

Transition from Sail to Steam on the Great Lakes in the Nineteenth Century

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Contrairement aux autres principales régions de navigation intérieure en Amérique du Nord, la région des Grands Lacs a soutenu un marché concurrentiel de la voile bien après l'introduction des bateaux à vapeur. En effet, le point de transition majeur vers la fin du siècle qu'a signalé l'apparition des vraquiers classiques à coque de fer et d'acier dénommés « laquiers » représente un aspect important de l'historiographie du transport maritime sur les Grands Lacs. Les données sur le tonnage déclarées par l'U.S. Bureau of Navigation ont tendance à appuyer cette évaluation, mais il importe de les examiner de plus près. Le présent document porte donc sur la provenance de ces données, c'est-à-dire les rapports sur le tonnage du bureau de douane, dès les années 1830. Au-delà de ces comptes rendus, l'auteur traite également des mouvements de navires, des stratégies de remorquage et, finalement, des écarts généraux dans les structures d'investissement. Lorsqu'il y a suffisance de preuve, les comparaisons tiennent compte de la région des Grand Lacs des deux côtés de la frontière internationale.

From small vessels the vessel owners got to using large barks and schooners, and from these they turned to investment in wooden steamers and tow barges. Now the tendency of investment is in the direction of large and fast steel steamers capable of carrying from six to 10 times the cargo of the average vessel of 20 and 30 years ago. The competition of such large craft has made the lake trade unprofitable for the “small fry,” and instead of longing for more vessels of that kind owners are willing to get rid of what they have. In the opinion of lake investors, a small vessel that goes to wreck without loss of life and with a fair amount of insurance, is a ship well sold.¹

In broad strokes, this hard-headed assessment of the transition from sail to steam, written at the end of the nineteenth century, is echoed in most of the literature on the subject. The story

¹ *Duluth News Tribune*, 27 April 1896, 2.

that triggered these musings highlighted major improvements in salvage gear and techniques, and discussed the viability of recovering some of the many vessels scattered about the bottom of the Great Lakes. Few would be worth the effort, the newspaper editor concluded, with the possible exceptions of the *Pewabic*, with its cargo of copper, and the *Cayuga*, with its modern steel hull. His conclusion was simple: changes in steam-propelled vessels in the previous decade and a half had rendered everything built prior to that point obsolete.

Those abandoned shipwrecks remain mute testimony to the uniqueness of the Great Lakes. Not only do the Lakes hold the world's largest supply of surface fresh water, but they offer inland navigation stretching over a thousand miles into the heart of North America. The nineteenth century application of steam to navigation rapidly transformed transportation on many inland waterways, those of the Hudson River and the Mississippi-Ohio system perhaps the most prominent among them. Where sloops on the Hudson and flatboats and keelboats further west were soon displaced by an expanding fleet of steam-propelled craft, on the Lakes commercial sail persisted into the twentieth century. In this respect, the navigation of the Great Lakes had more in common with coastal shipping both in North America and abroad where sail remained a viable alternative through most of the nineteenth century.²

During the War of 1812, substantial squadrons of sailing ships had navigated the Lakes. The largest vessel to be put into service, HMS *St. Lawrence*, at 2,305 tons, would be the single Royal Navy ship of the line ever confined to fresh water. With a loaded draught of twenty feet she would have been incapable of entering most ports of call on the Great Lakes in the nineteenth century.³ Barely a year after her launch, the return of peace freed investors on both sides of the border to begin plans to deploy steamboats, the first two of which went into service on Lake Ontario in the spring of 1817. Well over a century later there was still working sail on the Lakes.⁴

There has been a general consensus among Great Lakes historians that the transition from sail to steam as the dominant technology in Lakes shipping happened at some point between 1868 and 1885. John Jensen declared that "until about 1875 the wooden schooner,

² The various studies by John Armstrong of coastal shipping in Britain demonstrate this. John Armstrong and Philip S. Bagwell, "Coastal Shipping," in Derek H. Aldcroft and Michael J. Freeman, eds., *Transport in the Industrial Revolution*, (Manchester, 1983), 142-75; John Armstrong, "Climax and Climacteric: The British Coastal Trade, 1870-1930," in David J. Starkey and Alan G. Jamieson, *Exploiting the Sea: Aspects of Britain's Maritime Economy since 1870*, (Exeter, 1998), 37-58; John Armstrong, "Coastal Shipping: The Neglected Sector of Nineteenth-Century British Transport History," *International Journal of Maritime History*, VI, No. 1, (June 1994), 175-88.

³ Jonathan Moore, *Shipwrecks from the War of 1812 at Kingston, Ontario* (Kingston, 2008), 15. Jonathan Moore, "Frontier Frigates and a Three-Decker: Wrecks of the Royal Navy's Lake Ontario Squadron," in Kevin J. Crisman, ed., *Coffins of the Brave: Lake Shipwrecks of the War of 1812* (College Station, Texas, 2014), Appendix A, 371. It is worth noting that news of peace came before the Americans could launch their ships of the line or the British put into commission the two additional vessels they had been building.

⁴ *Our Son*, the last working schooner built on the Lakes sank with her cargo in 1930. The only cargo carrying sail vessel after this was the *J. T. Wing*, an import from the east coast which operated only a few years on the Lakes before being retired. Theodore J. Karamanski, *Schooner Passage: Sailing Ships and the Lake Michigan Frontier* (Detroit, 2000), 222-23. "The Schooner J. T. Wing Becomes Detroit's Marine Museum," *Telescope*, L, 1, (January - Apr. 2002), 5.

... was the most important vessel built on the lakes.”⁵ Theodore Karamanski, in a study focused on sail, noted that “it was not until 1868 that the number of sailing vessels peaked on the Great Lakes, at 1,855.” He later adds that, if one considered tonnage, the size of the sailing fleet actually peaked in 1873, as larger vessels replaced smaller, older ones.⁶ Bruce Bowlus, summarizing the evidence from 1861 declared: “Without question, sails rather than smokestacks dominated the horizons.”⁷

The evidence upon which these claims are based is worthy of closer inspection. Take for example the number of sailing vessels noted by Karamanski for 1868. He cites James C. Mills in *Our Inland Seas* who supplied the number without attribution or qualification.⁸ The number was first published by the Bureau of Statistics of the US Department of the Treasury, which had aggregated numbers reported by the individual American customs districts relative to the vessels documented in those offices. The number 1,855 from the 1868 report is the sum of the sail vessels on the “Northern Lakes,” which district included the 166 sailing vessels enrolled on Lake Champlain. Subtract those and we are left with 1,689 vessels on the Great Lakes from that year. Quoting either number, however, without qualification, flies in the face of the reality that the Great Lakes are international. If we add all the sail vessels registered in ports in Ontario in 1867 (305 schooners, barques, brigantines and sloops), the answer for the whole number of sailing vessels on the Great Lakes in 1868 might be closer to 1,994.⁹ Was 1868 the peak year for commercial sail on the Great Lakes? Seven years later the American fleet had rebounded to a number of only 44 fewer hulls, but of greater tonnage. Indeed, from 1873 to the end of the century, the sail tonnage on the Great Lakes as Americans defined “sail” and “tonnage” was never less than it had been in 1868.¹⁰

If one narrows the scope of the transition to the question of the technologies deployed in the movement of bulk freight then there is no debate about the impact of iron and steel bulk freighters driven by coal-fired, triple expansion engines, which appeared in the last two decades of the century. Where 300-foot hulls strained the limits of wooden shipbuilding technology, by 1900 the newest ore carriers were just short of 500 feet, with

⁵ John Odin Jensen, “Great Lakes,” in John B. Hattendorf, ed. *Oxford Encyclopaedia of Maritime History* (Oxford, 2007), II, 109.

⁶ Karamanski, 22, 36.

⁷ W. Bruce Bowlus, *Iron Ore Transport on the Great Lakes: The Development of a Delivery System to Feed American Industry*, (Jefferson, NC, 2010), 85. Note that our arithmetic relating to this specific piece of evidence differs. From two different sources quoting the Board of Lake Underwriters register for 1861, Bowlus calculates the value of the sailing fleet as 62.8 percent of the total value of the fleet. My calculations in table 2 yield 53.8 percent.

⁸ James Cooke Mills, *Our Inland Seas: Their Shipping & Commerce for Three Centuries* (Chicago, 1910, rep. Cleveland, 1976), 183.

⁹ Note that there is no corresponding number for the 1868 season. “Recapitulation, Province of Ontario” in “Return of Vessels owned and Registered in the Dominion of Canada, on 1st July 1867,” Canada, *Sessional Papers*, no. 73 (1868). While many Great Lakes steamboats were registered in Montreal, Quebec, only sailing vessels transferred from American registry used that those registers.

¹⁰ The numbers supporting this paragraph are all cited in the figures and tables that follow. Note that Karamanski was well aware that the tonnage had plateaued at a number higher than 1868.

larger vessels quickly following.¹¹ While some have claimed that this is the defining point of transition, I will argue that what happened in the 1880s is a shift in strategies for utilizing steam power in a single, albeit significant, trade on the lakes.¹² To understand the transition from sail to steam, other evidence has to be brought into consideration.

It should be further noted that this is not a paper about the evolution of tonnage measurements. There are excellent overviews of this process by Lyman and Salisbury that date from the 1940s and 1960s.¹³ The challenge that is addressed here is the lingering assumption that the formulas used on the Great Lakes in the nineteenth-century allow comparison between sail and steam without close examination.

What follows are a series of data sets and observations that provide some insight into the shifting balance of the deployment of sail and steam on both sides of the border in the Great Lakes region. By itself the count of commercial hulls is a weak indicator of the size of a fleet. There is data, albeit flawed, that offers a view of the size of the vessels in service on both sides of the border. Other data gives a general idea of the relative investments in ship technologies. Beyond that, this paper explores, at a very high level, the emerging interdependence of steam and sail in the business of towing. Finally, some preliminary data looks at the relative activity of the fleets both in terms of tonnage entering port, and the miles travelled by that tonnage.

1. American Tonnage

The typical measure of fleet sizes in the nineteenth century is that of tonnage. Tonnage is a measure of volume, not of mass. None of the references to “tons” that follow will involve cargo weight, vessel weight or displacement tons.

The single most comprehensive set of evidence of the deployment of sail and steam comes from a set of statistics published by the United States Bureau of Navigation, and before that by the Bureau of Statistics within the United States Treasury Department. Prior to the establishment of the Bureau of Statistics, a much simpler version of these statistics appeared in a table appended to the US Treasury Department’s annual *Report on Foreign Commerce and Navigation*. The next section will consider tonnage reports from Canadian sources, but the aggregated American data is much more consistent, covering in some fashion most years after 1830.

Prior to 1830 there is no systematic reporting of tonnage. The best estimates of the fleet that have survived suggest perhaps 4,500 tons of shipping on the American side in

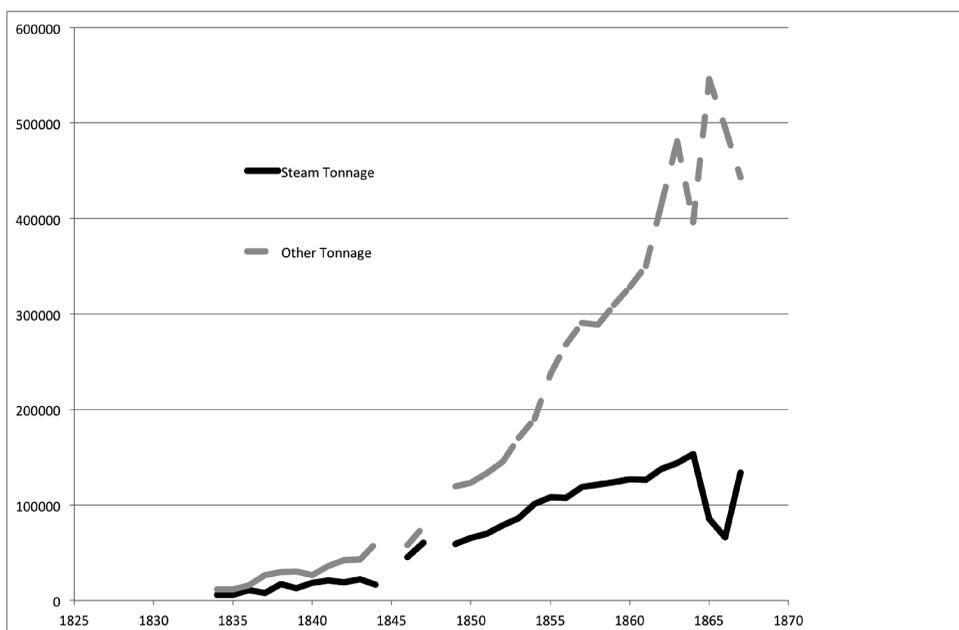
¹¹ Gary Dewar, “The Smallest 500-footers,” *Telescope*, XXXIX, 3, (May-June 1990), 59.

¹² Mark L. Thompson, *Steamboats & Sailors of the Great Lakes*, (Detroit, 1991), 36.

¹³ The best account of this is a two part series by John Lyman, “Register Tonnage and its Measurement,” *American Neptune* V, (July 1945): 223-34; (Oct. 1945): 311-25. W. Salisbury, “Early Tonnage measurement in England,” *Mariner’s Mirror*, LII (1966): 41-51, 329-40; LIII (1967): 152-64, 251-64; LIV (1968): 69-76. See also Yrjö Kaukiainen, “Tons and Tonnages: Ship Measurement and Shipping Statistics, c. 1870-1980,” *International Journal of Maritime History* VII (1995): 29-56.

1819.¹⁴ Of this the steamboats *Ontario* (231 tons), *Sophia* (49 tons) and *Walk-in-the-Water* (338 tons) account for a total of 618 tons or about 14 percent of the total. Of the Canadian steamboats in 1819, *Frontenac* was larger than the combined American steam tonnage at around 700 tons, while *Charlotte* (about 150) and *Dalhousie* (about 50), add to the total. Unfortunately, the Canadian sail fleet is inadequately documented, so no ratio can be estimated.

Figure 1: U. S. Tonnage 1831-67¹⁵



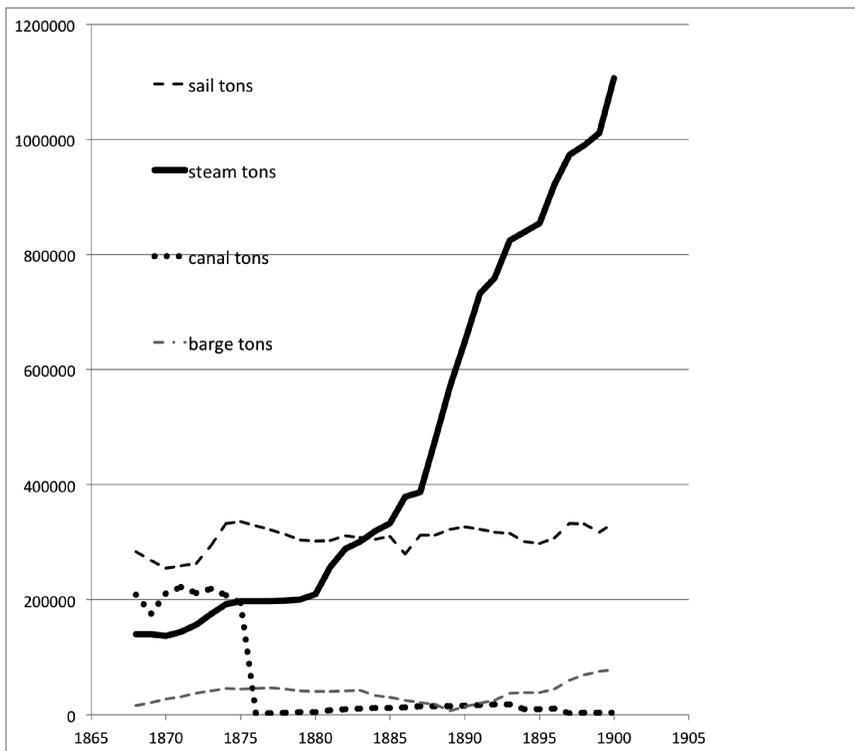
Source: United States, Treasury Department. Annual reports of Foreign Commerce and Navigation 1831-1867

¹⁴ For Lake Ontario there is a widely reprinted accounting from the *Sacket's Harbor Gazette*, which in the spring of 1819 listed fifty-one vessels with a total burthen of 2,531 tons, of which almost half was enrolled in Sackets Harbor. (D. Ford, "List of Vessels Employed in the Coasting Trade, on the American side of Lake Ontario," *Rochester Telegraph*, 30 March 1819). The aggregate above Niagara Falls comes from C. H. Keep, "The Commerce and Shipping of the Great Lakes," *Report on the Internal Commerce of the United States for the Year 1891, Part II of Commerce and Navigation: The Commerce of the Great Lakes, the Mississippi River and its Tributaries*, (Washington: Government Printing Office, 1892), 16, and is for 1816. The tonnage for the American steamers is drawn from their respective enrollments, while the Canadian numbers are from *Chronicle & Gazette* (Kingston), 22 November 1843.

¹⁵ The values for all of the figures follow the paper on page 27.

Figure 1 charts the aggregated tonnage from the customs districts on the Great Lakes up to 1867. One of the routine tables in the annual “Report on Foreign Commerce and Navigation” reported total tonnage by customs district and then in a separate column supplied a sub-total for tonnage employed in “steam navigation.” In this figure the “other tonnage” is the result of aggregating the results for the Great Lakes districts, and then subtracting the steam tonnage from the total. The returns consistently show a ratio of non-steam to steam tonnage between 3:1 and 3:2.¹⁶ At first glance, what appears to be of significance is a sharp decline in both absolute and relative size of the steam fleet in the period of the Civil War. The anomalies between 1864 and 1866 appear to be a combination of partial returns as the fleet was being re-measured and, more importantly, the decommissioning of a number of very large hulls and their conversion into barges intended for towing.

Figure 2 US Tonnage, 1868-1900



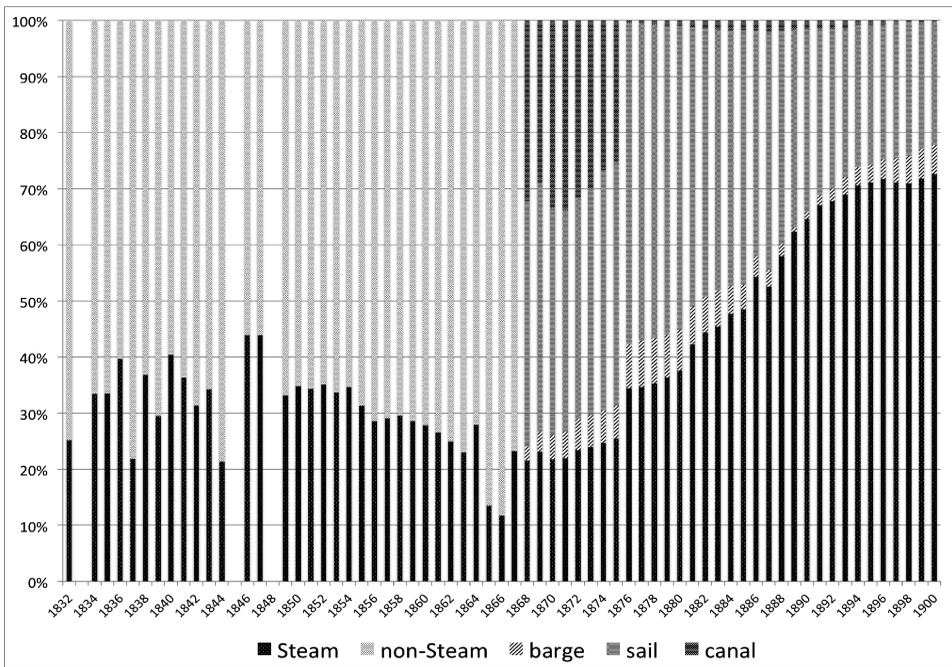
Source: “Number and Gross Tonnage of Sailing Vessels, Steam Vessels, Canal Boats, and Barges on the Northern Lakes, from 1868 to 1900”, United States, Bureau of Navigation, *Annual Report, 1900*, 388. In 1874, the Bureau of Statistics stopped reporting the tonnage

¹⁶ The raw numbers for 1845 are problematic because 100 percent of the reported tonnage for Buffalo, and all the customs districts in Ohio and Michigan were repeated in the steam column. The numbers for 1865 and 1866 are partial from some customs districts.

of non-steam powered canal boats engaged in intrastate commerce (like most of the canals emptying into the Great Lakes)

When this figure is compared with figure 2, the percentage of non-steam that was not rigged is striking. In 1868 barges and canal boats represented almost 47 percent of the non-steam tonnage enrolled in Lakes customs districts. No evidence surfaced in the course of this study to suggest whether this is typical of the ratio of non-steam vessel-types prior to 1868, but we do know that the Erie Canal boats, despite considerable protests, including one from the New York State Legislature, were required to be enrolled as early as 1825.¹⁷

Figure 3: US Tonnage, 1831-1900, by percentage of class



Source: data from figures 1 and 2

¹⁷ “Letter from the Comptroller of the Treasury to the Chairman of the Committee of Commerce, upon the subject of licensing, enrolling, and exacting a Tonnage Duty on Canal boats or vessels,” 31 December 1824. Quoted in *Register of Debates in Congress ... Second Session of the Eighteenth Congress...*, (Washington, 1825), 1: 47-48. The February 1825 debates are reported on pp. 628-30, which concluded with an exemption bill being tabled at third reading. The issue resurfaced in the 1840s when the canal boats were exempted from paying the marine hospital tax. The preamble specifically referred to canal boats “now by law required to be registered [trading to foreign ports], licensed [engaged in fishing], or enrolled [coastal trade] and licensed...” United States, *Statutes at Large*, 29th Congress, Sess. 1, Chap. LVI “An Act to exempt Canal Boats from the Payment of Fees and Hospital Money,” 16 July 1846.

Sail tonnage was roughly twice that of steam in 1868 and maintained some part of that advantage until 1881/82 when the steam fleet began to grow decisively, exceeding sail tonnage for the first time in 1884. It continued to grow dramatically to the end of the century and well beyond. What is less often noted is that sail tonnage in 1900 was at roughly the same level that it had reached in 1874. Clearly rigged vessels had a continuing value to operators. The curve for barge tonnage (as distinct from the canal boats) runs significantly below steam and sail and almost bottoms out at the end of the 1880s. A revival began in 1888 that can largely be attributed to Alexander McDougall's American Steel Barge Company's whalebacks, most of which were designed to be towed.

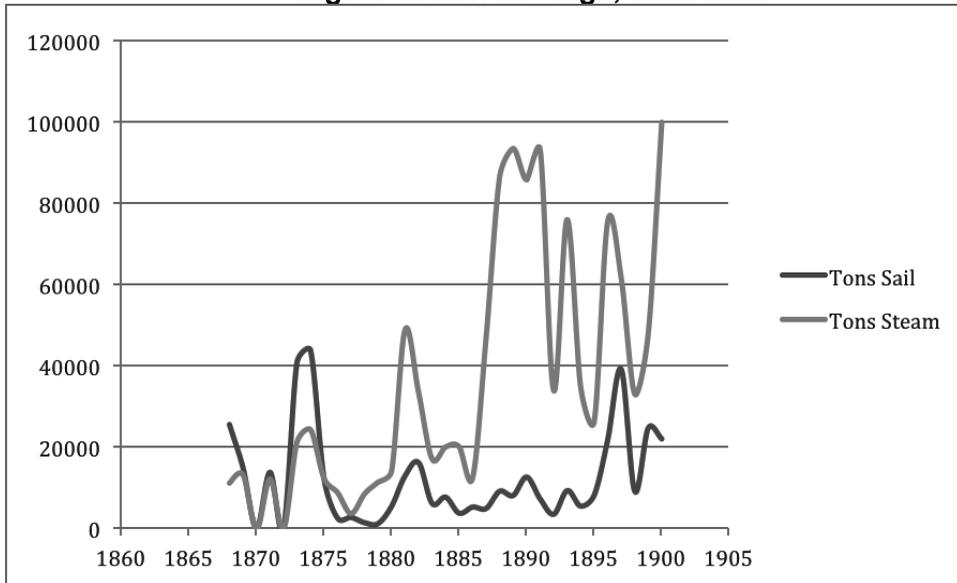
The dramatic upward curves for growth in both sail and steam tends to mask the ratios from the 1830s and 1840s. Figure 3 attempts to adjust for that by measuring each class of tonnage as a percentage of the whole for a given year. Clearly the enrollment of canal boats in the various customs districts at the end of the Oswego, Erie, Ohio and Illinois canals distorts the ratios before the non-steam canal boats were finally exempted from enrollment by legislation in 1873.¹⁸ That said, there is other evidence that on the American side of the Lakes, the ratio of steam to non-steam powered vessels was rising into the 1840s, declining through the decade of the 1850s and the major shift to steam began at the end of the Civil War. We will return to this later in the paper.

That broad conclusion is supported by the statistics for new American construction, numbers which are significantly more reliable for the period after 1868. As figure 4 demonstrates, the majority of new tonnage coming off the ways between 1868 and 1900 was steam. Only for three years early in the period was the tonnage of sail larger than that of steam. From it one can conclude that the sail tonnage on the Great Lakes from at least 1874 onwards was an aging stock of vessels that were finding ways of remaining viable, but that vessel owners had reduced significantly their investments in that technology a decade or more before the new steel behemoths started arriving. However, as the US Commissioner of Navigation noted in 1900, much, if not most, of the new "sail" tonnage was never intended to be more than a "rigged barge" whose sails were deployed in emergencies or when the reduced crews could reduce the strain on the steam vessel undertaking the tow.¹⁹

¹⁸ United States, *Statutes* (43 Cong. Sess. 1) 1874, chap. 110 "An act to amend the act entitled 'An act for enrolling and licensing ships or vessels to be employed in the coasting trade and fisheries, and for regulating the same,' passed February eighteen, seventeen hundred and ninety three." Approved 18 April 1874. This exempted from federal documentation any canal boats operating solely within the waters of a single state. The exceptions were those with sails or an engine. Some parties had tried without success for a number of years to have canal boats exempted, starting with H. R. 256 in 18th Congress, 2d Session (7 January 1825).

¹⁹ The US Commissioner of Navigation in his annual report for 1900 noted "The proportion of vessels ordinarily towed is larger than is indicated by the figures of the tables as the acts of Congress create distinctions between vessels with and without motive power of their own. A large tonnage of barges on the seaboard and on the lakes is schooner rigged, and these vessels are equipped with sails, though ordinarily towed ... The rig, however, of such vessels is designed rather to meet emergencies than as an ordinary commercial means of propulsion." *Annual Report of the Commissioner of Navigation For the Fiscal Year ended June 30, 1900* (Washington, 1900), 10.

Figure 4: New tonnage, 1868-1900



Source: "Statement exhibiting the Number and Tonnage of Sailing Vessels, Steam Vessels, Barges &c", United States, Treasury Department, Foreign Commerce and Navigation, 1868-1884; Bureau of Navigation, Annual Report, 1885-1900. [title of table varies slightly over period]

If one accepts as the general purpose of tonnage the measurement of the volume of enclosed spaces (gross tonnage), or simply those spaces used for the purpose of earning revenue (register tonnage), it is an unfortunate fact that the raw data for American steam tonnage is seriously flawed. There are issues with both the changing rules for measurement and how the American rules align with those of other fleets.

In broad terms, American customs houses used only two rules for the measurement of tonnage in the nineteenth century. The first was enacted in the first session of Congress in 1789, and was generally based on Builders Old Measurement as the British rules became known. The formula for single decked vessels of the class prevalent on the Great Lakes was simple:

$$(((\text{Length} - (3/5 \text{ breadth})) \times \text{breadth} \times \text{depth}) / 95)^{20}$$

In the United States this rule was not tinkered with until 1864. In the meantime, Britain had passed new legislation in 1819 and 1835 allowing deductions for the space occupied by the steam engine and boilers. Unlike the American formula, measurements based on these

²⁰ United States, *Statutes at Large*, 1st Congress, Sess. 1, Chap. XI "An Act for Registering and Clearing Vessels, Regulating the Coasting Trade, and for other purposes", sec. 3, 1 September 1789. For vessels with more than one deck inside the hull, half the beam was substituted for depth.

calculations returned both gross tonnage and a net registered figure often referred to as burden. More importantly, in 1854 the British Merchant Shipping Act overhauled the measurement of tonnage by enacting what became known as the Moorsom System. Much more sensitive to the varying block co-efficients of hulls, the rules called for additional stations along the hull to be measured, and for the first time included the enclosed spaces above what was designated as the tonnage deck. From this measure of gross tonnage a variety of deductions were allowed for machinery and other “non-revenue” spaces like crew quarters and the chart room. In this formula, the ton was standardized as 100 cubic feet.²¹ In May 1864, the United States adopted the Moorsom rules and instructions were issued to re-measure the American fleet.²² Initially, there was one deviation from the Moorsom rules: there were to be no deductions for the space occupied by the engine and fuel.²³ But before the re-measurement of the fleet began, a second variant was passed by Congress in February 1865, which said: “[the act of 1864] shall be so construed that no part of any ship or vessel shall be admeasured or registered for tonnage that is used for cabins or state-rooms, and constructed entirely above the first deck, which is not a deck to the hull.”²⁴

The effect of this was and remains significant. The greatest “beneficiaries” of Congressional tinkering were western river steamboats, but in 1865 virtually all of the Great Lakes steamboats over 300 tons by the old measure had at least one deck above the tonnage deck. By the First World War some passenger vessels had as many as three additional revenue-generating, enclosed decks above the main deck that were exempt from inclusion in any calculations of gross tonnage.²⁵

There are a number of consequences of this. Apart from tugs, steam barges and the emerging class of steel lakers at the end of the century, measures of American gross registered steam tonnage are not directly comparable to British and other figures. The most significant under-measurement came in the largest class of steam vessels built before 1881. Indeed, the emergence of one and two additional decks on Great Lakes steamboats had begun in 1838 and was general among both paddlewheel and propeller-driven craft by the mid-1850s.

In doing some of the analysis on vessel movement that will be reported later in this paper, the opportunity was taken to compare the tonnage of those vessels entering Buffalo

²¹ United Kingdom *Statutes*, 17 and 18 Victoria (1854), c. 120, “The Merchant Shipping Repeal Act 1854.”

²² “An Act to regulate the Admeasurement of Tonnage of Ships and Vessels of the United States,” United States, *Statutes at Large*, 38th Congress, Sess. 1, Chap. 83, 6 May 1864.

²³ This changed in 1882 when the United States adopted the Danube Rule. Lyman, Part II, 315. “An act to provide for deductions from the gross tonnage of vessels of the United States,” *Statutes of the United States of America* (47th Congress, 1st Sess., 1882), chap. 398, 300-01. (5 August 1882). The Frye Act of 1895, also explained by Lyman, would adjust this to match the deductions of the British Board of Trade.

²⁴ United States, *Statutes at Large*, 38th Congress, Sess. 2, Chap. 70 “An Act to amend an Act entitled ‘An Act to regulate the Admeasurement of Tonnage of Ships and Vessels of the United States,’ approved May sixth, eighteen hundred and sixty four.” 28 February 1865.

²⁵ The tonnage on the western rivers would have been even more undercounted as many of them were designed with an open main deck, which were also exempted from tonnage calculations. Rising above the main or tonnage deck of the *City of Detroit III* (1911) were the promenade, gallery, upper and hurricane decks, the last of which was open to the sky.

during the 1860 season which survived to be measured under the new American system. The numbers are weighted by the frequency with which a given vessel arrived in Buffalo during that season so the results should be considered preliminary. In general, the major classes of sail vessels (barks, brigs and schooners) had their gross tonnage reduced by about one quarter, while the major class of steam vessels, propellers, had their gross tonnage increased by about the same percentage.²⁶ Without the 1865 revision, the increase in steam tonnage would have been even higher.

2. Canadian Tonnage

There is no comparable set of numbers for Canadian tonnage on the Great Lakes. For vessels solely engaged in inland navigation, the British Navigation Acts did not require Upper Canadian vessels to be registered. When the provincial legislature finally passed a registration act in 1845, it was permissive. It quoted chapter and verse of the rules for measurement then current in Great Britain, which had been passed ten years earlier. Essentially, the new register provided a method for documenting vessel ownership should someone lending money require evidence of that mortgage that he could present in court.²⁷ Mandatory registration would not come into force until 1874. At that time, registrations of new Canadian vessels on the Great Lakes were to be surveyed according to the rules of the Merchant Shipping Act (the Moorsom rules) as most recently amended.²⁸ But it was not until 1877 that Canadian steamboats previously registered using the 1835 rule set had to be re-surveyed and Canadians finally had a relatively complete registry with a single set of rules for tonnage.²⁹

²⁶ The steamboats in this calculation are an anomaly as almost all the entries were by the paddle-wheel rail ferry *International* making twice daily crossings between Buffalo and Fort Erie. Essentially a barge with paddlewheels, her tonnage was reduced.

²⁷ John M. Mills, "Early Ship Registration in Canada," *FreshWater*, III, 1 (Summer 1988), 15. Province of Canada, *Statutes*, 8 Vict. (1845), c. 5 "An Act to secure the right of property in British Plantation Vessels navigating the Inland Waters of this Province, and not registered under the Act of the Imperial Parliament of the United Kingdom, passed in the third and fourth years of the Reign of His late Majesty King William the Fourth, intituled, *An Act for the Registering of British Vessels*, and to facilitate transfers of the same, and to prevent the fraudulent assignment of any property in such Vessels." (17 March 1845). Because of the permissive nature of this act regarding registration, a later law recognized that in adjudicating cases involving vessels not measured under British or Canadian law that someone would have to calculate the tonnage under local rules. (Province of Canada, *Statutes* 1864 (27-28 Vict.), cap. 13, sec. 12.) Steamboat Inspection Act (Canada, *Statutes*, 1869 (32-33 Vict.), cap. 39, sec. 10) gave the inspectors the right to demand to see the registration.

²⁸ Canada. *Statutes*, 36 Victoria (1873), chap. 128 "An Act relating to shipping and for the registration, inspection and classification thereof." The act was passed in the spring of 1873, but required review in Britain. Consequently it did not come into force until 17 March 1874.

²⁹ Canada. *Statutes* 40 Victoria (1877), chap. 19 "An Act respecting the Measurement of Steam Ships registered under the repealed Act of the late Province of Canada" (assent 28 April 1877). Section 1 only allowed until 1 July 1877 for steamboats to be re-measured and tonnage dues paid on the new measurement. The act deliberately made no mention of adjusting the tonnage of sailing vessels or barges.

To complicate matters further, the original inland registration act had made no provision for vessels which had not been built within the British Empire. When passed in 1845, the prohibitions in the British Navigation Acts on this score were still being enforced. With their relaxation in 1849, it was possible for Canadians to buy American tonnage, but the only registry open to them was the imperial registry in Montreal, which was largely intended for Canadian vessels that were going to go to sea. So from that date until 1874 all American-built hulls sold to Canadians were measured according to British legislation, first using the 1835 rules and then after 1854 under the Moorsom rules and are documented in the Montreal registers. Few, if any, were taken to Montreal to do this. Indeed some were too large to pass down the canals.³⁰

One final point needs to be made about Canadian registration. Unlike the American regulations, there was no annual requirement in Canada to renew a vessel's license. Only after 1857 were steamboats only subject to an annual inspection. Consequently vessels might be wrecked or abandoned years before the official documentation was brought up to date and closed at the port of registration. If the owners did not require a mortgage on the hull, there was little incentive to inform the customs officials. Moreover, the Canadian shipping lists, like the one published in 1878, typically aggregate tonnage and counts by port as a total, but not by class of vessel.³¹ The result is that there are few reliable official counts of Great Lakes vessels sub-divided by their means of propulsion and aggregate tonnage available from official Canadian documents. Because of this table 1 is supplemented by a variety of other sources. In broad terms, these sets of evidence provide ratios of Canadian sail to steam tonnage that were in the same range as those of the American tonnage, between 3:1 and 3:2, with the gap closing. Both steam and sail also saw dramatic growth in the 1850s and 1860s.

One example may stand for the general challenge presented by this data set. While not registered, the *Passport* had been officially measured in Montreal in 1849, three years after her launch. The Surveyor's Certificate (eventually filed with her registration papers in 1861) showed her to be 184 1786/3500 tons with an engine room of 162 tons. The gross tonnage was not part of the form, but a simple pencil annotation on the certificate added these numbers up to 346 tons. In subsequent ship lists in table 1, she appears as 180 tons, 350 tons and 407 tons, even after she was officially registered in 1861 using the certificate from her 1849 survey. When *Passport* was re-measured on 1 May 1877 under the Moorsom rules, she was found to be 1033 gross tons (592 register), a three-fold increase in both gross and net registered tonnage that finally reflected her upper cabins.³²

³⁰ Library and Archives Canada (LAC), RG 12, A1, v. 176, Montreal Registrar of Shipping.

³¹ "Supplement 4 to the Annual Report of the Department of Marine and Fisheries for 1877, being a List of Vessels on the Registry Books of the Dominion of Canada, on the 31st day of December, 1877," Canada, *Sessional Papers*, 1878, v. 3, p. vii.

³² LAC, Kingston Registrar of Shipping, no. 94 (7 March 1861) (reel C-1211, frame 242) includes the Surveyor's Certificate of Admeasurement dated Montreal, 17 August 1849.

Table 1: Canadian Sail and Steam numbers and tonnage³³

Year	Sail		Steam		% Steam	Source
	No.	Tons	No.	Tons		
1844	120	8,957	14	3,133	26	Inspector General, Canada
1849	65	7,496	32	6,045	45	Inspector General, Canada
1854	218	30,568	119	18,600	38	<i>Register of British Shipping, Inland Waters</i> (calculated)
1856	166	25,435	63	15,888	38	<i>Daily Globe</i> (Toronto), 1856 (calculated)
1857	176	28,511	58	13,908	33	<i>Daily Globe</i> (Toronto), 26 May 1857 (calculated)
1859	211	35,493	87	28,450	44	Buffalo Board of Trade
1860	256	43,489	104	33,228	43	Buffalo Board of Trade
1861	239	42,213	97	29,292	41	Board of Lake Underwriters
1866	337	61,987	192	45,879	43	Ass. Of Canadian Lake Underwriters, <i>Lake Vessel Register</i> (calculated)
1867	305	41,882	73	14,005	25	Canada. Sessional Papers, "Return of Vessels"

Note: where the source indicates "calculated," the tonnage totals are drawn from the individual entries in the source document and calculated. The remainder provided aggregate numbers either for steam and sail, or by vessel type.

From a large sampling of vessel measurements in the registers of the Inland Navigation that have survived, there are two useful observations. In broad terms, the tonnage of vessels under sail were within perhaps 10 percent of their American counterparts.³⁴ This is not unexpected, given the general effort in developing the new rules in both 1835 and 1854 to produce tonnage numbers that were consistent, in the aggregate, with the existing measurement of the British fleet, which before 1835 had used a formula very close to that

³³ Notes for all of the tables follow the text on page. 25.

³⁴ LAC, Kingston and Montreal registers. This conclusion was derived by comparing the provincial gross tonnage with a calculation using the registered length, breadth and depth and the American tonnage formula.

used in the United States. Depending on the hull form there might be some small movement up or down, at least for sail.

The same did not hold true of steam. Both British rule sets allowed for the deduction of engine space from the tonnage. (Indeed this had been true since 1819). Under the 1835 rules the difference between gross tonnage and registered tonnage could be dramatic. The rules assumed that the engines used the entire width of the hull from the forward and aft bulkheads enclosing the engine and boiler, and allowed for the deduction of engine room length between the overall length before calculating registered tonnage. How much deduction? The earliest examples, representing configurations pre-dating the application of these rules saw deductions in the range of 10 to 33 percent. By the late 1840s, as shipwrights and engine builders responded to the potential savings presented by the rules, the deductions ranged between 40 and 75 percent. Note that these deductions are based on a tonnage formula that was still restricted to the measurement of the hull.³⁵ Like the American Customs House Measurement rules (and Builders Old Measurement before them), the 1835 tonnage rules paid no attention to enclosed spaces above the hull.

Consequently the gross tonnage of vessels measured under the Inland Navigation rules (1835) in Canada prior to 1877 were broadly comparable to the American hulls measured prior to 1864. Unfortunately, most government reports are based on the registered net tonnage. And both sets of measures ignore the additional enclosed spaces, most of them revenue earning on steamboats, that were rising above the main deck.

Before leaving the question of tonnage there is another issue that should be briefly raised. Tonnage was calculated by government surveyors in order to assign a variety of fees based on size. It was in the interest of the shipowner to reduce that number to the lowest value that did not give the appearance of fraud. The American 1864 act allowed the surveyor \$1.50 for each transverse measurement (a maximum of 16 in a vessel above 200 feet in length) and \$3.00 per deck above the tonnage deck (of which there was only one after the 1865 amendment).³⁶ At most the surveyor and his assistants might earn \$27 to deliver an assessment of a vessel that might have cost the owner well in excess of \$50,000. Given that vessels were not re-surveyed except after a major rebuild, the odds of discovering measurement errors were quite small.

Where the British Board of Trade had an office that reviewed measurements and asked questions, in Washington there was no review of the numbers submitted for a given vessel. In 1890, William Lytle (best known to historians of American steam navigation as the original compiler of the Lytle-Holdcamper list)³⁷, the clerk in the Bureau of Navigation in charge of the tonnage accounts, raised a flag that “vessels of the same dimensions often vary greatly in tonnage.” The Commissioner followed by noting

³⁵ This is drawn from the results of the calculations based on the sources in the last note using a sample of the steamboats.

³⁶ United States, *Statutes at Large*, 38th Congress, Sess. 1, c. 83, s. 4

³⁷ William M. Lytle and Forrest R. Holdcamper, rev. and ed. By C. Bradford Mitchell, *Merchant steam vessels of the United States, 1790-1868: The “Lytle-Holdcamper list” initially compiled from official merchant marine documents of the United States and other sources* (Staten Island, NY, 1975).

At a certain port [on the lakes] were built last winter two steamers from the same model, measured by the same officials, and one boat was made more than 50 tons larger than the other. At the same port other twin steamers were built, and though both are figured of exactly equal tonnage (a result impossible of attainment), the “register length” in both cases is given over 10 feet shorter than the length of the keel, which is the shortest length of a vessel.³⁸

Further research is required to determine who, if anyone, was ever penalized for such “anomalies.”

3. Investment

Given the inconsistencies and systemic biases in the measurement of tonnage in the nineteenth century, it may prove useful to have a brief look at different estimates of the value of the sail and steam fleets in the period under consideration. Most of the evidence in table 2 is drawn from the registers assembled by the marine insurance associations of the period, with the addition of a few estimates from other parties. What this table demonstrates is that a variety of sources believed that there was a rough parity between the value of the sail and steam fleets in the 1850s and 1860s, despite whatever differences there were in the reported tonnage. What is less clear is whether there were any systemic biases in both the inclusion of vessels or in their valuation. Did they, for example, pay much attention to fleets that were self-insured?

Table 2: Investment in Sail and Steam

	Sail	Steam	% Steam	Note	Source
Canadian					
1854	210,000	345,700	62	Halifax C'y	<i>Register of British Shipping, Inland Waters</i> (calculated)
1856	1,060,000	1,623,200	60		<i>Daily Globe</i> (Toronto), 1856 (calculated)
1857	942,050	1,145,800	55		<i>Daily Globe</i> (Toronto), 26 May 1857, p. 2 (calculated)
1859	856,700	1,314,500	61		Buffalo Board of Trade
1860	1,149,420	1,906,970	62		Buffalo Board of Trade
1866	1,253,110	1,569,000	56	Ontario	Ass. Of Canadian Lake Underwriters, <i>Lake</i>

³⁸ United States, Bureau of Navigation, *Annual Report*, 1890, 13-14. It was noted that the author of the 1864 US registration bill had included a test section but it was dropped for reasons of economy because of the Civil War.

	1866	1,310,510	2,343,600	64	Ontario and Quebec	Vessel Register (calculated) Ass. Of Canadian Lake Underwriters, <i>Lake Vessel Register</i> (calculated)
American	1849	3,538,000	4,330,000	55		Report on the Internal Commerce of the U. S.
Both	1856	6,862,750	6,061,600	47		Board of Lake Underwriters
	1858	7,720,300	7,496,700	49		Board of Lake Underwriters
	1859	5,846,350	5,690,387	49		Board of Lake Underwriters
	1860	5,456,700	5,198,500	49		Board of Lake Underwriters
	1861	6,398,650	5,476,800	46		Board of Lake Underwriters
	1862	7,477,420	5,763,600	44		<i>The Great Lakes or Inland Seas of America</i> , 1863
	1865	7,613,350	6,430,550	46	Gold value	<i>Buffalo Daily Courier</i> , 2 March 1866
American new builds	1844	217,580	325,000	60	upper lakes	<i>The New-York State Register, for 1845</i>
	1855	1,213,300	395,000	25		<i>Buffalo Daily Courier</i> , 4 Feb 1858
	1856	1,604,450	1,132,000	41		<i>Buffalo Daily Courier</i> , 4 Feb 1858
	1857	1,433,300	1,320,200	48		<i>Buffalo Daily Courier</i> , 4 Feb 1858

Note: all figures are in dollars exception the first row.

Of more importance, is that when the numbers shift from a position of parity, the higher level of investment is typically in steam. Why? The traditional answer has been the cost of the engine. But it should be noted that steam operators were still paying for building and furnishing the additional decks even if the measurement rules allowed them to escape paying tonnage fees for them.

4. Sail Under Tow

In charting the transition from sail to steam, one of the critical trends is the growing dependence of sail on steam tugboats, for tows over increasing distances. The deployment of tugs is one of the understudied aspects of maritime history in the Great Lakes region, with a number of exceptions. That part of the system that extends down the upper St. Lawrence

River to Montreal (the modern Seaway), saw the active deployment of barges and towboats from at least the 1820s by the forwarders who controlled the movement of goods between the Lakes and Montreal.³⁹ The major salvage interests have attracted some interest.⁴⁰ The 1899 merger of many of the towing outfits into the Great Lakes Towing Company has been documented as have a few of its rivals.⁴¹

We can start with the insights of Edward S. Warner, who draws almost exclusively on the evidence of surviving ship's logs and other archival sources to conclude "it would be difficult to overstate the importance of towing." Towing was essential in two critical phases of a Great Lakes passage: movements within a harbor (including entering and clearing the piers) and the passage between the head of the St. Clair River and the foot of the Detroit River (generally referred to as "the Rivers"). The sample that Warner was able to collect suggested that by the 1870s a vessel's annual bill for towing could run between 20 and 34 percent of operating costs, exceeded only (and not always) by the cost of wages. In broad strokes, Warner notes that from his first documented use of a tug in 1848-49 to the end of the 1850s "at least occasional towing with tugs had become a reality for virtually all masters with vessels of substantial size . . ."⁴²

If you broaden the range of sources consulted, it becomes apparent that the label "occasional" may need revisiting. As a point of departure, consider the *General Gratiot*, a small steamboat based in Detroit in 1831. Her first season's advertisement included the statement: "She is also intended for towing vessels up the Detroit and St. Clair Rivers, which she will endeavor to do at rates which will be satisfactory."⁴³ In the summer of 1840 came an "Anti-Monopoly Brig Line," whose purpose was to challenge the powerful steamboat combination on the upper lakes with lower rates for both freight and passage. In order to be competitive they announced that the vessels would "be towed up the rivers when the winds are adverse."⁴⁴ In two different "memoranda" published in the Buffalo papers the following

³⁹ Frank Mackey, *Steamboat Connections: Montreal to Upper Canada, 1816-1843* (Montreal and Kingston, 2000). Gerald J.J. Tulchinsky, *The River Barons: Montreal Businessmen and the Growth of Industry and Transportation, 1837-53*, (Toronto, 1977), chap. 4.

⁴⁰ Mary Frances Doner, *The Salvager: The Life of Captain Tom Reid on the Great Lakes*, (Minneapolis, 1958). Walter Lewis and Rick Neilson, *River Palace* (Toronto, 2008), chaps. 8 - 10. (Calvin Company and Donnelly Salvage); Alexander C. Meakin, "Commercial Wrecking on the Great Lakes, *Inland Seas*, XXIV, 1(1968), 3-15. Jamin Wells, "Professionalization and the Cultural Perceptions of Marine Salvage, 1850-1950," *The Northern Mariner/Le marin du nord*, XVII, 2, (April 2007), 1-22.

⁴¹ Alexander C. Meakin, "Four long and one short: A history of the Great Lakes Towing Company," *Inland Seas*, XXX, 4 (1974), 231-41 (and twelve additional installments). George Nau Burrige, *Green Bay Workhorses: The Nau Tug Line* (Amherst, WI, 1991).

⁴² Edward S. Warner, "Towing with Steam Tugs: An Aspect of the Great Lakes Commercial Trade under Sail," in Victoria Brehm, ed. *A Fully Accredited Ocean: Essays on the Great Lakes* (Ann Arbor, MI, 1998), 45-56.

⁴³ *Democratic Free Press* (Detroit), 21 July 1831, 3. The 1834 ad included her scheduled runs and noted that "Wednesdays and Thursdays will be employed by the boat, either in towing or making such other trips as may be for the interest of the boat . . ." *Ibid.*, 12 March 1834, 3.

⁴⁴ *Cleveland Herald*, 15 July 1840, 2 (quoting *Buffalo Republican*).

year are accounts of vessels in the rivers being towed by steamboats.⁴⁵ As the demand for shipping from Buffalo to Chicago intensified in the 1840s, the shallow St. Clair Flats emerged as perhaps the most significant choke point in the system. Not only were the channels obscure and winding, but their shallowness was a challenge for the largest class of vessels, both steam and sail, being built for the Chicago trade. In consequence, there emerged a more specific set of requirements just for that section that combined towing of vessels with lightering of the larger vessels (and consequently towing the lighters across to deeper waters for reloading).⁴⁶ In 1856, Lewis Cass, in a speech to the US Senate, noted that there were some eight tugs operating in the vicinity.⁴⁷

Before that, it was not uncommon to see accounts of older, smaller steamboats shifting into the towing trades, and by mid-decade purpose-built tugs were under construction in yards around the lakes.⁴⁸ By 1856, the newly incorporated Lake Navigation Company, had accumulated between sixty and seventy vessels. Rather than leave passage to chance they maintained their own tugs on the Detroit and St. Clair Rivers.⁴⁹ The following season one company official noted that they had spent about \$40,000 in towing in that region, and that each vessel spent on average three days passing through the rivers. Over the course of a season this amounted to the loss of at least one additional run. When the company's affairs were wound up following the crash of 1857, four of their tugs were in Detroit and the fifth was stationed at Chicago.⁵⁰ And these were only a few of the tugs on the rivers. When a tug association was proposed for the rivers in February 1859, there was some hope that some twenty-seven tugs in the region would join.⁵¹

In the meantime, the number of tugs operating in individual ports was growing rapidly. Many Great Lakes ports had narrow entrances and equally narrow confines leaving very little margin for error and few options with an ill-wind. In 1837, the owner of the *Badger*, built primarily as a lighter to service vessels too deep for the bar at the entrance to

⁴⁵ *Commercial Advertiser & Journal* (Buffalo), 14 September 1841, 2 ("Schr. *Ottawa* in tow by steamboat, coming over the Flats"; 3 November 1841, 2 ("... in the river, in tow by steamer, Brig *Toledo* and schooner *Texas*). One of the striking things about these observations is that the occurrence was sufficiently common that identifying the steam vessel doing the towing was of little interest.

⁴⁶ *Daily National Pilot* (Buffalo), 18 May 1846, 3. *Buffalo Commercial Advertiser*, 8 May 1847, 2-3. *Daily Republic* (Buffalo), 14 Aug. 1850.

⁴⁷ *Congressional Globe*, 18 March 1856, 664-65 (17 March) quoted in *Daily Republic* (Buffalo), 20 March 1856.

⁴⁸ *Daily Courier* (Buffalo), 10 June 1853 (*J. E. Follett*); 29 December 1853 (*J. D. Morton, United*). *Daily Republic* (Buffalo), 7 March 1854 (*Franklin*); 15 Apr. 1854 (*R. R. Elliott*); 16 May 1854 (*Emerald*); 18 May 1854 (*Echo*); 2 June 1854 (*Hamilton Morton*); 23 June 1854 (*Diamond*).

⁴⁹ *Daily Republic* (Buffalo), 26 April 1856, ad.

⁵⁰ *Daily Courier* (Buffalo), 14 April 1858.

⁵¹ "The Tug Association," *Detroit Free Press*, 19 February 1859, 1. The article also noted that only ten of these could be considered first class tugs, and the others ought to be laid up, because the ten could do the work on the rivers profitably enough for all of them. A further note from the *Detroit Free Press* 4 May 1859, 1, suggested that the association had failed, but that there were only some fourteen tugs actually running. Another number suggested for the number of tugs specifically on the Flats was 40 ("Bridging the St. Clair Flats," *American Railroad Journal*, 22 September 1855, 603).

Milwaukee, also anticipated towing in schooners “during adverse winds.”⁵² The next year, the *General Vance* was running the lower Maumee River and advertised she would attend “promptly to all calls from Capts. of vessels who . . . [desired] to be towed either up or down the river.”⁵³ Oswego would have two tugs by 1852.⁵⁴ Three years later, the city of Chicago was so tired of bridge/vessel collisions that council required all sailing vessels to be under tow when passing a bridge in the river.⁵⁵

But what of the towing of vessels from port to port across the Lakes? In 1835, the annual report of the Board of the New York State Canals, speculating about the possibility of canal boats being towed across Lake Erie to Cleveland and the Ohio canal, quoted one source:

An intelligent gentleman, of several years' experience in navigating steam-boats, and the two last seasons on Lake Ontario, informs us, that he considered it impracticable, as a regular business, for steam-boats on the lakes to tow vessels with safety, unless the vessels were fitted with masts and rigging, and sufficiently manned, so as to be conducted by sails in a storm; that storms often rise very suddenly on these lakes, and with such violence as would compel a steam-boat to cut loose vessels in tow in order to sustain herself.⁵⁶

Which is not to say that a long tow was not tried on occasion. When the *Bunker Hill* went aground on Long Point in Lake Erie in 1838, she had started out towing the scow *Ware*, before the line parted in the storm, much as had been predicted.⁵⁷ However, with towing of vessels “with masts and rigging” in confined waters becoming almost routine by the 1850s the notion that larger hulls could be towed on the open waters of the Lakes was not far behind.

In the wake of the crash of 1857, more than just the vessels of the Lake Navigation Company were tied up hoping for a buyer. John S. Noyes of Buffalo and his partners were interested in the movement of lumber from the Saginaw region to lumber yards in and around Buffalo. Rather than the much riskier towing of rafts, he acquired a number of older, larger steamboat hulls, stripped them down to barges and had them towed the entire distance by his tugs. In the course of the following decade there was a significant investment in barges under tow. By 1871, the *Saginaw Courier*, writing from the heart of Michigan's

⁵² *Daily Herald & Gazette* (Cleveland), 25 July 1837, 2 (quoting a Milwaukee paper of July 8).

⁵³ Maurer Maurer, “Navigation at the foot of the Maumee Rapids, 1815-1845,” *Northwest Ohio Quarterly*, XV, 3, (July 1943), 164 citing the *Ohio Whig* (Perrysburg), 10 November 1838.

⁵⁴ *Daily Courier* (Buffalo), 14 January 1853.

⁵⁵ Karamanski, 137.

⁵⁶ Quoted in David Stevenson, *Sketch of the civil engineering of North America* (London, 2nd ed., 1859), 35, (65-66 in the 1st ed.). Stevenson notes that the experiment had been tried once, with the steamboat operators disclaiming all liability for the barges in the event of poor weather.

⁵⁷ “The Bunker Hill,” *Detroit Free Press*, 3 May 1838, 2. The crew of the scow was rescued by the *Bunker Hill* before she went ashore.

lumber country, reported 128 lake barges with a customs house tonnage of 37,700 tons, a number which would peak shortly afterwards. In addition to the employment of tugs specifically in the trade, the editor noted the number of “steam barges” towing other barges. These were single decked, propeller driven, steam vessels with no passenger facilities, but with the capability of carrying a significant load of cargo both in their holds and on deck and often deployed in the timber trade. Their capacity plus their ability to tow additional unpowered barges made them particularly effective carriers.⁵⁸

Following the lead of the early steam barges, the *R. J. Hackett* was launched in Cleveland in 1869. In the context of a discussion of the transition from sail to steam, perhaps the more significant feature is not her role as the prototypical bulk lakes freighter, but that she came out with a purpose-built consort, the *Forest City*. More specifically, when listed in the 1870 edition of the *List of Merchant Vessels of the United States*, *Forest City* was classed as a 743.13-ton schooner. The *Hackett* was initially 748.66 tons.⁵⁹ Until *Forest City* was converted into a steamboat two years later she had never sailed off the tow line, despite her rigging. Together they represented just short of 1,500 tons of shipping all moving under the power of steam, but with half of its tonnage classed as sail in government accounts.

Here lies the key to the decline in the deployment of barges in the mid-1870s. Experience had shown that simple barges could be unwieldy. But a rigged vessel, with a crew on board might be in a position to save the craft and her cargo should an emergency arise. In consequence, beginning in 1870, the percentage of “sail tonnage” which actually operated under sail, began a precipitous decline. The five-masted schooner *David Dows* (1881) is commonly described as “reduced to a tow barge” after her second season, but all 1,418 tons remained on the “Merchant Sailing Vessels” side of the ledger.⁶⁰ Moreover, the largest class of rigged vessels were the ones most often under tow. In 1890, the Canadian four-masted schooner *Minnedosa* left on her maiden voyage on a line behind the tug *Thompson*.⁶¹ Perhaps the epitome of the “consort” was the “schooner” *Iron Queen* (1887) designed to be towed by her tug, the *Iron King* (1887).⁶² It is worth bringing into the discussion the evidence presented by Warner in his study of the tow-barge system, that many of the medium sized consorts operated in tow at some times, and independently at others.⁶³

In summary, the evidence strongly suggests that by the 1850s, the sail fleet on the Great Lakes depended on tugs to manoeuvre into and around the crowded, narrow harbors

⁵⁸ “A History of the Inception of the Barge Enterprise,” *Saginaw Courier*, 2 July 1872. *Daily Courier* (Buffalo) 24 August 1863. H. Perry Smith, ed. *History of the City of Buffalo and Erie County* (Syracuse, NY, 1884), 2: 200. Note that first regular tug in Buffalo was 1855, 198. Gordon Pritchard Bugbee, “Of Rabbits and Bulk Freighters,” *Telescope*, VIII, 1, (January/February 1979), 8-16.

⁵⁹ Bureau of Statistics, *List of the Merchant Vessels of the United States*, (hereafter *MVUS*), (Washington, DC, 1871), 93 (*Forest City*), 221 (*Hackett*).

⁶⁰ Kenneth R. Dickson, “The Largest Schooner (1881) in the World Revisited,” *Inland Seas*, XLII, 1 (Spring 1986), 8. *MVUS*, 1885, 110.

⁶¹ *Daily British Whig* (Kingston), 28 April 1890.

⁶² *Marine Review*, 17 August 1899 notes that the *Iron King* had a capacity of 2,200 tons and the *Queen*, not needing the engine space, of 2,500 tons. And yes *Iron Queen* was in the sailing section of the *MVUS*, 1889, 143 (1,384 gross tons). The same owners, in 1880, had paired the propeller *Iron Age* and schooner *Iron Age*.

⁶³ Edward S. Warner, “The Tow-Barge System Revisited,” *Inland Seas*, LXVIII, 2 (Summer 2012), 142-52.

of the Great Lakes. The relationship between tug and sail vessel dated from the 1840s in certain sections of the system. Indeed the increase in sail tonnage in the 1850s and 1860s can in large part be ascribed to the efficiencies of steam towing in confined waters being combined with the efficiencies of sail on the open Great Lakes. Nor were these the only improvements, not the least of which were the steam powered grain elevators that significantly reduced port turnaround in that trade. By the Civil War, some tugs were deployed in regular barge towing, and over the next decade many schooners replaced barges at the end of the tow line. The pairing of consorts was most frequently seen in the emerging ore trades with fewer individual owners and more corporate investors.

5. Turnaround

The discussion of consort operations on the Lakes raises an important theme that often gets lost in the discussion of hull numbers and tonnage calculations. Towing, in whatever circumstances, allowed rigged vessels to complete more voyages in the course of a season. The prevailing rationale for adopting the expense of steam in the first place had been the steady predictability and rapid turnaround of steam vessels.

Outside of bulk goods, other things moved on the Lakes ... and most of them by steam. The passenger trades on the Great Lakes persisted into the Great Depression. Genealogists may lament the absence of passenger lists, but there are not even counts of passenger traffic, except the occasional guess and or limited reports.⁶⁴ The particular advantage to passenger traffic is that, to a large extent, it is “self-unloading.” The disadvantage, of course, was that it was higher maintenance while on board ... and the cost of travel was adjusted accordingly.

With very few exceptions, the other principal traffic carried by steamboats through the course of the century was package freight. By its very nature, package freight is difficult to reduce to simple numbers. The variety of weights and sizes challenged the mates whose job it was to see it all safely stowed. The key to package freight, however, is that crew and shore hands carried or wheeled it on board. Nothing was poured or shovelled (at least intentionally). While we may lament the weaknesses of the tonnage statistics in the nineteenth century, at least some numbers survive. Modern government reports have the distinct advantage of reducing this to the declared value of the goods and standard sized containers in which shipments arrive. There were new package freighters built in the 1950s with some anticipation of profitability.⁶⁵ Today, package freight is still among the largest class of freight moved internationally, but in the last half century the deepest into the continent that the container ships routinely run has been the port of Montreal.

⁶⁴ The numbers supplied by Barton are some of the few that have become public from the mid-nineteenth century. James L. Barton, *Lake Commerce: Letter to the Hon. Robert M'Clelland ... in relation to the Value and Importance of the Commerce of the Great Western Lakes*, (Buffalo, 1846).

⁶⁵ M. Stephen Salmon, “‘This Remarkable Growth’: Investment in Canadian Great Lakes Shipping, 1900-1959,” *The Northern Mariner/Le marin du nord*, XV, 3, (July 2005), 20.

After the opening of the rail lines through to Chicago in the 1850s, there is a tendency to assume that both passenger and package freight traffic shifted to the rail lines. Indeed, a significant percentage did. However, some rail lines incorporated subsidiaries with steam vessels to extend their reach across the Lakes. In short, for much of the century, steam vessels were successful when they specialized in cargoes that detained them in port for only short periods of time, and let them focus on being out on the Lakes earning money.

The following are some samples of sail and steam moving through different ports in various years prior to 1884. The samples were chosen as much based on the availability of evidence as any sense of the representativeness of the place and time.

Table 3: Tonnage Duties, Port of York (Toronto), Upper Canada

	Sail		Steam		Total	% Steam
	Tonnage	Entries	Tonnage	Entries	Tonnage	Tonnage
1816	5012	135	0	0	5012	0
1817	5033	126	9394	22	14427	65
1818	5592	160	11529	27	17121	67
1819	6046	202	10248	24	16294	62
1820	8399	247	10248	24	18647	55

Source: Toronto Public Library, William Allen Papers. Note: The entries for *Frontenac* in the original assigned no tonnage in 1817, 150 tons (in a different hand) in 1818 and 427 tons in 1819 and 1820. This table assumes the 427 tons for all four years.

Thanks to the collection of lighthouse tonnage duties in the first two decades we have some indication of the names, sizes and voyages of a number of the early vessels operating on Lake Ontario. Unfortunately, only the returns for the port of York (Toronto) have survived for the era of steam before the first tonnage duties were repealed in 1821 (table 3).⁶⁶ Between half and two-thirds of the tonnage arriving in that port was steam. What this demonstrates is the impact of the vast differential between the size of the single steamboat entering York and the rest of the fleet. The typical size of the schooners, sloops and open boats that were charged tonnage ranged from twenty-five to forty tons, while the *Frontenac* was charged at a rate of 427 tons (she was rumoured to be closer to 700 tons which would have made the differential even greater).⁶⁷

⁶⁶ Upper Canada, *Statutes* (York, UC, 1823), "An Act further to relieve Vessels and small Craft from the payment of Light House Tonnage Duty," [passed 14 April 1821]. A later lighthouse tonnage duty was collected annually.

⁶⁷ Walter Lewis, "The *Frontenac*: A Reappraisal," *FreshWater*, II, 1 (Summer 1987): 28-39. United Kingdom, *Statutes*, 59 Geo. III (1819), cap. V "An Act to ascertain the Tonnage of Vessels propelled by Steam" (23 March 1819) allowed for the deduction of the length of the engine room as well as 60 percent of the breadth from the length of the keel in the tonnage calculation.

Table 4: Port Entries, selected ports and years

		Sail		Steam		Total		%
		Tons	Entries	Tons	Entries	Tons	Entries	Steam Tons
Buffalo	1835	46,611	644	95,040	319	141,651	963	67
Buffalo	1836	87,639	1031	211,749	708	299,388	1739	71
Mackinac	1837	7,218	64	6,813	15	14,031	79	49
Mackinac	1838	13,533	115	72,440	143	85,973	258	84
Buffalo	1848	175,480	1197	418,866	918	594,346	2115	70
Buffalo	1860	780,165	3148	917,993	1239	1,698,157	4387	54
Buffalo	Jul- Dec 1866	253,868	2834	546,797	1294	800,665	4128	68
Cleveland	1876	222,906	877	1,037,966	1401	1,260,872	2278	82

Table 4 presents additional ports from the mid-century period. A general pattern emerges from across the samples. The differential in the number of entries echoes contemporaries and subsequent historians commenting on the “forest of masts.” Without question, prior to the 1870s, the majority of vessels arrived under sail. What is striking is the pattern when one looks more closely at the measured tonnage arriving. In most seasons, the steam trades supplied the majority of tonnage arriving in port. That forest of masts was lingering in port waiting to unload and load.

The numbers represent the American vessels engaged in trade to American ports as the Canadian vessels were not well-enough documented to provide comparable tonnage values. To the extent that there is a small Canadian trade to Buffalo in 1860, the numbers may slightly under-represent sail for that year. The number of Canadian entries after 1860 are roughly balanced between the arrivals of schooners and those of scows or barges under tow.

Of more importance, is the presence of the rail ferry *International*, which appeared daily in the 1860 entries and twice daily in the 1866 entries over a much longer season. If she is eliminated, the Buffalo traffic in those two years is roughly balanced between steam and sail.

Finally, it is worth noting that the scows have been entered on the sail side of the ledger as many of them were enrolled as “scow schooners” and in the tiny fonts used in the Marine Lists they appear sometimes as “sch.” and other times as “scow”. That said, some scows routinely appeared in port under tow, especially from the Canadian side of the Niagara River, the Welland Canal and the Grand River Canal. It proved impossible in the case of the Cleveland entries in 1876 to separate schooners arriving independently under sail and consorts under tow.

Perhaps the most important observation that the foregoing data masks is the distance sailed by the vessels in question before entering port. The *International* made its daily entries into Buffalo after steaming about a mile across the Niagara River from the Canadian railhead

in Fort Erie. The grain fleet sailed most of the 895 miles from Chicago. What would be the result if we weighted the tonnage entered by the miles from the port of departure? Only a handful of entries were from ports which were ambiguous or could not be identified. In this paper the only calculations have been made for the fleet arriving in Buffalo in 1848 and 1860. By multiplying the original Customs House Measurement by miles from port of departure (tonnage miles) we get the results in table 5.

Table 5: Tonnage Miles, Buffalo Arrivals, 1848, 1860

	Tonnage Miles		(Adjusted Tonnage Miles)	
Buffalo, 1848				
Sail	50,522,598	23%		
Steam	165,290,035	77%		
Total	215,812,633			
Buffalo, 1860				
Sail	449,727,632	61%	339,684,414	49%
Steam	291,439,972	39%	351,555,118	51%
Total	741,167,605		691,239,532	

The activity in 1848 represented about a 1:3 ratio of sail to steam tonnage miles which reflects the fact that much of the steam fleet out of Buffalo was running the entire length of Lake Erie, with a regular line to the upper lakes. Sail, on the other hand was most frequently arriving from intermediate ports on Erie. This ratio is the inverse of the tonnage represented by the static fleet calculations. By 1860, many of the settlers who had moved west earlier were producing grain much of which was being shipped back under sail. Using the American tonnage formula as it appeared in 1860, the ratio of tonnage miles sailed into Buffalo harbour was approximately 3:2 in favour of sail.

The third column is a matter of speculation. As a significant number of the vessels operating in 1860 were re-measured in 1865, this column suggests the general ballpark of what the numbers might have been if the fleet had been measured using the American version of the Moorsom rules a few years earlier. This suggested that the tonnage-miles were about every split.

While there might have been more sailing vessels, reporting in aggregate more tonnage, when the fleets are examined in motion the steam powered vessels were more than making up the gap. The exception came with the grain boom during the period of the 1850s and early 1860s as the sail fleet expanded rapidly to meet demand for moving the crop. Meanwhile, the traditional steam fleet was withstanding the shock of the vast expansion of competition for their traditional passenger and package freight services presented by the railroad companies. By the late 1860s the railroads had moved to organize much of the Lakes package freight trade in their own shipping subsidiaries. At the same time the expansion of

bulk freight beyond grain brought new steam designs and new strategies for deploying traditional hulls in consort with them.

6. Conclusions

In the broadest of terms, in the years between 1817 and 1885 there is no period when either sail or steam can be said to dominate the lakes. Both fleets grew rapidly. The size of the fleet under sail did not reach its peak until after the Civil War, both in number of units and under the various rules for tonnage measurement. That said, part of the success of the sail fleet from the 1850s stemmed from the emergence of steam tugs in harbors and the increasing numbers available at the most congested and difficult passages between the lakes. These steam tugs combined with the triumph of the steam elevator to produce a significant improvement in sail turnaround and profitability. The vessels in the steam fleet, by any set of calculations, were always larger and more expensive per ton than their sail counterparts and cost more to operate. Profitability came from turning those vessels around as fast as possible. From the mid-1830s to the mid-1850s the steam fleet grew in response to significant migration into the region on both sides of the border. Passenger traffic had the advantage of being a largely cash business with the cargo “self-unloading.” Beyond the crush of peak-season, there were still significant profits to be made in moving package freight. As the railroads pushed through the lower region, these corporations made a point of deploying their own package freighters to extend their corporate reach. They maintained these investments until the US Congress passed the Panama Canal Act which mandated the separation of ownership of railroads and steam shipping companies. This forced the railroad-owned lines out of the trade during the First World War.

What emerged in the wake of the *Ontario* and *Frontenac* in 1817 and held true for the next sixty years, might well be unique in inland navigation. On the Great Lakes the transition from sail to steam remained roughly in balance for half a century. In the wake of the Civil War, the attraction to emerging industry of a steady stream of arrivals of the sort that could be better managed by steam began to shift the balance. The deployment of steam and sail in consort persisted through the end of the century, especially into ports and through locks that could not accommodate the great iron and steel bulk freighters that would once again change the face of the Lakes fleets beginning in the 1880s.

Notes for Tables

Table 1: Canadian Sail and Steam numbers and tonnage

1844:Province of Canada, *Appendices to the Journals of the Legislative Assembly*, 8 Vict. (1844-45), Appendix HHH. This was supposed to represent gross tonnage under the 1835 imperial rules as an 1840 circular from the Inspector General’s Office noted that the provincial act did not allow for deductions for engines and fuel. Province of Canada. Sessional Documents (bound) Trade & Commerce, 1848-64, Circular, Inspector General to Collectors of Customs, 1 Dec 1840. The legislation on which the duties was based was Upper Canada, *Statutes*, (7th Wm. IV), 1837, Chap. XCV “An Act granting to His Majesty a sum of Money for the erection of certain Light-houses, within the Province, and for other purposes therein mentioned”, sec. IV. Its language was that

vessels “shall be charged upon the full and actual measurement of every such Vessel” as long as they were larger than ten tons and sailing on Lakes Ontario and Erie.

1849: Province of Canada. *Appendices to the Journals of the Legislative Assembly*, 13-14 Vict. (1850), Appendix A, No 17. “Statement of Number and Tonnage of Vessels Registered at the ports of Quebec and Montreal and Inland Ports of the Province of Canada, and of Vessels belonging to the Province employed on the inland waters, not registered, 1849.” The succeeding report included the disclaimer “The Registration of Vessels on the Inland Waters of the Province, not being compulsory, this Statement exhibits but a small portion of the Vessels owned at the above mentioned Ports and Navigation these waters.” (*Ibid.*, App. A, No. 32 “Statement of the Number and Tonnage of Vessels built at the several Ports in the Province during the Year 1850”)

1854: *Register of British Shipping: Inland Waters* (Toronto, 1854).

1856: *Daily Globe* (Toronto), 1856.

1857: “List of Canadian Vessels,” *Daily Globe* (Toronto), 26 May 1857, 2. The list was preceded by a plea for compulsory registration.

1859: “Harbor Defences on Great Lakes and Rivers,” *The Merchant’s Magazine and Commercial Review* (April 1862), 342-43. The table is entitled “Tables from the Board of Trade Report January 1, 1861, showing the tonnage and valuation of the vessels engaged in the commerce of the Lakes in 1859 and 1860.”

1860: same as 1859

1861: *Report of the Eighth Annual Meeting of the Board of Lake Underwriters* (Buffalo, 1862) after p. 33.

1866: Association of Canadian Lake Underwriters, *Lake Vessel Register* (Toronto: 1866).

1867: “Recapitulation, Province of Ontario” in “Return of Vessels owned and Registered in the Dominion of Canada, on 1st July 1867,” Canada, *Sessional Papers*, no. 73 (1868). Note that there are three critical flaws with these numbers that make them almost unusable for the purposes of this paper. First, not every vessel was registered. The numbers for steam are net registered not gross tons. Finally, a significant portion of the Great Lakes steam fleet was registered in Montreal and in this document are indistinguishable from steam vessels normally operating down the St. Lawrence to Quebec, and up the Richelieu and Ottawa Rivers. On the other hand, the number of sail vessels is a minimum, would have been almost all Lakes vessels and the tonnage is generally comparable to American tonnage.

Table 2: Investment in Sail and Steam

Canadian

1854: *Register of British Shipping: Inland Waters* (Toronto, 1854).

1856: “List of Canadian Vessels,” *Daily Globe* (Toronto), 26 May 1857, 2. The list was preceded by a plea for compulsory registration.

1859: “Harbor Defences on Great Lakes and Rivers,” *The Merchant’s Magazine and Commercial Review* (April 1862), pp. 342-43. The Table is entitled “Tables from the Board of Trade Report January 1, 1861, showing the tonnage and valuation of the vessels engaged in the commerce of the Lakes in 1859 and 1860.”

1860: *Ibid.*

1866: Association of Canadian Lake Underwriters, *Lake Vessel Register* (Toronto: 1866).

American

1849: C. H. Keep, "The Commerce and Shipping of the Great Lakes", *Report on the Internal Commerce of the United States for the Year 1891, Part II of Commerce and Navigation: The Commerce of the Great lakes, the Mississippi River and its Tributaries*, (Washington: Government Printing Office, 1892), 16, citing the Board of Lake Underwriters.

Both

1856: *Report of the Proceedings of a Meeting of The Board of Lake Underwriters held at Cleveland, Ohio, February 11th, 1857* (Buffalo, 1857), 47.

1858: *Report of the Fifth Annual Meeting of the Board of Lake Underwriters held at Chicago, Ill., February 16th, 1859* (Buffalo, 1859), supplement "Marine Disasters and Loss of Life and Property on the Lakes for 1858," 6.

1859: *Report of the Sixth Annual Meeting of the Board of Lake Underwriters held at New York City, February 20th, 1860* (Buffalo, 1860), supplement "Marine Disasters and Loss of Life and Property on the Lakes for 1859," 9.

1860: *Report of the Seventh Annual Meeting of the Board of Lake Underwriters held at New York City, February 19th, 1861* (Buffalo, 1861), 45.

1861: *Report of the Eighth Annual Meeting of the Board of Lake Underwriters* (Buffalo, 1862) after p. 33.

1862: J. Disturnell, comp., *The Great lakes, or Inland Seas of America ...* (New York, 1863), 30-31 quoting the Board of Lake Underwriters.

1865: In addition to these two numbers were \$284,700 worth of barges.

American new builds

1844: O. L. Holley, ed., *The New-York State Register, for 1845*, (New York, 1845) 271.

Table 4: Port Entries, selected ports and years

The Mackinac entries are from the surviving customs documents for vessels (Mackinac Customs Manifests, Burton Historical Collection Detroit Public Library); The Buffalo and Cleveland entries are drawn from the Marine Lists published in one of the daily newspapers in the respective ports. The American tonnage numbers were drawn from the most recent enrollment (thus the 1866 and 1876 calculations reflect the re-measurement that took place in 1865) and are drawn from the Wisconsin Maritime Historical Society Great Lakes Vessel Enrollment Online Database (<http://www.shipwreck.com/shipwreck/wmhs/>), The Great Lakes Maritime Database (Thunder Bay National Marine Sanctuary, Alpena County Library and the University of Michigan (<http://quod.lib.umich.edu/t/tbnms1ic?page=index>), and the US Enrolments database on the Maritime History of the Great Lakes site (<http://www.maritimehistoryofthegreatlakes.ca/enrolment/>)

Table 5: Tonnage Miles, Buffalo Arrivals, 1848, 1860

From the same sources as table 4

Values used in Figures 1, 2 and 4

Year	Steam	non- Steam	barge	sail	canal	Steam %
1832	2919	8688				25.1
1833						
1834	5685	11311				33.5

1835	5685	11258				33.6
1836	10544	16017				39.7
1837	7514	26848				21.9
1838	17166	29457				36.8
1839	12748	30442				29.5
1840	18092	26650				40.4
1841	20591	36063				36.3
1842	19276	42032				31.4
1843	22202	42670				34.2
1844	16215	59530				21.4
1845	53323	Mis- reported				
1846	45511	58128				43.9
1847	60246	77064				43.9
1848						
1849	59466	119679				33.2
1850	65744	123166				34.8
1851	69717	133237				34.4
1852	78493	144884				35.1
1853	86390	170115				33.7
1854	100953	190378				34.7
1855	108233	237446				31.3
1856	107287	268009				28.6
1857	119035	290620				29.1
1858	121423	289075				29.6
1859	124013	309407				28.6
1860	127029	328640				27.9
1861	126523	350498				26.5
1862	137450	414458				24.9
1863	143852	480886				23.0
1864	153598	395926				28.0
1865	85595	546019				13.6
1866	65921	495079				11.8
1867	134110	443185				23.2
1868	139747		15956	283706	208386	21.6
1869	140243		21479	268104	175923	23.2
1870	136980		26976	254520	210311	21.8
1871	143901		31112	258985	221644	21.9
1872	156883		37443	263496	211539	23.4
1873	174599		42075	293498	218992	23.9
1874	192094		45940	332662	207922	24.7
1875	197073		44757	335822	193982	25.5

1876	197641	45264	329034	2413	34.4
1877	196984	46886	321890	2670	34.7
1878	197947	44975	313415	3740	35.3
1879	200925	41905	304475	4975	36.4
1880	209465	40612	302265	5153	37.6
1881	257250	40769	303272	7333	42.3
1882	288968	42049	311111	9486	44.3
1883	301256	42802	307734	10810	45.5
1884	318962	33326	305220	11612	47.7
1885	332365	29883	310384	11993	48.5
1886	378375	25205	279574	12708	54.4
1887	387208	21432	312667	14774	52.6
1888	476036	17868	312286	14793	58.0
1889	571205	6948	322695	15240	62.4
1890	648725	13584	326077	15716	64.6
1891	732577	20146	322535	16757	67.1
1892	758804	24995	317074	17813	67.8
1893	824527	37406	315245	17840	69.0
1894	839340	38888	300441	9670	70.6
1895	854019	38682	298297	9967	71.1
1896	920915	44849	307146	11072	71.7
1897	973511	60459	332249	2930	71.1
1898	989953	69371	331908	4104	70.9
1899	1010986	74982	316914	3811	71.9
1900	1106842	78409	333906	3700	72.7

Values for Figure 3

Year	Sail		Steam		Canal		Barges		Total	
	No	Tons	No	Tons	No	Tons	No	Tons	No	Tons
1868	126	25327	65	11308	172	16094	28	4236	391	56065
1869	83	14961	77	13338	179	15701	35	5458	374	49460
1870	67	10194	49	7153	151	16450	9	3288	276	34520
1871	59	13770	45	12292	112	13970	19	3794	235	40272
1872	56	12891	58	15895	90	11703	14	3958	218	42467
1873	112	40839	104	21364	161	23370	22	6755	399	88032
1874	130	43850	99	24440	119	18914	22	4733	370	87281
1875	62	12269	70	12459	4	3492	11	1620	147	26886
1876	35	2506	79	8955	3	2175	6	2468	123	14330
1877	29	2685	39	3786	2	1863	4	551	74	7296
1878	31	1389	55	8632	0	1159	2	129	88	10163
1879	30	1173	44	11531	5	1839	5	579	84	13919

1880	47	5427	63	14291	1	1789	7	1324	118	20992
1881	52	12936	109	49053	13	8375	14	3111	188	66826
1882	66	16163	128	33597	10	1485	5	1988	254	58368
1883	31	6140	100	17232	13	3789	3	1158	147	26259
1884	29	7667	80	20180	0	2547	1	10	110	27883
1885	28	3730	64	20228	3	395	3	552	98	24904
1886	15	5232	46	12611	7	952	5	411	73	19208
1887	34	4893	75	47183	15	2058	8	378	132	54513
1888	42	9130	139	86716	6	784	2	467	189	97099
1889	32	8097	145	93706	5	688	2	248	184	102740
1890	34	12613	115	86009	7	893	12	6739	168	106252
1891	30	7240	121	93290	14	1775	11	6852	176	109158
1892	41	3474	92	34117	9	1065	8	5448	150	44104
1893	21	9276	126	76161	5	669	11	11867	163	97975
1894	18	5473	71	34899	4	444	6	428	99	41245
1895	22	8165	58	26516	5	568	2	445	87	35695
1896	19	21825	75	75743	5	569	14	10184	113	108323
1897	26	39150	43	61787	10	1306	15	11041	94	113284
1898	11	9151	36	33215	8	1051	20	9409	75	52826
1899	21	24690	44	48207	9	1084	43	5835	117	79816
1900	6	22031	61	100157	16	1896	27	5019	110	129103