to the top of the plank sheer, with the covering board fastened onto the frame ends.

Main Transom and Framing of the Counter

The main transom timber rests within a notch formed in the upper face of the inner post against the inner sided face of the sternpost (Figure 11). The transom has recently been broken over the centerline at the inner post. This damage was not present in photographs of the site taken in 2014 (Dekina 2014). The port half of the transom slopes downward and aft. The starboard half of the transom remains in place but has shifted aft from its original position as the sternpost had leaned aft (Figure 11).

The starboard half of the transom has deteriorated on its upper face and part of this upper face has been detached and rests upright on the lake bottom below the starboard quarter. This section retains a standing knee on its outboard end, measuring 2 ft. 2 in. (0.66 m) in length along its horizontal arm, 1ft. 4.5 in. (0.41 m) in height, and is 4 in. (0.10 cm) thick. The lower outboard face of the knee is notched, presumably to fasten over the shelf clamp.

Though no counter timbers have been preserved, four fastenings, driven into the aft face of the transom timber indicate their placement along its length. A notch cut into the aft molded face at the transom's outboard end likely accommodated the outer counter timber. A larger fastening immediately outboard of the sternpost may have fastened a set of post timbers to either side of the transom. The fashion pieces formed the outer trim of the counter, protecting the end grain of the hull and counter planking. The outer faces of these timbers were curved to match the curvature of the counter. The port fashion piece has been preserved and lies resting on the bottom beneath the portside transom.

Cant and Half Frames

The number of cant frames in the bow cannot be estimated with the available information. However, the cant frames could not extend farther aft than the chock rail bitts, aft of which the molded faces of the frame-top stanchions are perpendicular to the centerline.

At the starboard quarter, the half frames are obscured by the ceiling and external planking, though the stations of the half frames are indicated by the protrusion of the futtocks from the break at the upper bilge. On the port side, the break below the upper turn of the bilge reveals the futtocks. The aftermost half-frame, observed at the upper turn of the bilge, appears to be a triple-frame set approximately 1 ft. 2 in. (0.34 m) forward of the transom with a total sided dimension of approximately 1 ft. 9.5 in. (0.55 m). All other frames on the quarters have a space of approximately 8 ½-9 in. (0.21-0.22 m) and siding of approximately 1 ft. (0.34 cm). It appears that at least three half-frames were fastened into the sides of the deadwood, though the overall number of half-frames employed in framing the stern is unknown.

Centerboard Case and Centerboard

The centerboard case was largely inaccessible below the main deck and therefore unobservable along most of its length but is exposed at the fore hatch and the midships hatch (Figure 12). Within these hatches, much of the centerboard case's height is obscured beneath coal within the hold.

The centerboard is situated along the centerline between 29 ft. 6 in. (8.99 m) and approximately 53 ft. (16.15 m) along the baseline, the aftermost extent being estimated from the positioning of the pennant chock (Figure 12). The forward end of the centerboard case projects forward of the aft head ledge of the fore hatch, the forward post of the centerboard case is fastened into the underside of the hatch beam with the strakes of the case laterally fastened through the post. Accordingly, the centerboard case has an approximate overall length of 22 ft. 6 in. (6.85 m). The width of the centerboard case and the dimensions of the cap plank could not be measured.

At 31 ft. 6 in. (9.60 m) along the centerline a small rectangular opening in the deck, measuring approximately 8 in. long by 4 in wide. (20.3 by 10.2 cm) was likely to allow inspection of the centerboard's pivot pin; thus, the pivot pin is located approximately 3ft. (0.91 m) aft along the centerboard's length when raised.

A metal plate 3 ft. (0.91 m) long is bent over the top of the centerboard case to cover the cap plank and uppermost strakes of the case within the opening of the midships hatch. Heavy wear on the cap plank around this plate suggests the plate was intended to protect the cap plank and centerboard from damage while loading coal by pocket chutes along elevated railway trestles. Douglas Bennet notes that the small hatches on coasting schooners prevented even distribution of coal throughout the hold, with the coal tending to mound in the center of the hatch. Trimmers were employed to shovel the mounded coal from the hatch opening out into the wings as well as fore and aft. Bennett also notes that loading with pocket docks was often through the main hatch and that the fore and aft hatches were used for access to the hold and to allow trimming coal fore and aft (Bennet 2001:44). A review of historical photographs of schooners at the Oswego and Sodus coal trestles consistently show lading with a single chute at the midships hatch, or with coal mounded at the midships hatch, indicating a similar method of lading through the midships hatch may have been employed aboard lake schooners.

Figure 12. (Left) The centerboard visible at the midships hatch. (Right) The centerboard pennant hole and chain looking aft (© Institute of Nautical Archaeology/ Author, 2021).

Hooks and Pointers

No observation of the hooks and pointers below deck at the bow was possible. On deck, a pair of pointers were fastened to the inboard face of the cap rails, extending aft to the catheads with a hook fastened to at their forward end. Two crossbeams extended between the pointers and supported a small forecastle deck. A small section of the forecastle deck planking remains on the port side with the strakes laid parallel to the centerline.

Ceiling Planking

The ceiling planking, obscured throughout much of the hull by coal, was observed only aft of the break of the deck. At the transom, there are approximately 14 ceiling strakes in place between the centerline and the upper turn of the bilge. All visible

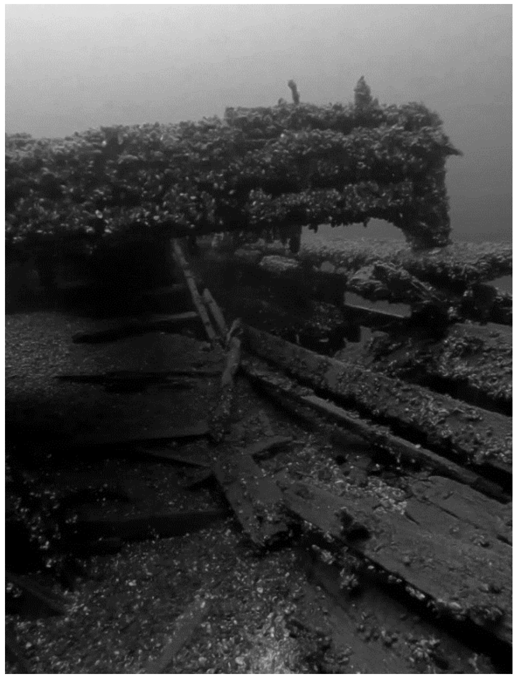

Figure 13. The disrupted structure of the deck looking forward from the great beam (By author, 2021).

joins within the regular ceiling strakes were simple butt joints, though the planks of the shelf clamp were joined with diagonal hooked scarphs. On the port side, the tenth ceiling strake from the centerline, a drop strake tapering narrower along its lower face, is notched to receive the cabin sole beams.

Deck Structure- Clamps, Beams, Ledges, Carlines, Hatches, and Coamings

Though much of the deck structure is obscured by the planking, the displacement of the deck planks along the sides of the deck has exposed many of the beam ends (Figure 13). As a result, the position of most of the beams aft of the forward hatch are known. As the planking along the centerline of the deck is uninterrupted, nothing can be said of the use of carlines, apart from their use in framing the hatches.

The outboard ends of the beams are supported on a beam shelf, a detached portion of which at the stern measured approximately 5-5.5 in. (12.7-14 cm) high. The thickness could not be ascertained. The shelf was supported by a clamp of similar size beneath it. A salting channel was cut along the centerline of the upper face of the observed beams.

The upper face of the shelf clamp is notched to receive the beam ends. No lodging knees seem to have been used in preventing fore and aft movement of the beams, instead filler timbers, which filled out the space between the deck clamp and the covering board above and between adjacent frames, prevented fore-and-aft movement of the frames (Figure 13). The covering board was fastened over the upper face of these chocks and the frame ends of those frames were not fitted with bulwark stanchions, thus securing the beams in place. Fastening patterns could not be determined.

The intactness of the deck forward of the forecastle hatch limited observation of the framing of the deck apart from that of the hatch itself. This hatch measures 2 ft. (0.60 m) fore-and-aft and 2 ft. 3 in. (0.68 m) athwartships, measured inside of the coamings. The forward and aft sides of the hatch were framed by beams, the sides by two carlines, presumably dovetailed into the beams. A coaming, approximately 2 ½ in. (0.06 m) wide was fastened onto the beams and the headers. The coamings and head ledges met in half laps at the corners, with the head ledges overlapping the coamings.

The forecastle companionway, visible in one historical photograph (Figure 5), has not been preserved. The companionway roof was cambered and sloped downward forwards, the sides curving down and overhanging the sides of the companionway. A ladder remains fastened to the after beam of the forecastle hatch, allowing access to the forecastle below. The positioning of the foremast hole, centered 17 ft. 6 in. (5.33 m) along the baseline, necessitated the placement of the mast partner beams immediately forward and aft of the mast.

The next attested beams are those of the hatch beams of the fore hatch, situated between 22 and 29 ft. 6.70-8.83 m) along the baseline. Both the fore and aft hatches measure 7 ft. (2.13 m) fore-and-aft by 8 ft. 6 in. (2.59 m) athwartships, measured inside the coamings. Both are similarly constructed. The hatch beams, 7 ½ in. (19.05 cm) sided, are dovetailed to receive a set of carlines that framed the sides of the hatch opening. Two half beams were dovetailed into the outer face of the headers and set on the shelf clamp between the hatch beams of each hatch. The hatch coamings themselves are approximately 10 ½ in. (26.7 cm) high at the centerline and 4 in. (10.2 cm) thick. The coamings met at the corners with half-lap joints, the coamings overlapping the head ledges. Four eye bolts are fastened along the outer face of each coaming by which the hatch covers were lashed down.

The midships hatch is situated between 39 and 46 ft. 6 in. (11.88-14.17 m) along the baseline. The main hatch measures 7 ft. (2.13 m) by 8 ft. 6 in. (2.59 m), inside the coamings and is constructed with the same techniques as the fore hatch. A beam crosses the hatch opening at 45 ft. (13.71 m) along the baseline, overlying the cap board of the centerboard case, which divides the hatch opening along its centerline. The coamings and head ledges are dovetailed at their centers to accommodate the strong backs of the hatch covers with the head ledges dovetailed to receive a fore-and-after that remains in place.

The mainmast partner beams are 9.5 in. (24 cm) sided and spaced 2 ft. 2 in. (0.65 m) apart, framing the mainmast hole. Aft of the mainmast partners, two beams are set between the aft partner beam and the forward hatch beam of the aft hatch, which is set between 63 and 70 ft. (19.20-21.33 m) along the baseline. Two beams were set between the aft beam of the after hatch and the great beam, all approximately 7.5 in. (19.05 cm) sided with 2 ft. 7.5 in. (0.80 m) space between. A small hatch or scuttle is present on deck, offset to starboard immediately forward of the great beam. This hatch measures approximately 1 ft. 6 in. by 1 ft. 6 in. (0.45m) inside of the coaming. It may have been intended to allow inspection of the aft end of the hold without the removal of the hatch covers.

The great beam appears to consist of two sister-beams, with the after sister-beam comprised of three timbers joined with diagonal scarphs. The construction of the forward sister-beam is unknown. An athwartships coaming was fastened atop the after half-beam but has only been preserved at its outboard ends. The outboard ends of the coaming show the coaming was lower along the width of the quarterdeck gangways. These gangways were approximately 4 ft. 6 in. (1.37 m) wide, inboard of which the coaming increased in height. These higher coamings functioned as the cabin footing and have only been fragmentarily preserved. A timber fastened to the after face of the great beam beneath and of a length slightly shorter than the short coaming may have served as a shelf to which the plank ends of the quarter-deck were fastened.

Figure 14. Looking forward from the break of the deck with the two iron stanchions at center and the row of centerline stanchions in the background (By author, 2021).

Covering Board

The covering board measures approximately 4 in. (10.1 cm) thick, and 12 in. (30.5 cm) wide. It was fitted from the inboard sides of the frame-top stanchions. It is notched to fit over the top timbers, with the outer faces of the frames flush with the outer face of the covering board. The covering board fastened onto the upper frame ends of the intermediate frames, the beams, and the chocks. A rub strake, the same thickness as the covering board, and a width the same as the thickness of the plank sheer, was fastened over the outboard face of the covering board, thus enclosing the frame-top stanchions.

Stanchions

The *Eccles* relied on a series of closely spaced deck-beam supporting stanchions and the centerboard case to support the deck along the centerline. Though limitations on the penetration of the hull prevented measurement or detailed recording of these stanchions, several were observable at the hatches and forward of the break of the deck to the aft hatch.

The stanchions at the forward hatch beam of each hatch are offset to starboard, suggesting these may be stepped into a sister keelson. Elsewhere, the stanchions were set along the centerline at each of the four beams between the aft beam of the after hatch and the great beam, most likely stepped into the upper face of the keelson. The stanchions were likely secured to the beams by iron plates, though further examination is necessary to corroborate this (Dorr 1876:46). A pair of iron stanchions were placed immediately forward of the aft bulkhead, supporting the great beam. These stanchions have been bent forward by the compressive force of the hull striking the bottom (Figure 14).

Exterior Planking

The planking below the lower bilge is obscured by the vessel's upright position. Amidships, four strakes are visible between the bilge and the load waterline wale. The load waterline wale is approximately 8 ½ in. (2.1 cm) wide. Four strakes were fastened between the load waterline wale and the plank sheer. The strakes amidships, both below and above the load waterline wale, are approximately 6 in. (0.15 m) wide. The plank sheer is 1 ft. (0.30 m) in width. Rub strakes were fastened over the chainplates along the plank sheer. The inboard face of the rub strake is inlet to fit over the chainplates.

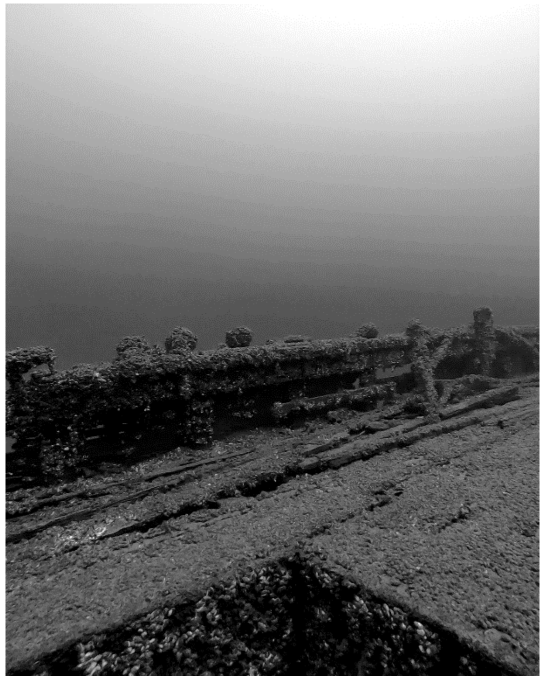

Figure 15. The inner face and framing of the bulwarks (By author, 2021).

Bulwarks, Cap Rail, Rail Stringers, Chock Rails, and Bulwark Fittings

The bulwarks are framed by top timbers set on 3 ft. 6 in. (1.06 m) centers, with heights of 2 ft. 6 in. (0.45 m) amidships (Figure 15). The cap rail expands from 1 ft. (0.30 m) amidships to 2 ft. (0.60 m) wide along its curve at the bow. It is approximately 6 in. (0.15 m) thick and fastened on top of the top timbers. Two rail stringers were fastened to the inner and outer faces of the stanchions beneath the cap rail.

Between these rail stringers and the covering board, the bulwarks were planked with seven narrow strakes. Five small scuppers were cut into the lowest strake of the bulwarks amidships and a narrow gap between the covering board and this lowest bulwark strake functioned to free water from the deck. The relatively light planking of the bulwarks allowed the bulwarks to be broken out should the scuppers prove insufficient (*Daily British Whig* 1905; Karamanski 2001:177).

At the bow, the chock rails extended from the knightheads to immediately forward of the fore chains. The chock rail is intact to port but has been detached on the starboard side forward of the cathead along with the cap rail. The chock rails were thus 6 ft. 6 in. (1.98 m) long forward of the catheads and 10 ft. 6 in. (3.20 m) long aft, and approximately 5.5 in. (0.13 m) in height. The chock rail was narrower than the cap rail at approximately 5.5 in. (0.13 m) wide. A set of iron chocks were fastened to the upper face of the chock rails between the catheads and the hawse pipes.

The catheads extend outward parallel to the cant of the frames. The catheads consist of a knee, the lower arms of which were fastened to the inner-sided face of the stanchions and extended at least to the deck. This arm is fitted into a notch in the inner face of the cap rail and fastened into the rail stringers and stanchions. The upper arm of the cathead has an outboard length of 3 ft. 6 in. (1.06 m). The port cathead has been partially disarticulated from the bulwarks, having been pulled aft by the rigging in which it has become entangled.

Pairs of timber heads were placed along the aft end of the chock rails, immediately aft of the main chains, and at the quarters immediately forward of the taffrail. A single timber head was fastened to the bulwarks amidships on each side, slightly forward of the mainmast. The timber heads were fitted to the inside of the bulwarks, being notched into the inboard face of the cap rail and presumably fastened to the cap rail, covering strakes and to the deck.

The stern chock rails extend from the taffrail forward for an exposed length of 17 ft. 2 ½ in. (5.24 m). While its internal construction remains unknown, two thin stakes are fastened to the outboard face of the rail, with a cap rail forming the upper face. The forward end of the chock rail terminates in a simple diagonal trim piece. Nothing has been preserved of the counter or taffrail, for which historical photographs are the principal source of information (Figure 5). The taffrail continued at the height of the chock rails, its outer face formed by three planks butted end to end. At the join of the taffrail and chock rails, a wooden chock was fitted inboard of the davits, the inboard end of the chock timber terminating in a curved molding. A fairlead was cut into this chock on each side.

Deck Planking

The deck planking of the *Eccles'* deck is characterized by relatively narrow but thick strakes laid parallel to the centerline of the hull. Plank widths measured 5.43-5.45 in. (13.1-13.7 cm) along the sides of the deck. At the bow, the plank ends are tapered to fit flush against the outer face of the covering board. The outermost planks and plank ends may have rested on the chock timbers between the frame ends, which extended beyond the covering board forming a shelf.

Interior Bulkheads

The *Eccles'* interior spaces were subdivided by a minimum of two transverse bulkheads, one being the aft bulkhead of the forecastle, and the aft bulkhead separating the hold from the aft cabin. Without penetration of the hull, no observation of the forecastle bulkhead was possible.

A portion of the aft bulkhead (Figure 14) consisting of nine vertically laid planks, was preserved on the port side. The upper ends of these planks are fastened to the forward face of the great beam, while their lower ends are buried in coal and could not be observed. A horizontal nailer is fastened to the forward face of the bulkhead at approximately half of its height, its position indicated by a row of fastenings in the planks. The bulkhead is broken out starboard of the centerline and to port. Several partially buried boards scattered starboard of the intact bulkhead are likely the remains of the bulkhead which extended across the entirety of the hull.

Reconstructing *Katie Eccles'* Hull and Discussion

The Last Schooners Project 2019 season produced substantial though incomplete information for the shipbuilding techniques employed in building the *Katie Eccles'* hull as well as data useful for reconstructing and analyzing its hull form. As the *Eccles* possesses an exceptionally intact and nearly complete hull, it represents an important datapoint for late-19th-century hull forms on the Great Lakes. Accordingly, the reconstruction of the *Eccles'* lines from the photo model was among the principal objectives of the project.

Among the historical documents that are the most useful in understanding the development of wooden sailing vessel designs and for providing insights into the specialization of hull forms are documents attesting to the shipwright's process of hull design. The design of a hull is integrally interconnected with the envisioned economic role and potential profitability of a vessel. A well-designed hull necessitated that the vessel maintain good seakeeping characteristics and stability while retaining sufficient capacity, in addition to incorporating the design constraints imposed by the route or role in which the vessel was to be employed.

Ship lines provide a conventional means of portraying three-dimensional hull forms in two dimensions. Though the designing of vessels by drafting lines was well-developed by the mid-19th century, this process was seldom used or necessary in the construction of wooden sailing vessels on the lakes (Wilson 1989a:205). Rather, half-models seem to have been the primary method of designing hulls and such models constitute the principal source of information for hull forms presently available (Wilson 1989a:213-215). Half models were carved representations of the molded hull form; that is, the form of one half of the hull along the outer-sided face of the frames without planking, split along the centerline to represent one half of the symmetrical hull. These models were carved to a satisfactorily faired form, either from a solid block of wood or from horizontal laminated lifts of uniform thickness, which were fastened together to form a single block of wood. The resulting half-model provided a more intuitive means of understanding of the characteristics of the hull. This allowed the prospective owner, often represented by the appointed master of the vessel, to modify the design of the hull and improved understanding of the vessel prior to construction. When the lifts were split horizontally or the block was sawn along the frame stations, the models provided a template from which the curvature of the frames could be taken off of and lofted in full scale for the frames (Chapelle 1960:8-12).

Despite the half-model's usefulness to the shipwright, the lofting of the frames from a model required that the lifts be separated, or in the case of block half models, that the block be cut vertically along the frame stations. As a result, half-models were frequently discarded. Rarely did shipwrights take the time to reassemble the lifts unless they wished to retain the model for replication of hull design or comparison with other hulls. As a result, extant half-models are rare (Greenhill 1988:33).

While the half-model provides an intuitive means of understanding hull form, without imposing the added abstraction of converting a three-dimensional form to two-dimensions, they require direct interaction with the model and are therefore have limited applications to the archaeologist in this form. Ship lines, therefore, are the conventional means of conveying hull forms. Yet, of the thousands of commercial sailing vessels built on the lakes throughout the 19th century, ship lines exist for only 36 vessels. These lines were not drafted by the original shipwrights, but rather are the result of later documentation efforts, with lines being taken off half-models or from extant hull remains.

The first effort undertaken to record Great Lakes merchant vessels was the *Historic American Merchant Marine Survey*, conducted in 1936 and 1937 under the Works Progress Administration and sponsored by the Smithsonian Institution. This survey produced 13 sets of lines, most being derived from builder's half models and the mold loft notes, and in two instances, lines were taken off from a derelict vessel itself

(Jackson 1983:1-78). Howard I. Chapelle published a set of lines for the schooner *Challenge*, built by William Bates at Manitowoc in 1852 (Chapelle 1946:271). Archaeological studies by C. Patrick Labadie and C.T. McCutcheon produced lines and construction drawings for the schooners *Bermuda* and *Alvin Clark* (Labadie 2003; McCutcheon 2013). From 1987-1989, Garth Wilson's *Great Lakes Historic Ships Research Project* (GLHSRP) contributed eight new sets of lines for Great Lakes sailing vessels from archives and half models (Wilson 1989a, 1989b). In the more than three decades since the GLHSRP, only three line drawings of Great Lakes merchant vessels have been added, all of which have been produced by nautical archaeologists from Texas A&M University (Sabick 2004:110; Deckinga 2013:14-15; Herbst 2019:89). With limited new data from which to conduct comparative and technical analysis of hull forms, few additions have been made in our knowledge of hull design in the last 30 years.

The 2019 photo model provided the basis for the reconstruction of the *Eccles'* lines. Once the photo model was completed in *Agisoft Metashape*, the model was exported as an OBJ file, a standard file format for three-dimensional images. This file was then imported into *Rhinoceros3D*, a three-dimensional modeling and computer-aided design (CAD) software. In *Rhinoceros*, the section command was used to take transverse sections of the mesh, recording the contours of the hull at set distances along the baseline. These section lines were individually traced and faired to remove irregularities in the contours from the photo model. These station lines represent the hull form *outside* the planking.

The principal obstacle to the alignment of the station lines in the body plan was the hogging of the bow and stern which has resulted in the complete flattening of the sheer that is evident in historical photographs (Figures 4-5). The sheer line was estimated by projecting a horizontal line through amidships on these photographs and estimating the rising above this line at regular intervals, using the width of the plank sheer as a diminishing scale due to its known width and uniformity along the length of the hull. This allowed the alignment of the station lines along the reconstructed sheer height in the body and half breadth plans. The positions of the stations marked on the body plan and sheer plans were then transferred to the body plan. The orientation of the station lines was adjusted to fair the hull and correct for subsequent distortions resulting from site-formation processes, using the height of the deck as a control point to aid the alignment of the stations.

The height of the rabbet line along the keel was calculated by subtracting the estimated deck planking thickness of 2.5 in. (6.4 cm), the depth of hold 9ft 6 in. (2.9 m), the thickness of the ceiling planking, the frame molding at the keel, and the external planking thickness along the floors from the height of the deck along the centerline (Dorr 1876:31,50-56). The keel was minimally sided 10.5 in. (26.7 cm) and molded 8 in. (20.3 cm). Due to the notching of the upper face of the keel for the floors, approximately 1.5 in. (3.81 cm) was deducted from the keel's sided dimension to determine the keel's protrusion beneath the frames amidships. The keel was given a slight rise beginning at one-quarter of the keel length from the ends (Dorr 1876:25-26). The bottom was reconstructed with a deadrise amidships of 1/4 in. (0.64 cm) to every foot of breadth

(Dorr 1876:30). With the station lines aligned approximately, four water lines were drawn to check the fairness of the hull. Adjustments to individual station alignments were made as necessary to attain a fair curve of the waterlines.

The stern necessitated some informed conjecture to reconstruct. As the sternpost has been displaced aft along with the main transom, the original angle of the sternpost was estimated from the adjustment of the main transom forward to abut the aftermost half frames. The angle of the sternpost was then adjusted to correct for the flattening of the sheer. The rake of the counter was estimated from the preserved lowest strakes of the wheel box, the aft face of which abutted the counter planking. The lines were completed with the addition of two buttock lines, depicting the longitudinal contours offset from the centerline. The runs of these buttock lines, along with those of the waterlines, provided the approximate breadth for the counter. Once the lines were completed and faired, a diagonal was used to verify that all station lines were fair.

Reconstruction of Katie Eccles' Construction

While the 2019 survey allowed the reconstruction of *Eccles'* lines (Figure 16) and provided information for construction techniques used, substantial portions of the hull were inaccessible. Due to the absence of direct observations of some hull components, or available scantlings lists, the Board of Lake Underwriter's 1876 *Rules for the Construction, Inspection, and Characterization of Sail and Steam Vessels* proved to be an invaluable reference for the reconstruction of minimal scantling and fastening requirements for the *Eccles* (Dorr 1876). In 1880 *Katie Eccles* possessed an A1 insurance rating and therefore met the minimum standards set out in the 1876 *Rules* (*Daily British Whig* 1880).

The establishment of rules for the standardized classifications for vessels by the Association of Lake Underwriters in the 1850s would become the most powerful pressure influencing the Great Lakes shipbuilding tradition. William Bates emphasized that of insurability was of eminent economic importance stating, "the influence of underwriters' surveys must necessarily outweigh every other, exercised by third parties, in the construction of all ships that are to be insured (Bates 1856:2)." Beginning with the Board of Lake Underwriters in 1856 and continuing with its successor, Inland Lloyds from 1884, rules for the characterization and construction of the ships were established with input from shipwrights in light of their accumulated experience in shipbuilding for the lakes (Bates 1856:1-8, 1857:190-194).

The result was that by the late 1870s, though hulls varied with their intended purpose, the techniques used in constructing them were increasingly constrained to established construction methods and standard systems of proportioning scantlings. A comparison of the available scantlings from the *Eccles* against hypothetical scantlings estimated from the proportioning system established in 1876 *Rules for the Construction* indicates that the *Eccles'* construction closely followed these standards in both scantling measurements as well as methods of construction. The only apparent contradictions with the *1876 Rules* observed is the hatch dimensions, which are 8 ft. 6 in. (2.59 m) athwartships, whereas the *Rules* prohibited hatches exceeding 8 ft. (2.44 m) in vessels

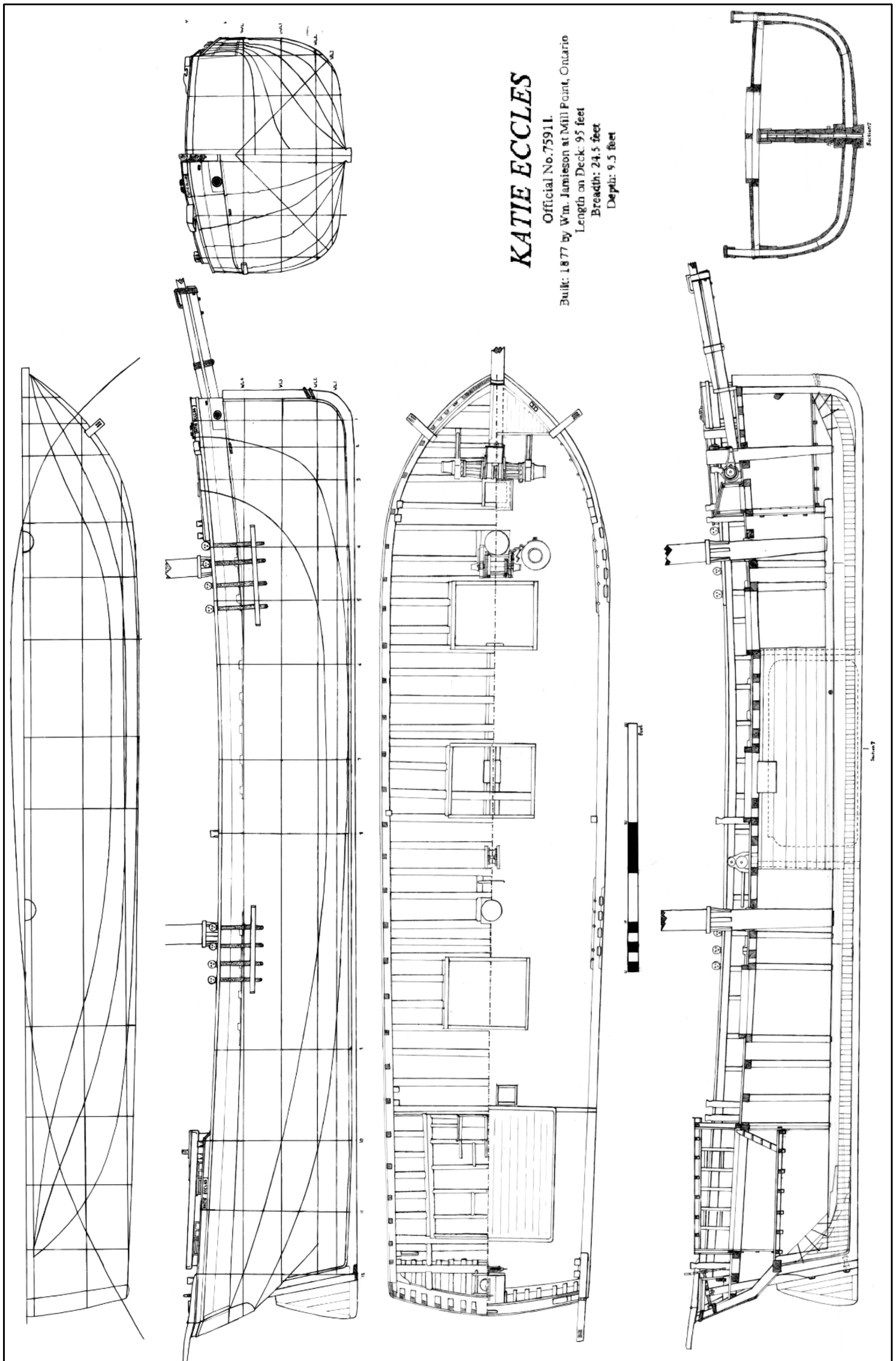

Figure 16. Reconstruction of *Katie Eccles* (Drawing by author, 2021).

rated A1, and in the spacing of the bulwark stanchions at every other rather than at every frame (Dorr 1876:31,74). While this inconsistency may have been an oversight on the part of the surveyor, it is perhaps more probable that the hatch dimensions were the result of the 1889 rebuild which restored the vessel to an A 2 ½ rating, at the time of which, the 1876 rules had been replaced (Taylor 1886:16, 1890:26). Enlarged hatches may have coincided with increasing reliance on trestle loading, providing more room to work around the mounds of coal that formed in the hatches when trimming the vessel.

Accordingly, the 1876 *Rules* should provide a reliable basis for reconstructing those portions of the hull for which no archaeological observations were possible. In contrast to many shipwreck reconstructions undertaken to date, an abundance of information was available concerning the topsides and deck arrangement of *Katie Eccles* while information was scarce for the lower portions of the hull.

The scantlings of the keel, stem, and sternpost were reconstructed according to the 1876 *Rules* specifications and minimum scantlings. The keel was reconstructed to measure 8 in. (20.32 cm) molded and 10.5 in. (26.67 cm) sided. The stem and sternposts were reconstructed 10 in. (20.4 cm) sided and molded. An inner stem was added as it was necessary to fill out the stem along the curve of the rabbet into the stem. The stem was reconstructed with simple apron in keeping with the deadwood observed at the stern (Dorr 1876:25-30).

The keel was formed of a minimum of three lengths of timbers, with single timbers fore and aft and pocket pieces set on either side amidships. These pocket pieces set outboard on either side of the keel timbers were scarphed to the keel and cross-fastened together, the space between them forming the slot for the centerboard. These scarphs were minimally 9 ft 2.5 in. (2.80m) forward and aft of the centerboard case head ledges. The timbers of the pocket pieces, which have been reconstructed as stacked double, were minimally molded 9.2 in. (23.36 cm). The seams formed by the doubled pocketed pieces and the centerboard were reconstructed to adhere to the figures provided in the 1876 regulations (Dorr 1876:26-27,46-49).

The position of the frame stations was estimated by measuring centers of 21 in. (53.34 cm) from known frame stations. The exact number of frame stations remains unknown. Frames which were outboard of the centerboard case were reconstructed as half frames. All other floors crossed the keel. For three frames forward and four aft of the centerboard case head ledges, additional floors were fitted between the frames to strengthen the hull (Dorr 1876:48). The molded dimensions of the frames were estimated as 10.25 in. (26.3 cm) at the keel, 6 in. (15.2 cm) at the bilge, and 4.35 in. (11.1 cm) at the frame heads (Dorr 1876:30-33).

The main and rider keelson arrangement is based upon C. Patrick Labadie's archaeological illustrations of the three-masted schooner *Lottie Cooper* with minimum scantlings of 8.6 in. (21.84 cm) sided and 16 in. molded (40.6 cm) derived from Dorr (Labadie 2021, Dorr 1876:36). The arrangement of the *Katie Eccle's* deck beams, the clamp, and carlines was based upon archaeological observations of the site (Dorr 1876:50-56).

The arrangement of the transom and stern timbers was likewise based upon McCutcheon and Labadie's plans of *Bermuda* and *Alvin Clark*, as these vessels both possess a short transom overhang, similar to that apparent in historical photographs of the *Eccles* and from the 1876 *Rules* (Dorr 1876:29; McCutcheon 2013).

While the quarter deck is absent, the width of the gangways was determined from the length of the raised coaming on the great beam inboard of the bulwarks. The arrangement of the *Eccles'* quarterdeck, with a break of the deck, a recessed cabin, and a slightly elevated quarterdeck was only permitted in vessels with a length between the perpendiculars of less than twelve times the depth of hold, or with less than nine-foot draft (Dorr 1876:78). The height of the sole beams of the cabin deck was estimated from rebates in the *Eccles'* ceiling planking at the stern above the level of the deadwood. The cabin height was reconstructed with a headroom of approximately 7ft. (2.13 m), which seemed to align closely with the height of the cabin roof visible in historical photographs. The half-beams and carlings of the quarterdeck were reconstructed according to the spacing of beams and deck apertures observed forward of the great beam.

The *Katie Eccles'* Hull in Context and Conclusions

The reconstructed lines (Figure 16) show *Katie Eccles* had a full midships section, the station lines changing minimally between stations 6 and 8 and remaining full throughout much of the midbody. While the hull was full, the lowest waterlines of the bow are slightly hollowed tapering upward into full topsides waterlines and broadening rapidly to full bow paired with a vertical, straight stem. The *Eccles*' bilges were slack

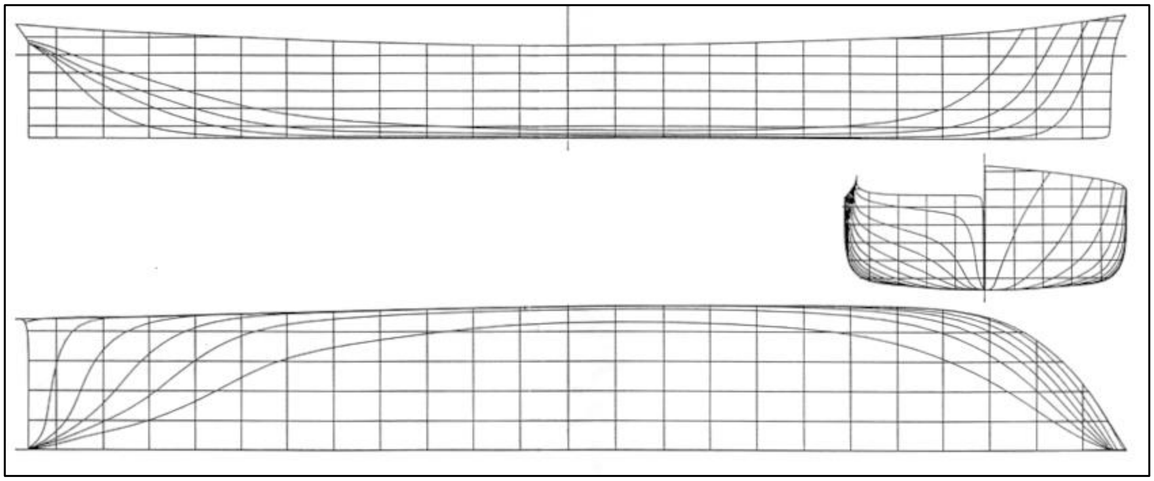

Figure 17. *Eliza Fisher's* lines (Image Courtesy of the Marine Museum of the Great Lakes at Kingston).

when compared to many lake vessels, with a gradual, round curve between the straight, relatively flat deadrise and the nearly vertical sides.

The *Eccles* shows significant similarities to the *Eliza Fisher*, a two-masted schooner of similar size, measuring 93 ft. 7 in. (28.52 m) between perpendiculars, 24ft 7 in. (7.49 m) in breadth, and with a draft of 7 ft (2.13 m) built at Kingston by Edmund Beaupre in 1867 (Wilson 1989a:230-234). *Eliza Fisher* (Figure 17) possessed a slightly finer entrance resulting from the outward curvature of the upper stem that elongated the waterlines in the upper part of the hull. Like the *Eccles*, *Eliza Fisher* seems to lack a true parallel midbody. Though the stations amidships are similar, they are not identical to the master frame. The *Eccles* possesses finer runs below the light waterline, likely due to its more rounded bilge than is present on the *Fisher*.

The similarities of these vessels bring into question to what degree hull forms had begun to standardize under the influence of underwriter's regulations, shared experience of shipwrights and shipmasters, and past precedence by the end of the 19th century.

The *Eccles'* hull, while capacious for its comparatively modest size, diverges from design characteristics of vessels intended for longer-distance inter-lake trades, particularly from canal sailing vessels designed for trade between Lake Ontario and the Upper Lakes ports by way of the Welland Canal. These vessels were constructed to maximize their capacity and therefore profitability after tonnage fees were paid, while they still needed to fit into the locks (Monk 2003:60). While the Second Welland Canal was in operation between 1848 and 1887 these dimensions were constrained to 150 ft. (45.72 m) long by 27 ft. (8.22 m) wide with a 9 ft. (2.74 m) depth. Moderate canallers were typically 136 ft. (41.45 m) long with a breadth of 25 ft. 7 in. (7.80 m) and a draft of 9 ft. (2.74 m), but extreme variants existed that were as long as 145 ft. (44.19 m) and 26 ft. (7.92 m) in breadth. These vessels typically possessed flat floors, sharp turns of the bulge with vertical, straight sides, resulting in a particularly full hull with a high block coefficient (Monk 2003:45-47,49).

The *Lady McDonald,* a 136 ft. 10 in. (41.71m) and 25 ft 7 ½ in. (7.81 m), built in 1873 is typical of such vessels (*Toronto Mail* 1873). The lines of *Lady McDonald* (Figure 18) show a full hull with a long parallel midbody extending the majority of the length of the vessel. This midbody is characterized by flat, straight sides with a low, sharp turn of the bilge and slight deadrise. This is paired with fuller waterlines in the bow which rapidly taper to a vertical stem, and short hollowed runs aft. While more moderate hulls were still classified as canal-sized sailing vessels, hulls that were

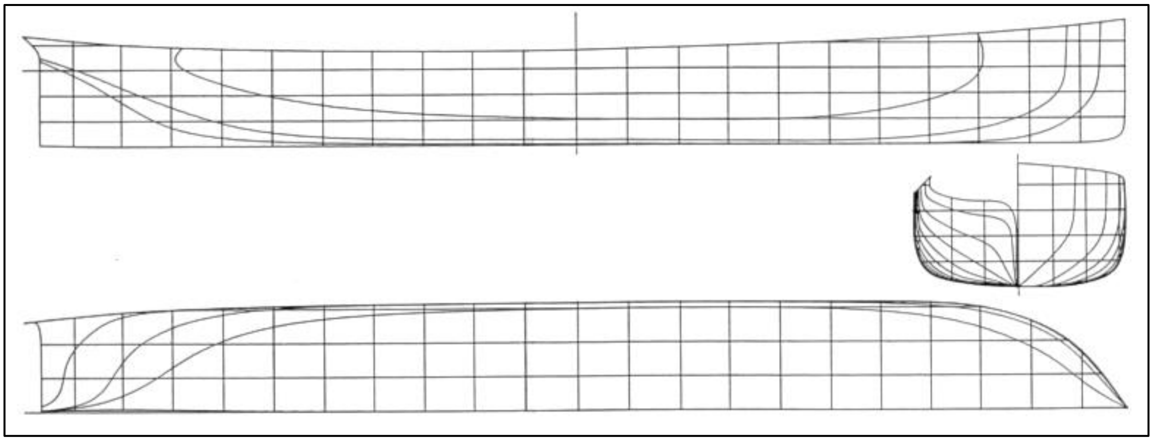

Figure 18. ***Lady McDonald's*** **Lines (Image Courtesy of the Marine Museum of the Great Lakes at Kingston).**

designed for the inter-lake trade through the Welland Canal consistently prioritized capacity over their sailing properties and performance (Jackson 1983:40-42).

The wider radius of *Eccles'* turn of the bilge, which reduced overall wetted surface area and drag at the expense of volume, and the absence of a true parallel midbody, which would have impeded maneuverability, seems to have prioritized its sailing performance over the absolute maximization of hull capacity. The resulting difference in these hull designs is likely attributable to the unique economic conditions within the respective trades for which they were constructed.

Vessels intended in long-distance forwarding on the lakes, due to the longer passages with the inevitability of delays resulting from towing through the St. Clair River and Lake St. Clair, the passage of the Welland Canal and unfavorable weather and winds, was likely to negate any economic advantage that a faster and less capacious design might possess. Therefore, such vessels were designed to maximize the capacity and revenues of each trip. Furthermore, the wider dispersion of the vessels with which long-distance canal sailing vessels were competing meant that arrival times and weather conditions experienced along the routes were varied, making arrival dates unpredictable.

In contrast, vessels engaged in the shorter-haul lake shoring trade such as *Katie Eccles* relied on maximizing the number of trips per season to remain profitable. Accordingly, such vessels spent proportionally more of their time in port during which revenue was lost. As such, masters sought to expedite turnaround times. C.H.J. Snider noted that intense competition emerged between masters of various vessels to be the first to arrive at the dock, thus foregoing time spent idling while other vessels unloaded ahead. Before the invention of steam-powered unloading machinery, Snider notes that a late arrival could set a vessel's owner back by as much as a week's wages (Snider 1932). Furthermore, the comparatively small area in which these vessels were operating made individual vessels and their competition subject to largely similar weather conditions, resulting in the intensification of competition between vessels as sailing vessels tended to set out together (*Toronto Globe* 1922; Snider 1932). By prioritizing the sailing characteristics of a hull over the maximization of its capacity, the *Katie Eccles'* hull design likely provided its owners an economic benefit by allowing the potential completion of more trips within the sailing season by avoiding potential delays in handling cargo.

Though the differing requirements of both the inter-lake and intra-lake trades resulted in significant variations in the philosophy of hull design, both forms embodied the qualities that Henry Hall praised in lake sailing vessels when he stated, "the lakers are admirable vessels and are exactly adapted to the commerce in which they are employed, being fast, great carriers, cheap and profitable. No more can be said of any vessel (Hall 1884:138)."

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CHAPTER VII

THE ARCHAEOLOGY OF THE *KATIE ECCLES*, PART II- MASTS AND RIGGING

A reliance upon wind provided the propulsion of, as well as the principal constraint, to the movements of sailing vessels. Innovative rigging technologies introduced with industrialization significantly altered the rigging of sailing vessels throughout the 19th century. The development of wire rope and its use for rigging applications was among the most influential and important technological innovations for sailing vessels of the 19^{th} century, increasing the durability and weatherliness of the rig.

At the outset of the 19th century, cordage for sailing vessels was made of natural plant fibers, but on the Great Lakes, local availability of hemp ensured that hemp cordage was most commonly used (Martin 1992:111, 2013:151). By the 19th century, the accumulated experience of centuries of use of natural fiber cordage had resulted in a high degree of refinement in techniques of working with ropes that were an integral aspect of traditional seamanship.

Despite this experience in maintaining rope rigging, natural fiber cordage, particularly with hemp cordage, possessed several inherent limitations for which the efforts of the crew in maintaining it could only partially compensate. Foremost was its lack of dimensional stability with its changing moisture content. Fiber cordage readily takes up moisture resulting in swelling of the rope’s diameter and causing shrinking along its longitudinal axis. While this shrinkage was largely reversed as the rope dried and relaxed, rigging set under tension while dry, if wetted, might be stretched beyond its recovery limits, damaging or resulting in the failure of the rope. With constant stretching and shrinking of the standing rig, lines that served to stay and reduce flexing in the mast and to transfer strains from the mast to the hull, tensioning the shrouds and stays was a persistent preoccupation of seamen (Smith 1990:3; Martin 1992:150-156). Without adequate attention to the proper tensioning, the standing rig was rendered either ineffective in supporting the masts due to insufficient tension in the shrouds and stays, significantly increasing the possibility of failure of individual shrouds and stays and the likelihood of a catastrophic dismasting.

Another limitation of rope was its relatively short service life, due to susceptibility to wear externally and internally between the individual threads and strands of the rope, as well as general weathering and rot. The serviceability of natural fiber rigging was often extended by worming, parceling, and serving the standing rig. In this process, yarns were laid between the strands. The rope was then wrapped in strips of tarred canvas or leather and bound with a single yarn, referred to as “thin stuff.” To further waterproof the service, the entire rope was slushed with tar, a process that had to be repeated to prevent rot and limit fluctuation of moisture content within the rope. Parceling and serving was time-consuming, laborious, and imposed additional costs (Smith 1990:78; Lever 1853:3). Furthermore, parceling and serving the rig increased its windage by increasing the cross-sectional diameter of the cordage while also increasing weight aloft, where it possessed the greatest effect on vessel stability and strain on the rigging and masts.

However, it was not these limitations that resulted initially in the search for a replacement for natural cordage, but rather, as with many maritime innovations of the early 19th century, the pressures of the Napoleonic Wars on the Royal Navy. Following the Franco-Russian Treaty of Tilsit, which imposed an embargo on the shipment of naval stores, including Baltic hemp, Lieutenant Samuel Brown, R.N.. began experiments with the replacement of hemp cordage for the Royal Navy in 1808. Brown proposed and successfully tested bar chains articulated with pins secured with forelocks aboard two merchant vessels, however, the invention was not adopted by the British Admiralty (Brown 1809:6-7,38). By 1827 similar arrangements had been adopted aboard some British and American merchant vessels (American Daily Advertiser 1827; MacGregor 1984:150-151; Martin 1992:106-107). This arrangement never gained widespread acceptance, as the failure of a single link resulted in the failure of the entire chain, a persistent concern due to the inconsistent of quality of iron manufacturing in the early 19th century (Martin 2013:152).

By the 1830s, selvagee wire rope had been introduced. Selvagee rope consisted of several bundled unannealed wire strands laid parallel which were then bound together with a fine wire. The rope was then parceled and served. Though selvagee ropes had a higher tensile strength than hemp rope, they were less flexible and lacked elasticity. Furthermore, while parceling and serving did not add to the rope's strength, it did increase its weight and windage. Another disadvantage was that selvage ropes could not readily be spliced into longer lengths due to the parallel lay of their constituent wires (Shelley 1862:188-189; Martin 2013:153-154).

In 1830 George Wright Binks, a foreman of ropemakers at the Woolwich Royal Naval Dockyard, invented a rope of twisted iron wire strands and began private manufacture of his design in 1835. Bink's wire rope was constructed in a manner similar to traditional laid rope, with bundles of wire yarns twisted into strands which were then laid together in an opposite twist around a wire core. In this arrangement, the breaking of a single strand or yarn would not result in the failure of the rope, as the load was then assumed by the remaining strands. As a result, laid wire ropes were considerably more reliable. Bink's design formed the basis for most marine wire rope designs thereafter (Martin 2013:152-53).

In 1844, Andrew Smith patented an improved laid-wire rope with a core of oiled-manila, around which were laid six strands of iron wire with right hand lay, each strand being comprised of seven wires twisted in the opposite direction of the lay. The oil-saturated core minimized the shrinking and swelling of the core while providing internal lubrication and cushioning for the wires, reducing internal wear within the rope. Smith's rope possessed a tensile strength twice that of similar diameter hemp rope, allowing the diameter of rope in the rig to be reduced. This resulted in a correlative reduction of the rig's weight and windage, while the wire remained flexible and retained some elasticity. While numerous patents were issued throughout the latter half of the 19th century, most were derivations from Bink's and Smith's designs (Martin 1992:101-103,109-111, 2013:155).

Steel wire was introduced among British wire manufacturers with the invention of the Bessemer process for steel manufacturing in 1854. The Bessemer process was not adopted by American steel manufacturers for nearly a decade. Steel wire rope offered increased flexibility, due to its increased ductility and tensile strength when compared to galvanized iron. Martin notes that a 12 in. (30.4cm) hemp rope, which weighed 28 lb. (12.7kg) had equivalent strength to a charcoal steel wire rope weighing only 13.75 lb. (6.2kg). A steel rope of the same strength weighed only 8.5lb (3.86 kg) per fathom with a tensile strength twice that of iron for the same diameter (Martin 2013:156). However, inconsistency in the early manufacturing of Bessemer steel slowed its replacement of galvanized iron (Martin 2013:155).

Though initially met with reservations among seamen and ship owners, wire rope achieved widespread acceptance as seamen gained experience in working with it and as its advantages became apparent (Greenhill 1980:20; Martin 2013:157). Wire rigging was widely accepted aboard British merchant vessels as early as the 1840s and 1850s but was not widely adopted on American vessels before the mid-1860s. American manufacture of wire rope rigging was impeded by the limited quality and capacity of the emerging domestic iron and steel working industries, and the absence of the Bessemer process for steel manufacturing until the mid-1860s.

The higher quality and more consistent manufacturing of British wire and limited demand in North America, resulted in American and Canadian reliance on British wire imports until the late 1870s and early 1880s. Furthermore, the manufacturing capacity of the American iron-working industry was diverted by the war effort for the American Civil War between 1860 and 1865, ensuring control of the market by British importers and domestically produced hemp rope into the 1870s (Martin 1992:109-111).

Martin proposes that wire rigging arrived on the Great Lakes in 1862, when Robert Gaskin of Kingston began importing wire from George Binks and Brothers, outfitting a new vessel of his own with wire rigging. By the following year, wire rigging was in widespread use on the lakes, and by 1874, most new vessels being outfitted at Chicago were wire rigged (*Toledo Blade* 1867a, 1867b; Martin 1992:109,114-115). By 1881, with increasing domestic markets for wire rope and the development of the American iron and steel industries, American-manufactured wire rope surpassed British imports on the lakes, further lowering costs for ship owners outfitting their vessels with wire rigging (Martin 1992:117). By the 1880s, wire rigging, particularly standing rigging, was common, if not yet ubiquitous aboard lake vessels.

Damien Saunders notes that, despite the sailing rig's importance both as a means of propulsion and as a factor influencing hull design and construction, rigging is vastly under-recorded and understudied among nautical archaeologists (Saunders 2010:3). This is particularly true of studies of wire rope rigging and the rigging innovations introduced in the final years of sail.

Katie Eccles retains a well-preserved, albeit incomplete assemblage of spars and rigging, providing an important dataset for rigging practices on the Great Lakes after the adoption of wire rigging in the latter years of the 19th and early-20th centuries. Though the lower foremast, the foresail boom and gaff are unaccounted for, nearly all standing rigging components, fittings, and their attachment points to the hull have been preserved. Unfortunately, while the construction of wire rope is itself diagnostic of both date and manufacturer of the wire if the patent can be identified, no sampling of wire rope was possible with the remote survey methods employed in this study and within the restrictions of the permit (Martin 2013:151).

Description of the Rigging Remains

Bowsprit and Jib Boom Spars

The *Eccles'* bowsprit remains intact and in situ, stepped into the forward face of the pawl post with its lower face resting on the stemhead (Figure 19). The bowsprit has a housed length of 7 ft. (2.13 m), measured to the forward face of the stem and has an octagonal cross-section formed by the chamfering of the corners. The steeper steeving of the bowsprit evident in historical photographs (Figures 4-5) was likely lost with the flattening of the sheer, as the bowsprit is now nearly parallel to the deck. The bowsprit was secured to the stem by a gammon iron inboard of the chock rails.

The outboard length of the bowsprit, measured forward of the chock rails is approximately 12 ft. (3.65 m), making the overall length of the bowsprit approximately 19 ft. (5.79 m). The outboard length has a flat upper face, formed by the fastening of two battens to either side of the bowsprit, or by a plank fastened to a flat upper face of the bowsprit, terminating just before the iron bowsprit cap band.

The jib boom has an overall preserved length of 28 ft. 6 in. (8.68 m), with a doubling of 12 ft. 6 in. (3.81 m). It was secured by an iron band 3 ft. 6in. (1.06 m) forward of the chock rails, and by the bowsprit cap. The outermost section of the jib boom is broken off at approximately the attachment point for the inner jib stay and lies beneath the jib boom. An iron band is secured just below the head of the jib boom, to which are shackled the jib boom guys on its lower face.

Figure 19. (Left) The bowsprit and jib boom with the bobstays, starboard and port bowsprit guys, jumbo jib stay, and jumbo jib boom. (Right) Portside view of the bowsprit (Photo by Author).

Spreader and Martingale Spars

The spreader and martingale spars rest on the bottom beneath the bowsprit cap and jib boom with the martingale spar overlying the spreader (Figure 19). A saddle fitted to the forward face of the spreader rested against the underside of the jib boom when the spar was lashed in place. Two fairleads hang from staples on the starboard arm of the spreader. These were not observed on the port side.

The martingale tapers from top to bottom, and has a set of jaws at the top of which it fastened against the head of the bowsprit and the lower side of the jib boom (Figures 4 and 19). No measurements could be obtained for the spreader or martingale spars.

Bowsprit and Jib Boom Standing Rigging

The inner and outer chain bobstays are attached to staples on the underside of the bowsprit at 10 and 11 ft. (3.04 and 3.35 m) forward of the chock rails. At its inboard end, the inner bobstay is attached to a bobstay plate fastened through the stem at the top of the forefoot. The outer bobstay plate is attached to the forefoot below the inner bobstay plate and is embedded in the sediment.

On both sides of the bowsprit, a set of chain footropes are shackled into a staple on the outer face of the rail stringers beneath the cap rail. These footropes are attached to the sides of the bowsprit 8 ft. (2.44 m) forward of the chock rails. The bowsprit shrouds are present but remain intact only on the starboard side. The starboard bowsprit guy is attached at a shroud iron on the side of the bowsprit 12 ft. (3.65 m) forward of the chock rails. The inboard end was shackled to a plate fastened into the plank sheer beneath the catheads. The port shroud has broken near its inboard end with the shroud hanging down from the bowsprit. The details of the chain of both the bowsprit shrouds and bobstays were not discernable due to dreissenid fouling.

Jumbo Jib Stay, Jumbo Jib Boom, and Horse

The jumbo jib stay remains attached to the bowsprit immediately inboard of the bowsprit cap, 11 ft 6 in. forward of the chock rails. It lies draped to port of the bowsprit running aft along the port side on the bottom. At its upper end, the forestay remains looped around and seized back on itself at the hounds of the foremast.

Just aft of the bowsprit cap, a fore and aft iron horse, on which the jumbo jib boom traveled, is fastened into the upper face of the jib boom, immediately aft of where the jumbo jib stay was looped and seized around the bowsprit. No hardware was observed on the jumbo jibboom, though its inboard end was obscured by rigging laying on deck. The boom, approximately 18 ft. 6 in. (5.64 m) long lies resting across the bowsprit and extends out over the starboard rail (Figure 19).

Foremast, Foretopmast, Crosstrees, and Trestletrees

Though the foremast step could not be observed and, therefore, the position of the mast step along the baseline could not be precisely determined, the foremast hole is centered 17 ft. 6 in. (5.33 m) along the baseline with a diameter of approximately 2 ft. (0.60 m). The mast has been un-stepped without causing damage to the deck.

While the foremast beneath the hounds is missing, the doubling of the foremast and the foretopmast rest on the bottom with the hounds resting against the hull at the port forechains and the masthead extending outward (Figure 20). The foremast doubling, partially obscured by the mainmast which overlies its lower end, has an approximate length of 9 ft. 6 in. (2.89 m) with an octagonal cross-section formed by the chamfering of the corners of the lower masthead.

The trestletrees were fastened immediately above a set of iron hounds. Historical photographs of *Katie Eccles* show that it was outfitted with parallel crosstrees, with a platform on each side of five cross-planks fastened along their outer ends with space between each (Figures 4-5). The forward crosstree remains intact and in place to starboard, whereas the aft crosstree is partially detached and lies at an angle to the fore crosstree. Three eyes were fastened into the aft face of the doubling below the mast cap to which the peak halyard blocks were hooked.

Figure 20. The foremast doubling with the topmast fid and the remains of the crosstrees visible.

The foretopmast has a length exceeding 38 ft. 6 in. (11.73 m).[5] Its lowest section has a squared cross-section, with a tapering rounded cross-section along its remaining length. The topmast remains stepped between the trestletrees with an iron fid, an iron bar tapering along its upper side, keyed into its slot at the foot of the topmast from the starboard side.

Foremast Shrouds and Fore Chains

The foremast retains both sets of wire shrouds which are looped about the doubling of the masthead above the trestletrees. Each set of four shrouds comprising two wires with deadeyes turned in at their ends looped about the doubling of the mast. The

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[5] The foretopmast's length could not be measured in photo model as the truck of the mast was not rendered. This measurement represents the measurable extent within the photo model.

starboard shroud deadeyes lay inboard of the fore chains and the deadeyes fastened at the cap rail, running across the deck and over the port chock rails at the bitts to the foremast hounds. The port shrouds have fallen inboard of deadeyes on the cap rail, with the shrouds running forward and over the port chock rail between the cathead and the bitts to the foremast hounding below. Two shroud battens were fastened to the fore shrouds above the deadeyes and immediately above the port and starboard running lights. The running lights, the backboards of which have not been preserved, had Fresnel-lens lanterns set against a backboard, which were lashed to the shrouds. Two Fresnel lenses, presumably from these lights, are among an assemblage of artifacts on the port side of the deck immediately forward of the great beam. Three battens were lashed to the upper ends of the shrouds in place of ratlines as the shrouds narrowed at the hounds beneath the crosstrees.

The fore chains consist of four bar chainplates on either side, bolted through the second strake beneath the plank sheer and presumably through the frame. At the plank sheer the chainplates were protected by a rub strake, 13 ft. 6 in. (4.11 m) long and approximately 5 in. (0.12 m) wide. Above the rub strake, the chainplates are exposed on the outboard face of the bulwarks to the cap rail. Individual chain plates measure approximately 5 ft. 9.5 in. (1.76 m) long and approximately 3.5 in. (8.89 cm) in width. The upper end of the chainplates passed through slots in the cap rail and were secured in place in these slots by the fastening of a batten along the outboard face of the cap rail. The foremost chainplates were spaced at centers of 2 ft. 6 in., 2 ft. 3.5 in., and 2 ft. 6 in. (0.76, 0.70 and 0.76 m) apart.

A three-hole deadeye is hinged to the upper end of each chainplate. Between the first and second deadeyes, either a single sheave block or a small deadeye was fastened to the cap rail. This and an eyebolt fastened to the upper face of the cap rail immediately aft of the fore chains likely represent fittings associated with the jig tackles, used to tension the shrouds.

Four belaying pins were set in a pin rack along the cap rail's inner face between the cathead and the chock rail bitts. The pin racks were formed by fastening a batten along the inner face of the cap rail with holes drilled along the seam into which the pins were set. At least three belaying pins, but possibly as many as five were observed set along the cap rail at the fore chains. These were set in line with the first deadeye, between the second and third deadeyes, and between the third and fourth deadeyes. A fourth pin may be present beside the fourth deadeye, but is partially obscured, with a fifth beside the eyelets for the jig tackles aft of the fore chains.

Foremast Forestays and Backstays

The jumbo jib stay remains looped and seized about the mast at the trestle trees, passing forward through the opening between the trestletrees and inside of the forward crosstree. The inner jib stay is bent to the foremast doubling between the upper and lower peak halyard eyebolt approximately halfway up the doubling. The outer jib stay is looped about the head of the topmast, approximately 36 ft. (10.97 m) above the heel. The main topmast stay and the mainstay remain shackled to eyes on the after side of the mast cap.

Mainmast and Main Topmast

The mainmast is centered at deck level at approximately 58 ft. (17.67 m) along the baseline. The stump of the lower mainmast has a diameter of approximately 2.6 ft. (0.79 m) at deck level and is secured in the mainmast hole by wedges that remain in place. Several partially preserved mast hoops remain about the mainmast on deck. A boom saddle was fitted to the mainmast, its upper face 4 ft. (1.21 m) above the deck. It was supported on six chocks, each 3 ft. (0.91 m) long. The mainmast is snapped off above the boom saddle, 4 ft. 5 in. (1.34 m) above the deck.

The main portion of the mainmast lies off of and parallel to the port side, overlying the hounds of the foremast. The preserved length of this section of the lower mainmast, measured to the mast cap, is 63.5 ft. (19.35 m) with a doubling approximately 10.5 ft. (3.20 m) long. Therefore, the lower mainmast had a height of approximately 68 ft. (20.72 m) above the deck, with the hounds 57.5 ft. (17.52 m) above the deck. Its diameter at the masthead is approximately 1 ft. 1.5 in. (0.34 m). The mainmast trestletrees are detached and the loops of three of the pairs of shrouds have slid down the mast to the hounds. The iron hounds are approximately 4 ft. 3 in. (1.29 m) long, with widths of 1 ft. (0.30 m) at the top, tapering narrower along their length. The main topmast is broken off even with the top of the mast cap.

Newspaper accounts recorded that the *Eccles'* topmasts remained standing after its loss, so their present position alongside the hull was almost certainly the result of the subsequent clearance of the masts (*Cape Vincent Eagle* 1922; *Sandy Creek News* 1922).

As the mainmast overlies the foremast doubling the foremast was taken down first. The break in the foremast immediately beneath the attachment of the shrouds at the hounds and the absence of the mast below is likely the result of the inability to free the mast from its step due to the shrouds. Accordingly, the mast was cut off below the hounds, the topmast and doubling falling to port with its shrouds still attached. The foremast was then taken up. The mainmast was broken off above the boom saddle subsequently falling to port, indicating that a different approach was adopted for removing this mast (Pers. Comm. Kevin Crisman).

Main Shrouds and Main Chains

The mainmast shrouds were rigged in like manner to the fore shrouds. The port set of shrouds has been pulled forward with the sheer rails and deadeyes laying to starboard and slightly aft of the midship hatch. The shrouds then run forward over the corner of the midship hatch, across the fore hatch, and the foredeck, draping over the rail at and just aft of the port cathead. The shrouds remain looped around the masthead but slid down to the hounds. The port shrouds lie slightly forward of their deadeyes along the port rail, running forward along the inside of the bulwarks, overlying the port foremast shrouds before running over the cap rail at the port chock rail bitts.

The main chains likewise consisted of four chainplates fastened in like manner. The chainplates are spaced 2 ft. 6 in., 2 ft. 4 in. and 2 ft. 6in. (0.76, 0.70, and 0.76 m) apart. Four deadeyes were aligned along the outboard side of the port cap rail. A deadeye was fastened to the rail between and inboard of the first and second deadeyes for a jig tackle. A belaying rail was fastened to the inboard faces of two stanchions beneath this block. The rail has only been preserved on the port side. Four belaying pins are aligned along the mainmast deadeyes, with another pin forward at the block.

The main chains have sustained considerably more damage than the fore chains. On the port side, the aftermost chain plate has been bent forward. Of the starboard main chains, only the third chain plate remains in place along the cap rail with its deadeye articulated. The first and second chainplates have pivoted on their bolts in the second strake beneath the plank sheer and hang downward. The fourth chain plate appears to remain partially attached but is broken off at the level of the planksheer.

Fore and Main Booms and Gaffs

A single spar lies on the bottom well off the port quarter, laying approximately parallel to the hull with its jaws pointing forward. As a result of its relative isolation from other site features, this spar was not incorporated into the site photo model, and accordingly, measurements could not be taken. Without reliable means of measuring this spar, its identification relies on a comparison of its form with historical and photographs (Figures 4-5).

Historical accounts record that part of the main boom was recovered by Capt. Claude Cole when he first located the *Eccles* in December 1922, thus eliminating the possibility it is this spar as the remaining spar is complete, leaving the fore boom and two gaffs as candidates for the portside spar (*Cape Vincent Eagle* 1922; *Sandy Creek News* 1922). According to historical photographs, the fore gaff should possess two bands for the peak halyard blocks, as well as two pendant blocks beneath the gaff jaws, while the main gaff would possess three bands for the peak halyard blocks as well as an eye to which a flag halyard block was hooked.

The remaining spar on site retains its gaff jaws, each jaw formed from a single block fastened to the sides of the spar. A clapper remains in place, its upper end inclined aft, resting in a notch at the end of the spar and between the jaws. The inboard face of the clapper curved to the mast and is set flush with the inner face of the jaws. A hanging iron is fastened into the upper faces of the jaws, to which the throat halyard blocks were fastened. A single eye bolt was observed on the underside of the port jaw for the pendant blocks of the main topsail outhaul.

While the length of the spar is relatively free of dreissenid fouling, especially dense and discrete bands of fouling are notable at the outer tip and three bands along the outer half of the spar's length. The preference of dreissenid mussels for ferrous metal substrates suggests these obscure the bands for the peak halyards and end cap. Part of the eye of the end cap is visible. The placement of these fittings, particularly the end caps and the number of peak halyard bands, allows reliable identification of this spar as the main gaff. Therefore, the fore gaff, fore boom, and main boom remain unaccounted for.

Main and Fore Sheets and Sheet Horses

At 54 ft. 6 in. (16.61 m) along the baseline, the foresheet horse is fastened to the deck, presumably bolted through a beam. The iron horse is approximately 2 ft. 6 in. (0.76 m) in length. The main sheet horse is missing with the upper section of the stern.

Description of the Running Rigging Remains

In contrast with the abundance of standing wire rigging remains, there are few observed remains of running rigging. Soft rigging components, primarily lines, have either not been preserved, or have been buried in sediment and were not observed anywhere on site, strongly suggesting that these components were comprised of natural fibers. Some hard components of the running rig were identified, namely several blocks and the sheaves within the spars listed previously without associated cordage. While the assemblage of identified blocks is incomplete, the straps in combination with the type of blocks are often diagnostic, allowing tentative identifications of the function of some blocks. As these hard rigging components are portable, it is uncertain how many of these blocks remain in their original contexts.

Off the port side amidship, beside the base of the mainmast laying along the port side of the hull is an iron ring-strapped double block, partially embedded in the sediment. This block is iron strapped with an outer strap spanning between the cheeks and an inner strap in line with its central face forming an eye at the top of the block within the outer strap, a strap arrangement present on all identified blocks on the site. The strap is linked to a ring, suggesting that the block served as the lower block of one of the sheet tackle, though without a direct association to one of the sheet horses, it is impossible to determine which sheet tackle the block is associated with.

A single-sheaved block remains hooked to the upper iron eye immediately below the lower foremast cap. This direct association with the mast allows its identification as the uppermost forepeak halyard block, used to manipulate the peak of the fore gaff.

Likewise, two single-sheave fixed hook blocks remain hooked to the upper and lower eyes on the mainmast doubling. These blocks can be identified as the upper and lower main gaff peak halyard blocks.

The jumbo jib stay retains two blocks forming a tackle which may tentatively be identified as the jumbo jib downhaul. The blocks are covered in a thick fouling layer, obscuring all the details. The proximity of the blocks to one another indicates that the jumbo jib sail was lowered at the time of the *Eccles'* loss.

A block hooked into an eye on the cap rail 51 ft. 6 in. (15.72 m) along the baseline, just forward of the main chains, is possibly the lower attachment point for the foretopmast flying backstay or jig tackle.

An isolated double block rests against the aft port corner of the midship hatch coaming. The eye formed by the inner and outer straps appears to be empty and no fixed hook or ring was observed. Another double block rests on the deck to starboard of the mainmast. This block is fitted with an open hook. Both blocks show indications of having been frequently handled by divers, making their proveniences unreliable.

A treble block lies within the port quarter atop the collapsed lower turn of the bilge. This block possesses an inner and outer strap with the ring it was presumably fitted with. This treble block is most likely the lower block of the fore or mainsheet tackle.

Discussion of *Katie Eccles'* Rigging

The fitting out and maintenance of rigging was an ongoing and substantial investment for vessel operators (Saunders 2010:3). As vessel owners were principally concerned with the economic return of any investments in their vessels, the cost of any potential improvements was considered against the potential benefits. As the profit margins for sailing operators decreased, investment in maintaining the rig could only be decreased marginally if a vessel's seaworthiness were to be maintained.

Wire rigging not only increased the reliability and durability of rigging, but also offered considerable savings over hemp cordage, both at purchase and at replacement. As early as 1844, commentators noted that wire rigging offered vessel owners a savings of approximately 20 percent on the initial purchase of rigging materials (Marshall 1844:86). Martin warns that due to differing methods of pricing hemp and wire rope, hemp cordage being sold by weight, and wire by the length, an exact estimation of the costs of rigging in hemp and wire rope are potentially misleading (Martin 1992:111, 118; 2014:156). Before the 1870s, the reliance on British-imported wire rope resulted in increased prices relative to domestically produced available hemp rigging. By the late 1870s and 1880s, increasing competition from domestically manufactured wire rope and an increasing number of patented designs resulted in gradually decreasing prices.

Whereas natural fiber rigging required constant inspection, maintenance, and relatively frequent replacement, wire standing rigging had a service life of between 10 and 15 years, thus providing added savings (*Cleveland Morning Herald* 1873; Kipping 1893:140).

The introduction of wire rigging reduced the overall labor required to maintain and work the rig. Wire rope required less frequent inspection and did not require the crew to worm, parcel, and serve standing rigging. Another task that was eliminated was the constant tensioning of the stays and shrouds using the jig tackles as the cordage shrunk and relaxed with fluctuation in its moisture content. By reducing the frequency of these routine but labor-intensive tasks, wire rigging enabled the rig to be operated and maintained by a smaller crew.

While *Katie Eccles* extensively used wire rope, its rig seems to represent an intermediate stage in the implementation of wire rope in standing rigging. Though the *Eccles* employed wire rope for the stays and shrouds, the rig arrangement remained largely consistent with methods used in rope rigging, albeit with greater use of iron fittings. The shrouds were looped about the doubling of the masts and seized back onto themselves without the use of shackles. Though turnbuckles, which provided a more convenient method of tensioning the rigging, were in use from at least the 1870s, they were not used aboard the *Eccles*' rig. Instead, the lower end of the shrouds were secured to the chainplates by four pairs of deadeyes and lanyards. A lanyard was rove through the three-hole deadeye before being hitched over the upper deadeye and seized back onto itself. Thus, while the rig incorporated wire shrouds, the strength of the shrouds was ultimately limited by hemp lanyards which secured them to the hull.

Hemp lanyards possessed several potential advantages over full wire shrouds and turnbuckles that likely account for their continued use. The elasticity of hemp lanyards, which would stretch when over-tensioned, ensures equal tensioning between the shrouds and ensuring no single shroud assumed the full strain imparted by the rig (Leather 2001: 22). By limiting the length of the lanyard, the amount of longitudinal shrinkage and stretching within any one shroud was reduced. Furthermore, in an emergency in which the rigging became entangled or in a dismasting, when the rig might need to be cleared, wire shrouds could not be readily or rapidly cut away without special tools. The use of lanyards allowed the shrouds to be cut rapidly while maintaining most of the advantages of wire shrouds (Martin 2013:157).

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CHAPTER VIII

THE ARCHAEOLOGY OF THE *KATIE ECCLES*, PART III- DECK EQUIPMENT AND MACHINERY

The merchant sailing vessel was fundamentally an economic enterprise, intended to make the owner profit through commerce. The hull designs and shipbuilding techniques used on the Great Lakes became highly refined and adapted to the economic roles that these vessels fulfilled. Though the hull established the foundation of vessel profitability, the increasing mechanization of many labor-intensive operations in the latter half of the 19th century allowed sail to persist in competition with steam. While steam vessels and modern methods of freight handling were by far most adapted to benefit from industrialization, sailing vessels benefited considerably from innovations in the design of windlasses, capstans, and winches, and from the introduction of the donkey boilers paired with steam-powered hoisting winches. By significantly increasing the efficiency of onboard labor, these devices enabled a reduction of the crew along with their wages and other associated expenses and thus extended the economic viability of sailing commerce.

Shipboard machinery was the subject of intensive experimentation and innovation in the 19th century, increasing its efficiency, but these devices are rarely discussed in contemporary records and have received relatively little study among archaeologists and rarely received detailed comments from contemporary authors. The *Katie Eccles* retains a seemingly complete assemblage of machinery and deck fittings attesting to the dynamic changes in shipboard management, sailing operations, loading, and unloading, and crewing aboard vessels at the end of the 19th and early-20th centuries. Detailed examination of *Katie Eccles'* machinery by divers can provide an abundance of information on the assemblage. However, the non-disturbance approach of the project and dreissenid fouling prevented the identification of patents, manufacturers marks, and dates of manufacture, as well as their operational condition at the time of the vessel's loss. Furthermore, the tangle of wire rigging in the bow prevented close-in recording of the windlass and machinery due to the potential for entanglement of the remotely operated vehicle or its tether.

Description of the *Katie Eccles'* Equipment and Machinery

Windlass

Katie Eccles' has a purchase-lever operated windlass, colloquially referred to as "Armstrong's patent windlass," typical of those fitted to schooners throughout the mid-to-late 19th century (Chapelle 1973:677; Harland 2003:55)(Figure 21). The wooden barrel of the windlass is situated with its centerline approximately 10 ft. 6 in. (3.20 m) along the baseline. The forward side of the windlass is immediately aft of the pawl post, the forward face of which is 7 ft. (2.13 m) aft along the baseline. While precise measurements of the barrel were prevented by poor resolution of its forward side in the photo model, an estimation of the barrel diameter at 18 in. (45.7 cm) can be made from the site orthophoto. Along the centerline of the barrel are the pawl teeth. A single iron

Figure 21- The windlass and pawl posts on the foredeck (©Institute of Nautical Archaeology/Author, 2019).

pawl is visible, articulated with the after face of the pawl post. Immediately outboard of the pawl rim on either side are the purchase rims.

The castings for the purchase arms are fitted against the forward side of the barrel and pivot on a pin in the side of the pawl post, positioned to ratchet against the teeth of the purchase rims. These purchase arms were actuated by linkages connecting them to an athwartships rocker mounted to the upper forward face of the pawl post. The outboard ends of this rocker are socketed to receive brake levers inserted from both sides. When actuated up and down, the rocker translated this motion to the purchase arms, which then ratcheted against the purchase rim, imparting a near-continuous rotation to the windlass barrel (Chapelle 1973:677-679).

Neither brake-lever was observed, though the considerable quantities of rigging, particularly at the port bow, prevented complete observation of the deck forward of the windlass. The rocker remains with its starboard side elevated and portside depressed.

The whelps of the barrel are between 1 ft. and 2 ft. 6 in. (0.30-0.76 m) outboard of the centerline, along which the barrel diameter tapers towards its outboard ends. The individual whelps were obscured by dreissenid fouling but were presumably iron to protect the windlass barrel from incurring damage when the turns of chain about it slipped. Beyond the whelps, between 2 ft. 6 in. and 3 ft. 4 in. (0.76, 1.01 m) outboard of the centerline, are a set of cast iron wildcat warping drums, also referred to as chain wheels, containing recessed pockets along their circumference to accommodate individual links of studded chain cable. The introduction of wildcats lessened the tendency of chain cable to slip and work its way up the whelps and bind while being hauled in (Harland 1988:198, 2003:59).

Outboard of the wildcats, the barrel is supported by two Carrick bits. Howard Chapelle notes that windlasses of this type had an iron axle was driven into the ends of the barrel along its central axis. Rested within a bearing mounted in the Carrick bitts, this axle was held in place by the cheek pieces fastened to the bitts (Chapelle 1973:677-678). It is presumably the same with the *Katie Eccles'* windlass. The forward face of the Carrick bitt was braced by a diagonal truss extending between the upper vertical face of the bitt and the bedding timbers in the deck. Outboard of the Carrick bitts, and fastened to the ends of the barrel axle, are a set of warping heads for use in handling ropes or hawsers.

A chain stopper is hanging from a lanyard about the pawl post and rests atop the pawl rims of the windlass barrel and against the after face of the post.

Ground Tackle- Anchor and Chain Cable

Many features of this windlass were developed to accommodate and improve the handling of iron chain cable, which was invented by 1808 by Samuel Brown or Robert Flinn. Introduced in the Royal Navy by 1812, chain became ubiquitous by the 1840s (Harland 2013a:72). By 1810 stud-linked chain had been introduced alleviating the tendency of non-studded chains to kink and bind within the hawsepipes when letting out the cable (Harland 2013a:81). Chain anchor cable offered many advantages over traditional hemp cables. Possessing higher tensile strength, chain cables allowed the reduction of the diameter of the links while maintaining tensile strength when compared to the same diameter of hemp cable. Furthermore, the weight of the chain cable imparted a catenary to the cable, alleviating strain on the chain and providing better holding, though at the expense of added weight and difficulty in handling. Furthermore, chain cable proved substantially more durable and cost-effective than hemp cables (Harland 2013a:74-75).

Katie Eccles' port chain remains seated within the wildcats on the port warping drum, while the starboard chain appears to run over the starboard whelp, indicating that immediately before the abandonment, the *Eccles'* crew attempted to raise the port anchor. This is further supported by the chain piled on deck aft of the windlass within a chain trough. Both chains run forwards through the hawsepipes, which in an apparent contradiction of Mitchell's account to Snider and remain intact with both flanges of each pipe in place (Snider 1943b). Each hawsepipe consists of a single hawsehole drilled through the bolster block and the bow timbers on either side of the stem, fitted with an iron pipe with flanges on the inboard and outboard faces of the bulwarks. Outboard of the hawsepipes, both the port and starboard chains run down and aft, running beneath the turn of the bilge below the catheads. While the details of the chain links were not distinguishable due to dense fouling by dreissenid mussels, the pairing of this chain with wildcats indicates that this was probably stud-linked chain cable.

A single anchor was located, 30 ft. (9.14 m) off the starboard side amidships with its shank pointing in the direction of the hull. The anchor has a collapsible iron stock with a shank approximately 6 ft. 4in. (1.92 m) long, a crown 11 ½ in. (0.29 m) in depth and a distance of 4 ft. 7 in. (1.40 m) between bills. The palms measure 1 ft. 6 in. (0.45 m) long. The anchor rests with its stock standing upright off the bottom. The upper end of the shank is fitted with a ring. The chain cable shackled to the ring, runs toward the hull and under the bilge amidships; accordingly, it is impossible to determine to which hawse it belongs. A second chain of smaller links runs from the anchor ring to just below the cap rail amidships.

Identifying the size of the *in* situ anchor is complicated. The *Rules for the Construction, Inspection, and Characterization of Sail and Steam Vessels* of 1876 mandated minimum anchor outfits according to a vessel's registered tonnage. At 120 tons the *Eccles* would have initially been equipped with a minimum of three anchors: a best bower of 600 pounds (272 kg) with a 13/16 in. (2.1 cm) diameter chain links, a second bower of 385 pounds (175 kg) with 5/8 in. (1.6 cm) link chain cable, and a 100-

pound (45 kg) kedge anchor. The listed weights excluded the weight of the stocks (Dorr 1876:76-77).

In the mid-19th century, anchor weights were commonly estimated by taking the cube of the shank length (6 ft. 4 in./1.93 m) and multiplying it by 0.0114. This provided an estimated centum weight (cwt.), equivalent to 110 pounds (49.9 kg) (Tomlinson 1854:47; Souza 1998:62). For the remaining anchor, this equates to 2.895 cwt., or approximately 318 pounds (144.5 kg). This weight aligns most closely with the weight of the second bower specified by the 1876 *Rules*.

It is unclear whether *Eccles* anchors retained this initial outfit of anchors throughout its lifespan, as anchors were frequently lost, and changing underwriter's requirements may have necessitated alterations to the original outfit. Finally, the increasing inability of aging vessels to obtain insurance meant that, in their later years, vessel owners lacked economic incentives to invest in the outfitting of their vessels beyond what was seen as absolutely necessary. Accordingly, the *Eccles'* anchors may have varied from their original outfit. These factors may account for the apparent absence of a kedge anchor, which is likewise not mentioned in Snider's account (Snider 1943a, 1943b).

The Donkey Engine- Vertical Boiler, and Steam Hoisting Engine

The *Eccles'* was equipped with a single-drum, single-cylinder hoisting engine and boiler colloquially referred to as a "steam donkey" or "donkey engine." Despite the important role that these portable, comparatively lightweight steam engines possessed in mechanizing shipboard and longshore labor, little research concerning their development and date of introduction has been made. James Barry suggests that donkey engines were first introduced on the Great Lakes in 1867 (Barry 1973:92; Carrell 1985:14). However, an 1854 article in the *Buffalo Daily Courier* mentions the presence of an eight-horsepower steam hoisting engine aboard a lake sailing vessel (*Buffalo Daily Courier* 1854). References to the installation of hoisting engines on lake vessels increased steadily in the following decades; Snider states that by the 1890s, the donkey engine was common aboard schooners (Snider 1932).

Donkey engines consisted of a simple, compact single or double-cylinder steam engine powering a geared hoisting drum. Steam was typically provided by a vertical fire-tube boiler or vertical cross-tube boiler, which provided a relatively lightweight and compact means of generating steam pressure that occupied minimal space on deck. In the vertical fire tube boilers, the internal firebox was surrounded by water within the boiler body with a single flue tube exhausting to the top of the boiler. Their limited heating surface made them inefficient. Furthermore, as the water within the reservoir did not extend to the top of the flue, overheating of tended to result in leaks (Shealy 1912:17). In water tube type boilers, several tubes containing water crossed the furnace increasing the heating surface and therefore improving efficiency in producing steam (Shealy 1912:21). Both designs saw widespread use in maritime applications.

Figure 22. (Left) The vertical boiler resting on the fore deck. (Right) the hoisting winch set forward of the fore hatch (by Author, 2019).

The *Eccles'* vertical boiler, likely of the vertical-cross tube type (Figure 22), is situated 19 ft. 6 in. (5.94 m) along the baseline and offset to starboard approximately 4 ft. (1.21 m). The placement of the *Eccles'* vertical boiler and winch at the foot of the foremast permitted the use of the fore gaff for unloading cargo from the main hatch. The baseplate and ash box of the boiler remains fastened to the deck, indicating the boiler's original position, though the body of the boiler has toppled to starboard with its upper end against the bulwarks slightly forward of the chock timber heads. The drainpipe and gauge cocks are visible on what is now the aft side of the boiler. On the forward side of the boiler is the pipe steam pressure gauge. The gauge itself rests on the deck aft of the boiler.

The funnel and crown plate are detached from the boiler and lie immediately forward of the boiler body on deck (Figures 7 and 22). Douglas Bennet notes that, for many vertical boilers, the funnel and crown were removable when not in use, reducing the possibility of fouling or impeding the swinging of the foreboom. This may account for its present position (Bennet 2001:70).

The vertical boiler was attached to a steam engine and hoist by a steam pipe which fed into a valve chest and single-cylinder on the starboard forward side of the winch. The piston arm was linked by a pitman to a flywheel on the starboard side of the winch assembly. The flywheel was attached to a small spur wheel by a connecting rod, which presumably acted on the main spur wheel on the main barrel. This main spur wheel is situated inboard of the starboard bearings of the main barrel. Outboard of both bearings is a pair of warping ends that extend beyond the frame. The winch base consisted of two fore-and-aft beams secured to the deck.

What appears to be a steam pipe runs forward from near the valve chest to what is likely a steam siphon, the upper end of which is situated on deck 14 ft. (4.26 m) along the baseline, immediately aft of the starboard Carrick bitt of the windlass (Figures 7 and 22). Details of this feature are obscured by dreissenid fouling, yet its connection to the boiler and the absence of bilge pumps elsewhere in the hull support its identification as such.

Centerboard Winch

The iron centerboard winch (Figure 12) was originally mounted above the centerboard pennant hole and now rests on one of its faces on deck to port. The pennant wire runs from the pennant hole to the winch drum with several turns remaining around the drum. Each frame plate of the winch is formed as a rounded trefoil arch, both plates being connected by tie rods at the top of each frame and at the top of each leg. Though many of the details of the gearing and drums are obscured by dense dreissenid fouling, the pinion wheel of the upper barrel and the sprocket wheel of the lower barrel appear to be located against the lower frame.

Rudder and Steering Gear

The rudder and the rudder stock remain in place against the sternpost without any apparent damage to which might be attributed to the failure of the *Eccles'* steering. The rudder is of the 'plug-stock' type in which the stock is set forward of the rudder body, with the stock centered over the pintles. The rudder stock begins approximately 2 ft. (0.61 m) below the top of the rudder, fastened into its forward face. The rudder has an exposed length, to the head of its stock, of approximately 12 ft. (3.65 m). No pintles or gudgeons were identified.

The rudder body has a height of 6 ft. (1.82 m) along the sternpost and a maximum width of 3 ft. (0.91 m) along the bottom. The flat upper face is approximately 1 ft. (0.34 m) long. The rudder consists minimally of an afterpiece, two middle pieces, and a main piece embedded in the lake bottom, though this could not be confirmed.

The *Eccles'* steering gear and wheel box were dismounted and now hang from the head of the rudder stock by the front panel of the wheel box. The lowest strakes of either side of the wheel box remain attached, bound together by the internal supports and the front panel. The angled aft face of the wheel box indicates that the box was constructed against the counter.

Though many details are obscured by dreissenid fouling, the steering gear is a worm-simple type gear, in which the threaded worm is mounted above the stock. The worm of the steering gear rested on bearings forward of the rudder stock and aft, mounted to the taffrail. The eight-spoke wheel has an exterior diameter of approximately 3 ft. (0.91 m), the iron band forming the outside rim of the wheel being 3 in. (7.6 cm) wide.

Folding Davits and Stern Chocks

Katie Eccles was equipped with folding davits. The inboard halves of these davits were fastened to the upper face of the aft chock rails. The inboard davit timbers measured 5 ft. 5 in. (1.67 m) in length. The davit arm has a slightly curved upward profile along its length of 4 ft. 6 in. (1.37 m). Only the portside davit arm was present on site. The davit halves are articulated by a barrel hinge on the upper face of the davit and davit arm, allowing the arm to be folded inboard, reducing projections outboard of the counter. Two slots for sheaves were cut into the outboard end of the davit arms. These sheaves were paired with a double block that served as the davit falls assembly for hoisting the boat (Figure 5). Set inboard of the davits, on both sides of the counter, were two wooden chock fairleads to secure the boat.

Fenders

At least two wooden fenders were located, one laying on deck to port between the midships and aft hatches and the other off the port side amidships. These timbers measure 9 ft. (2.74 m) long, 9 ½ in. (0.24 m) wide, and had a slightly curved profile to conform to the hull. Two such fenders are visible in Figure 4 suspened from timberheads at the break of the spar and quarterdeck and from the midships timberheads. The fenders were hung from a rope becket looped about the timberheads and of a length to hang the fender between the covering board and the load waterline. A second line was used to raise the lower ends of the timbers while underway.

Discussion of Equipment and Machinery

The extant machinery of the *Katie Eccles* displays the owner's preoccupation with increasing the efficiency of labor and provides testament to the pressures placed on sail operators in the final years of sailing commerce. Though lacking machinery present on some of its contemporaries, the *Eccles'* equipment increased the efficiency of the most labor-intensive tasks, which either required several hands simultaneously, or additional crewmen as relief to take turns at the task. The result was the increased efficiency of the crew's labor, allowing the reduction of the complement needed to operate the vessel, thereby offering the owners savings in wages or allowing them to forego the hiring of additional longshoremen and machinery in port.

The *Eccles'* windlass has no observable features introduced after the 1860s, and except for the wildcat warping drums, was fundamentally similar to windlasses outfitting lake vessels in the 1840s and 1850s (Harland 1988:198, 2003:59)

The windlass underwent rapid development throughout the 19th century, with some 205 patents taken out for windlasses with the U.S. Patent Office between 1790 and 1895, with half of these issued in the years following 1874 (Whitney 1896:120). Prior to introduction of the brake lever-operated windlass the 1840s, windlasses consisted of an octagonal barrel rotating between two bitt posts supporting its outboard ends; two or more rows of square slots were cut into the barrel to receive long bars or handspikes. Early windlasses were rotated by inserting handspikes vertically into the slot on top of the barrel and then heaving the handspike down until it was parallel with the deck. With each quarter turn, the handspikes had to be removed and reinserted and the operation repeated, the progress being maintained by a pawl acting against pawl rims cut into the windlass barrel (Whitney 1896:113).

The brake or purchase-lever operated windlass, introduced in the 1840s substantially improved both the purchase of the individuals operating the windlass and the rate of hoisting anchors. Before the introduction of later patent windlasses, these brake-operated windlasses were principally made of wood, the wooden components being shaped by the shipwright, with the iron components cast by foundries (Chapelle 1973:677). Contemporary with the introduction of this type of windlass, iron whelps were introduced to prevent damage to the whelps from wear, slipping or backsliding of chain cable. By the 1860s wildcats, pocketed warping drums with recesses fitted to hold the individual links of the cable, were introduced on windlasses (Harland 1988:198, 2003:59; Russell 2004:56-57).

While the ratcheting action of the brake-lever operated windlass greatly improved the efficiency and speed of hoisting cable with its sustained action on the barrel and the elimination of the need to remove and reinsert handspikes with every quarter turn, hoisting the anchors continued to be a laborious task. The colloquial name of these windlasses, the “Armstrong’s patent windlass,” referred not to the patentee of the design but the effects on the crew’s arms. Douglas Bennet, who spent time as a foremast hand on some of the last British coasting schooners, stated of working the levers, "It was impossible for other reasons to work it for any length of time without having to stop, it would have been considered as bad as continuous pumping, even though the actual force required to pull the brakes down was quite light (Bennet 2001:61-62)."

While *Katie Eccles* was not equipped with a capstan, innovations in capstans and windlass were closely interconnected. The capstan functioned similarly to the windlass, but, unlike the windlass, revolved on a vertical axis, its rotational movement being imparted by means of the crew heaving at capstan bars inserted into radially- arranged slots in a drumhead atop of the capstan barrel. Whelps were fitted to the barrels to increase the diameter of the capstan, therefore improving its efficiency, and improving its purchase on the messenger cable.

While early windlasses permitted crewmen to exert force more efficiently on an individual basis than the capstan, hoisting was slowed by the requirement to ship and unship the handspikes four times per full rotation. However, each individual heaving a capstan exerted less force than was possible with the vertical motion of the windlass bars. Accordingly working capstans required a larger crew, but allowed rapid hoisting with a continuous rotational movement, only requiring that rotation stop to surge or loosen the messenger around the capstan intermittently. However, the mechanical advantage provided by the ratcheting mechanism of the brake-operated windlass and the resulting increase in the rate of hoisting, allowed hoisting to be accomplished by only two crewmen with a near continuous rotation of the windlass barrel. The windlass was employed universally aboard lake vessels in the latter half of the 19th century while capstans were less common (Whitney 1896:118-119). Due to the diameter of cables and the inability of a large cable to bend around a capstan, an endless messenger cable was turned about the capstan and rigged to a block, allowing the anchor cable to be tied off or nippered to the messenger and heaved in.

The adoption of chain cable brought about rapid refinement in capstans design, many developments which were transferred to windlasses. Following the introduction of chain cable, hemp messengers were initially retained and were nippered to the links of the cable much as they had been with hemp (Harland 2013b:338). Damage to the whelps resulting from the backsliding and slipping of the chain resulted in the introduction of iron whelps by 1840. However, iron whelps were not particularly effective when used with chain (Harland 2013a:76). By 1828, the English firm Gordon and Company introduced sprocket wheels at the base of the capstans. The sprockets of this earliest design intermeshed with a chain of alternating un-studded long and short links, requiring precise forging of the chains which were prone to stretching or collapse. In 1835, Benoit Barbotin fitted the links of a standard studded chain to specifically sized recessed pockets in the capstan drum, with each link being held within its own pocket. Barbotin's invention alleviated the issues of slippage and backsliding, while allowing the use of standard chain sizes. Furthermore, this design eliminated the need for the messenger, allowing the cables to be hoisted with the windlasses directly (Harland 2013b:338-340).

From the 1850s, new designs integrated the windlass and capstan, the windlass being powered by the geared capstan situated on the forecastle deck above. The earliest such "double windlass" design seemingly was James Emerson's Patent Double Windlass of 1855 (Emerson 1855). While such "double windlasses" continued alongside brake-lever operated windlasses, it was the former type that formed the basis for early direct steam-powered windlasses and capstans.

Although the *Katie Eccles'* windlass did not employ steam power, steam was applied to the hoisting of anchors and the operation of windlasses and capstans aboard some vessels by the 1860s (Souza 1998:50-51). The earliest iterations of steam-assisted windlasses were powered by a donkey engine with an endless messenger chain turning a chain wheel fitted to the windlass barrel (Souza 1998:50-51). Introduced in 1874 by the American Ship Windlass Company, direct-acting steam-powered capstan-windlasses were powered by two horizontally mounted cylinders set at right angles to one another and mounted to the underside of the deck. Later designs mounted the cylinders directly on the windlass baseplate, with the cylinders being vertical or mounted on an incline (Souza 1998:50-51). While steam-powered windlasses proliferated aboard steam vessels and in the largest sailing vessels, manually operated purchase-lever type windlasses remained in widespread use aboard smaller schooners on the lakes.

By the 1890s mechanical assistance provided by steam donkeys alleviated much of the hardest labor aboard sailing ships, radically altering the traditional occupational skills of sailors and the operations of sailing vessels (Snider 1932).

Among the most important uses of the donkey engine was the loading and unloading of cargo (Bennett 2001:69-70). In the mid-19th century and somewhat later in small ports, loading and unloading of sailing vessels was a long and laborious task, particularly for heavy loose bulk freights such as anthracite coal. In the mid-19th century, loose freights were brought aboard by stevedores, carried in sacks or wheelbarrows, and were then dumped into the hatches. Shovellers within the holds then distributed the cargo. Mansfield notes that this process often took between three and seven days, while a cargo of 5,000 bushels would take two to three days to unload (Croil 1898:253-254; Mansfield 1899:529).

Advances in mechanized unloading were introduced in the latter half of the 19th century, but on sailing vessel's the small, unevenly spaced hatches and the impediment of the rigging limited the usefulness of mechanical unloading devices. The resulting delays in unloading meant a substantial loss of revenue for ship operators as per diem costs remained consistent as the vessel idled in port awaiting unloading or in the slow process of manual unloading. Loading and unloading involved further expenses in elevator fees, wharfage, hiring longshoremen, and hiring machinery from the wharf owner, though these were relatively fixed and therefore more easily anticipated expenses. Vessel owners were eager for any means to reduce these fixed costs and to increase revenue by minimizing the time their vessels idled in port.

The donkey boiler alleviated the need to hire longshore machinery. A cargo gaff hoisted on the after side of the foremast was commonly used to lift heavy cargoes into or out of the holds. The cargo gaff could be operated by hand winch, with one man manning the winch, while two additional men handled the lines used to swing the gaff inboard and outboard (Bennet 2001:72). A more time-efficient alterative, teams of horses or mules could be hired wharf side or kept aboard. The teams were hitched to the hoisting tackle falls and driven to lift the cargo clear of the hatches. A team of horses was commonly kept aboard lake sailing vessels before the 1880s, stabled in a structure referred to as a horsebox on the deck between the foremast and the forecastle companionway (Snider 1932).

Early mechanization of sailing vessels was primarily confined to wharf side machinery and focused on expediting loading. Gravity-assisted loading of grain from elevators was introduced with steam-powered elevators as early as 1848 (Karamanski 2001:150). From the late 1860s, the construction of pocket docks for coal in the coal ports expedited loading for those ships employed in the Lake Ontario coal trade.

The work of loading at trestles was carried out by crews of workmen under a foreman. Loading the unevenly spaced hatches of the schooners required that the crew shift the vessel to align the holds with the chutes when one hatch was filled. Once the pocket doors were opened, the coal cascaded from the chutes into the open hatches. Trimmers below deck, working in the coal dust-choked holds, then shoveled coal into the wings from the mounds in the hatchways between successive loads from the pockets, distributing it throughout the hold. Then the hatches were cleared and the process was repeated until the vessel's loading was completed. Loading from trestles was hard on the ships but allowed loading to be accomplished in several hours in what formerly might have taken one or two days. The initial shock of tons of coal being poured into the hatches resulted in rapid and uneven point loading on hulls. Furthermore, the cascade of coal had the potential to wear the exposed centerboard box over time (Snider 1931).

By the 1860s, donkey engines were being used wharfside to hoist buckets of loose freight out of the holds or from shore. In 1887, Alexander Brown introduced the Brown Hoist, a donkey-engine powered crane mounted on a rail carriage. This crane hoisted a grab bucket with a capacity of 2000 pounds (907 kg). The boiler and steam engine of the Brown Hoist also served to power the rail car on which the crane was mounted, allowing the Brown Hoist to move cargo along rails at a rate of 150 to 200 ft. (45.7-61 m) per minute (Dappert 2006:27,29). The Brown Hoist was the largest unloading machine that could practically be used on sailing vessels, reduced loading and unloading times by approximately one-third (Barry 1973:121-123).

For Canadian schooners operating out of small ports which lacked substantial mechanized loading facilities and where laborers were often scarce, particularly in the 20th century as commerce and longshore employment opportunities declined, the work of unloading increasing fell upon the crew. The placement of a donkey boiler and hoist on deck beside the foremast permitted the application of steam power for the use of a cargo gaff, allowing more rapid operation and increased lifting capacity, which increased the amount of work that could be accomplished with a comparatively small crew (Bennet 2001:69-70). However, the rate of unloading was still limited by both the capacity of the buckets that could be lifted as well as the rate of the shovelers in the holds. In ports where stevedores remained available, the donkey engine alleviated the need to hire machinery to assist in unloading, therefore reducing expenses.

In addition to hoisting cargo, the hoisting winches of the donkey engine assisted with the handling of mooring lines, hawsers, and running rigging. On *Katie Eccles,* both the windlass and hoisting winch were fitted with a set of warping heads intended for use with fiber rope or wire rope, the line being hitched on or with multiple turns about the heads to provide purchase on the line. While towing hawsers and mooring lines might be worked using the windlass, the steam winch was ideal for handling running rigging.

Finally, the steam produced by the boiler when the hoisting engine was not running could be used to pump water from the bilge. Leaks were an inevitable reality of wooden ship construction and bilge pumps were an indispensable part of the ship's equipment. Pumps became even more important as vessels aged and maintenance declined, leaks became more frequent with the hogging of the hull. The declining seaworthiness of the aging schooner fleet was clearly understood by those sailing them, and contemporary accounts note that these vessels were often not taken out unless the crew were certain of settled conditions (*Oswego Palladium-Times* 1925).

Most sailing vessels on the lakes in the mid to late 19th century were equipped with suction pumps. These simple suction pumps functioned with a set of pump tubes fitted on either side of the keelson and extending from the bilge to above the deck, the pump tube protected within a planked-in pump well. The pump was operated by actuating a brake lever connected to an iron rod and piston containing a one-way valve. A second valve in the lower end of the tube admitted water when suction was formed by raising the piston, which was then transferred by the piston valve to the upper chamber on the downstroke of the piston and lifted to the top of the tube.

The suction pump continued to predominate throughout the 19th century. By the 1850s, its components were increasingly replaced with iron (Oertling 1996:74). By the end of the 19th century, patent Deluge Pumps and diaphragm pumps had been introduced. These pumps were more easily maintained and accommodated multiple arrangements for the mounting of the brake-lever, and improved reliability, lifting, and flow rates (Bennet 2001:82).

Bilge pumps were indispensable for all vessels, even more so for an aging wooden vessel, and so it is remarkable that the *Katie Eccles* does not retain any observable evidence of bilge pumps fitted on the deck abaft the mainmast, the usual position for pumps. It is possible that the pumps were situated off-centerline in the small hatch opening to starboard forward of the break of the deck and that the pumps were salvaged. What appears to be a crushed metal pipe to starboard may be evidence of the remains of a pump tube at this location, but this identification is speculative. Instead, *Katie Eccles* seems to have relied upon a steam siphon fitted abaft the windlass. This simple arrangement employed steam from the donkey engine to generate a suction, lifting water through a siphon pipe that extended to the bilge below decks. The removal of hand-operated pumps may have been a result of the insufficient size of the crews to sustain the immense effort required to work them for any prolonged period. The steam siphon would have allowed continuous pumping while the donkey boiler had built up steam.

While no individual vessel could bear witness to all of the dynamic, contemporary developments in shipboard machinery or equipment, *Katie Eccles* possesses a significant assemblage of machinery, including steam-powered machinery. This illustrates not only technological innovations introduced by industrialization but also the economic pressures exerted upon sailing vessel operators in the final years of the 19th and early 20th century. The adoption of steam-powered machinery and increasingly labor-efficient devices allowed operation by a smaller crew. As sailing commerce neared its end, financial pressures and the efficiencies offered by such machinery resulted in chronic under crewing, increased acceptance of risk, and further deterioration of onboard labor conditions.

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CHAPTER IX

OPERATING SAILING VESSELS IN THE ERA OF STEAM

While developments in bulk freight handling, management of steamship lines, maritime technologies and mechanization transformed the operation of steamships and greatly increased their efficiency, sailing vessels were far from passive onlookers as they were overtaken by steamships in the late-19th and early-20th centuries. Though they continued to be constrained by the limitations of sail and its dependency on the wind, sailing operators extended the financial viability of their aging vessels well beyond their anticipated service lives. By incorporating many of the previously discussed technological innovations, and accepting increased risk, sailing vessels fought to remain competitive.

Financing, Insuring, and Maintaining Sailing Vessels

For vessel owners, their ship, whether propelled by steam or sail, was a profit-making enterprise, the daily operations of which were entrusted to the master, who also commonly held part-interest and therefore was motivated by receipt of a portion of profits in addition to his monthly wages. As the master was responsible for nearly all aspects of the vessel's operation, including management of the vessel's finances, negotiation of charters and freight rates, hiring, and payment of towing fees and tolls, a skilled master was indispensable for the profitable operation of a vessel (Karamanski 2001:115).

For the first owners, the building and outfitting of a vessel represented a substantial investment and acceptance of financial risk. Receiving a return on this investment required that it pay for itself and generate a profit before the vessel reached the average life expectancy of wooden sailing vessels which a vessel could reasonably be expected to attain before extensive rebuilding of its wooden hull was required. On the Great Lakes this lifespan, though not exceptionally short, was still comparatively brief. Wooden vessels had an average service life of approximately 15 years, though a vessel might be used for up to 20 to 25 years required rebuilding and constant repair. The local availability of timber of exceptional quality enabled the comparatively inexpensive replacement of these vessels. Most owners seem to have preferred replacement of vessels before incurring the persistent expense and effort of maintaining an aging and uninsurable vessel (Inches 1962:2; Barry 1996:149; Ford 2018:92).

The annual rate of return for investment in new vessels varied widely with fluctuating freight rates, demand for shipping tonnage, and by the vessel's route, trade, and management. James L. Barton notes that, in 1847, a new vessel might cost between $1000 and $14,000, but might annually earn between $500 and $6,500. Barton states that the average annual revenue was nearer to $3,000; such profits might allow a vessel to be paid off within two seasons (Mansfield 1899:437). In the 1860s, high tonnage demand and freight rates contributed to the expansion of shipbuilding with high confidence in the profitability of sailing vessels into the early 1870s, with the potential for even schooners of comparatively modest tonnage to produced substantial profits and to rapidly pay off initial investments (Cooper and Jensen 1995:12). In 1872, a 315-ton canaller was built at

Oswego for Thomas S. Mott costing $24,000. The vessel was paid off by 1873 and had made a profit of $17,500 by the end of that season (*Buffalo Commercial Advertiser* 1872; *Oswego Commercial Advertiser* 1872; Palmer 2010). Though such profits were possible during good shipping seasons, in seasons with low demand and low freight rates, profits dwindled or disappeared entirely, with many owners idling vessels rather than keeping them in operation with the possibility of minimal profit or even loss (Karamanski 2001:119-120).

Though in the early 1870s a new vessel might be paid off within two to three shipping seasons if managed by a competent master, the initial costs of construction were often too high for wage-earning individuals who aspired to ownership and the social mobility that accompanied it (Karamanski 2001:119). The limited service life of wooden vessels meant that their values depreciated as they aged. The availability of low-cost used vessels provided ambitious lake men the opportunities to become vessel owners, and with it to attain upward social mobility. While construction of new vessels established a high barrier to ownership, vessels, new and used were often purchased or financed by multiple shareholders, limiting the exposure of the any one individual to financial risk (Karamanski 2001:115-119).

The value of used sailing vessels did not depreciate linearly with a vessel's age. Vessel values varied with contemporary markets and with the ratings assigned by insurance underwriters. Beginning in 1856, the Association of Lake Underwriters established rules for the classification of vessels to more reliable standards for the inspection, characterization, and construction of lake vessels to reduce incidences of losses by ensuring and improving the quality of lake shipbuilding (Bates 1856:1-8). In the 1866 *Rules* eight classification ratings were listed: A 1*, A 1, A 1-, A2, B1, B1-, B2, C1, C2. The ratings characterized both the quality of the materials and the vessel's construction and form. Vessels assigned the highest ratings, A1 and A 1*, required regular inspections at prescribed points throughout the process of construction. All were subject to random inspections permitted at any time or following repairs and refits. Ratings were routinely reduced after a set number of years, the span being determined by the initial rating, but could be raised following refits or prescribed repairs (Lewis 2000).

In 1876, revised rules were published incorporating the input of shipwrights and improvements in shipbuilding over the intervening years as well as more detailed instructions for construction, specifying mathematical progressions for determining minimum scantlings, and prescribing construction methods for vessels of particular tonnages. Furthermore, the *Rules* included tables listing the expected longevity of timbers of varying grades in various components of the hull, and instructions for their inspection at prescribed intervals (Dorr 1876:75, 97-118; Lewis 2000).

The influence of insurance on the value of a vessel is seen in the recorded values for *Katie Eccles*. Though the initial construction cost of *Eccles* is unknown, the *Eccles* retained an A1 rating and an assessed value of $7,500 in 1879 (Morey et al. 1879:38). The following year it was sold for $8,000 (*Daily British Whig* 1880b). In 1886, with its rating reduced to A 2 ½, the *Eccles* was valued at $4,000. Its value increasing to $5,500 following restoration to an A 1 ½ rating (Polk 1884:89; Taylor 1886:16). By 1901 the *Eccles,* now rated A2 ½, was valued at $2,100 at the time of its last located survey

(McMurrich 1902:26). Kenneth Pott estimated that the value of one Oswego-built scow schooner, valued at $8,000 in 1872, declined by approximately three percent annually (Pott 2001:53).

This decreased value reflected the decrease in the future potential for profits, as cargoes eligible for insurance were reduced. Grain, typically the most profitable cargo, required a high rating to affordably insure due to its high cost and susceptibility to water damage should leaks allow water into the hold. Vessels carrying cargos less susceptible to water damage, such as coal or lumber, did not require a high rating. However, underinsuring or operating uninsured seems to have been common, particularly as sailing vessels aged out of insurability or sailed late in the season (Ford 2018:120).

In the absence of significant governmental regulations restricting sailing vessels operations, insurability formed one of the principal regulatory oversights for standards of vessel maintenance and serviceability. Owners applying for a specific rating were required to contractually agree to abide by the underwriter's regulations on loading and reporting along with the inspector's report, establishing a financial incentive for vessel owners to comply. As vessels aged out of insurability, or as operators chose to save on high premiums by sailing uninsured, little regulatory constraint existed (Martin 1995:201).

As with age the profitability of smaller sailing vessels declined, routine maintenance was commonly deferred by many operators lacking the available funds. Vessels idling while in winter layup could be refitted and repaired without incurring loss of revenues, but routine investments in vessel maintenance were increasingly limited to the repairs necessary to keep the vessel in service as prospects for paying off the repairs over the coming season became increasingly tenuous (Palmer 1999:51-53; Pott 2001:53). Declining standards of vessel maintenance contributed to attrition among the remaining sailing vessels, either through loss or abandonment as vessels became increasingly unseaworthy.

Freight Rates, Revenue, and Finances

The profitability of operating sailing vessels was inseparably tied to freight rates and until the early 1880s freight rates remained sufficiently high in most trades to permit a reasonable assurance that a vessel could pay itself off and bring profits if spared from significant mishaps and operated by a competent master (Mansfield 1899:437).

Freight prices and rates on shipping were set by contemporary market conditions and therefore varied considerably throughout the shipping season. Rates were influenced by supply and demand, available stockpiles at both the clearing and terminal ports, local elevator storage capacities, the availability of shipping tonnage, insurance rates, the routes it was carried along, and the season of the year. Freight rates were typically highest at the beginning and end of the shipping season (Martin 1995:146; Karamamski 2001:115).

As the master was typically responsible for all aspects of a vessel's operations throughout the shipping season, anticipating changes in freight rates imposed enormous pressures on masters to maximize the revenues of the vessels under their management on behalf of the owners. While owners were increasingly involved in the management of their vessels throughout the season through the use of the telegraph, for much of the 19th century, the master was given wide discretion in chartering freights, insuring both vessel and cargo, and in the financial affairs of the vessel (Martin 1995:171; Karamanski 2001:15, 114-116, 186).

In periods of low demand, it might become impossible to operate profitably. The mid-1870s were particularly hard for Lake Ontario vessel owners and are likely representative of the struggle of sailing vessel operators in the final years of sailing commerce. Jerome Laurent estimated that in 1873, 4.13 cents per bushel was the minimum rate at which a schooner might profitably carry grain from Chicago to Buffalo. Between 1857 and 1859, freight rates on grain between Chicago and Buffalo annually-averaged 6.24 cents per bushel, with rates dropping from their high in 1857 at 9.89 cents to just 3.76 cents during the depression the following year. Between 1860 and 1869 freight rates recovered, annually averaging 9.174 cents, with rates reaching 12.34 cents in 1866. While grain freight rates varied widely in the 1860s, reaching a low in 1867 at 6.67 cents per bushel, even in slow years, rates remained well above the threshold of profitability. However, by the end of the 1860s, rates began a steady downward trend.

Between 1870 and 1873 rates on grain averaged 8.14 cents per bushel. The recession of 1873 brought a reduction of 52.8 percent between 1873 and 1874, and for the remainder of the 1870s rates averaged only 3.64 cents. The economy recovered by 1880, but rates on grain never reached their former prices, instead averaging 3.21 cents through the 1880s and 1.78 cents between 1890 and 1898, well below Laurent's proposed profitability threshold (Mansfield 1899:535; Laurent 1983:1-24; Cooper and Jensen 1995:14). As grain rates fell below three cents per bushel, sailing vessels were effectively relegated from the inter-lake trade grain trade, with their participation increasingly limited to the beginning and end of the season when rates increased (Cooper and Jensen 1995:14; Meverden and Thomsen 2013:6).

While freight rates appear to have remained higher in the local grain trade on Lake Ontario due to the absence of competition from larger bulk carriers, many trading vessels nevertheless struggled. Willis Metcalfe provides a view into the struggles of the two-masted schooner *Olivia* of Toronto during the 1878 shipping season, which was a low point of the depression of the 1870s. That year the *Olivia* advertised rates for carrying coal at 20 cents per ton from Oswego to Toronto but was unable to maintain consistent charters in spite of the low rates. As a result, *Olivia* idled for weeks between charters for one to two trips. As *Olivia* could only carry 300 tons without being overloaded, these charters brought in a total of $60.00 per trip, from which was deducted a week's wage for the crew, at a rate of $1.00 per day, totaling $35.00 without provisioning expenses. Towing bills at Toronto and Oswego further added $4.00 each way. The limited revenue was again reduced by interest payments on repairs the previous winter for $2,000 leaving *Olivia* essentially without profit (Metcalfe 1975:40-42).

Though local grain shipments could prove profitable when high demand for shipping allowed raised rates, similar struggles were present in this trade. In September 1878, *Olivia* shipped 7,973 bushels of barley from Chapman and Sons of Toronto for Failing and Pratt of Oswego at a rate of 1.25 cents per bushel. At that rate, the one-way trip brought freights of $99.72, from which were deducted $19.94 in elevator fees, payment for shovelers of $23.93, and a short-cargo charge, which meant that the operators made $47.33 before wages, upkeep, and tug bills (Metcalfe 1975:42).

In October, *Olivia* took two cargoes of barley for Oswego, taking on 3,000 bushels of barley at Napanee and 3,240 bushels at Mill Haven, with a second cargo on 17 October totaling 7,314 bushels at 1 ¼ cents per bushel from Mill Haven to Oswego. Metcalfe notes that these three runs by *Olivia* resulted in revenues of only $226.00 from which was deducted the wages of six crew, towing expenses of approximately $32.00, as well as costs for maintaining the vessel (Metcalfe 1975:42-43).

Amidst immense pressure to maximize revenues, overloading became endemic aboard sailing vessels on the Great Lakes. By the 1870s, operators with vessels employed in the inter-lake trade loaded their vessels to the limit of clearance of the canals as a financial necessity, regardless of the associated risks to the vessel and those aboard. Lacking capital to construct larger, more profitable vessels, overloading provided owners the only means of increasing revenues on a per-trip basis. No regulation on either side of the border prevented them from doing so (Martin 1995:23,167). In February 1890, the *Daily British Whig* noted:

> "Everything connected with the trade on the lakes seems to put a premium on overloading. For one thing, the season of navigation is very short. Then, though the trade is simply enormous, the competition is very great. That competition has brought freight rates down to almost the lowest possible ebb. All commanders of

vessels are thus anxious to carry as much as can in any way be stowed aboard. Every extra ton is so much clear profit, and so far increases the earnings (*Daily British Whig* 1890a)."

These circumstances were compounded for canal sailing vessels, particularly from the 1870s. Before the enlargement of the Second Welland Canal in 1873, the clearance depth of 10 ft. (3.04m) over the lock sills prevented the overloading of vessels already designed to maximize their dimensions and draft within the locks. In 1873, the depth of the locks was increased to 12 ft. (3.65m) to allow clearance by larger vessels (Mansfield 1899:235). Sailing canal vessels constructed to the former canal dimensions, whose owners lacked the finances to construct new vessels to the dimensions of the enlarged locks, were placed at a disadvantage and were loaded beyond their intended capacities to maximize their earnings while they were still able to turn a profit (*Daily British Whig* 1882).

The *Chicago Inter-Ocean* estimated that sailing canallers accounted for 90 percent of losses with all hands in 1877 (*Chicago Inter-Ocean* 1877). The *Oswego Palladium*, responded to the criticisms against canallers citing that it was overloading rather than shortcomings in their construction that was responsible for the high losses among canallers and their crews (*Oswego Palladium* 1874).

That same year, in response to high losses, the Board of Lake Underwriters convened a meeting in Chicago to establish inspectors for the loading of vessels. The meetings established a system of arbitration between the underwriter's inspectors and operators for instances in which a vessel was cited as overloaded. Vessel operators, of course, widely opposed such restrictions (*Daily News* 1874). The underwriter's rule often formed the only effective restraint on overloading. The Board of Lake Underwriters established rules for determining minimum loaded freeboard, as well as the requirement that the shipwright calculate the load waterline and scribe it into the planking to mark the draft, and that vessel be built for loading to this load waterline (Dorr 1876:81,93-96). These rules only applied to insured vessels, and therefore had little relevance to uninsured or uninsurable vessels, which represented an ever-increasing number of sailing vessels and particularly those employed as tows.

Despite numerous efforts and intermittent public outrage, no government regulations restricting the loading or under-manning of sailing vessels on the Great Lakes were implemented on either side of the border until well into the 20th century. In 1876, the British Parliament passed Samuel Plimsoll's Merchant Shipping Act of 1876 establishing load line requirements to restrict the overloading of British vessels. This legislation applied only to British vessels on saltwater, not to Canadian inland shipping. Considerable loss of life on the lakes in the 1870s and 1880s due to overloading prompted a widespread public outcry for regulation along the lines of Plimsoll's act on both sides of the border (*Daily British Whig* 1880a, 1880c, 1887a, 1887b).

In 1889, a commission was convened by the Canadian government investigating the issues of overloading as a result of demands by the Knights of Labor. Its report stated:

> "It is in evidence that sailing vessels navigating inland waters frequently undertake voyages under circumstances which imperil

> the lives of the crews. It is earnestly recommended that the State provide by legislation for proper inspection of all vessels on the lakes and rivers of Canada; and further, that such vessels be not permitted to leave port unless found seaworthy, sufficiently manned with competent sailors…and not overloaded (Royal Labor Commission 1889:9)."

The Knights of Labor's proposals included provisions for the establishment of government inspectors at Montreal, Kingston, and at Welland, suggesting that overloading was most problematic aboard vessels passing through the Welland and St. Lawrence Canals (*Daily British Whig* 1889). Despite labor's involvement, nothing was accomplished (*Daily British Whig* 1890b).

The cause was taken up by the International Seaman's Union in October 1905, and by the Kingston City Council in 1906, which requested that the Marine Department appoint an inspector at Kingston to oversee the loading of vessels. Both efforts were refused largely due to the opposition of the Dominion Marine Association, the largest association of Canadian vessel operators (*Daily British Whig* 1905, 1906a). Intermittent and unsuccessful efforts followed with no load line regulations being enacted in Canadian inland waters until after sailing commerce had ended.

In May 1888, the United States House of Representatives convened an investigation into the high lake vessel losses of the previous season, totaling 73 vessels. The investigation focused on overloading and the efficacy of enacting load line legislation for American vessels. The inquiry found that neither the Commissioner of

Navigation of the Bureau of Navigation, nor the U.S. Steamboat Inspection Service held the necessary authority to enforce load line regulations and no legislation followed (U.S. Congress 1888:1-2).

While intermittent efforts to introduce legislation requiring load lines and restricting overloading were introduced in the United States Congress, nothing came of such efforts until the Load Line Act of 1929, which explicitly exempted Great Lakes vessels (U.S. Congress 1929a, 1929b). It was not until the Coastwise Load Line Act of 1935, too late to have influenced sailing vessels, that load lines were required on the lakes (U.S. Congress 1935).

Another means of increasing the freight volume carried by a vessel was the use of towing. In the days before the enactment of the McKinley Tariff in 1890, the small schooner *Robert McDonald*, with a capacity of only 4,000 bushels was able to double its profits by taking advantage of high grain rates, and make three trips between Prince Edward County and Oswego under tow, though the grain rush at Oswego caused by the tariff was atypical (Snider 1945).

Towing became common for sailing vessels on the Great Lakes from the 1840s, with vessels being taken in tow for the transit of the Detroit and St. Clair Rivers, through the Sault Sainte Marie and Welland Canals, as well as for movement within harbors between anchorage areas and the wharves where they were loaded and unloaded. By the late 1840s and 1850s, sailing vessels were reliant on towing for daily operations in confined waters, particularly within ports (Warner 1998:45-49). Towing added reliability to sailing schedules, for vessels formerly might have been windbound for days or weeks.

The unavailability of tows or by the failure of negotiations on the rate to be paid still caused delays, however. By towing for portions of their voyage, sailing vessels were able to complete more trips every season, albeit while incurring added expenses. Towing bills often comprised 20-34 percent of a vessel's expenses, an amount exceeded only by the wages of the crew (Warner 1998:50,52).

The realization that aging schooner hulls could make a profit at the end of a towline was recognized by the 1860s, and many schooners and sailors ended their careers at the end of a towline. While seen as an ignominious end for their vessels by sailors, towing permitted sailing vessels to complete more trips within the sailing season, maximizing their freight revenues by supplementing the carrying capacity of the towing steamship without a significant increase in operating costs and with the reliability of steam navigation. As a result, an inexpensive sailing vessel could be made profitable, though the sailing vessel itself was reduced to an auxiliary hold. Fixed costs could be reduced further by reducing the rig by removing the topmasts, raftee, gaff topsails, and jib booms, reducing the crew complement needed to sail the vessel, and offering savings on maintenance and material replacement costs (Carrell 1985:14-15).

As employment prospects diminished in sail and with sailors excluded from employment in steam due to licensing requirement, acceptance of work aboard schooner barges brought with it loss of status and some of the lowest-paid labor on the lakes (Martin 1995:197).

Sailing Labor on the Great Lakes

Thin financial margins and falling revenues demanded a reduction of expenditures for sail to remain financially viable. Crew wages, which were consistently the largest expense in operating a vessel, represented the most reliable means of reducing fixed operating costs (Martin 1995:144). Edward Warner's analysis of the schooner *Exile's* financial accounts for 1879 shows the importance of wages to the finances of a schooner. *Exile's* annual expenses totaled $8,015.70. Of these expenses, $2,719.14 was spent on the crew's wages or 33.9 percent of the vessel's costs, while "Extra Labor" accounted for an additional $1,493.36, or 18.6 percent (Warner 1998:52). Reducing the crew size meant further saving on associated expenses such as provisioning and accommodation (Souza 1998:107).

As a result, under-manning was ubiquitous aboard small sailing vessels in the waning years of sail. As noted previously, investments by owners in increasingly efficient marine technologies allowed improved efficiency of shipboard labor and was concentrated in labor-intensive tasks or tasks which occupied much of the crew's time, thus allowing fewer crew to operate the vessel under normal conditions.

In a 1914 article, the *Toronto Globe* noted, "Undermanned schooners have sailed and will continue without accident when weather is favorable," citing that *William Jamieson*, a sistership to the *Katie Eccles* built by Wm. Jamieson the year following the *Eccles*, was then crewed by three men and a boy, with two women also aboard, leaving only 2 men and a boy to handle the sails. The article further remarked that the donkey engine "that displaces men for trimming and setting canvas is a fair-weather contrivance.

With a wheel-chain parted or jammed, two men would be needed at the tiller. It is almost always in stress of weather that lines part, seams open, or pumps break down (*Toronto Globe* 1914).” The *Katie Eccles* is a glaring example of the extremity that under crewing might reach. In 1906, the *Eccles* was reported to have been crewed by five men and a cook. In November 1922, it sailed very late in the season with a crew of only three (*Daily British Whig* 1906b; Snider 1943).

Sail labor on the Great Lakes was characterized by short-term employment with rapid turnover of crews, with forecastle hands often signing on for a single trip, sometimes for as short as a single trip of two days (Martin 1995:84). As demand for labor aboard steam vessels increased, experienced seamen were increasingly drawn to steam, with its higher pay and more consistent employment, particularly from the 1890s, as steamship lines shifted towards hiring from shipping offices and long-term employment.

While wages were typically higher on the lakes than were available for wage labor ashore, wages aboard schooners varied considerably throughout the shipping season and year to year with variations in the availability or scarcity of labor, fluctuating freight rates, and the influence of collective actions by both labor and vessel operator associations (Larrowe 1959:12). During periods where the potential for profits was high, particularly late in the shipping season when freight rates reached high premiums, wages increased substantially (Martin 1995:131,144).

In 1818, monthly wages averaged $10.00 for seamen, $25.00 for cooks, $25.00-30.00 for mates, and $40.00-50.00 for masters. By 1836 monthly wages for seamen had increased to $15.00, to $36.00-$60.00 for first mates with masters making $600.00-1000.00 annually (Martin 1995:145). Karamanski notes that in the prosperous years of the 1860s and 1870s, rates of $1.25 and up to $2.50 per day late in the season were typical (Karamanski 2001:107-108).

The accounts of the schooner *Russel Dart* from 1860 and 1861 show the extent to which wages changed throughout the shipping season. In April 1860 and 1861, seamen received average monthly wages of $24.14. As freight rates decreased into the summer, seamen's wages decreased to $21.19, $17.77, and $22.00 in May, June, and July. In August, wages began to increase, and seamen received $24.33, $24.28, and $36.88 in August, September, and October respectively. In November and December, very late in the season, wages increased to $65.02 and $243.75 per month, though it should be noted that seamen typically signed on by the day, and work for more than a few days in December was atypical (Martin 1995:145-146).

Steamer crews received higher pay than their sailing counterparts, with some notable exceptions. An 1890 census report accounting for 1,072 steam and 758 sailing vessels, recorded average monthly wages for sailing masters at $77.18, while their counterparts on steam vessels received $109.15 monthly. First mates on sailing vessels received just $52.14 monthly in contrast to $71.56 for those on steamships. While such disparity in wages was consistent across nearly all positions, seamen received $38.39 in sail and $35.96 in steam. This higher pay in sail for seamen likely resulted from the increased responsibilities and lack of consistent watch schedules as well as the need to go aloft (Mansfield 1899:485-486; Martin 1995:148-149). A schedule of standard wages published at Cleveland on 21 March 1902 established monthly rates of $70.00 and $55.00 for first mates in sailing vessels of the first and second classes, $50.00 for second mates, and $45.00 for cooks and seamen. Meanwhile, wages among first mates aboard steel steamers ranged from $78.00 to $96.00 and from $78.00 to $84.00 on wooden steamers with second mates earning between $54.00 and $66.00. Seamen on all vessels were paid $45.00 per month (Bureau of Navigation [BuNav] 1902:149).

For independently operated sailing vessels, hiring and setting wage rates was typically the master's responsibility. At the end of the 19th century, wage rates were increasingly influenced by the unionization of seamen and the establishment of associations of vessel owners, both of which intermittently published standardized wage scales. While the influence of the unions peaked in the 1880s and 1890s, the shrinking sector of labor in sail and the shift of the unions towards the representation of steamship labor meant that sailing vessels operated largely outside these restrictions, with wages negotiated by the master and potential hires (Martin 1995:83).

Wages aboard Canadian vessels were consistently lower than those on American vessels. In the 1870s and 1880s, Canadian seamen's wages averaged $1.00 per day at Kingston when signed on with a vessel. Those working aboard barges were paid considerably lower wages, earning from as much as $1.00 per day to as little as $10.00 per month (*Daily British Whig* 1888).

While masters resorted to reducing their crew to cut costs and increase the dividends of the owners and often themselves, the reduction of employment within sail had adverse effects on the sail labor, not least of which was an increasing scarcity of experienced seamen. Between 1889 and 1906 the number of individuals employed on the lakes on sailing vessels decreased from 5,758 to 2,258. Of those remaining in sail, 768 were employed on schooner barges and 1,490 individuals were working aboard independent sailing vessels (Straus 1908:145). As the availability of experienced seamen decreased, vessel operators were increasingly confronted with an inability to obtain sufficient crews to operate their vessels (Foulke 1963:122).

The system of apprenticeship, whereby unskilled hands acquired the skills of the sailor's trade, was a slow process. As opportunities for shipboard employment diminished, so too did opportunities for new hands to acquire the skills of the trade by apprenticing with experienced seamen. As a result, the labor force under sail suffered a deskilling of the trade, which increased competition for employment between unskilled laborers who could be paid lower wages and higher-paid experienced seamen (Martin 1995:171).

The issues of availability of labor were aggravated by the high turnover of labor aboard lake vessels. Emil Frankel's analysis of labor turnover in lake shipping for the year 1917 found that, despite significantly higher pay, 66 percent of the unrated crew aboard bulk carriers were employed for less than one month aboard the same vessel, with an additional 18.9 percent serving between one to three months. Aboard steam vessels employed in the lumber trade, 49 percent were employed longer than one month, with 29.5 percent employed between one and three months, 9 percent between three and six months, and only 12 percent remained longer than six months (Frankel 1918:49-51).

No comparable information is available for sailing vessels in 1917. The account books of the schooner *Russel Dart* from 1860 to 1861 shows that mates remained aboard for an average of just over four months. Stewards and cooks remained two and one-half months. Seamen typically stayed on between one and a half months and two months (Martin 1995:94). Masters often discharged the crew while idling in port to avoid incurring additional wages while awaiting improvement of freight rates or dock space, though this might result in delays in obtaining a new crew when departing (Hoaglund 1917:26; Karamanski 2001:105).

The innovations and improvements in shipboard machinery alleviated, at least in part, many of the most labor-intensive tasks and increased labor efficiency, but crew complements were reduced and labor conditions were often negatively affected. Though tasks might now require fewer hands, the individual demand placed upon the remaining hands was increased.

This was further exacerbated by the lack of watch and watch schedules, a common practice aboard trading vessels engaged in short trips. Douglas Bennet notes a near-universal lack of watch and watch schedules aboard trading vessels, the comparatively short passages, and minimal crew prioritized the completion of the trip over the fatigue of the crew (Bennet 2001:15). To avoid delays in awaiting docking, sailing masters often sought to arrive early in the morning to load and return the same day. This meant overnight runs, which in turn required that the crew to work through the night (*Daily British* Whig 1897; Snider 1932, 1943).

The labor of the crew did not necessarily cease once mooring lines were made fast, as masters and mates oversaw the lading and trimming of the vessel (Snider 1931). The crew might assist the stevedores by shifting the vessel and handling lines or, more rarely, by loading and unloading the vessel themselves, particularly in ports where longshore labor was unorganized or unavailable, or where loading occurred outside of established dock facilities, such as in the lumber trade (Martin 1995:58). These strenuous schedules with long and inconsistent hours imposed immense strains on crews throughout routine operations, and when combined with under crewing, had the potential for catastrophic consequences in emergencies.

The emerging dominance of steam vessels in Great Lakes freight transport and the transition of the majority of those employed in lakes shipping to steam brought substantial shifts in the status and traditional occupation structure of labor on the Great Lakes. By the end of the century, the divergent systems of management, increasing segregation of sail and steam labor forces, and vast differences in shipboard life and labor structures could be said to have resulted in the emergence of separate maritime cultures. That of sail was characterized by traditional independently operated vessels, and apprenticeship, while the other was characterized by industrial organization, corporate management, and technical specialization.

This divergence of competing maritime cultures was evident in the inability of maritime labor on the lakes to effectively organize as interests diverged and antipathy increased between sail and steam laborers. Early efforts towards unionization by lake seamen on the lakes had begun with the establishment of the Seaman's Benevolent

Union of Chicago in 1863, a professional society of sailing lake men intended to aid the mutual improvement of its members and by extension their trade, rather than for any economic ends. While this organization proved short-lived, it was revived as the Lake Seaman's Benevolent Association in 1878, this time with the stated intention of influencing wages (Hoaglund 1917:10).

Membership in early labor unions was restricted to those possessing traditional skills in sailing seamanship, thus defining the limits of their profession and the standards of professionalism to deliberately exclude steam laborers, who were seen as unskilled and an afront to the profession (Hoaglund 1917:13). This enmity was in no small part founded in fundamental differences in the means of acquiring the skills of their respective professions. Among sailors, the skills of seamanship were traditionally acquired through an apprenticeship, with individual advancement determined by experience. While requirements for certificates of competency set formalized requirements for officers on applicable vessels, few barriers prevented a sailor's advancement from deckhand through the ranks of seaman, able seaman, and mate. During the 19th century, an ambitious sailor might reasonably expect to become a master and to attain ownership or part ownership of the vessel they sailed. Accordingly, the system of apprenticeship allowed the prospect of substantial upwards social mobility among sailors (Martin 1995:182).

Apprenticeship had important implications for the specialization of labor on sailing vessels as well. As a result of this apprenticing, the sailing master knew all of the skills performed by those under his command, and while the master remained the ultimate authority and responsibility for the operation of the vessel, those aboard shared a common professional skillset acquired through experience and a high level of competency in operating their vessels (Hoaglund 1917:160-162,166; Daley 2018:120).

In contrast, the increasing technical complexity of steam vessels throughout the 19th century resulted in a high degree of specialization among steamer crews. This separation was reinforced by regulations requiring certificates of competency which required formalized education, establishing a more rigid hierarchy of labor aboard. The result was that the steamboat master was primarily concerned with the effective management of the vessel on behalf of the owners rather than extensive knowledge of the vessel's machinery. The latter was the responsibility of the chief engineer. As a result, each position aboard steamships possessed a narrower skillset which was not necessarily shared by others within the crew, and had duties not shared by others (Martin 1995:183).

Matthew Daley notes that in contrast to the relative social mobility afforded in sail, steam labor was characterized by credentialed specialization, in which individual ratings fulfilled a limited role (Daley 2018:120-121). In British Canada, licensure requirements for engineers were established with the Inland Navigation Acts of 1845, was amended in 1859, and reaffirmed by the new Dominion government in 1868 and 1882. Canadian lake masters and mates were not licensed until 1883 (Martin 1995:191-192).

In the United States, the Steamboat Act of 30 August, 1852 established the Steamboat Inspection Service under the Department of the Treasury, which instituted licensing requirements for steam masters and engineers with no corresponding regulation of sailing vessels. Certificates of competency in sail were not required in the United States until 1898, and even then this requirement applied only to officers of vessels exceeding 700 gross tons. The Seamans Act of March 4, 1915, instituted licensure requirements for able-bodied seamen, by which time American sailing vessels had largely disappeared from Lake Ontario (Martin 1995:191).

For sailors, professionalism within their trade was defined as broad competency in seamanship, including a knowledge of all skills of operating the vessels required of their ratings. Among steamship labor licensure and formal education in navigational schools came to define professionalism, a definition which deliberately excluded apprenticed sailors (Martin 1995:181). In contrast, the limited scope for practicing the skills of seamanship on steamers represented a debasement of professional seamanship to sailors. This perceived affront was amplified by the higher pay and increasing enfranchisement of steam in organized labor at sail's expense (Hoaglund 1917:13, 25; Martin 1995:181). The result was continual conflict between sail and steam labor throughout the latter years of the 19th century.

In 1863, 93 percent of all tonnage on the lakes was still in sailing vessels (Marine Review 1904:30). As a result, when the first efforts to organize labor on the lakes began, sail labor controlled unionization efforts. When the Lake Seamen's Union was founded in 1878, its rolls were restricted to those with sail training. High demand for labor and prosperity of lake shipping in the late 1870s and 1880s favored unionization efforts, and throughout the 1880s, the Lake Seamen's Union pursued wage setting and closed-shop agreements with operators who were left without recourse but to agree (Larrowe 1959:12).

The Cleveland Vessel Owner's Association was established in 1880, followed by the rival Lake Carriers Association of Buffalo in 1892 to oppose to the unchecked control of the seaman's unions in setting wages (Martin 1995:72). These developments, while centered on the Upper Lakes, extended to Lake Ontario as attested by the establishment of local branches of both the Seamen's Union and an Oswego Vessel Owners Association affiliated with the Cleveland Vessel Owner's Association. The Oswego Vessel Owners Association attained some success in improving local commercial conditions, setting local towing rates at Oswego, which had been higher than average, reducing the cost of towing through the Welland Canal, as well as establishing standard freight rates from Oswego (*Oswego Daily Palladium* 1875, 1878a, 1878b, 1879a, 1879b, 1879c).

Early efforts to organize marine labor on the lakes were impaired by the inflexibility and unwillingness to unify among rivalrous sectors of labor on the lakes, as seen in the exclusion of steam-trained seamen from the Lake Seamen's Union. Exclusion not only limited organization of labor within what was a unified labor market, but also resulted in the emergence of competing marine labor movements including the National Marine Engineers Association, the International Longshoremen's Association, and the Marine Firemen, Oilers, and Watertenders Benevolent Associations, all of which competed to organize steam labor (Hoaglund 1917:31,46-49).

With sailors representing an ever-diminishing sector of marine labor, the Lake Seamen's Union and affiliates on the coasts formed the National Seamen's Union of America in 1892 and opened its rolls to some steam positions. In 1899, the union was extended to Canadian locals and was renamed the International Seamen's Union in 1899 (Hoaglund 1917:21-22). By the mid-1890s steam controlled the majority of the Seaman's Union rolls, and membership was extended in 1902 to deckhands on steamers (Larrowe 1959:15).

As steam labor increasingly came to control the nominally unified marine labor movement on the lakes, the union came to represent the interests of increasingly corporatized labor in steam. With diminishing influence, sail enrollment declined throughout the 1890s. As steam labor came to control the Seamen's Union, its leaders adopted an increasingly adversarial approach towards independent sailing operators characterizing sail as lacking standards of professionalism (Martin 1995:153-154).

By the end of the first decade of the 20th century, seamen aboard sailing vessels had largely withdrawn from the labor organizations they had established and which had ceased to advance their interests.

With sail-trained labor largely withdrawing from organized labor, the Seamen's Union found itself increasingly in opposition to other unions and associations of vessel owners. In 1892, the Lake Carrier's Association of Buffalo and the Cleveland Vessel Owners Association merged to form the Lake Carriers Association. At the same time, the Longshoremen's Union, established in that same year, increasingly competed for representation of labor, seeking to establish representation of all marine labor on the lakes (Larrowe 1959:14-15,19-27).

In 1908, after several years of cooperation and closed-ship agreements between the Seamen's Union and the Lake Carriers Association, the carriers ended relations with the unions, the Lake Carrier's Association adopted a union breaking stance, using stockpiles of commodities and anticipation of a slow shipping season to weaken the position of the unions. The Lake Carriers Association also enacted an open shop policy, establishing hiring offices and owner's union and standard wage scales of their own (Hoaglund 1917:78; Larrowe 1959:30-33,36). By the 1910s, the Lake Carriers Association had gained unilateral control of steam labor on the lakes. While some sailing vessels were operated by members of the Lake Carriers Association, these seem to have been primarily towed vessels, while independent sailing vessels run by largely unorganized labor and operators operated on the periphery, largely unregulated as unions shifted towards advancing the interests of steam (Larrowe 1959:14; Martin 1995:154).

The 1890s laid the foundations of what Matthew Daley characterizes as a "fully-integrated industrial system," forming the basis of the modern Great Lakes transportation system and economy. This system was characterized by the consolidation of steam tonnage in vertically-integrated corporate shipping fleets within their respective industries, detailed schedules, sailing times, all of which were controlled by shore management and carried out by the master, who possessed little autonomy (Daley 2018:11).

First implemented within John Rockefeller's Bessemer Steamship Company in 1895, shipping lines began operating based on annually-negotiated contracts for high-volume low-profit freight, rather than negotiating individual charters at fluctuating rates (Hoaglund 1917:25). With set amounts to be delivered at pre-determined rates, operators obtained consistent employment for their fleets and sought to improve the efficiency of each vessel and thereby maximize the profitability of the fleet. This combined with the improved economies of scale that could be realized by increasing the overall tonnage of individual vessels was the central motivating influence behind the seemingly exponential increase in the length and tonnage of bulk carriers in the 1890s and 1900s (Labadie 1989:28). These developments were accompanied by the increasing imposition of onshore management in the day-to-day operations of vessels, with the masters and chief engineer being issued orders and operating instructions including schedules for sailing times, fuel-consumption schedules, and set speeds along their routes (Hoaglund 1917:25; Daley 2018:122).

The shift brought further divergence in the structure of labor aboard sail and steam vessel. In independent sailing operations, the master was appointed by the owners of the vessel and possessed broad authority in nearly all aspects of the ship's operation throughout the shipping season. While the appointment of a knowledgeable master did much to ensure the profitable operation of the vessel, the position of a master was usually insecure if the master was not himself a part owner (Martin 1995:73). Even if the master were a part-owner, laws preventing the removal of a master that owned a minority share in a vessel were removed in 1872, making the position somewhat more tenuous (BuNAV 1895:50; Martin 1995:72). While the sailing master's independence was diminished by the increased involvement of owners in scheduling charters by the use of the telegraph, masters retained much of their traditional independence to the end of sail.

In the new system, the master of the steamship relinquished much of the autonomy and authority that they formerly held, reduced to middle management within the corporate structure without owning an interest in the vessels they operated (Hoaglund 1917:24-26,40; Martin 1995:171). In addition, the opportunity for upwards social mobility for the sailor traditionally presented by obtaining the rank of master and the opportunity for ownership of a vessel had long since been closing in steam.

The shifts in the management of steam were not all deleterious though. Despite the collapse of labor organization in the first decade of the 1900s, steam moved to a pattern of more secure and consistent employment, with crew members being incentivized to remain aboard for the entire season, to standardized and intermittently adjusted wage scales, to owner's beneficial programs possessing many of the benefits of unions, as well as to improved working conditions (Martin 1995:178).

All of these changes conspired to solidify the divide between sail and steam labor, almost exclusively at the expense of the less-efficient sailing vessels and the dwindling number employed in sail.

By the mid-1890s it had become apparent that there were few future career prospects in sail. Jay C. Martin notes that by 1884 and 1909 most new officers standing for competency examinations sought steam certifications. Sail, nevertheless, would persist into the fourth decade of the 20th century. Those who remained in sail did so for many reasons, including devotion to traditional seamanship, resentment of steamships and the seamen serving on them, or a refusal to stand for competency examination for steam and effectively starting over. While some were able to transition to steam, many retired from the lakes entirely. Others, particularly those who maintained certificates in both sail and steam transitioned into steam roles. (Martin 1995:170). The shift from sail to steam was not solely a shift in technology, but entry into a separate and unfamiliar maritime culture, one in which sailors saw their experience in sail count for little. For those who remained in sail, it was an ongoing struggle to secure themselves financially or to find alternate means of income as the end of their sailing careers approached.

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CHAPTER X

CONCLUSIONS

By the early 1880s, the momentum of shipping on the Great Lakes decidedly shifted in favor of steamships. While before the mid-19th century sailing vessels possessed a practical monopoly on the transport of the Great Lake region's bulk commodities, the latter half of the 19th century witnessed the establishment of steam's dominance in the bulk freighting economy and the foundation of the modern Great Lakes transport system.

The 1840s and 1850s witnessed the emergence of innovations within steam-propulsion technology and novel steam-driven propeller types, the steam barge and the bulk freight carrier, which heralded the entrance of steam into bulk freighting and, therefore, into direct competition with sailing vessels for control of that trade. The revolution in steamship transportation that followed between the late 1850s and the early 1900s was not technological alone but also brought fundamental and far-reaching changes to nearly all aspects of maritime life, labor, the management, and conduct of commercial transportation on the Great Lakes. Among these changes was an increase in the influence of onshore management to the detriment of the master's independence and authority aboard, the scheduling of nearly all aspects of operation, a shift towards seasonal contracts set at previously negotiated rates, and improved mechanized methods of handling bulk freights (Martin 1995:198-199; Rodgers 2003:27; Daley 2018:122-123).

These differences resulted in the emergence of separate maritime cultures among those working aboard sail and steam vessels. One was characterized by apprenticeship-based labor, a shared skill set, high social mobility, and independent ownership and operations under sail, the other by increasing corporate consolidation of ownership, limited social mobility, skills specialization, and operations under the oversight of corporate shore management (Hoaglund 1917:25; Martin 1995:177-202).

The gradual shift in the transport economy towards comparatively low-profit, high volume freight transport, enabled by the increased efficiency of steamships, mechanized bulk freight handling, and the concurrent exponential expansion of steam tonnage on the Upper Lakes, rapidly rendered sailing ships uncompetitive and unprofitable where these were in direct competition (Cooper and Jensen 1995:14; Meverden and Thomsen 2013:6).

The inter-lake trade on the Great Lakes was primarily eastbound, with the majority of trade on the Upper Lakes moving domestically between American ports or from American ports to Canada’s easternmost lake terminal, Kingston, for transshipment and forwarding down the St. Lawrence River to Montreal and Quebec City. The majority of eastbound trade on the Upper Lakes was shipped to the western terminus of the Erie Canal at Buffalo for forwarding further east, down the canal, effectively bypassing Lake Ontario.

Lake Ontario possessed a unique position among the Great Lakes, having both the smallest share of lake commerce and two of the three eastern terminals of the lake trade at Kingston and Oswego. Lake Ontario’s commerce with the Upper Lakes was constrained by the Niagara Falls, which prevented continuous navigation with the Upper Lakes, and by the rapids of St. Lawrence River, which limited navigation between the lower St. Lawrence Estuary and Lake Ontario. Both of these obstacles were overcome by the construction of the Welland and St. Lawrence Canals by the 1840s. While the canals permitted continuous navigation, their lock dimensions limited the size of vessels transiting to and from Lake Ontario and the Upper Lakes (Croil 1898:264-265; Ford 2018:87). The largest bulk carriers on the Upper Lakes, being unable to transit the Welland Canal, instead utilized Buffalo as the eastern terminus of their trade.

Lake Ontario's commerce was limited by the restrictions of the Welland locks and from the lack of coordination between the Canadian Welland and St. Lawrence Canals' locks before 1884, effectively limiting the competition with more efficient, and ever-larger bulk carriers operating on the Upper Lakes, for Lake Ontario shipping interests. As long as the Welland locks prevented passage by larger steamships, and tolls on the Erie Canal remained high, American and Canadian vessels carrying grain to Lake Ontario's terminals remained profitable, providing a lower-cost alternative route to bypass the tolls of the Upper Erie Canal. Steam vessels operating on Lake Ontario before 1884 were typically smaller than those on the Upper Lakes and less efficient, limiting the intensity of competition between steam and sail within the local trading economy. The result of these restrictions were local economic conditions favorable to sailing commerce. Within the comparatively small area of the lake, a local transport economy thrived with a distinctly international character.

Sailing commerce operating under canvas experienced a protracted end beginning in the mid-1870s. Though the decline of sail and the ascendency of steamships was certainly apparent by the 1880s, not least by those employed on sailing ships, sailing vessels persisted for another half-century, though in dwindling numbers (Martin 1995:170; Lewis 2015:352).

For vessels owned and operated from Lake Ontario ports, the pressures of steam competition were most acutely felt in the inter-lake trade through the Welland Canal, which came into direct competition with steamships on the Upper Lakes as they moved grain along the same routes. American sailing vessels on Lake Ontario were the first to decline on Lake Ontario, being almost entirely reliant on the grain forwarding trade with the Upper Lakes through the Welland Canal. The elimination of tolls on the Erie Canal in 1883, the continuation of tolls for the Welland Canal for some years thereafter, and the inability of shippers to avail themselves of the economies of scale afforded by larger vessels removed all remaining financial advantages of the Lake Ontario and Oswego Canal routes for American vessels. By the end of the 19th century, American sailing vessels had nearly disappeared on Lake Ontario (Larson 1983:53-54; Meverden and Thomsen 2013:7).

By the turn of the century, sail had found a temporary respite in the Canadian shore of Lake Ontario. Though the American forwarding trade increasingly bypassed Lake Ontario, for Canadian shippers the St. Lawrence River remained the principal outlet of the Great Lakes and for the Canadian grain forwarding trade. In contrast to south shore shipping, the Canadian shore of Lake Ontario possessed a thriving trade in grain and lumber, shipping these domestically to Kingston as well as internationally to Oswego. Much of this international trade, which consisted primarily of Canadian vessels exporting Canadian grain and lumber products to Oswego, was ended by the McKinley Tariff of 1890, leaving coal as the sole remaining commodity for sailing vessels (Palmer 1986:246-251; O'Connor 2010:11).

From the 1860s, anthracite coal became an increasingly important export from New York ports, brought to the southern shore of Lake Ontario by rail from Pennsylvania and carried across the lake to Canada. With small charters hired directly by consumers, with their low operating costs, the comparatively short distances involved, and the prevalence of minimally-improved ports along the north shore and the Bay of Quinte, Canadian sailing vessels were ideally suited for this local coal trade. By 1910, the remaining sailing vessels and the New York coal ports were almost entirely dependent on the anthracite trade. It was in this trade that the sailing fleet would conclude its final years.

Following the enlargement of the Welland Canal in 1884 to the same dimensions as the St. Lawrence Canal's locks, and the introduction of canal-size steamships constructed specifically for the Welland Canal, steamship trade supplanted sail's former dominance in the Canadian grain trade through the Welland Canal (Duerkop 2017:3-6). With canallers able to steam from the Upper Lakes to the Lower St. Lawrence unobstructed, Lake Ontario ports were increasingly bypassed, their role as transshipment ports being gradually eliminated as steam vessels passed to terminals down the St. Lawrence River (Gilmore 1957:97; Duerkop 2017:6).

Through all of these developments, sailing operators were not passive onlookers. The Last Schooners Project's pilot season, which surveyed the two-masted schooner, *Katie Eccles*, sought to document the archaeological legacy of these last sailing vessels operating on Lake Ontario and the changes they underwent as sailing operators sought to compete with steam and were gradually overtaken. The increasing pace of industrialization brought significant technological changes to sailing vessels, which altered life aboard and enabled sailing vessels to remain financially viable despite their changing economic circumstances during the last half-century of sailing commerce.

This process of adaptation was ongoing throughout a vessel's service life, from its design and construction to intermittent rebuilds and refits. This adaptation to economic needs is evident in the reconstructed hull and analysis of the *Eccles'* hull design, which showed a vessel well-adapted to the requirements and conditions of local trading, and contrasting with hulls of sailing canal vessels. The *Eccles'* hull shares many common characteristics with *Eliza Fisher*, a contemporary two-masted schooner operating on Lake Ontario. Both vessels share a similar hull form that seems to have prioritized good sailing characteristics over maximum capacity. Thus, the *Katie Eccles'* hull was likely designed for intensive competition in short-distance during a short sailing season, in which profitability was based on completing as many trips in the season as possible. Further analysis of hull forms from the Great Lakes is needed to contextualize the development and uniqueness of such hull forms, an effort impeded by the lack of available ship lines; however, the methodology used herein and the proliferation of three-dimensional modeling provides an opportunity for further research. Furthermore, shipbuilding practices were increasingly regulated and standardized under the influence of underwriter's regulations, the influence of which is apparent in the *Eccles'* construction.

Under increasing financial marginalization, owners and masters sought to keep their vessels in service by any means possible. This resulted in fundamental changes to shipboard routines and work, but often had negative implications for the sailors and the sailing labor force in general.

Among the more beneficial changes for ship owners was the adoption of new marine machinery and technologies that were being introduced at a rapid pace in the latter half of the 19th century. The use of wire rope rigging was one such innovation, offering improved reliability and function while costing less on the initial purchase and saving on labor to maintain the rig. Other innovations in marine machinery sought to increase the efficiency of shipboard labor, particularly for labor-intensive tasks requiring multiple crew members. Perhaps most important among these novel marine technologies was the introduction of auxiliary steam power in the form of the donkey engine and the steam-powered hoisting engine, as attested on the *Eccles.* Such donkey engines assisted the crew in the loading, unloading, sail handling, and numerous other routine tasks.

The Last Schooners Project's investigation of the *Katie Eccles* provides significant evidence for the selective processes by which operators adopted novel technologies to the end of remaining financially viable, while the history of its loss belies some of the negative effects that accompanied these changes. The improvement of labor efficiency aboard brought with it the compelling and cost-saving temptation to reduce the crew to an absolute minimum to save on wages and other associated expenses that accompanied the crew. Increasing financial pressures made under-manning endemic on sailing vessels by the end of the 19th century, whether for financial reasons or as a result of the dwindling availability of experienced sail laborers. This contributed towards worsening labor conditions aboard, as the work of the now-absent crew was taken on by those few who remained.

These worsening working conditions were accompanied by an increased acceptance of risk and pervasive overloading of nearly all vessels. All the while, the sailor was largely without regulatory protections or recourse through labor unions by which to seek redress for their grievances and the dangers they faced, the unions having been co-opted by the steam labor as the importance of sailing labor diminished (Larrowe 1959:14; Martin 1995:154; Souza 1998:114-121).

The first two decades of the 20th century witnessed sailing vessels rapidly dwindle in numbers. By the 1920s, they represented a small minority of tonnage and vessels operating on the Great Lakes. Attrition among the remaining sailing vessels ensured an inevitable end to sailing commerce. The retirement of *Lyman Davis* in 1932 brought an end to the era of commercial sail on the Great Lakes. The wrecks of these last sailing vessels remain, providing an exceptional archaeological testament to the final years of sailing commerce. Among these ships, *Katie Eccles* is one of relatively few archaeologically studied commercial vessels on Lake Ontario and an important example of a trading schooner.

With an abundance of historical sources documenting its operations and its well-preserved remains, the *Eccles* provides an important archaeological example of one such sailing vessel. *Katie Eccles* has produced important data for Great Lakes wooden shipbuilding techniques and hull designs in the last quarter of the 19th century, as well as evidence for the central role of insurance underwriters in the refinement and standardization of shipbuilding techniques and the proportioning of scantlings. Furthermore, the *Eccles'* well-preserved assemblage of deck machinery and wire rigging provides a presently unparalleled glimpse at technological innovations and implementation aboard Great Lakes vessels near the end of sail commerce.

Though in their later years, vessels such as the *Katie Eccles*, *Lyman M. Davis*, *Julia B. Merrill* and *Oliver Mowat* received scarce attention in newspapers and among historians, these schooners and their archaeological remains provide testament to the final years of traditional inland sailing commerce on the Great Lakes. Accordingly, their historic significance was disproportionate to their dwindling economic importance.

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