Defining the Great Lakes Passenger Freight Propeller: A Statistical, and Historical Study

by

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Passenger freight propellers were integral to the Great Lakes economy for nearly 100 years. A unique vessel type created for a unique need, shipbuilders combined different new technologies to create faster, more efficient, and more comfortable ships. This thesis explores the technical development of the passenger freight propeller using statistics, and comparisons to the historic record. Since ship design is a complex process, involving numerous considerations, multivariate linear regressions were determined to be the best fit. From these techniques, a more nuanced view of the passenger freight propeller emerged. While primary sources alone can provide important information about larger companies or maritime disasters, the ships or smaller companies were under-recorded. Utilizing ship registration data, the contribution of these smaller companies is more visible. After comparing the initial statistics, historical comparison answered some questions and provided some more. This thesis should be taken as a jumping off point for future research into this important Great Lakes ship.

Defining the Great Lakes Passenger Freight Propeller: A Statistical, and Historical Study

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CHAPTER 1: INTRODUCTION

This thesis uses historical sources to both define and build a developmental panorama of the Great Lakes passenger freight propeller. Passenger freight propellers were a class of vessel that operated on the Great Lakes in the latter half of the nineteenth century, which carried goods and people across the lakes to ports that were far from railway stations. During this time, there were many changes to shipbuilding technology and to the Great Lakes canal system (Fairlie 1898; Larkin 1994; Lafferty 1998; Karamanski 2000). Passenger freight propellers also changed, partially because of technological improvements and economic need. Measuring which of these technical innovations had the most impact on passenger freight propellers is difficult; however, today there are a wide variety of sources available that provide a basis for a statistical comparison of these ship changes. Statistics comparing details and overall dimensions of these ships through time will illuminate how all these operational and developmental forces came together to impact these vessels.

Sailors and locals on the Great Lakes have called passenger freight propellers many different names. They called these ships: package freight propellers, passenger propellers, package/freight propellers, and potentially countless names lost to history (Mansfield 1899a; Hartmeyer 2014). All these names indicate the few known unifying features of this class: that they carried both passengers and package freight and were powered with propellers. Besides the presence of propellers on shipwrecks, there is little from this definition that lends itself to individual identification. Researchers distinguish package freight from bulk freight by the cargo's size and fragility, which does mean that passenger freight propellers are typically smaller than bulk freight propellers that carried cargos such as grain, iron, coal and rocks. Further, carrying passengers mandates that the passenger freight propellers included passenger-specific spaces on board ships, including cabins and potentially passenger recreation areas. Researchers on the Great Lakes have found wrecks with these spaces intact, but most known passenger freight propeller wrecks have lost their cabins in the deposition process (Rodgers 1995; Rodgers and Green 2003; Hartmeyer 2016). Clearly, in order to better understand these ships individually, researchers must have more unifying details and features for this vessel class, including an understanding of how outside factors impacted these ships' size ratios and numbers.

Researchers have noted the general pattern that passenger freight propellers get larger over time before eventually disappearing from the Great Lakes (Rodgers and Green 2003; Hartmeyer 2014). This overly general pattern is too subjective for useful analysis. This study therefore will not only confirm or deny this pattern but also identify which potential factors created it. It will also create "snapshot" views of the average passenger freight propeller, decade by decade.

Over time, researchers have also pointed to many different factors to explain the rise and fall of passenger freight propellers (Fairlie 1898:55; Cooper 1996; Rodgers and Green 2003:26–27; Hartmeyer 2014:12–13). Potential factors include: the expansion of the railroad system, the expansion of the canal system, the rate of immigration into the Great Lakes, and economic changes. While each of these aspects must have impacted passenger freight propellers and their owners, it is difficult to tell which factor had the most impact. This is because researchers have mainly focused on individual vessels. It is easy enough to understand the motivations for the owners of a single ship; it is far more difficult to see if these motivations were the norm for other ship owners. Luckily, there is a solution.

Research Questions

A historian using statistical analysis can easily visualize and compare substantial amounts of data that would likely overwhelm an individual analyst. This method is ideal for understanding the development of passenger freight propellers in the 19th century, as there were hundreds of this class of ship. While other researchers have studied individual examples of these vessels, a mass analysis of historic data and comparisons to known historic events and changes will allow for the understanding of larger trends and relationships (Cooper 1996; Rodgers and Green 2003; Hartmeyer 2014). Small-scale comparisons can only draw out differences between the ships included; a statistical analysis of a large database can create statistically significant information. This information can show the trajectory of passenger freight propeller size, relationships between size and construction methods, and relationships between these ships and historic changes to the Great Lakes.

To better understand passenger freight propellers, this thesis will answer these questions:

Primary

- What were the economic and social forces that led to the creation of the passenger freight propeller?

Secondary

- Is the size change of passenger freight propellers the result of improvements to the Great Lake Canal System?
- What were passenger freight propellers primarily used for?
- Is the size change of passenger freight propellers the result of economic changes in the Great Lakes?

The Historic Collection of the Great Lakes Online Ship Database from Bowling Green University contains a plethora of information on these vessels. This database was compiled over the course of almost 40 years from the physical manuscript collection at Bowling Green University. This information includes the gross dimension of individual ships and historical information gathered from legal documents. The problem with this database is that the data forms rarely include the entire class of the vessel, only the rig. While most of the entries in the database have pictures of the vessel, some do not, and some photos are not clear enough for analytical purposes. This means that there is not always a specific way to confidently separate out passenger freight propellers from other types of propellers. Further, every time a piece of information is chronicled in a new format, there is a risk of recording errors.

Luckily, the Bowling Green State University Online Ship Database does record the owner and registry number for these vessels. This information can be cross-referenced with Lloyd's Register of British and Foreign Shipping, the Register of American Merchant Vessels, and John Mansfield's *History of the Great Lakes*. Lloyd's register was a recording of initially British ships available for reference since at least 1760 (Behrendt and Solar 2014:570). This particular source will truly only be useful for the Canadian, and admittedly few British and Irish ships included in this study. Most of the historic ledgers, including the ones published in the 19th century, are now available online and provide another potential source of information on passenger freight propellers (Bowling Green University 2017; Mansfield 1899b; Lloyd's Registry 2018).

John Mansfield was a historian and journalist who worked in Chicago, Illinois, during the turn of the 20th century (Mansfield 1899a; 1899b; Baird and Brown 1905). Mansfield loved the

Great Lakes and dedicated much of his life to faithfully recording the history of this region. The resulting volumes, *History of the Great Lakes*, records less technical information than the Bowling Green database or the List of American Merchant Ships, but includes detailed information on shipbuilders, ship companies, and lake captains, beyond what official registers or insurance companies included. This information can clarify whether vessels were used as passenger freight propellers, although Mansfield does not mention every ship on the lakes.

The List of American Merchant Vessels is an annual register, submitted to the US House of Representatives and published by the Department of Labor and Commerce. The first list was mandated by law in 1868, and each subsequent list is completed on June 30th of each year (Department of Commerce 1878:i). Each annual list includes every ship registered and actively used in America. While this study does include non-American ships and ships built prior to 1868, this source was integral in confirming the data sampled from the Bowling Green State University Online Historic Ship Database.

During the 19th century, the majority of the passenger freight traffic on the Great Lakes was owned by railroad companies attempting to extend their lines to distant ports (The Evening Argus 1895:4; Association of American Railroads 1946:2). Prior to proliferation of steam technology and the opening of the canal system, the most commonly used vessels on the Great Lakes were schooners, or early Native American style birch-bark canoes (Mansfield 1899a:386). Once steam engines were common, by the mid-19th century, passenger freight propellers became the ideal vessel for package freight, such as manufactured items moving from east coast factories. Unlike earlier schooners, passenger freight propellers were easily loaded with freight below deck and comfortable for passengers. Unlike steamers, defined on the lakes as a contemporary steam vessel for passengers powered through large sidewheels, passenger freight propellers had sleek hulls with the use of propellers rather than sidewheels, passenger carrying superstructures that allowed for transportation both in cramped canals and the open lake water. And unlike bulk carriers, they were maneuverable enough with a shallow draft to navigate into smaller ports (Hartmeyer 2014:40–41). Later on, entrepreneurs created companies specifically focused on passenger freight traffic, like the Goodrich Transportation Company and the Northern Steamship Company (Mansfield 1899a:464)

After the passage of the Transportation Act of 1940, railroad companies no longer considered water transport to be economically feasible, especially for passenger freight traffic (Association of American Railroads 1946:3). This act put water carriers under the control of the Interstate Commerce Commission (ICC). This act also imposed the rules and regulations that had previously only been applicable to railroads to water carriers (Dewey 1941). As the railroad companies were coming off the heels of the Great Depression, the sudden loss of the legal benefits of using water transportation to supplement railroads meant that there was no motivation to reinvest in passenger freight propellers.

Limitations

Since the database for this study is compiled from historical sources, all the limitations associated with such sources apply to this analysis. Historical sources can be inaccurate or incomplete, and without physical remains to compare them to, it is difficult to determine if the written documents are accurate. The equations used in calculating net and gross tonnage changed over time, which might create a distortion of tonnage that did not physically exist (US House of Representatives 1895; Vasudevan 2010:9–15). If the definition of net tonnage changed dramatically, newer ships might appear to have less or more profitable space than older ships, even if the physical distribution of the internal structures remained the same.

This study initially considered the inclusion of archaeologically studied passenger freight propeller wrecks as a way to test the conclusions from the statistical tests and to offer explanations of some of the trends noted by these tests. Unfortunately, the four best recorded passenger freight propeller wrecks, *Atlanta, Pewabic, Empire State,* and the Claflin Point wreck have been too damaged by the site formation processes to yield anything but gross hull construction detail. *Atlanta* burned to the waterline, removing any information about its passenger spaces or other upper deck structures (TIMES 1906:11). *Empire State* and seemingly the Claflin Point wreck, were both converted to engineless stone barges before also burning to the waterline, so even if they were intact they would be more useful in answering questions about barges (Rodgers 1995:15; Rodgers and Green 2003:29). *Pewabic* sits at the bottom of Lake Huron, at 168 feet. While it is intact enough to answer questions about its internal structures and distribution of space, the depth of this vessel has prevented the academic study of the inside of this vessel (Hartmeyer 2014:58, 66). As this study already includes information on these ships' gross dimensions from historical sources, their detailed inclusion was determined to be redundant.

In addition to general limitations of historic sources, this thesis includes information from official, legal registration, ship insurance records, local newspapers, and 19th century marine writings. Even though marine insurance fell under the jurisdiction of federal and state policy, during the time span this study covers there were few enforced standards. American insurance companies during the 19th century often had difficulty competing with European insurance companies, and therefore American records are not nearly as complete as their European counterparts. Further, shipping companies also had private, individual underwriters as an insuring option (Winter 1935:15–17). Finding the records of all the insurance companies and underwriters that serviced American shipping companies would constitute its own thesis.

As mentioned above, the full class of a vessel was not always recorded in the List of American Merchant Ships, or the Bowling Green Database. *History of the Great Lakes* often does; however, Mansfield did not record all the 19th-century ships and this study considers ships of the 20th century as well. All care will be taken to include only passenger freight propellers, but it is possible that a few examples of other classes will be included. Of course, any ship not obviously a passenger freight propeller will be carefully examined, to determine its classification.

There are also many variables that could impact a ship size that were not typically recorded. Hogging trusses add strength to a ships hull and can be used to extend the length of the vessel, but their presence and position were only recorded by Mansfield on occasion, and never in the Register of American Merchant Vessels (Department of Commerce 1878; 1895; 1910; 1930; Mansfield 1899a:413). Hogging trusses are additional supports often located above a vessel's superstructures that prevent the keel of a shallow drafted vessel from bending or breaking. Technical improvements to engine efficiency and hull strength could impact the gross and net tonnage, but exact engine type was also rarely recorded for specific ships (Mansfield 1899a:399, 404–408; Lafferty 1998; Hartmeyer 2014:16, 41; Rodgers and Green 2003:25, 27). Intended routes could limit the width and depth of a ship, as the canal and lock system was improved only sporadically, but again the intended or actual route of a vessel was rarely recorded (Fairlie 1898; Larkin 1994). By averaging together as much data from confirmed passenger freight propellers as possible, the impacts of the variables are lessened. A multivariate analysis can also remove this limitation. Multivariate analysis can also indicate the impact of an external variable, in addition to showing whether a combination of variables had a greater impact on these ships than the individual variables themselves.

Thesis Structure

This study is separated into two main parts. The statistical analysis comprises the first part, and the comparison of the resulting statistics to historic sources is the second. Information gathered from the Bowling Green State University Online Ship Database, the List of American Merchant Vessels, and *History of the Great Lakes* were entered into a database generated by the Statistical Package for Social Sciences (SPSS) version 24. SPSS can hold a large amount of data and perform a wide variety of statistical tests, making it an ideal software for this study.

The variables included in the database are ship name, registry number, year built, length, width, depth, gross and net tonnage, hull material, hogging truss position, building location and source. Ships that were missing more than one of these variables are not considered in this study, resulting in a database of 354 ships. Several descriptive statistics will be generated from this database, primarily: number of ships per year, hull material and hogging truss position. Almost all the ships included in this study have a definite build year and hull material, but as mentioned, hogging truss position was more difficult to determine. The dataset would be limited too much if only ships with fully understood constructions were included. For the tests that specifically look at the impact of hogging trusses, only those ships with full data will be included. For passenger freight propellers, hogging trusses were typically large arches of iron or steel and could either breach the top deck to be visible at the surface or were entirely under-deck structures.

While gathering data, ships newer than 1910 were not included. This is largely because after 1910, passenger freight propellers were falling out of use. After WWI ended, there was a slight increase in passenger freight propellers, but by this time the railroad network had expanded across the Great Lakes region to the point where ship transportation was no longer convenient or practical (Association of American Railroads 1946). No minimum date was established, to ensure the earliest passenger freight propellers are included. The earliest ship included in this study, *Hercules*, was built in 1843 (Case 214, Appendix A).

Two types of tests will be applied to look for patterns and relationships within this database. The first will be univariate analysis; each individual variable will be compared one-on-one. The second will be multivariate analysis; groups of variables will be compared both against each other and the variable time (Hand 2008:83). The overall goal of the multivariate analysis will be to determine if there are any overarching patterns and if the variables identified in this study are the actual strongest impacts on Great Lakes passenger freight propellers. For both tests, the dependent variable will be size, determined by the length, beam, depth, and tonnage. While it is possible that the size of these vessels was primarily impacted by only one variable, it is far more likely that a combination of variables had a stronger effect. Ships that do appear to be outliers, but not clearly a different ship class are reviewed in more detail. If they cannot be clearly determined to be passenger freight propellers, they will not be included.

The univariate and multivariate analysis will apply to both the database as a whole and to individual decades within the overall set. This will create average views of the ships by decade and allow for the second half of this study. The second half of the study identifies major changes to passenger freight propellers and compares those changes to known historic events that could reasonably impact the Great Lakes. This portion allows for the inclusion of variables that are not easily assigned to specific ships or companies, such as political developments, larger economic trends, and changes to the canal system.

This study will create a better understanding of passenger freight propellers on the Great Lakes. The data from the Bowling Green State University, the List of American Merchant Vessels, and *History of the Great Lakes* provide more than enough data for a statistical analysis of these vessels. While there have been several investigations into individual passenger freight propellers, it is time for a broader, more comprehensive contextual view.

CHAPTER 2: HISTORY OF THE PASSENGER FREIGHT PROPELLER

In point of the means of locomotion we have seen the oar superseded by the sail, and this is gradually being replaced by steam, that prodigious invention applied by Fulton to the propulsion of vessels, and which in our own days we see gradually changing the face of commerce and all naval tactics….They will however, tend to preserve, by the cheapness of transport, an infinite number of vessels of all capacities, and above all, those beautiful clippers, sailing vessels only, whose rate of progress competes with steamers owing to their fine lines, and the disposal of their sails (Nautical Magazine 1871:4).

Steam-powered ships in general were not quickly accepted as the game-changer they really were. Over the course of the 19th century, as steam technology evolved, steam-powered ships ever so slowly took over as the primary form of ship locomotion. Even over half a century after their first launch, steam-powered ships were considered merely an addition to the variety of ships people used to move raw materials, manufactured goods, and other people. The early iterations of these vessels were the grand sidewheelers, or steamers as they are called on the Great Lakes, whose images are firmly implanted in popular culture as one of the defining characteristics of the early and mid-19th century (Nautical Magazine 1871:4; Stone 2015:12–16). In comparison, average propellers are not given half the attention of steamers.

The story of how steam-powered ships entered the Great Lakes is a long one, and one that has been sufficiently told in a number of publications. Most of these publications focus on steam travel in general, with cursory sections on either passenger travel or propeller ships. Propeller ships, and passenger freight propellers in general, are often considered a side note, or merely a variation of the more romanticized palace steamers (Mansfield 1899a; Cooper and Jensen 1995; Rodgers 1996; Karamanski 2000; Hilton 2002; Henry 2013; Stone 2015). To be clear, palace steamers absolutely cleared the way for passenger freight propellers. Yet these ships were common on the Great Lakes for almost 70 years, and persisted, in reduced numbers, until the 1960s (Stone 2015:1–3). These ships deserve a detailed history. This chapter attempts to shine a light on the history of passenger freight propellers: why they were created, why they overtook sidewheelers, and why they eventually left the Great Lakes.

When European settlers first reached the shores of Lake Huron in 1615, they found overland travel to be nearly impossible. Various Native American groups had control over the territory and were not willing to simply allow these new people into their lands. The natural geography of the Great Lakes region was rough, filled with swamps, elevation changes, and dense forest (Mansfield 1899a: 65–71). Traveling by land was dangerous and time-consuming. The lakes quickly became the preferred mode of travel, as they allowed explorers entry into the center of the continent without having to deal with any of the dangers and difficulties on shore. Lake travel would continue to be the standard for the next three hundred years.

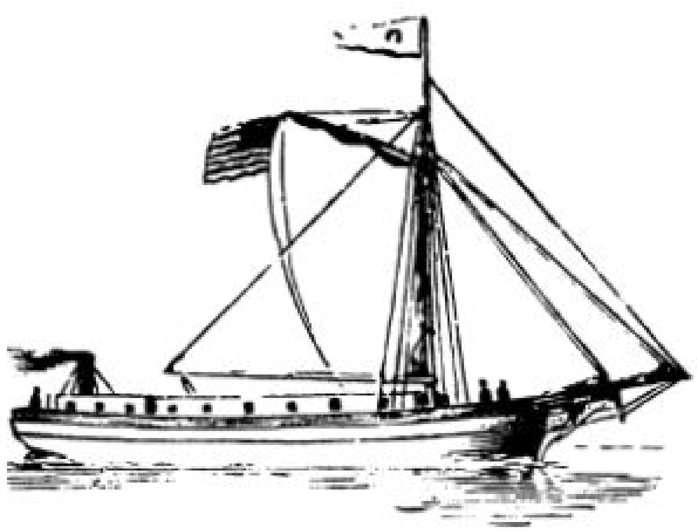
The dense wilderness of the Great Lakes region prevented much interest in settling the region until after the War of 1812 (Mansfield 1899a:132). Once the wave of immigration started, shipbuilders rushed to meet the demand of settlers, growing markets, and eastern industry by building faster and easier to load ships. The first unique Great Lakes ship was the two-masted schooner, which solved the loading issue by increasing access to the hold (Mansfield 1899a:129). Schooner passage was rather uncomfortable for passengers, as they were primarily built for cargo (Stone 2015:45). The successful launching of *The North River Steamboat* in 1807 by Robert Fulton opened up an exciting new opportunity for ship owners in the Great Lakes (Philip 2003:204). Building off of the intense rivalry from the War of 1812, Canadian and American shipbuilders raced to be the first to launch a steamship on the Great Lakes (Stone 2015:15).

Either *Frontenac* or *Ontario* were the first steam-powered vessel built to steam on the

Great Lakes. This is a highly debated topic with a wide variety of opinions and for the purposes of this research, will not be discussed further (Mansfield 1899a; Fry 1896; Mills 1910; Hilton 2002; Stone 2015). Built in 1816, these vessels spearheaded interest in using steam to travel the lakes, but the actual number of steamers grew slowly; by the end of the 1820s, there were only 12 steamers on the lakes (Mansfield 1899a:394). This slow acceptance of steam-powered ships was likely due to the natural connections between the lakes, which were characterized by falls, rapids and narrow passageways. The Erie Canal opened in October of 1825, opening the western lakes for settlement from the east coast and steam travel (Hilton 2002:26). This canal was followed by the opening of the Welland Canal in 1829 between Ontario and the upper lakes (Mansfield 1899a:232). With the upper and lower lakes connected, settlers were able to reach what would become the mid-west.

Paddlewheel steamers served the purposes of early settlers well, but there were some problems inherent to this design. First, paddlewheel ships were initially designed with rivers in mind; the large waves possible in the open water of the Great Lakes meant the wheels could be forced out of the water or plunged well below it. This often violent see-saw motion was not only disturbing to passengers, it also increased the amount of stress on the engines as the brunt of the forward propulsion was shifted side-to-side. Even during calm weather, steamers would speed up and slow down as the engine directed energy to the paddlewheels. The motion was very noticeable, and some people found it uncomfortable. Steamers also began to get wider, quickly moving past the acceptable maximum width for the Erie and Welland Canals (Hartmeyer 2014:41; Stone 2015:102).

The very first propeller driven ship on the Great Lakes was *Vandalia*, launched in 1841 (Smith 1986; Stone 2015:103). Initially called a "Steam Schooner," *Vandalia* was essentially an experimental vessel meant to deal with the problems lake captains were experiencing with steamers on the Great Lakes. In the Great Lakes vernacular, a propeller driven ships is simply referred to as a propeller. Beyond the problems discussed above, paddlewheel steamers could not easily fit through canals. *Vandalia* had dual, Ericcson style propellers, sloop rigging, above-deck cabins for passengers, and a double cylinder engine (Mansfield 1899a:403; Smith 1986). Prior to *Vandalia's* successful trial voyage, propellers were regarded with suspicion (Neilson 1987:8). After *Vandalia* proved the practicality of propellers, the number of propellers built for the Great Lakes nearly exploded. By 1854, propellers surpassed steamers in terms of tonnage, but this number also included a large number of straight cargo vessels (Mansfield 1899a:405; Neilson 1987:8; Stone 2015:104; Figure 2-1). While *Vandalia* proved that propellers were suitable for the Great Lakes, and did have the ability to carry passengers, it was not truly a passenger freight propeller. *Vandalia* opened the way for propeller cargo vessels and did not disrupt the large palace steamer's place for comfortable passenger travel on the Great Lakes.



THE FIRST SCREW STEAMER, PROPELLER VANDALIA.

FIGURE 2-1 - The Vandalia (Mansfield 1899a:404).

The first true passenger freight propeller on the Great Lakes was *Hercules*, launched in

1843 by Bidwell & Banta in Buffalo, New York. *Hercules* had all of the markers of a passenger freight propeller: 14 staterooms, room for 46 berths, and a propeller engine small and out of the way enough to not disrupt the hull capacity (Democracy 1855; Mansfield 1899a:404). This clear mix of passenger and cargo space was likely meant to force more profit out of the newer ship type, as propellers were still much slower than the earlier paddlewheel steamers; propellers ran at half the speed that sidewheelers did. The main benefit shipowners saw in propellers was that propellers typically required much less fuel than steamers (Stone 2015:104).

This efficiency encouraged the creation of more practical passenger accommodations than the lavish palace steamers. John Mansfield (1899a:407) described one palace steamer as having "a stateroom picked out in gold, luxuriously upholstered furniture, sumptuous carpets and a finely designed balcony in antique brass. There is also a complete library, a very cozy café and smoking room for card playing, etc." In comparison, passenger freight propellers were designed with affordability and efficiency in mind; two years before *Hercules* was launched, the average passenger ticket cost $30 dollars, but by 1845 the average ticket cost $20 (Stone 2015:104).

Other researchers have depicted passenger freight propellers as a direct competitor to palace steamers, and the slow acceptance of passenger freight propellers as an indication of the propeller's initial failure (Mansfield 1899a:404–408; Hilton 2002:79; Stone 2015:102–105). While it is accurate that propellers did not overtake palace steamers as the primary form of traveler transportation until the 1870s, comparing passenger freight propellers to palace steamers is misguided. Passenger freight propellers were not attempting to fill the same economic role as palace steamers. If they had been, the ship designers of *Hercules* and subsequent passenger freight propellers would not have put so much focus on also carrying freight. Further, changes in ship technology are almost always regarded with suspicion, from both sailors and passengers alike (Neilson 1987:4; Rodgers 1996:8). While there were still assuredly many steamers on the lakes for decades after *Vandalia* was launched, passenger freight propellers brought the working class to the upper lakes.

The 1840s also saw significant increase in ship traffic, technological improvements, and immigration to the upper Midwest that continued into the 1850s. Part of this was due to artificially deflated prices enforced by The Steamboat Association, or Combination. Established in 1840, the Combination not only enforced specific routes and rates, they also collected tariffs and fees from their members. This blatant attempt at a monopoly did manage to set industry standards and encouraged trust in the regularity of the steamboat lines; if only that ship owners not part of the Combination were insistent on beating them in every way conceivable. Independent steamers and propellers established regular lines along the lakes' coastline by 1848. Prior to this, travelers required coaches or were forced to use the Combination's intermittent services (Hilton 2002:32).

Included among the technological improvements introduced during the 1840s was the hogging truss. Hogging trusses combated the hull warping, or hogging, that occurs on wooden ships with too extreme length-to-width ratios (Mansfield 1899a:413; Stone 2015:93–94). These trusses were typically iron arches placed on either side of the centerline, although several variations existed. Shipbuilders also placed hogging trusses along the centerline, or as ceiling arches attached to the interior of the hull. These arches helped create the iconic image of steamers and allowed shipbuilders to take full advantage of improving steam engine efficiency (Figure 2-2). While the opening of the Erie and Welland canals allowed inter-lake travel, the dimensions still heavily limited ship design.

When propellers were introduced, ship lines had to create more tuck around the stern to allow the best water flow for propeller and rudder efficiency (Hilton 2002:40–44). Hogging trusses allowed sleeker, faster designs while reducing the risk of hogging. As discussed in a later chapter, passenger freight propellers had an average length-to-width ratio of 6:1, which would not be possible without hogging trusses.

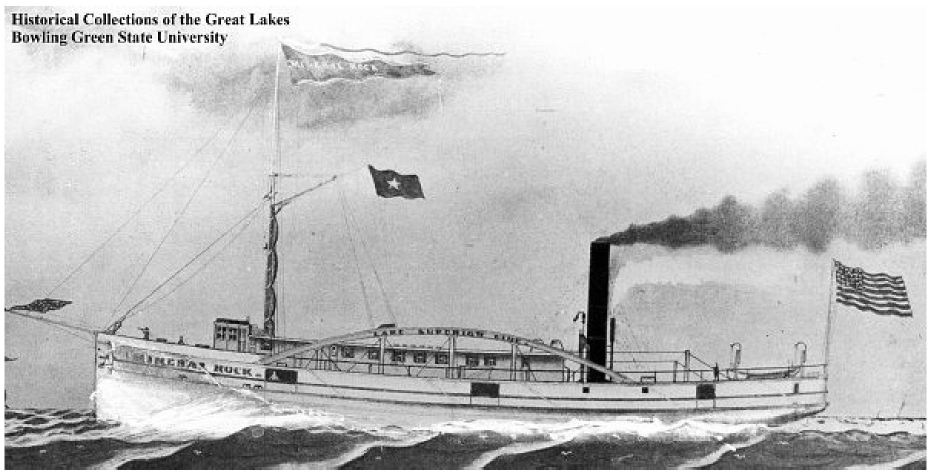


FIGURE 2-2 - Illustration of the propeller *Mineral Rock*, showing an extreme version of a hogging truss (Bowling Green State University 1860)

The Combination did not survive the 1840s and, typical of any cartel disruption, the number of competitors on the Great Lakes increased dramatically. In 1849, shortly after the Combination's final dissolution, there were only 45 propellers registered on the Great Lakes, but in 16 years that number had increased over four-fold to 184 (Hilton 2002:43). The 1850s and 1860s were also noted by a period of mixed lines. Ship companies continued to use steamers, but slowly started to introduce propellers as their designs got sharper, faster, and more efficient (Hilton 2002:40–44; Stone 2015:102–105).

The strides shipbuilders made in shipbuilding technology were brought to a halt during the Civil War. Focus shifted to naval technology, and the number of civilians traveling slowed. This resulted in a slight dip in average gross tonnage in the 1860s, which rebounded in the

1870s. (Hilton 2002:103). During the Civil War, passenger freight vessels found their place moving soldiers, iron, copper, and food for the war effort. In addition to their more oblique, official role, individual abolitionist citizens and shipowners gave runaway slaves passage on passenger vessels, although specific accounts tying this activity to passenger freight propellers specifically is rare (Stone 2015:140–142).

The 1860s also established passenger freight propellers as carriers of fruit, a natural relationship for ships working in Michigan. This combination of passenger and fruit traffic was ideal during the mid to late 19th century, as rail lines and eventually roads were not heavily developed. Ships could not only get to markets faster than traditional terrestrial transportation routes, but their range of travel in the Great Lakes was much larger. Moving fresh fruit from rural ports to larger markets such as Chicago, Green Bay, and Milwaukee also created natural passenger lines after the first rush of immigration subsided. During the 1860s to the 1870s, passenger freight propellers slowly shifted from immigrant transport to the standard form of transportation across the Great Lakes (Association of American Railroads 1946:77; Hilton 2002:102–105).

Railroad development in the upper Midwest began shortly after the first canal systems in the later 1830s but were generally thought to not be competitive with ship traffic. At the time, they were not; laying rail across the vast wooded wilderness required a significant amount of starting capital. To preserve their businesses' interests, railroad owners would often partner with passenger ship lines or even owned their own passenger freight propellers to continue service beyond the actual rail lines. If railroad owners wanted to establish their lines in the Midwest to the same level of profit they experienced in New England, they needed to work alongside the ships already moving people and products across the Great Lakes (Hilton 2002:33–40).

At first, cooperation between railroads and passenger ships primarily benefitted the railroads. Without the extensive web of rail lines, railroad owners relied on a variety of ships to ensure that their clients' cargo reached as many towns as needed. As population increased around the upper Great Lakes, ship owners needed to switch gears. It was no longer profitable to rely solely on new immigrants and travelers to the region, so pairing with railroads ensured that they would have a steady stream of passengers and cargo (Stone 2015:160).

The need for flexibility in the ship lines only increased as the century progressed. The Goodrich line became an industry leader in this regard. When the Michigan Southern Rail Road and the Michigan Central Rail Road were completed in 1852, the age of the palace steamer seemingly ended (Michigan Department of Transportation 2014:7). Travel time between major cities on the lakes decreased, gilded staterooms and palatial amenities lost their appeal. After the Panic of 1857, the customer base for such luxury accommodations disappeared, and the age of the palace steamer ended (Calomiris and Schweikart 1991:810–811). A.E. Goodrich saw an opportunity in 1862. Expanding his line to include night party excursions, Goodrich was able to force profit out of his ships almost 24/7 during the sailing seasons. Goodrich's ingenuity and drive allowed the Goodrich Transportation Company to become so iconic that the history of Great Lakes passenger freight propellers is almost the history of the Goodrich Transportation Company (Mansfield 1899a:344).

To be perfectly clear, there were still plenty of other passenger freight propeller lines not belonging to Goodrich. Examples of larger lines include Pere Marquette, Holland & Chicago Transportation Company, Indiana Transportation Company, and Graham & Morton Transportation Company. For the most part, however, these companies trailed behind Goodrich, taking their lead on ship design, routes, and rates. Similarly, Goodrich's ups and downs were tied to, and informed, the general trajectory of the passenger freight propeller industry (Hilton 2002:177–303). The main exception would be smaller ship lines, such as Samuel Neff & Sons, that were extraordinarily regional, more conservative, and not as well documented (Heier 1999). Ideally, this chapter would include a detailed discussion of these smaller companies, but sources for these ships are few and far between. Unlike the large lines, the owners of these ships never became household names, and their ships were likely unknown outside of the few small towns they serviced. Further research is required to truly understand how these smaller ships fit into the story of passenger freight propellers as a whole. For now, a brief overview of the Goodrich Transportation Company will serve as a jumping off point.

Goodrich's first ship, a steamer called *Huron*, was launched in 1856. In comparison to the company's later ships, *Huron* was tiny, at only 350 gross tons. Initially, the line only ran between Chicago and Milwaukee, but as both cities grew larger, the line had to expand (Mills 1910:238). *Huron* was a paddle steamer and, therefore, not included in this study (Figure 2-3). Over the next fifty or so years, the Goodrich line would establish itself as the preeminent passenger line on the lakes using passenger freight propellers.

FIGURE 2-3 - The Goodrich Transportation Company's first ship, *Huron* (Bowling Green State University ca. 1860s).

In the early period, the Goodrich fleet was a mix of steamers and propellers, mimicking the makeup of the Great Lake fleet as a whole (Democracy 1855; Mills 1910:240). During the 1870s and 1880s, the Goodrich line consisted primarily of propellers. Even with their success with traveler and tourist traffic, Goodrich ships still carried seasonal fruit or manufactured goods below deck, placing most of the passenger accommodations above deck (Hilton 2002:130–131). As mentioned, Goodrich also introduced the concept of night and day excursions during this time, although these fun trips did not become an advertising focus until the 20th century. The advertisement in Figure 2-4 also indicates that pricing was not a concern. Forty dollars for a roundtrip to Mackinac Island was a little under half the average monthly income in the United States in 1924 (Gilder Lehrham Institute 2017).

FIGURE 2-4 - A Goodrich advertisement for their Twilight and Daylight Trips (Goodrich Transit Co. ca. 1920s).

The industry limped along during the Great Depression, but never fully recovered. As the Depression wore on, consumers became less and less interested in pleasure travel, and less and less capable of travel in general. Finally, Goodrich was there at the end, slowly merging with every other steamship company on the lakes before finally declaring bankruptcy in 1932 (New York Herald Tribune 1933; Hilton 2002:166).

Weakened by the Depression, the final death knell of the passenger freight propeller industry was the Transportation Act of 1940. Transportation companies, like Goodrich and the Wheeler Rail Company, had attempted throughout the thirties to thwart disaster by consolidating more and more lines; but this did not prove to be the solution (Hamby 1991:12–13). Corporations created more and more tenuous systems of debt, lending, and stock futures. As consumers lost interest in pleasure travel, Goodrich and other transportation companies responded by reducing the number of routes and switching advertising techniques. While only a decade prior, the focus was on fun excursions with dancing and music, Goodrich's advertised their low prices during the 1930s (Figure 2-5).

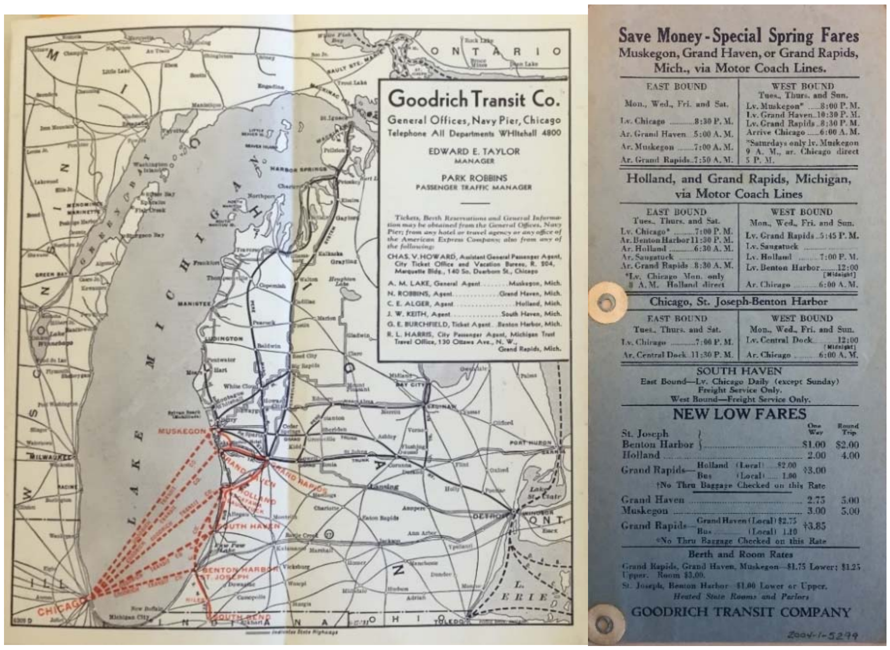


FIGURE 2-5 - The Goodrich Transit Company's 1931 route map and spring schedule (Goodrich Transit Co. 1931a; 1931b).

To combat the growing monopolies of interstate travel companies, the Interstate Commerce Commission [ICC] was formed in 1887. The ICC initially presided over disagreements between railroad companies, broke up and prevented monopolies, and enforced regulations (Okayama 2016:129). For a long time, ship carriers, particularly lake ship carriers, were able to avoid government regulation from the ICC. The Transportation Act of 1940 brought ship carriers under the control of the ICC, bringing with it the possibility of government rate control, federal safety standards, and harsher anti-trust scrutiny (Dewey 1941). By this point, technologically speaking, ship transportation had very little benefit over rail, bus, or truck passage. Essentially, the only benefit of including ships in a transportation strategy for most cargo types in the 1940s was to avoid federal scrutiny (Association of American Railroads

1946:19). With this benefit gone, so too went the passenger freight propeller.

The period of inter-lake passenger ship travel was finished. After nearly a century of being the most convenient, safe, and affordable form of travel, passenger freight propellers could no longer compete with terrestrial methods of transportation. The once grand vessels of the Goodrich transportation company were either broken up or sold for pennies on the dollar (New York Herald Tribune 1933). More and more households had personal automobiles and by the 1950s, road-trips were the preferred method of sight-seeing and tourism. Pleasure excursions on the Great Lakes persisted but became the realm of smaller yachts and the wealthy elite. In transportation and tourism, the Great Lakes became a backdrop behind sprawling highways and towering skylines. Passenger freight propellers had done their job by taming the frontier, and in doing so, created their own obsolescence.

The narrative created by looking at solely historic sources is an incomplete one. Smaller companies often went under-recorded. Their motivations and solutions to the same problems the larger companies were seeing are difficult to see using only newspapers, contemporary analysis or even modern texts on the era. The next chapters will explain how using statistical analysis of ship registration data and careful comparisons to known historical events and the chosen example ships will create a better picture of the forgotten side of the passenger freight propeller.

CHAPTER 3: METHODOLOGY

The bulk of this thesis is a multivariate statistical analysis of a ship database created from several sources; the Historic Collection of Great Lakes Ships from the Bowling Green State University, the Official Registry of American Merchant Vessels, and John Mansfield's *History of the Great Lakes*. This chapter outlines the selection process for the ships included in this study and justification for the specific multivariate analysis used. This analysis is intended to create both an overall understanding of the ships within this study, as well as targeted view of the individual decades.

Multivariate analysis refers to a wide range of statistical tests that compare the relationship between a dependent variable and multiple independent variables. Variables are typically numerically expressed qualities either belonging to, or impacting, the subject matter at hand. The benefit of using multivariate analysis over a univariate analysis is that the impact of the sum of the independent variables is front and center. As ships are a culmination of multiple individuals' decisions and concerns, it would not make sense to only look at one independent variable, or independent variables separately from each other (Baxter 1994; Hand 2008).

This study considers a wide range of variables, requiring multiple tests to truly understand how they all fit together. While some of the variables are well suited for statistical analysis, particularly ship dimensions, others were not as easily defined. Hull material and hogging truss position provided the largest challenge. These variables have a clear impact on the maximum allowable size of a ship, but it is difficult to rank them as numerical values. Logically, a steel or iron hull can support a larger ship than a wood hull, but it is impossible to say that a steel hull is "more" than a wooden hull. Similarly, hogging trusses provide additional support to a ship's keel, but one type of hogging truss is not "more" than another. These factors were represented as a series of binary variables: “wood hull, or not”, “steel hull, or not”, “above deck hogging truss, or not”, etc.

As mentioned, the information on these ships within this study came from the Historic Collection of the Great Lakes Online Ship Database from Bowling Green State University (BGSU), the List of American Merchant Vessels, and John Mansfield’s *History of the Great Lakes*. The BGSU database was selected for the first stage of the sampling process since it includes information on an overwhelming number of ships in an easily searchable website. This online database was the basis for the information included within this study. The Official Registration of American Merchant Vessels and *History of the Great Lakes* were included as supplementary texts (Department of Commerce Bureau of Navigation 1878; 1895; 1910; 1930; Mansfield 1899a; Bowling Green State University 2017). While the List of American Merchant Vessels often did not provide additional information on the ships’ dimensions, it was integral to the selection process and to confirming the data gathered from the BGSU database.

Ship records were sampled from the BGSU database by searching for vessels with propellers built before 1910, returning 1,683 results. These results included all forms of propellers, from bulk carriers to life-saving vessels. Unfortunately, the BGSU database rarely used the term “passenger freight propeller” or stated the ship’s primary purpose. To avoid including other ship classes, only vessels with confirmed, clear photographs that displayed a majority of the deck were considered. Ships that had no photograph, or poorly focused photographs, were cross-referenced, where appropriate and possible, with the List of American Merchant Vessels, local newspapers, and *History of the Great Lakes* to determine the original ship owner’s primary business endeavors. A selection of the ships were cross-referenced against the List of American Merchant Vessels to spot check the data listed in the BGSU online database. Roughly half of the ships in the dataset were cross-referenced against one of the annual List of American Merchant Vessels, published each year by the United States Department of Commerce, Bureau of Transportation (Bureau of Navigation 1878; Department of Commerce and Labor 1895; 1910; 1930; Table 3-1). The information from the primary sources were assumed to be more accurate than the BGSU online database, and in the few cases where there were conflicts, the data from the primary sources was used.

Table 3-1: The number of ships cross-referenced against the primary sources (Table by Author).

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	172	48.7	48.7	48.7
	YES	181	51.3	51.3	100.0
	Total	353	100.0	100.0	

American Lloyd's Register of American and Foreign Shipping was considered as a potential source to fill in the gaps left by the List of American Merchant Vessels; however, few of the ships included in this study were recorded by American Lloyds. The difference in the sources arises from the List of American Merchant Vessels being an official list of all the merchant vessels registered in America and American Lloyd's Register being a list of the ships belonging to the insurance subscribers. American Lloyd's primarily focused their business on Ocean-going vessels, and the lake-bound vessels included in this study simply were not recorded by American Lloyd's (Taylor 1865:8–10; Meyers and Salter 1883; US House of Representatives 1895).

Clear photographs were carefully examined for construction and design features that would mark the ship as something other than a passenger freight propeller. Elements that were instant disqualifiers included: lack of upper deck structures, clear use of deck space for bulk cargo, the presence of permanent loading equipment, or an exposed cargo hold (Figure 3-1). If the photograph still left any uncertainty about the ship class, the next step was to research the ship owner in local newspapers or John Mansfield's *History of the Great Lakes.*

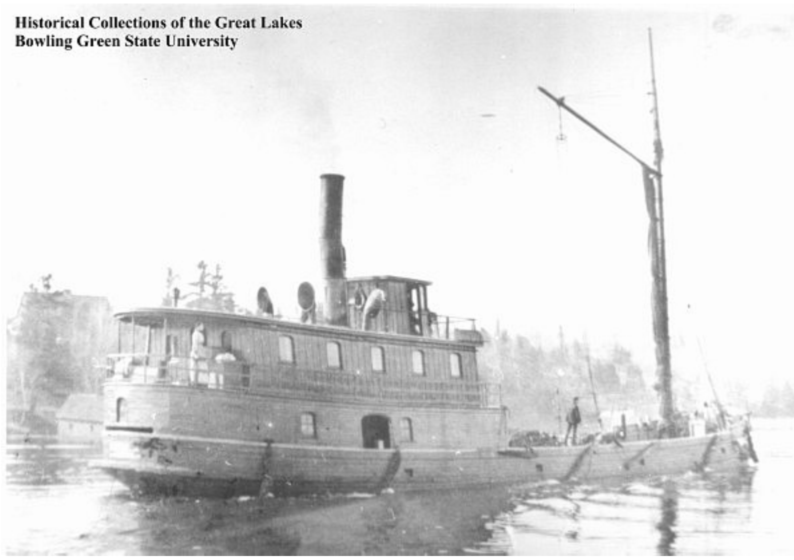


Figure 3-1: *Aberdeen*, a ship that was not selected, because of the visible open cargo hold and crane that marked it as a steam barge (BGSU).

While passenger freight propellers are easily distinguished from bulk carriers, they were rather similar in design to ferries and excursion vessels. Several of the ships included in this study appear to have been both passenger freight propellers and ferries at various stages in their careers. This might imply that the distinction between the two classes is immaterial; however, passenger freight propellers necessitated more space per passenger due to travelers being on board for multiple nights. These vessels appear very similar in photographs, although not all the vessels within the Bowling Green Great Lakes Online Ship Database have confirmed photographs. These ships' company information was cross-referenced with the information from the above sources. At this stage, all companies that were not explicitly part of the passenger freight trade were excluded.

Another factor that was considered in the sampling process was the name and registry number of the vessel. Twenty-three of the vessels returned by the original search were named

“CG-###” and were registered to the United States Coast Guard. Another ship was named *Dubuque (Gunboat #7)* and registered to the United States Navy. Similarly, *Hyacinth* was registered to the US Department of Commerce (BGSU 2018). Clearly, government-owned vessels would not have been included in the passenger freight trade. All of the vessels included in this study were, at the time of their building, registered to a private owner or company.

Beyond determining which ships were most likely passenger freight propellers, ships with clearly inaccurate or missing data were excluded. Examples include a 90-foot long ship with a depth of over 200 feet that could not be found in any of the primary sources; whether this is a mistake from the original documentation or from the digitization process is unclear. This is not to imply that all the data included is completely accurate. More believable recording errors, or flat-out miscalculations, are almost assuredly included. Further, there are several ships within the database that are missing information for one variable. Only ships that were missing more than one piece of information were excluded. Fortunately, the database includes 354 ships, so the impact of a few inaccuracies should be minimal.

The statistics recorded directly from the BGSU database and cross-referenced against the Register of American Merchant Vessels were: Ship Name, Registration Number, Year Built, Length, Width, Depth, Net Tonnage, Gross Tonnage, Building Location, Rebuild Year (if any), Hull Material, Hogging Truss, and the Source. From these statistics, this researcher also generated length-to-width ratios, the difference in tonnages, and decades the ships were built. This information was entered into a database using the Statistical Package for Social Sciences, version 24 (SPSS). This software was selected due to the ease of variable management and analysis inherent in the program’s user interface. This program’s main benefit over other statistical packages such as *R* and SAS is that it removes the need to code statistical tests, while still allowing for the codification of more complex analysis.

As mentioned, Hogging truss refers to a specific type of support system for a ships' keel. These structures allow for longer ships and could be built both above and below deck. Hogging truss presence and position were recorded whenever possible, however, most vessels within this study did not have a record of the lack or presence of a hogging truss. Instead, hogging trusses were assumed for any wooden ship longer than 130 feet, and any iron ship 150 feet long, as longer ships were recognized to be at a higher risk of hogging (Thearle 1873:201). These lengths were determined arbitrarily, but are supported by the fact that most of the ships in this thesis above these lengths have a higher length to beam ratio (Table 3-2). Since most of the information on hogging trusses were taken from photographs, the exact position and type, unfortunately, cannot be included as a variable within this study. The data taken from photographs could only indicate the presence of above deck hogging trusses. Compared with the ship lengths, all the ships with an above deck hogging truss were longer than 140 feet. This indicates that such a robust structure was only assumed to be required for longer ships.

Table 3-2: The number of ships above 150 feet in length, per length to width ratio (Table by Author).

		Frequency	Percent	Valid Percent
Valid	4.00	4	1.5	1.5
	5.00	72	27.5	27.5
	6.00	94	35.9	35.9
	7.00	80	30.5	30.5
	8.00	11	4.2	4.2
	9.00	1	.4	.4
	Total	262	100.0	100.0

When the hogging truss was not visible they were classified as “below deck” hogging trusses. This classification includes all forms of additional iron keel and hull support or ceiling laid structures not visible above deck. Ideally, this variable would be based entirely on historical and archaeological sources. Unfortunately, finding the blueprints and wreck sites for each of the 354 ships included in this study would be time prohibitive and likely futile.

After editing the database, basic descriptive statistics were generated for hull material and each of the scale variables. Hull material information was recorded as a nominal variable, with “unknown”, “wood”, “iron”, “steel”, and “composite” as the allowable variables. While this variable was used to create graphics specific to hull material, new binary variables were required for the multivariate analysis. This prevents SPSS from “ranking” otherwise unranked data. Similarly, hogging trusses were also transformed into binary variables. For ease of reference, cases were organized alphabetically and then numbered 1-354.

Figure 3-2 and Table 3-3 were the first chart generated for the purposes of this study. These charts help inform which univariate and multivariate analysis will be most useful. The data displays a high amount of variance in dimensions, but a low amount of variance in hull material. At first glance, this seems almost impossible, or clearly representing multiple vessel classes; however, this variation can be explained by remembering that this dataset includes seven decades of ships. These seven decades saw a wide range of technological changes and improvements, allowing for larger and larger vessels, including the creation of metal hulls. To control for the changes between decades, each test will be done both for the database as a whole, and for each individual decade. The multivariate analysis stage and the comparison to the chosen examples will help further explain this wide variance.

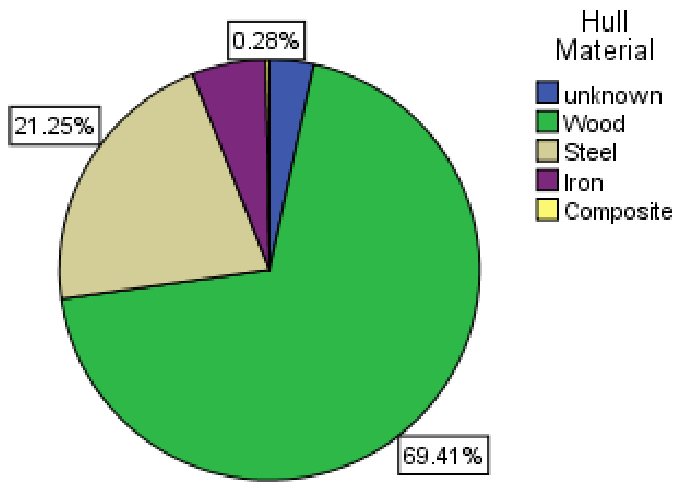


FIGURE 3-2 Distribution of ship dimension and hull material for the entire dataset (Chart by Author).

Table 3-3: Descriptive statistics for the whole dataset (Table by Author).

	N	Minimum	Maximum	Mean	Std. Deviation
Length	354	55.00	362.00	178.0407	67.41865
Width	354	10.00	56.00	30.3931	7.87251
Depth	341	3.00	28.00	13.0574	4.94844
Net Tonnage	238	12.00	2652.00	786.3148	640.93254
Gross Tonnage	353	24.00	5265.00	928.3289	844.51721
Valid N	235				

Besides a simple understanding of the over-all average ship dimensions, Figure 3-2 also illustrates that while length varied greatly, width and depth were far less variable. Potential causes for this will be examined later in the study. Determining which multivariate analysis tool to best test the relationships between the variables was a bit more difficult.

Multivariate analysis can be either exploratory or descriptive. Exploratory analysis can ask "why" questions of datasets, while descriptive analysis can ask "what" questions. This study is primarily asking the question: "were passenger freight propellers built in a specific way, and if so, why?" In previous research, passenger freight propellers are defined primarily as a behavioral designation; a ship is a passenger freight propeller if it carried passengers, package freight, and used a propeller (Cooper and Jensen 1995; Rodgers 1996; Hartmeyer 2014;). While this definition is useful for a researcher studying an individual ship, it is not particularly useful as a vessel classification. This classification still allows for the possibility of high variability within "passenger freight propeller" as a class, even so far as potentially not making up a unique ship construction class. For this type of question, a descriptive multivariate analysis works best.

The wide variation shown in Table 3-3 presents a rather difficult problem. Clearly, there are substantial outliers present in this dataset. A careful re-examination of the sources for the individual outliers for each of the variables located four potential outliers: Case 147 *Christopher Columbus*, Case 205 *Hamonic*, Case 295 *Pere Marquette 18*, and Case 336 *Tionesta* (Appendix A). All four of these ships were easily identifiable as passenger freight propellers during the initial sampling phase. *Hamonic* was identified as a passenger freight propeller as it was built for the Northern Navigation Co., which was listed by John Mansfield (1899:470) as one of the Canadian Transportation lines (Bowling Green State University). *Pere Marquette 18* was similarly identified as a passenger freight propeller, as it was owned by the Pere Marquette Railway (Ludington Daily News 1905; Bowling Green State University). *Tionesta* was listed in the Registry of American Merchant Ships as engaging in "inland passenger" service (Department of Commerce and Labor 1930:306).

Christopher Columbus is the only whaleback propeller included in this study. Typically, simply being a whaleback would be sufficient enough to conclude that it is not a passenger freight propeller, as whalebacks are a specific form of a bulk freighter (Lengieza 2016:3). However, as exemplified in Figure 3-3, *Christopher Columbus* clearly was outfitted with above-deck passenger accommodations. Further, in the 1910 List of American Merchant Vessels, it was listed as being part of the passenger trade (Department of Commerce and Labor 1910:160).

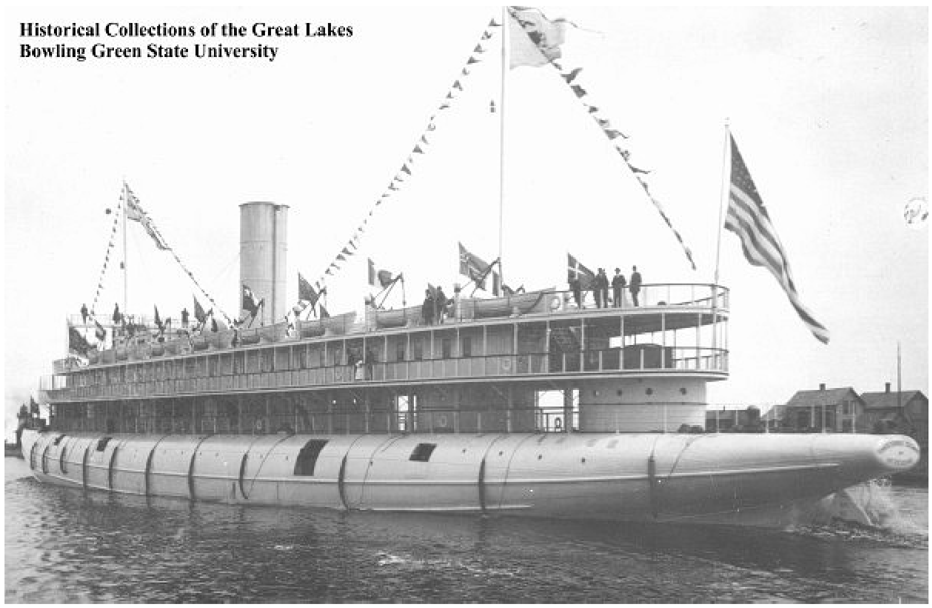


FIGURE 3-3: *Christopher Columbus* at dock (Bowling Green State University 2017).

All four of the outliers were built after 1900, potentially indicating a change in the conceptualization of these ships. Even still, they were far larger than their contemporary 19th century counterparts. For the purposes of this study, two sets of statistics were created: one with, and one without the outliers. After completing these two sets of tests, there were no obvious differences between the tests with and without the outliers; therefore, only the tests with the outliers are reported.

The primary question for this thesis is to see how the economic and social changes for the Great Lakes lead to the creation, development, and eventual abandonment of passenger freight propellers. Clearly, this necessitates the separation of the dataset into sections based on time. Decades were chosen as natural segments, resulting in the dispersion below in Table 3-4.

Table 3-4: Distribution of ships built per decade (Table by Author).

		Frequency	Percent
Valid	1840.00	4	1.1
	1850.00	18	5.1
	1860.00	42	11.9
	1870.00	86	24.4
	1880.00	103	29.2
	1890.00	55	15.6
	1900.00	45	12.7
	Total	353	100.0

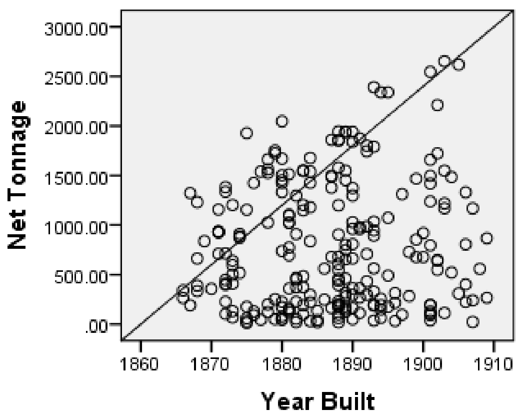
Most of the decades have sufficient data to be included in this study; however, the 1840s have too few ships to note any variation. These four ships are included within the overall statistics but are excluded from any test comparing decades to one other. This difference in ship number will be clearly designated when appropriate.

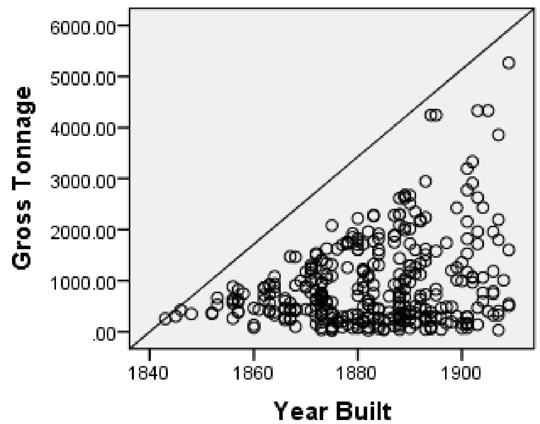
The presence of significant outliers prevents the use of potentially useful statistical tests. A one-way ANOVA could look for significant variation with hull material or hogging trusses as the dependent variable, but the largest ships would need to be excluded. Similar problems arise using two-tailed T-tests, and regression analysis (Hand 2008; Bingham and Fry 2010). To continue with the study and provide a robust analysis, the multivariate tests were conducted both with and without the outliers. After running all of the tests with and without the outliers, no significant difference was noted. As such, only the tests with the outliers included are reported in this study.

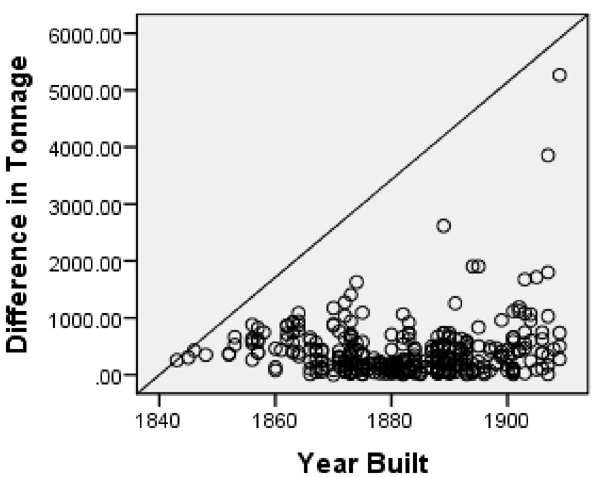
Before selecting the specific multivariate test used in this study, several precursor scatter plots were generated. These charts were generated in order to determine which of the potential independent variables could actually be useful in the multivariate linear regression analysis at the center of this study. While it would be easier to simply include all of the numerical variables that have been identified as potential factors for the development of passenger freight propellers, avoiding overfitting is more important. Overfitting is the result of considering too many predictors, and results in a model that is more likely to identify important variables based on random chance rather than actual relationships (Chatterjee and Simonoff 2013:30). These charts are used as a justification for the use of the independent variables within the multivariate regression and are not results themselves (Figure 3-4).

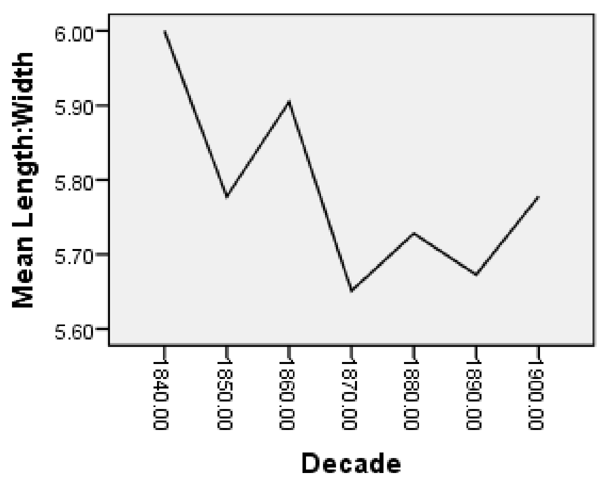
Creating univariate regression charts also visualizes the shape of the relationship between the dependent and independent variables. This is a required step in selecting a regression model. While it is impossible to select a statistical model that is a true representation of the physical world, it is possible to have one that is the best representation. In general, a regression model can be linear or non-parametric. The linear models assume that the dependent and independent variables have a relationship that can be depicted as a straight line. Non-parametric models assume that the independent and dependent variables have a relationship that cannot be depicted as a straight line, such as a bell curve or an exponential curve. Therefore, if the charts in Figure 3-4 do not demonstrate a straight-line relationship, a non-parametric model is the best fit. Simply assuming that the data has a linear relationship and moving forward with a linear multivariate regression without this step could result in distortion of the correlation, to the point of artificially creating a relationship where none exists (Darlington and Hayes 2016:343–344).

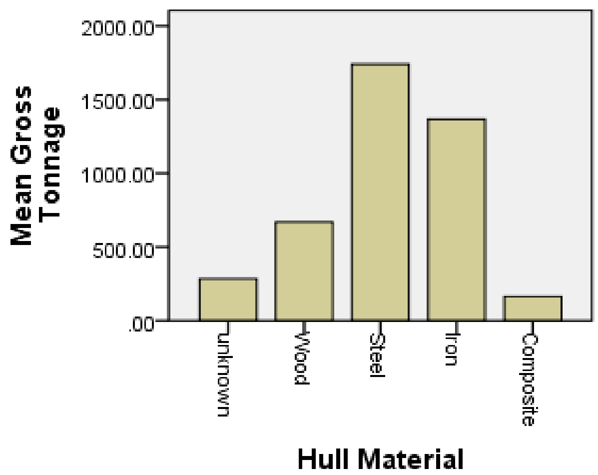
These scatter plots (Figure 3-4) provided a visual representation of the general relationships between each of the relevant statistics. This step required a projected dependent variable. Since most of the variables were dimensional and interconnected, this leaves only a few testable variables. The variables “gross tonnage”, “net tonnage”, “difference in tonnage” and "length-to-width ratio" form the dependent variables. The variables "build date", "hull material", and "hogging truss" comprise the independent variables. Due to the nature of length-to-width data, their preliminary relationship tests are demonstrated with line graphs, while the relationships for hull material and hogging truss are demonstrated with bar graphs.

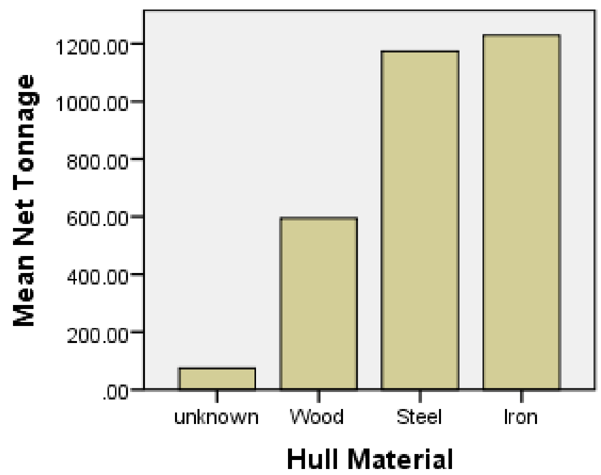


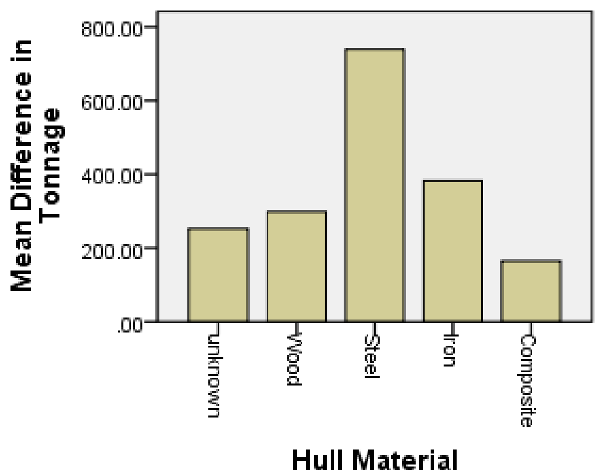


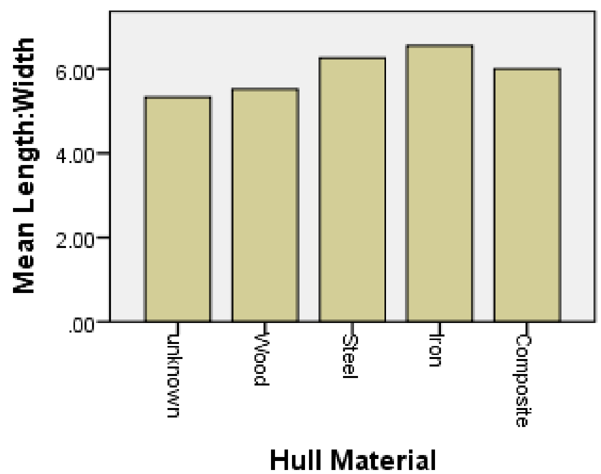


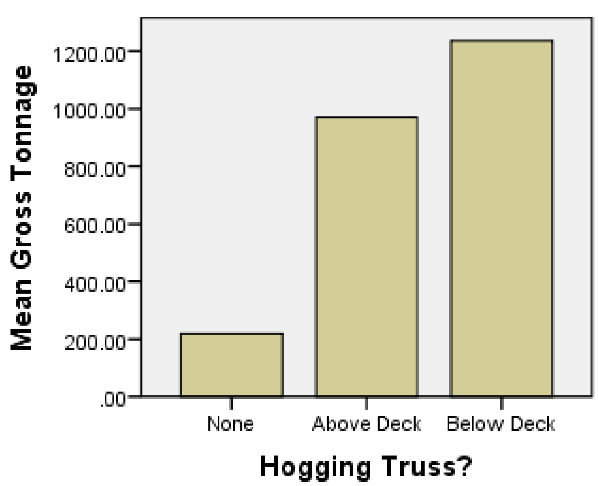



Mean Gross Tonnage
2000.00
1500.00
1000.00
500.00
.00
unknown
Wood
Steel
Iron
Composite
Hull Material


Mean Net Tonnage
1200.00
1000.00
800.00
600.00
400.00
200.00
.00
unknown
Wood
Steel
Iron
Hull Material


Mean Difference in Tonnage
800.00
600.00
400.00
200.00
.00
unknown
Wood
Steel
Iron
Composite
Hull Material


Mean Length:Width
6.00
4.00
2.00
.00
unknown
Wood
Steel
Iron
Composite
Hull Material


Mean Gross Tonnage
1200.00
1000.00
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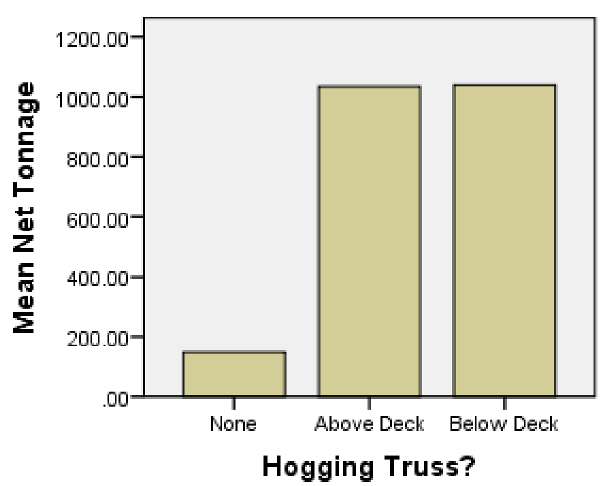
400.00
200.00
.00
None
Above Deck
Below Deck
Hogging Truss?


Mean Net Tonnage
1200.00
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None
Above Deck
Below Deck
Hogging Truss?

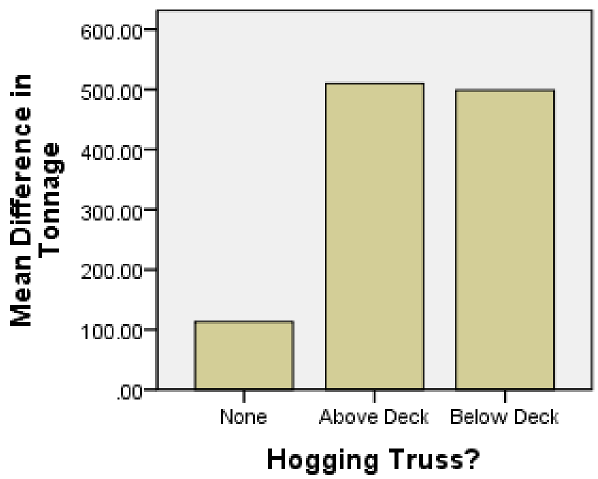
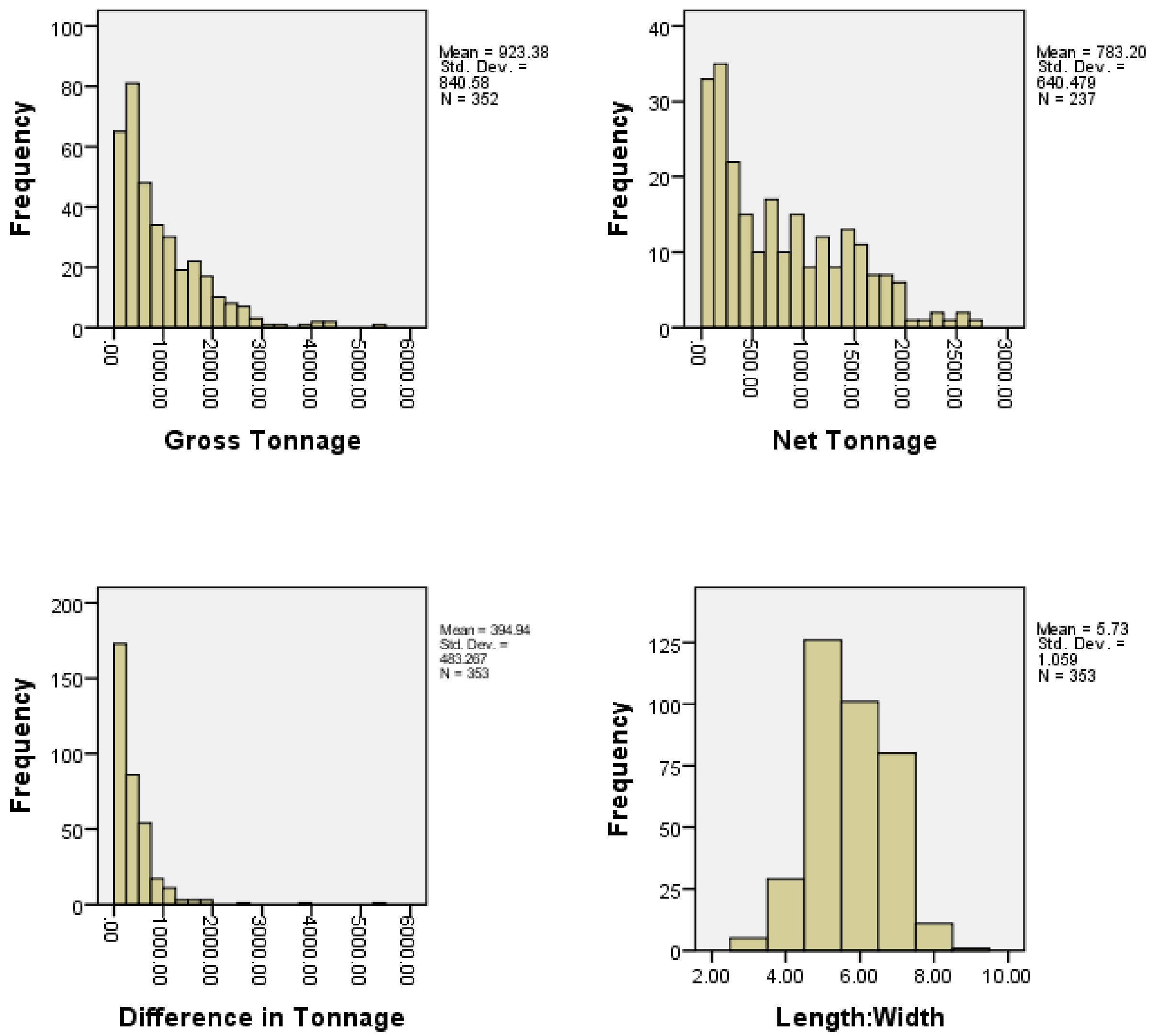


FIGURE 3-4 - Preliminary scatter plots and bar graphs (Charts by Author).

While the relationship between the dependent and independent variables does not appear strong initially, they are close enough to explore further using a linear regression. Based on the scatter plots in Figure 3-4, gross tonnage appears to have the strongest correlation to year built; this relationship will be explored further in the following chapter. The other dependent variables, net and difference in tonnage, appear to change very little over the years but show high variance between hull material types. Interestingly, while the tonnage variables appear relatively stable, the mean length to width ratio decreases over time. This indicates that the ships were getting broader, potentially because of more powerful and efficient engines, or to take advantage of wider canals and locks. Most importantly, all of the relationships depicted in Figure 3-4 are linear, justifying the use of a linear regression as the primary analysis for this study.

The frequencies in Figure 3-5 also display a prominent level of clustering. This could be the result of some outside force influencing the design of these ships. Potential explanations include restrictive port size or diminishing returns. The relationship between passenger freight propellers and port size can be examined easily by comparing the maximum ship size allowed by the ports to the mean ship size. While there is not much historical data on port conditions in the rural northern portions of the Great Lakes, the nature of the lake bed prevents many improvements (Great Lakes Coastal Resilience 2013). Therefore, the information on modern NOAA navigation charts can stand in for historical data. There might be some differences in depth due to erosion, but the amount of erosion over the past century and a half is likely to be small.



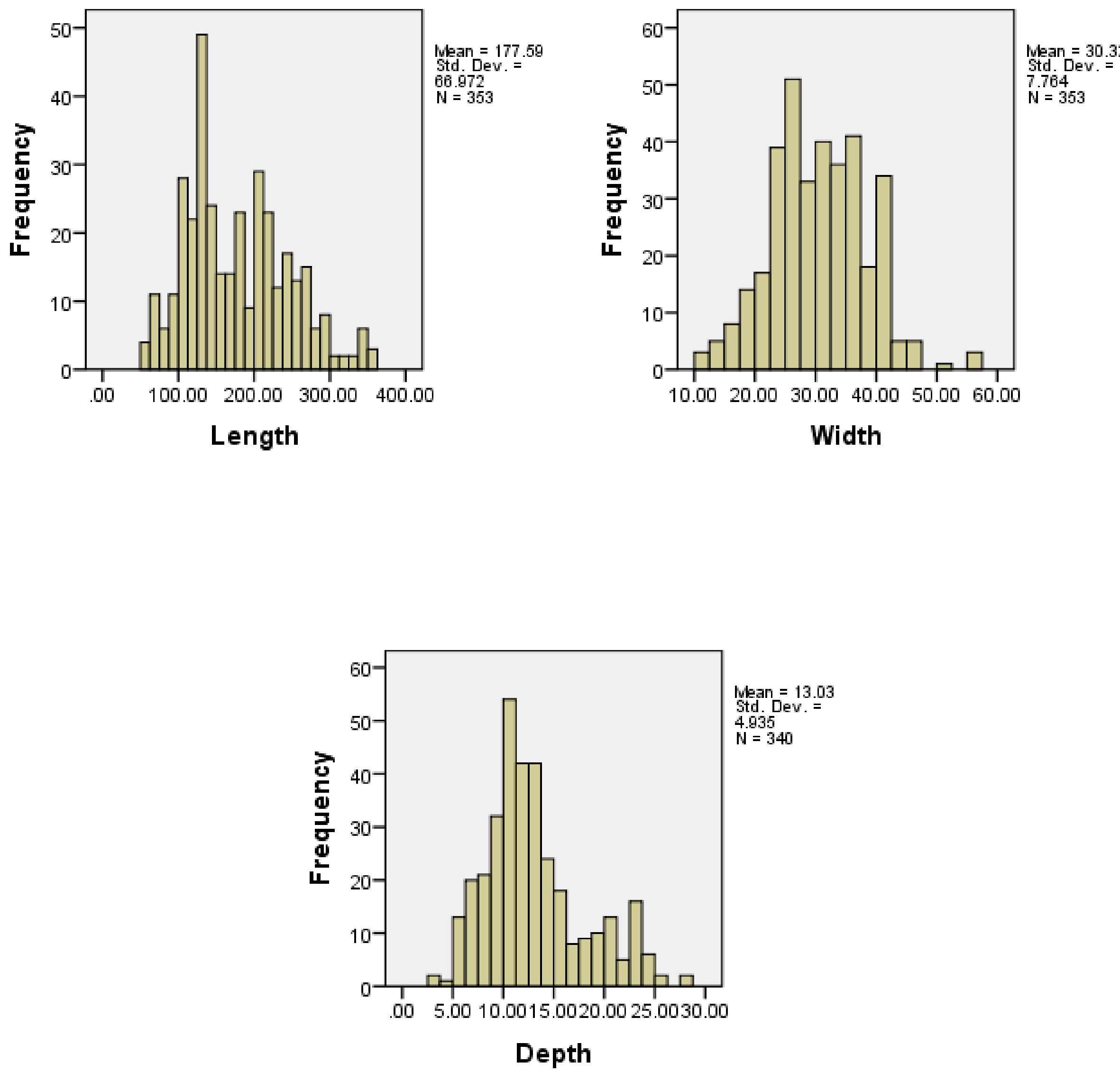


FIGURE 3-5 - Histograms for dependent variables (Chart by Author).

As listed, another potential cause of clustering includes the impact of the canal system within the Great Lakes. Several researchers have drawn the connection between canal dimensions and ship dimensions (Fairlie 1898:54–55; Barry 1973:76; Kalabon et al. 2013:231; Hartmeyer 2014:21). For ships attempting to travel between lakes, canal and lock sizes would represent a very real wall to increasing sizes. This potential relationship will be explored in a similar method as the relationship to port size. The actual canal dimensions throughout the 19th century is known, as they were multi-state construction projects.

Determining whether there was a significant diminishing return is going to be more difficult, and potentially outside the range of this study. While some of the bigger name companies, like Goodrich and Western Transit, have documented passenger fees and operating costs, the vast majority of this information has not been preserved, particularly for smaller companies (Heier 1999). Further, ticket fees and operating costs likely fluctuated wildly over time. If there is still variation that needs to be explained, costs could be examined in further research.

Due to the mostly linear relationship between the proposed dependent and independent variables, a standard linear regression analysis was chosen. This test was conducted for each of the dependent variables (gross, net and difference in tonnage, and length-to-width ratio) against each of the independent variables (build year, build location, length, width, depth, hull material, and hogging truss) as univariate tests for all of them and multivariate tests for all the independent variables besides hull material and hogging truss. Standard chi-squares were also produced for each of the dependent and independent variables. The results of these tests will be discussed at length in the following chapter.

Linear regression models examine the relationship between two or more variables, by determining how much of the variation in the dependent variable is explained by changes in the independent variables. Simply put, the result of this test can be summed up as "every time the independent variable changes by 1, the dependent variable changes by *b*" where *b* is the coefficient or the relationship between the independent and dependent variable expressed numerically (Baxter 2003:53; Bingham and Fry 2010:7). Multivariate regression is like univariate linear regression, except it finds the coefficient for the sum of the independent variables' effects. Essentially, it looks at whether the independent variables as a group have a stronger impact on the dependent variable than as individual variables (Baxter 2003:55; Bingham and Fry 2010:64–96).

These multivariate tests were conducted for the dataset, as well as separate, natural sub-sections within the dataset. These subsections were build decade and building location. As discussed above, only the 1860s to the 1900s were included within the paneled multivariate regressions. Creating subsections for multivariate linear regression controls for factors that could have a larger impact on the independent variables. The initial multivariate tests will explore the variation within the entire dataset; these paneled regressions will explore the variation in specific location or decades. Comparing the multivariate regressions for the individual decades and years will highlight those differences.

Paneling the tests by decade is fairly straightforward. Decade groups were created from the building years pulled from the BGSU database using SPSS's "Recode into different variable" function. The process for location was a little more complicated. The BGSU online database and the primary sources list both city and state for the building location, and well over 100 individual locations were recorded. The new "state built" variable was created manually, a process made faster using coded variables. At this point there were 15 separate states recorded; the top 5 states were used to panel the multivariate regressions.

The methods outlined within this chapter provided an intriguing look at the creation and development of passenger freight propellers within the 19th century. The actual results and conclusions are discussed at length within the following chapter. After the preliminary tests conducted to assist in selecting a multivariate test, the most immediately intriguing relationship was between gross tonnage and year built. This is particularly interesting, as there does not appear to be a strong correlation between the other ship dimensions and year built. Multiple linear regression appears to best fit the relationships shown, as all the relationships appear to be mostly linear. While a statistical analysis cannot cover all the factors that go into building a ship, it will be seen in the following chapter that it can be used to tease out the impact of interconnected variables.

CHAPTER 4: DISCUSSION OF RESULTS

The methods outlined in the previous chapter resulted in a total of 29 multivariate tests. These tests alone will not provide enough insight into the Great Lakes passenger freight propeller, but in conjunction with known historic events, this study will create a better understanding of the development of passenger freight propellers. This chapter will explain the results of all 29 multivariate tests as a precursor for the next chapter. These tests show some intriguing differences between build location and year that help inform the primary concerns of the ship owners.

This chapter is split into three sections: results of the chi-square analysis, the multivariate analysis, and the third synthesizes the results into a form useful for comparison to the historical record in the next chapter. As this chapter, and thesis in general, is not a "how-to" guide to statistics in history, the results of these tests will be discussed in general language. Chi-square and regression results are reported in the standard manner but without overly complicated jargon.

The preliminary results of these tests indicate a few interesting qualities of passenger freight propellers. The first being that increasing length was given priority over increasing width or depth. Second, while there is a significant difference between ships built in the 1900s versus the 1840s, this change is so gradual it cannot be seen looking at build year. Build location had a significant impact on the overall size of these ships that rivaled the impact of build decade.

Chi-Square Results

The first set of tests completed were a set of chi-squares comparing the primary dependent variables against build year and location. These chi-squares helped provide a preliminary view of the primary relationships at the center of this thesis. Unlike the regression analysis discussed later in this chapter, these tests were not paneled by build decade or location. Chi-squares also cannot analyze the relationship between one dependent variable and multiple independent variables. These tests do indicate general trends within the database but cannot be used to fully explore the relationships held within.

Figure 4-1 is a visual display of the crosstabulation and chi-square for ship length and build year. All 354 ships were included within this test. 120 ships were classified as “short”, 111 were classified as “average” and 122 were classified as “long”. These designations are based off the distribution of the overall database; “short” means the ship length is in the smallest third of the database, “average” means the ship is in the middle third, and “long” means the ship is in the upper third. This test showed a significant relationship between ship length and build year, $x^2(27.413) = 12$ ($p=0.007$). While this is a promising result, the differences in the number of ships per build decade might have skewed the results. The most populous decade, 1880, has 103 ships or nearly a third of the entire database. The least populous decade, 1840, has only 4 ships, or under 1% of the entire database. Even with this difference in numbers, Figure 4-1 does appear to show significant changes in length over time. In general, there was a larger percentage of “long” ships in 1900 than there was in any other decade. In the earlier decades, “average” length ships were more common. This could indicate that shipbuilders became more willing to deviate from the norm as passenger freight propellers became more common.

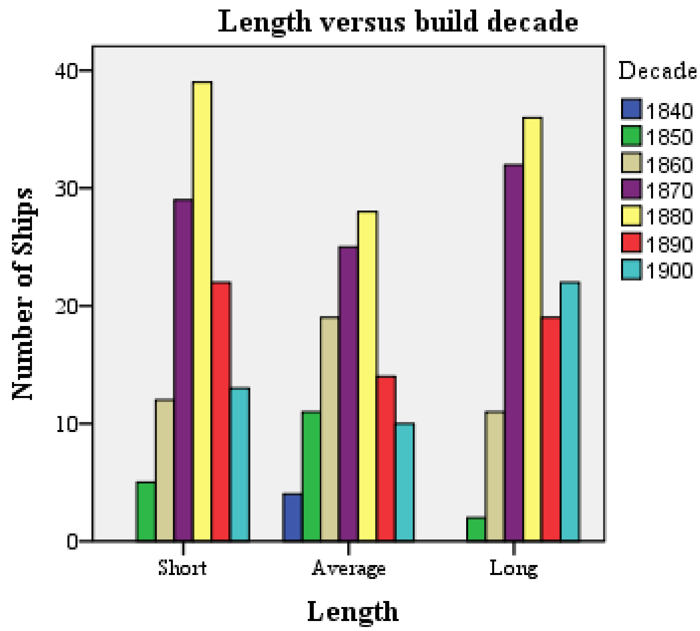


FIGURE 4-1: Clustered bar chart showing the relationship between ship length and build year (Graph by Author).

Width showed a far stronger and more significant relationship to build year, $x^2(48.39) = 12(p > .001)$. Essentially, the ships get broader over time. 109 ships were classified as "narrow", 125 were "average" and 119 were "wide". This is in line with the relationship between length and build decade, and helps to build a picture that in general, passenger freight propellers became larger over time. The relationship between width and build year is even more extreme than length and build year. There were no "wide" ships until the 1860s, and less than 20 of the ships built in the 1900s were "narrow" or "average" (Figure 4-2). While this does create a picture of passenger freight propellers getting larger over time, this chart also makes clear that there was less variation in width sizes than there was with length. There are a few possibilities for this that will be explored more in the next chapter; including, canal size, port size, and estimated engine efficiency.

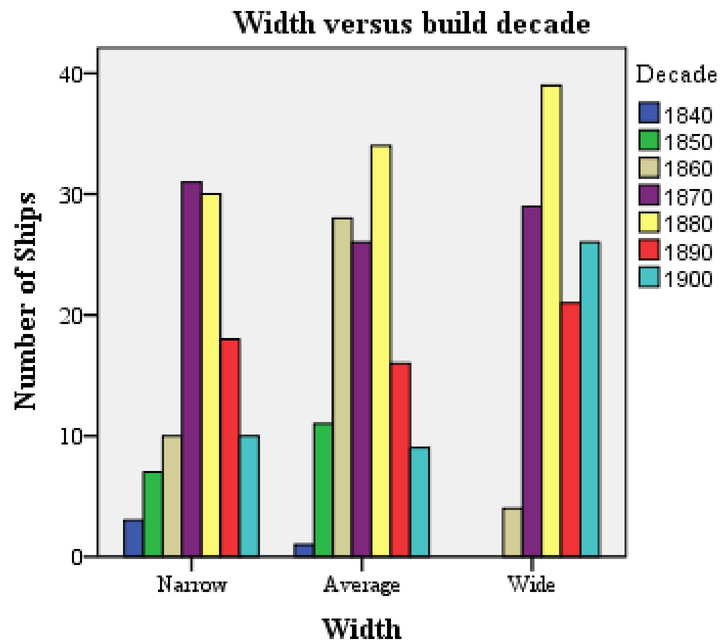


FIGURE 4-2 - Clustered bar chart showing the relationship between ship width and build year (Graph by Author).

Depth and build year also have a significant relationship, $x^2(72.81) = 12(p > 0.001)$. This is by far the most extreme relationship, with no high depths in the 1840s or 50s. Only 340 ships were included in this analysis, as 13 were missing concrete or believable information on depth. Again, this could be due to the difference in number of ships per decade but the fact that there is not as much of a difference in the other chi-squares indicates otherwise. The clustered bar chart in Figure 4-3 also displays a similar pattern as Figure 4-1; The decades after 1860 have more “small” and “large” ships than “average” ships. This potentially indicates a divide in passenger freight propellers, between ships that serviced smaller, rural ports and ships that serviced larger, more urban ports. Obviously, this conclusion is not concrete, and the potential relationship between ship size and ports will be explored more in the next chapter. Other possible explanations for this split include the factors mentioned above, but with a more extreme effect.

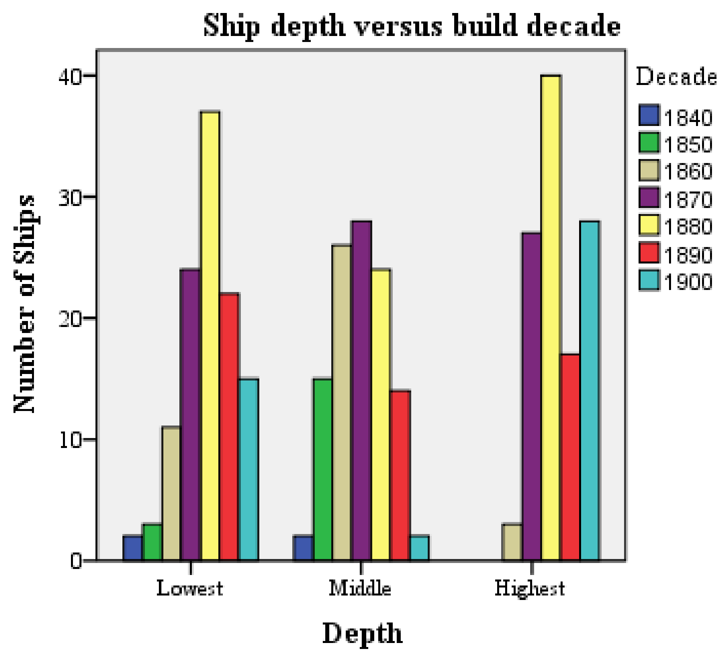


FIGURE 4-3 - Clustered bar chart showing the relationship between ship depth and build year (Graph by Author).

Continuing the trend, gross tonnage and time have a significant relationship x^2(43.452) =12(p>0.001). This makes sense, given that gross tonnage is a function of width, length, and depth. 352 ships were included within this test, as 1 ship did not have a recorded gross tonnage. 116 ships were classified as "small", 117 as "average" and 119 were "large". Like the chi-squares above, there were less "average" ships, in proportion, built after 1860 (Figure 4-4).

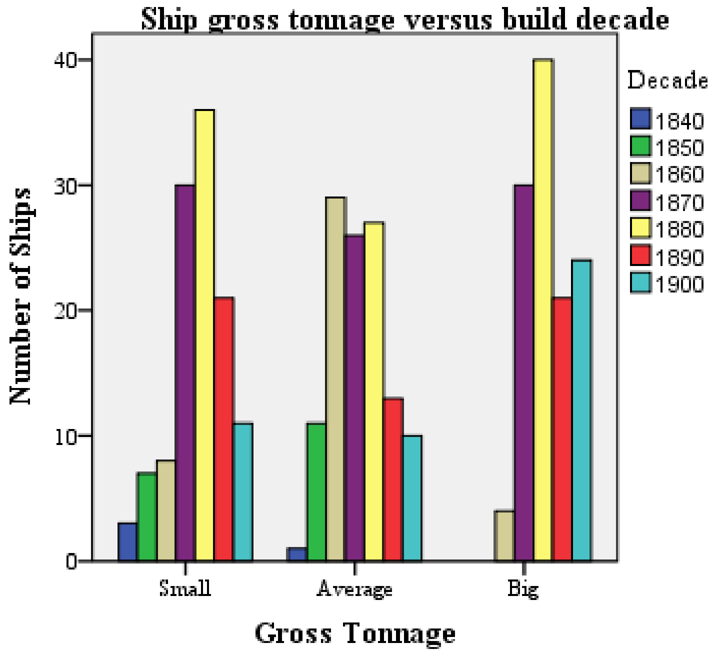


FIGURE 4-4 - Clustered bar chart showing the relationship between ship gross tonnage and build year (Graph by Author).

Net tonnage, unlike all the other chi-squares, did not have a significant relationship to time, $x^2(6.4) = 8 (p = 0.603)$. In addition, as Figure 4-5 demonstrates, net tonnage simply was not recorded before 1860. Only 237 ships were included in this test for that reason. The most likely reason why net tonnage does not have a significant relationship to time when all the other ship dimensions does is likely due to the legalistic nature of net tonnage. American legal statutes, specifically Section 417 of the Revised statutes, defined net tonnage as the "profitable" space of a ship. The definition of this space did change over time, and did not include every space that added to the marketability of a vessel (Department of Commerce Bureau of Navigation 1878; US House of Representatives 1895; Vasudevan 2010:10). Most importantly, ship owners were not legally required to include designated crew spaces until 1895, and open air spaces were specifically excluded from the profitable area (US House of Representatives 1895). Some ships prior to the passage of the 1895 Deductions from Gross Tonnage Act might have still included designated crew spaces, even if they were not required to. Notably, the open-air concerts and dances that the Goodrich Transportation Company advertised in the 1920s were specifically in areas that were excluded from net tonnage (Figure 2-4). Even though legally these areas were considered non-profitable, they clearly added to the marketability of the ships and the overall profits. Figure 4-5 does indicate some cursory, if not significant, differences between the decades. 1870 and 1880 had similar distributions of net tonnage, while the 1900s had a pattern that mimics the overall patterns of the chi-squares above; there were more “small” and “large” ships than “average” passenger freight propellers.

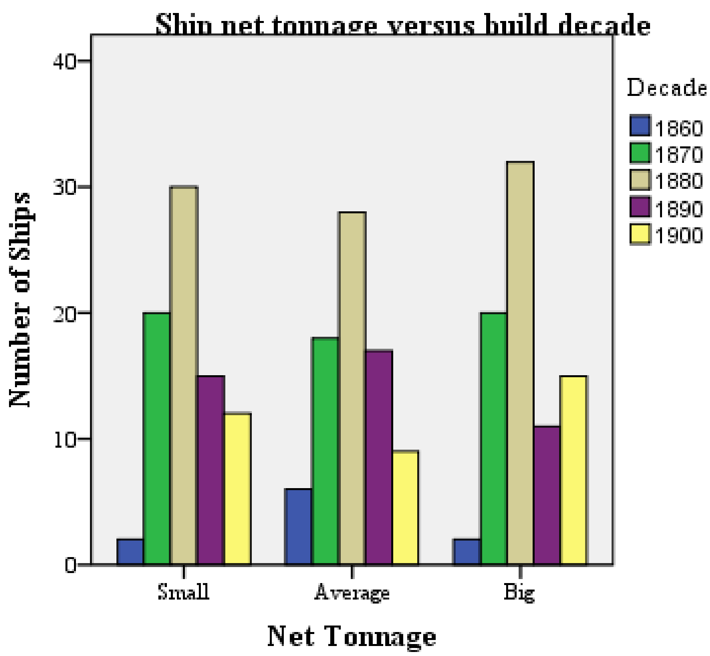


FIGURE 4-5 - Clustered bar chart showing the relationship between ship net tonnage and build year (Graph by Author).

Difference in tonnage had a significant relationship with build year, $x^2(36.76) = 8(p > 0.001)$. This is more or less expected; difference in tonnage is a direct function of gross tonnage and net tonnage. Figure 4-6 demonstrates a more severe jump between decades than the chi-squares for gross or net tonnage. After the 1880s, the amount of “small” and “average” differences in tonnage drop dramatically. A larger difference in tonnage indicates that shipbuilders were dedicating more space to the "non-profitable" portions of the ship. This might have contributed to passenger freight propellers falling out of favor. If there were more spaces on board that required, rather than generated, revenue, company owners would have looked for other solutions for their shipping needs.

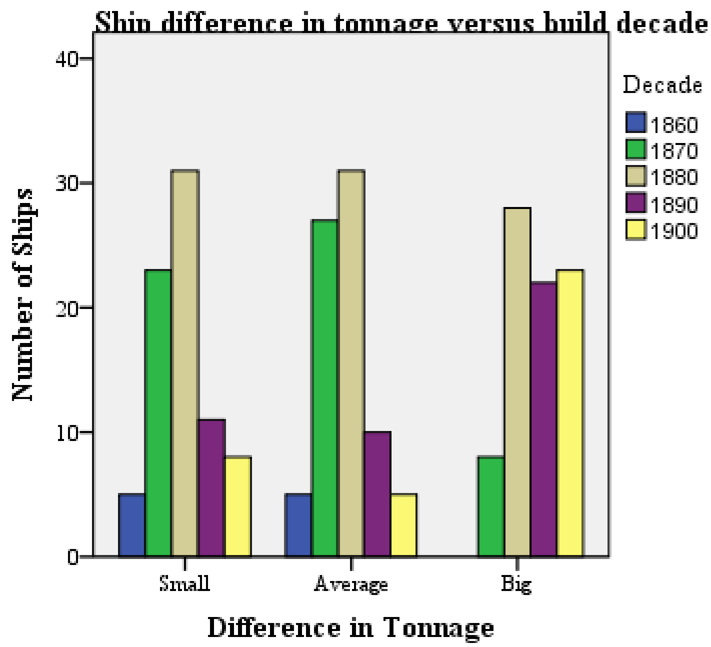


FIGURE 4-6 - Clustered bar chart showing the relationship between ship difference in tonnage and build year (Graph by Author).

Beyond time, one of the more crucial factors is location, or more accurately, regional differences of shipbuilders. While delving into individual shipbuilder's backgrounds would more clearly illustrate these differences, that would be an entirely different study. Using the ship's building location is a passable stand-in for the shipbuilder's background. Build location also plays a part in the final design of a ship as launch sites dictate size and form as much as the craft's targeted market destination. Since there were so many towns listed as build location, this category was simplified to states and provinces. States that built less than 5% of the ships were excluded from this test, leaving 4 states and 1 province: New York, Michigan, Ohio, Ontario, and Wisconsin. These 4 states and 1 province comprise 90.37% of the entire database, or 329 ships (Figure 4-7).

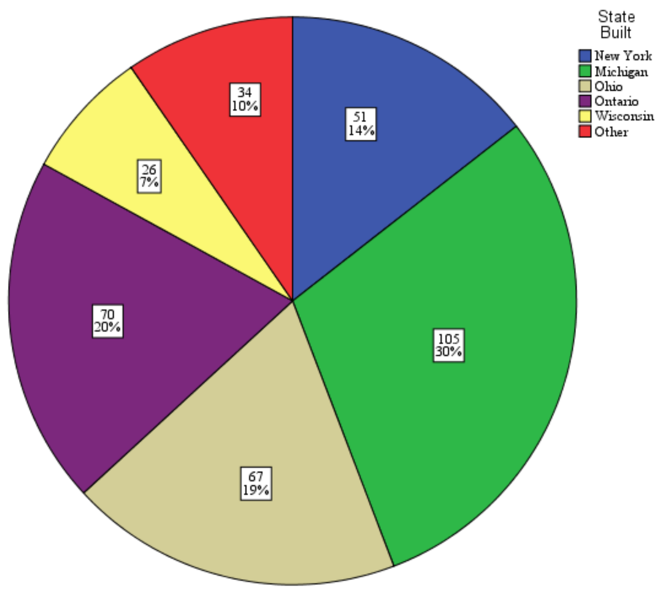


FIGURE 4-7: Breakdown of the five most common states (Chart by Author).

Beyond personal differences in shipbuilders for these locations, the geographies of the states themselves could impact ship design. New York has easy access to the Atlantic Ocean as well as the Great Lakes. While all the ships included in this study were registered to steam in the Great Lakes, several of them could have been intended to be coastal vessels as well. The sources used in this study did not include information on shipbuilder intention. Further, only Ontario has full access to all five Great Lakes, more than likely, the shipbuilders in the other states built for the lakes in which they had the best access. This would especially be the case before the canal systems were improved.

Gross tonnage and build location have a strong, significant relationship, $x^2(41.815) = 10(p = 0.000)$. In general, Michigan and Ontario shipbuilders made more “small” ships, while New York and Ohio made more “big” ships. Wisconsin, surprisingly, made so few ships that it is difficult to say what was the standard for a Wisconsin ship (Figure 4-8). This difference in ship size could indicate a difference in the sizes of ports the ships visited. Other potential explanations include that New York and Ohio were more populous than Michigan and Ontario during the mid to late 18th century. A larger consumer base would both require and facilitate the creation of larger ships.

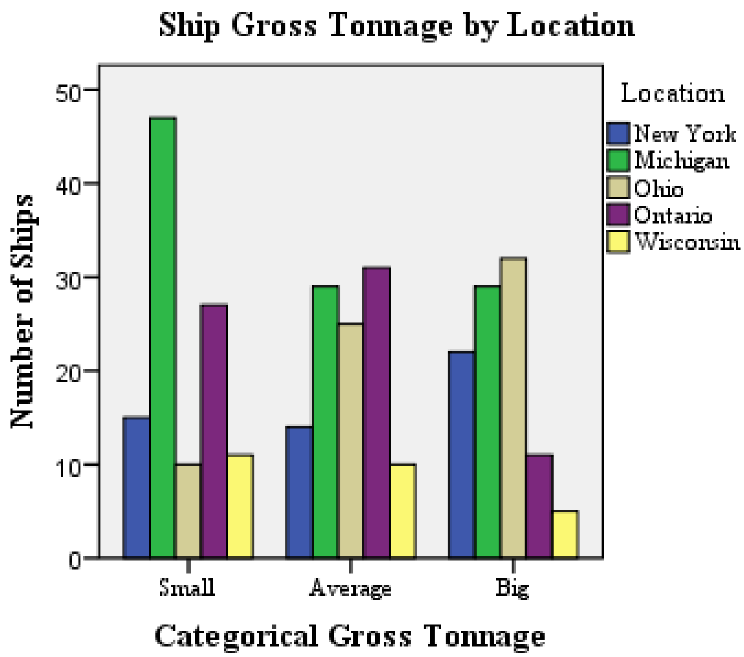


FIGURE 4-8 - Clustered bar chart showing the relationship between ship gross tonnage and build location (Graph by Author).

The other markers of ship size; length, width, depth, and net tonnage; also display significant relationships to location. The general trends presented in the discussion of the relationship between gross tonnage and location continued through to the rest of the chi-squares. This further solidifies the idea that build location influenced design, either due to regional differences of shipbuilders or physical limitations of shipyards. That being said, building location also has a significant relationship to time, $x^2(80.76) =24(P>0.0001)$ (Figure 4-9).

As demonstrated in Figure 4-9, the most prevalent building location for passenger freight propellers shifts dramatically over time. Before the 1870s, New York and Ohio built the most ships, and then Michigan and Ontario overtake them. Michigan shipbuilders not only produced the most ships in the 1880s, they also singlehandedly produced more ships than all the shipbuilders in the 1890s. Since the distribution of building locations is not consistent across the various decades, this could explain why the ship dimensions have such a strong relationship to location. The relationship to location could simply be displaying the same relationship to build decade. Michigan having larger ships is probably a function of the shipbuilders having access to newer construction techniques and better materials.

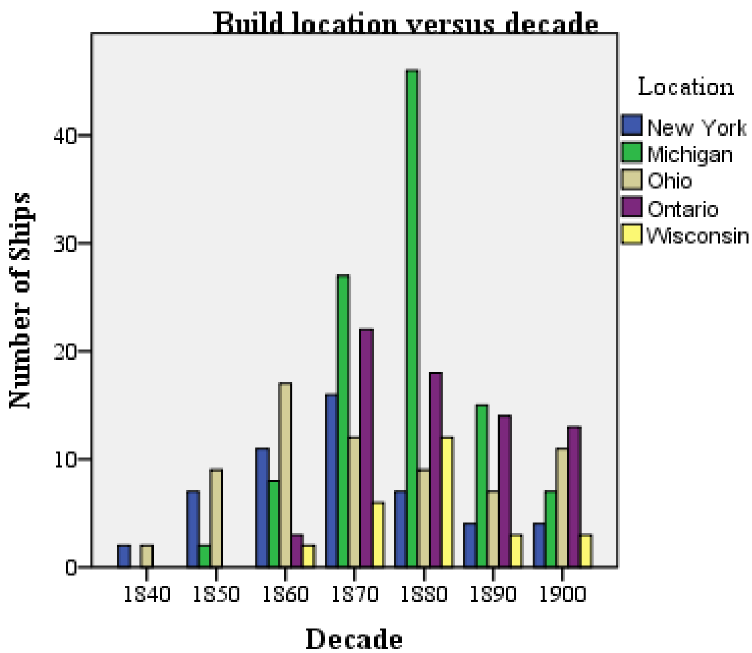


FIGURE 4-9 - Clustered bar chart showing the relationship between ship build location and decade (Graph by Author).

Linear Multivariate Regression Results

While the chi-squares are ideal for describing the relationship between the ship dimensions, building location, and decade, they cannot show how all the factors together impacted the passenger freight propellers. As described in the previous chapter, multiple linear regressions were selected as the ideal test to examine these complicated relationships.

Table 4-1 shows the results for the first multiple linear regression of this study. This regression used difference in tonnage as the dependent variable, with length, width, depth, year built, and hull material as the independent variables. The large unstandardized B is primarily a function of the wide range of tonnages present in this database. The entire sum of the independent variables does have a significant relationship ($p<0.0001$). Interestingly, width by itself has a weak, negative, insignificant relationship to difference in tonnage. This is exceedingly strange, as width was one of the variables used to calculate tonnage. This could potentially indicate differences in priorities. Passenger freight propellers typically placed most of the passenger spaces above deck; a wider top deck would allow for larger or more passenger berths. The trade-off would have to include decreasing the length and depth of the ships, either due to the cost of building a larger ship or physical limitations of fitting through canals and locks. Since this variable has a negative relationship to the dependent variable, the entire equation has a negative relationship; however, since the only negative independent variable has such a weak, insignificant relationship it can be disregarded. None of the independent variables have a strong relationship to difference in tonnage. This indicates that the combined impact of the independent variables was far more important than the individual variables.

Table 4-1: Result of multivariate linear regression with difference in tonnage as the dependent variable (Table by Author).

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-11953.332	1464.023		-8.165	.000
	Length	2.009	.383	.468	5.249	.000
	Width	-.899	3.141	-.024	-.286	.775
	Depth	12.834	3.840	.219	3.342	.001
	Year Built	6.184	.785	.299	7.879	.000

a. Dependent Variable: Difference in Tonnage

The results of the regression test focusing on gross tonnage were similar to the findings of the analysis for difference in tonnage. Again, the overall regression had a significant relationship to the dependent variable ($p > 0.0001$). As mentioned, width, or beam, has a negative, weak, insignificant relationship to gross tonnage. The differences are intriguing. Primarily, length has a very strong relationship to gross tonnage, with a standardized Beta at 0.884. Year built and depth still have significant relationships, but they are much weaker here, with a standardized Beta at 0.143 and 0.094 (Table 4-2). These differences should also exist in the regression for net tonnage.

Table 4-2: Results of multivariate linear regression with gross tonnage as dependent variable (Table by Author).

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-17387.976	2383.734		-7.294	.000
	Length	11.157	.623	.884	17.905	.000
	Width	-8.060	5.114	-.073	-1.576	.116
	Depth	16.218	6.252	.094	2.594	.010
	Year Built	8.689	1.278	.143	6.799	.000

a. Dependent Variable: Gross Tonnage

An unpredicted result that emerged from the multivariate linear regression focused on net tonnage is that the overall relationship is barely significant ($p = 0.083$). Further, this is the only version of tonnage that has a significant relationship with width, even if it is a weak, negative one. Once again, length has the strongest relationship to net tonnage, with a standardized beta of .975 (Table 4-3). This result is potentially taking focus away from the other variables. In comparison to length, all the other variables will appear to have a weaker relationship to net tonnage.

Table 4-3: Results of multivariate linear regression with net tonnage as dependent variable (Table by Author).

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	5046.066	2902.658		1.738	.083
	Length	8.714	.528	.975	16.492	.000
	Width	-8.368	4.297	-.107	-1.947	.053
	Depth	8.982	5.172	.074	1.737	.084
	Year Built	-3.047	1.549	-.049	-1.968	.050

There are a few potential explanations for this that will be explored more in depth in the next chapter. Firstly, net tonnage is not a direct function of the gross dimensions; instead, net tonnage represents the molded dimensions of the "profitable space" (Vasudevan 2010:10). Defining this space on a straight cargo vessel would be easy in comparison to defining it on a partial passenger vessel. The laws dictating the recording of net tonnage in America are very clear about the practical spaces that cannot be considered profitable, such as the engine hold or helms workings. The only clarification that passenger vessels receive in the 1895 Deductions of Gross Tonnage Bill was that "any…permanent closed-in space on the upper deck available for cargo or store, or for the berthing or accommodation of passengers" shall have their tonnage ascertained (Navigation 1894; US House of Representatives 1895). Potential areas of variation in this definition include whether passenger support spaces, like the kitchens or first aid areas, were included as profitable or non-profitable. In addition, some ships prior to the passage of the 1895 Deductions from Gross Tonnage Bill might have included designated spaces for crew, or at least officers', living spaces. Companies attempting to lower costs or increase perceived profitable space might not have specifically designated such spaces, even though clearly the crew must have slept and stored their personal items somewhere on board, and there was no legal requirement for designated crew spaces prior to 1895 (US House of Representatives 1895) As such, any significant relationship between net tonnage and the gross dimensions comes as a bit of a surprise. There are many other potential influencers on net tonnage which could easily remove the impact of the gross dimension variables.

Length-to-width ratio was the fourth and final variable considered in the regression tests for the overall database. There are, of course, some obvious relationships present within this test. This is the one variable that should have a negative relationship with width, which is demonstrated in Table 4-4. Interestingly, this is the only variable considered that has a significant relationship to year built ($p = 0.114$). Since the other markers of ship size do not have a significant relationship to time, this indicates that the shipwrights were simply redistributing the weight of these ships, rather than straight out making them bigger. If the only major influencers of the size of passenger freight propellers was the limitations imposed by the lock and canal system in the Great Lakes, it would be reasonable to expect them to get larger while maintaining similar length-to-width ratios over time. If the only major influencer was the efficiency of the engine, the ships should get narrower over time, not wider, to allow for faster and faster ships. The ships getting wider and shorter over time indicate that shipbuilders prioritized an aspect that has not been seriously considered academically (Barry 1973; Cooper 1996; Bamford 2007).

Table 4-4: Results of multivariate linear regression with length-to-width ratio as dependent variable (Table by Author).

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	9.560	2.662		3.591	.000
	Length	.028	.001	1.749	40.042	.000
	Width	-.157	.006	-1.130	-27.405	.000
	Depth	.017	.007	.079	2.458	.014
	Year Built	-.002	.001	-.029	-1.583	.114

a. Dependent Variable: Length:Width

This anomaly justifies taking a closer look at the length-to-width ratio. The minimum length-to-width ratio in the database is 3:1, the maximum is 9:1, and the mean is 6:1. This variable has a standard deviation of 1.06 (Table 4-5). This indicates a rather tightly distributed variable; In reality, this variable virtually has no variation.

Table 4-5: Distribution for the Length-to-Width variable for the entire data set, represented as a whole number (Table by Author).

	N	Minimum	Maximum	Mean	Std. Deviation
Length:Width	353	3.00	9.00	5.7337	1.05928

The bar charts in Figure 4-10 only help to deepen the mystery. The bar chart on the left uses the maximum length to width ratio for each decade, while the bar chart on the right uses the mean length to width ratio. This difference could solely arise from the large difference in number of ships per decade noted earlier in this chapter. Even with having the highest length-to-width ratios after 1880, the sheer number of ships with length-to-width ratios below 6:1 in each decade would drag the mean down. Rather than having a simple negative relationship to build decade, the variation within length-to-width ratio has a strong positive relationship to build decade.

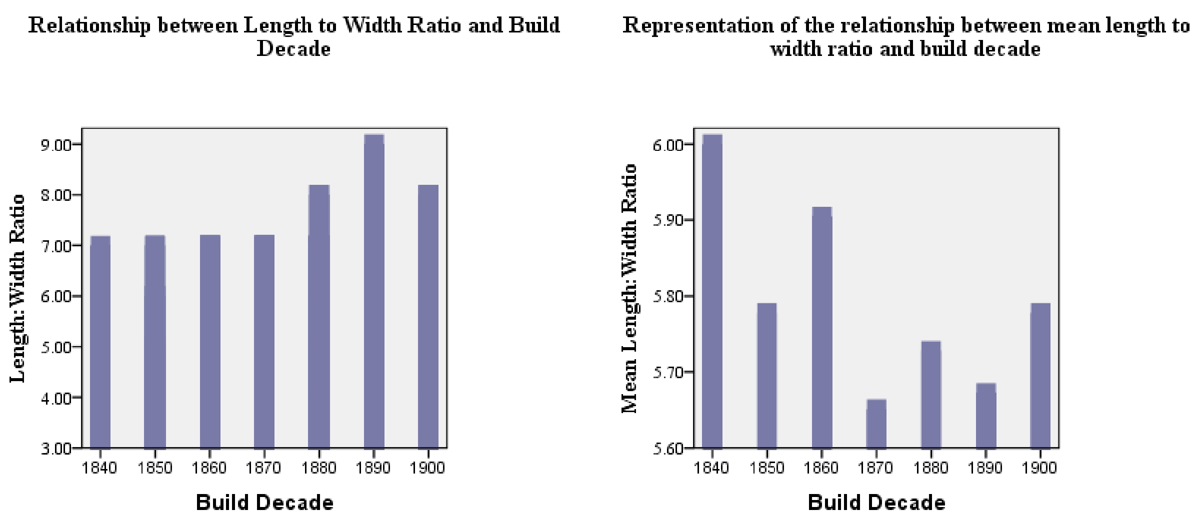


FIGURE 4-10 - Bar charts showing a contradictory relationship between length-to-width ratio and build decade (Graph by Author).

As Figure 4-11 demonstrates, length-to-width's standard deviation gets larger over time. An increase in variation shows that shipbuilders became more willing to experiment in ship design, or that the shipowners had increasingly diverse needs. At this juncture, it is difficult to say what precisely caused this increase in variation, but potential causes will be explored more in depth in the next chapter. Among the probable causes include the introduction of steel-hulled ships, the increase in population on the western shores of the Great Lakes, the improvement of the canal systems allowing for a larger variety of ships to pass through, the availability of more powerful engines, or the start of product manufacturing on the western shores of the Great Lakes.

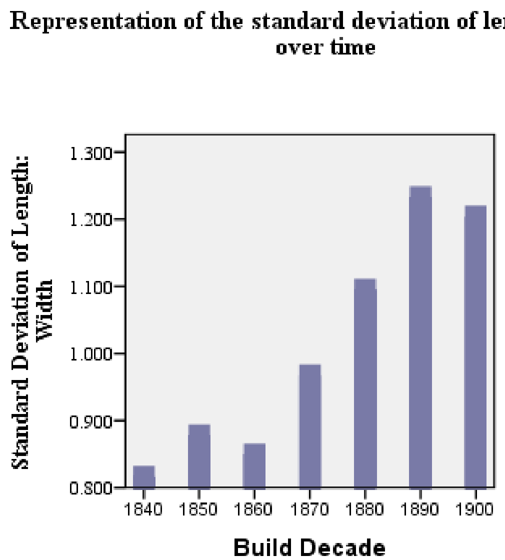


FIGURE 4-11 - Bar chart showing the standard deviation for length-to-width ratio over time (Chart by Author).

While geographic considerations and variations would be better studied by looking at individual ships, certain generalities are possible from a multivariate regression. Figures 4-7 and 4-8 indicate a potential relationship between building location and ship size, but also potentially merely a relationship between building location and decade. To determine which is the case, the author ran a series of multivariate linear regressions for each of the five most common locations. These tests used the same dependent and independent variables as the tests discussed above. The results of these tests are shown in the following figures, Tables 4-6 – 4-10.

Tables 4-6 – 4-10 are the results from the multivariate linear regressions for each of the five most common building locations. Immediately, a few intriguing differences become apparent. Only New York ships (Table 4-6) have a significant relationship between gross tonnage and the independent variables ($p < 0.001$). Unlike the problem discussed with the decade regressions, this is not due to New York having built more ships than the other states. As Figure 4-12 shows, New York built ships represent 14.45% of the entire database or 51 ships. Only Wisconsin's number of ships hold any potential of impacting the regression; Wisconsin built ships comprise 9.63% or 26 ships. Having so much fewer ships can change the result of a linear regression, but it is not uncommon to have around 20 cases in such a test (Shennan 1990:186–189; Drennan 1996:182; Bingham and Fry 2010:99–102; Figure 4-12). With that in mind, the fact that Wisconsin has a p-value of 0.079 should be an indication that there really was no relationship between gross tonnage and the dependent variables specifically in Wisconsin.

Taking a closer look at the individual independent variables, depth shows the most variation between the states. Ontario and Michigan built ships have a significant relationship between gross tonnage and depth ($p=0.045$; $p > 0.001$), while the three other states do not (Tables 4-6 – 4-10). Both of these states have the best access to the lakes. Ontario comprises the entirety of the Canadian Great Lakes coastline. Potentially, Ontarian shipbuilders were able to create a larger variation in depth than the other location's shipbuilders. Michigan has an easy access to any of the lakes, except Lake Erie. Under certain assumptions, this access to the lakes could explain the significance of depth in Ontario and Michigan. Assumption one is that the ships stayed primarily in the lake they were built in. Assumption two is that none of the shipbuilders on the lakes produced more ships than any of the others. Clearly, one of these assumptions is wrong, or Michigan shipbuilders placed a higher priority on depth than Ohio, New York, or Wisconsin shipbuilders.

The results for width in these regressions are also rather intriguing. In the overall regressions and the regressions by decade, width had a negative relationship to gross tonnage. For Wisconsin built ships, width has a positive, significant relationship to gross tonnage (B=0.429, p=0.031; Table 4-10). Seemingly, unlike every other Great Lakes shipbuilder, Wisconsin shipbuilders increased the width of the ship in order to increase the size. This could potentially indicate a difference in shipbuilder background, or a difference in the size of ports in Wisconsin versus other Great Lakes states. In addition, most of the Wisconsin built ships were built later, after 1880, and Wisconsin represents the smallest number of ships included in this part of the study (n=26). The apparent difference in Wisconsin ships may be the result of lower temporal variation. It is also important to note that this difference may not be exclusive to passenger freight propellers, and that more research is needed to see if this trend appears in other ship classes.

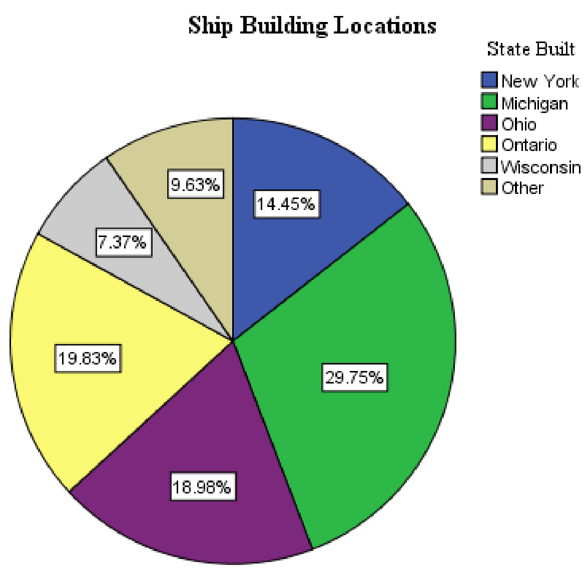


FIGURE 4-12 - Breakdown of Shipbuilding locations (Chart by Author).

Table 4-6: Results of the multivariate linear regressions for New York built ships (Table by Author).

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-21867.769	3699.997		-5.910	.000
	Length	12.597	1.113	1.174	11.318	.000
	Width	-23.946	9.160	-.265	-2.614	.012
	Depth	-4.691	11.710	-.027	-.401	.691
	Year Built	11.349	1.993	.226	5.695	.000

a. Dependent Variable: Gross Tonnage

Table 4-7: Results of the multivariate linear regressions for Michigan built ships (Table by Author).

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-11256.877	4667.548		-2.412	.018
	Length	9.930	.888	.858	11.185	.000
	Width	-13.344	6.935	-.140	-1.924	.057
	Depth	32.545	9.864	.219	3.300	.001
	Year Built	5.506	2.495	.077	2.207	.030

a. Dependent Variable: Gross Tonnage

Table 4-8: Results of the multivariate linear regressions for Ohio built ships (Table by Author).

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-20974.592	6568.087		-3.193	.002
	Length	14.946	1.665	1.006	8.976	.000
	Width	-23.261	13.381	-.181	-1.738	.087
	Depth	.336	17.233	.002	.019	.985
	Year Built	10.561	3.605	.181	2.930	.005

a. Dependent Variable: Gross Tonnage

Table 4-9: Results of the multivariate linear regressions for Ontario built ships (Table by Author).

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-13316.508	6619.778		-2.012	.049
	Length	10.996	1.733	.746	6.346	.000
	Width	3.809	13.280	.029	.287	.775
	Depth	40.097	19.559	.177	2.050	.045
	Year Built	6.301	3.513	.088	1.794	.079

a. Dependent Variable: Gross Tonnage

Table 4-10: Results of the multivariate linear regressions for Wisconsin built ships (Table by Author).

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-7597.730	7883.263		-.964	.346
	Length	4.087	1.811	.501	2.257	.035
	Width	33.616	14.519	.429	2.315	.031
	Depth	4.716	21.867	.042	.216	.831
	Year Built	3.448	4.144	.080	.832	.415

a. Dependent Variable: Gross Tonnage

A faint picture of the standard 19th century Great Lakes passenger freight propeller is starting to appear from the multiple linear regressions. Their overall size was primarily determined by length. There was minor variation in depth. When shipbuilders wanted to make them wider, they chose to sacrifice length and depth. While the ships do appear to have changed somewhat over time, in comparison to other variables, the build year typically had a weak relationship to the markers of ship size. There was minor variation within length-to-width ratio, but there was more variation in the later decades. The sheer number of passenger freight propellers jumped in the 1880s but quickly fell off in the 1890s and 1900s. The overall trajectory is one of slow acceptance, sudden popularity, and a rapid decline.

Since most of the changes in passenger freight propellers happened between the 1870s and the 1900s, multivariate linear regressions were also run for each of those decades. All these tests are discussed together, as the most important aspect of them are the differences between them.

Gross tonnage was the first variable compared between the decades. The relationship between gross tonnage and the predictor variables was only significant in the 1870s ($p = 0.022$). In all the other decades, only length had a significant relationship to gross tonnage. This is likely due to a few factors. Firstly, as indicated by the other multilinear regressions, length clearly had a substantial impact on gross tonnage. As mentioned above, one variable's impact on the dependent variable can overshadow any influence other variables have. It is also possible that the independent variables are covariate; that is, the independent variables themselves have significant relationships with each other. The effect of this is less noticeable in larger samples. If this is not the case, the fact that length still has a visible, significant impact on gross tonnage indicates that increasing length was given more of a priority than increasing width or depth.

Finally, this could be the result of the increasing specialization in passenger freight propellers. Around the turn of the century, population around the Great Lakes increased dramatically, especially in larger ports like Chicago, Green Bay, and Milwaukee. At the same time, there would still have been plenty of smaller ports that passenger freight propellers could service. This could have resulted in a split in design for larger and smaller port designations for passenger freight propellers that would confound a linear regression.

Similar patterns existed for the rest of the dependent variables tested. Only gross tonnage and net tonnage in 1870 had a significant relationship to the independent variables. Due to this result, multicollinearity was carefully considered as the source; however, none of the other signs were noted (Bahovec 2011). Most notably, there were no substantial changes to the regression coefficient when variables were removed. This increases the likelihood that after the 1870s, passenger freight propellers would be better separated into two sub-classes: large-port passenger freight propellers and small-port passenger freight propellers. This will be examined in more detail in the next chapter.

After the initial regressions were completed, the author discovered that length and width have a significant relationship, meaning that the multicollinearity suspected in the regressions above was actually occurring. The regressions for the overall database, locations, and decades were all re-run with just depth, hull material, and year built as the independent variables. Instead of reporting on all the results, only those that significantly differ from the results mentioned above are discussed.

The overall view of passenger freight propellers did not change all that much after recalculating the regressions. Most importantly, the standard error of estimate increased with the new regressions. This value is a representation of how well data fits the regression equation; a larger standard error of estimate means that data is further away from the regression line. Meaning that while removing the length and width variables did allow the actual impact of the other independent variables to become visible, the new regressions were worse at predicting the dependent variables than the old ones. This was expected, as length and width clearly had a significant impact on tonnage. By removing them, the impact of the other independent variables becomes clearer, even if the overall regression is less descriptive of the dependent variable.

For the overall regressions, everything had a significant relationship to the dependent variables. This proves that depth, year built, and hull material had an impact on gross tonnage, net tonnage, length-to-width ratio, and the difference in tonnage. While the previous regressions obscured this result, this is the logically expected outcome. More intriguingly, however, is that year built has a negative relationship to net tonnage and length-to-width ratio. This confirms some thoughts discussed above; passenger freight propellers did get broader over time, and there was less profitable space on board over time. This both likely contributed to passenger freight propellers not having a significant profit after the turn of the century and, therefore, their eventual rejection by passengers and companies.

The new regressions by location provided more interesting results. The overall strength of the regressions was much lower than the previous ones. Most of the results match the new overall regressions, except hull material does not have a significant relationship to gross tonnage, net tonnage, or length-to-width ratio in New York, Ohio, and Ontario. In Michigan and Wisconsin, hull material does have a significant relationship to those dependent variables, but not to difference in tonnage. At first glance, this difference might simply be a function of how many of each hull type were built in each state. A closer examination shows this is not the case. As displayed in Figure 4-13, New York and Michigan shipbuilders created wood, iron, and steel ships, yet they have opposite patterns in their relationships with hull material. Further, the only state that produced just wooden ships was Wisconsin. There is clearly a third, unknown variable that is creating this result, but it is unclear what this might be.

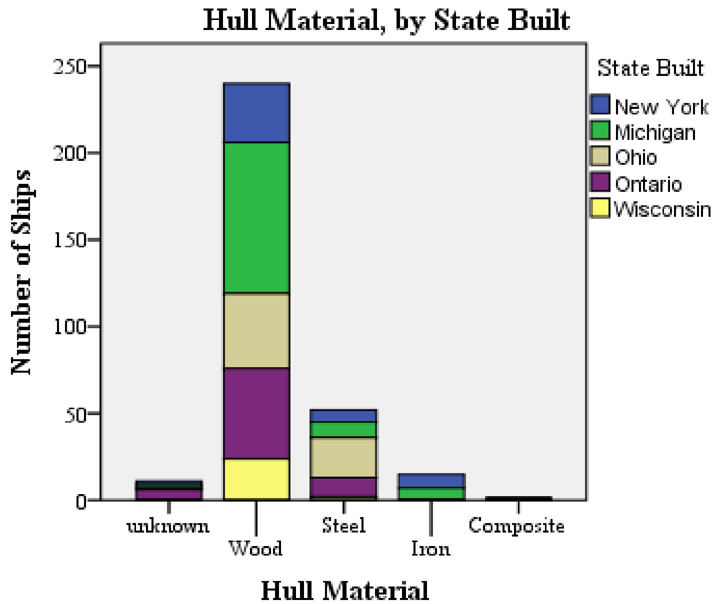


FIGURE 4-13 - A breakdown of hull material amounts by building location (Chart by Author).

Depth and year built are both consistently significant across all states; however, in most of the states, year built has a negative relationship to the dependent variable. In summary, the length to width ratio gets smaller over time, net tonnage gets smaller over time in every state but the province of Ontario and gross tonnage gets smaller over time in Michigan, Ohio, and Wisconsin. Again, it is not clear why this is the case. Potential causes include the higher population in New York and eastern Ontario, requiring larger ships for passengers and manufactured goods. This relationship will be explored in further detail in the next chapter.

The new regressions by decade also provided some intriguing differences from the original ones. Depth was significant ($p = 0.000$) in each of the new regressions. Only three of the new regressions were significant overall: 1870s difference in tonnage, 1880s gross tonnage, and 1880s difference in tonnage. This potentially indicates a period of vast experimentation after the 1880s, one with so many potential variables this study could not account for them all. Year is also only significant in the tests mentioned above, and in many of the tests is almost purely noncorrelated. This potentially indicates that actual changes or improvements stopped happening after the 1880s, or at the very least, were not adopted by every shipowner.

With the new regressions in place, a more detailed picture of the Great Lakes passenger freight propeller appears. Passenger freight propellers seemingly occurred in many different forms, depending primarily on the building location. The variation in these ships was so high, the exact cause cannot be determined. This is potentially due to the wide variation in geography of bays and inlets throughout the Great Lakes, or the amount of population, or the tradition of shipbuilding with which the shipwright was familiar. It is also possible that differences in government regulations and insurance requirements created the differences seen between Ontario and US built ships. All these relationships will be explored further in the next chapter.

CHAPTER 5: COMPARISON AND ANALYSIS

Chapter 4 sufficiently covered the results of just the statistical analysis but left more questions asked than answered. In order to flesh out the skeleton picture the statistical analysis created, the results are compared in this chapter to the historical record. This chapter includes potential explanations for the apparent oddities in the statistics for the passenger freight propeller and historic context.

This chapter is solely comprised of the comparison to known historic events and changes. This study is intended to be a jumping off point for a closer examination of passenger freight propellers, a broader discussion of ship class identification, and a general description of passenger freight propellers as a constructed ship class.

The previous chapter noted several statistical trends that require further exploration and explanation through a comparison to the historic record. These trends consist of wider ships after 1880, the dramatic spike of number of ships in 1880, a split in most common sizes after 1870, the appearance of steel and iron ships after 1883, difference in tonnage getting significantly larger over time, and build year's negative relationship to size. Some of these trends likely have similar explanations; others might be wholly unrelated to each other. Chapter 2 covered a cursory history of passenger freight propellers and the related regulation; this chapter will focus on external pressures to the industry. This chapter will examine the canal system, ports, change in engines, competing industries, and regulations not directly related to shipping.

Comparison to Historical Sources

This section attempts to explain the trends noted in the statistical analysis mentioned above. As noted in the previous chapter, wider ships began appearing after 1880. This fits with previous researchers' explanation that Great Lakes ships got wider, and larger in general, as the canal and lock system was improved (Mansfield 1899a:233; Fairlie 1898:54–55; Shaw 1990:177). To test this, Figure 5-1 was created to note spikes and lows in the database that the multivariate analysis could not note.

Figure 5-1 indicates a few immediate issues. First, the large drops in 1860 and 1885. Secondly, the spikes between years makes the overall trajectory rather difficult to follow. Looking solely at the highest points in each decade, there is a slight upswing in average ship width after 1880, with a far more dramatic upswing in the 1900s. The significant drop in 1860 and 1885 can be ignored after a careful examination of the database. In 1860, only 1 passenger freight propeller was identified, and in 1885 only 3 were. This creates a visual distortion in the chart, as opposed the several years in 1840 with no identified passenger freight propeller. Since there were still ships built in 1860 and 1885, those ships' widths create a potentially artificially low average.

Even with the extreme highs and lows present in the average width of the passenger freight propellers, certain years pop out as potentially significant to specifically compare with the changing canal and lock system: 1861, 1890 and 1900. 1861 was the first year the average width was over 30 feet, 1890 was the first year the average width was over 35 feet, and 1900 had the second highest width at 44 feet (Figure 5-1). If the assumption is true that ships on the Great Lakes were made larger as the canal and lock systems were improved, these dates should correspond with major events in that process.

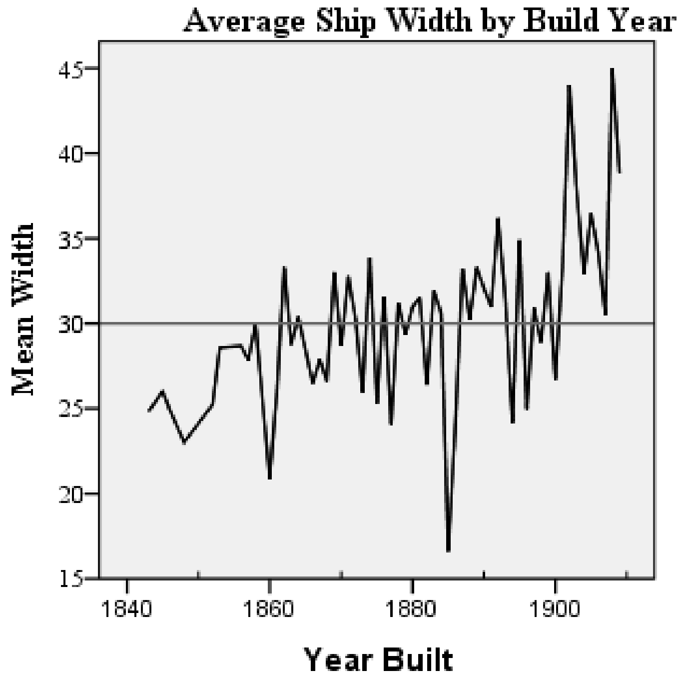


Figure 5-1: The average ship width over time (Chart by Author).

The Erie, Welland, and Sault Ste. Marie canals and lock systems were selected for this comparison, as they are the major connections between the upper and lower lakes and the east coast. Several smaller canals were created throughout the Great Lakes during the 19th century, but the impact of the smaller canals would be primarily regional. Since this study did not, and could not include the ships' typical route, it is impossible to separate the database into ships that were inter-lake versus intra-lake vessels. Most of the commerce on the lakes does appear to have a multi-lake component, however, so it is a safe assumption that most of the passenger freight propellers were inter-lake vessels.

The Welland Canal was completed well before the first passenger freight propeller was launched, in 1829. The Welland was widened and improved in 1833, to 24 feet at the narrowest point, and was left there until 1880, when the narrowest point was widened to 45 feet (Mansfield 1899b:232–234). The Welland canal was one of the more important connections between the lakes, as it was the first major canal and allowed for ships to safely navigate around Niagara Falls.

The Erie Canal was planned and debated in starts and stops throughout the first quarter of the 19th century. Finally, in 1834 the canal was opened, even though it was not technically completed until 1845. For the purposes of this study, the completed width in 1841 is used as the starting point. The canal was again improved in 1890 to 140 feet wide at its narrowest point. There were several improvements to the Erie Canal between 1845 and 1890, but the narrowest point did not increase until 1890 (Mansfield 1899b:255). For clarity, this study will only look at changes to the canal and lock system that resulted in an improvement in the narrowest point.

The Sault Ste. Marie refers to the series of lakes, rivers, and rapids that connected Lake Superior to Lake Michigan. Initially, interest in settling the shores of Lake Superior was so small that the dangerous, narrow passage was enough for the traffic between these two lakes. In the mid-19th century, however, copper was discovered on the western shores of Lake Superior, and immigration to the area boomed. The copper industry also required increasingly larger ships to bring their ore to the markets on the lower lakes. In 1855, the first set of canals and locks that opened this passage was completed. The Sault Ste. Marie canal and lock system deepened the natural waterways and added locks to allow larger ships to safely traverse the passage. The choke points were not within the canal itself, but the locks. Both original locks were 70 feet wide, and even that prevented many ships from passing through. The first set of improvements were completed in 1881, and this increased the narrowest width to 80 feet. The Canadian government decided that this was insufficient in 1887 and constructed their own canals which opened in 1889. The first Canadian lock system merely added another pathway for ship traffic to take.

Finally, in 1891, the American government widened their canal and lock system at Sault Ste. Marie to 140 feet (Mansfield 1899b:242–244).

In comparison to the changes in the canal system, the changes in passenger freight propeller width is minuscule (Figure 5-2). The average ship width appears to closely follow the width of the Welland Canal, although passenger freight propellers were wider, on average in 1861. Further, while the average ship width does not stray far from the Welland Canal's width, the significant changes in width does not appear to follow the Welland canal improvements. Rather, the change in 1890 might be tied to the opening of the Sault Ste. Marie canal and locks.

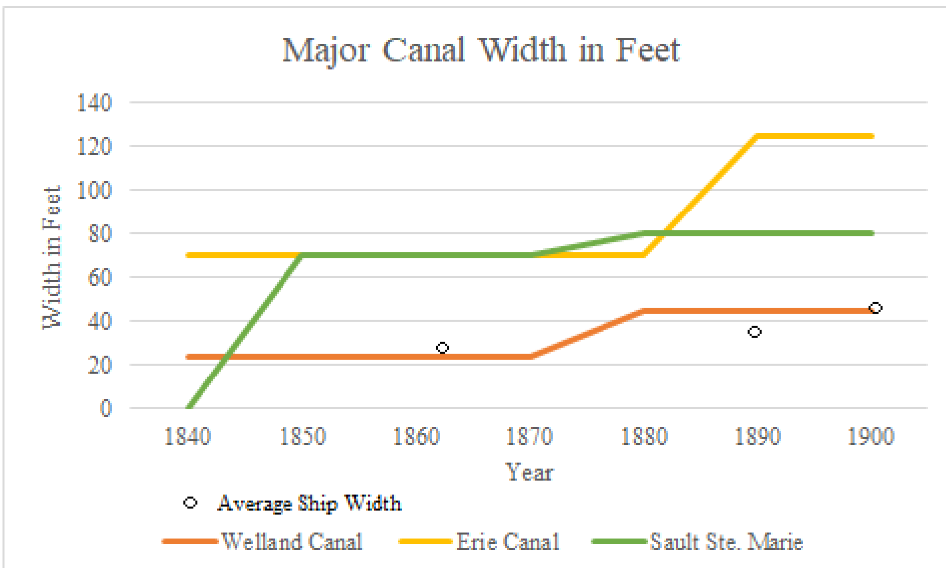


FIGURE 5-2 - The width of the major canals over time, with the average ship width of significant years noted (Chart by Author, Mansfield 1899b:242-244).

In comparison to canalers, passenger freight propellers had significantly large leeway within the canals. Canalers were a class of purpose-built bulk freighter that typically had less than six inches of clearance on all sides in the canals (Salmon 1998:111). There are a few potential reasons why passenger freight propellers might not have pushed the maximum width in the canals when other shipbuilders built their ships as wide as the canals could allow. First, passenger freight propellers needed to be concerned about customer comfort and safety. Canalers, being bulk freighters, would only have crew and freight on board; owners could put their interest in profit first with these ships. While canalers prove that passenger freight propellers could have easily been made larger without a significant increase in danger, it is possible that owners of passenger freight propellers were concerned about customer perceptions.

Secondly, passenger freight propellers would have been servicing more ports than any bulk freighter would. Ports and harbors that were smaller than the canals would necessitate smaller ships. Further, smaller port towns were less likely to have railroad tracks and as discussed in Chapter 4, railroads used passenger freight propellers to extend their routes beyond their rail lines (The Evening Argus 1895:4; Association of American Railroads 1946:2). Finding information about average port size, particularly the smaller ports, was more difficult than finding information about canals. Since the canals were government-sponsored projects, their construction and improvements were well recorded. Port and harbor improvements tended to be local projects, excluding the more trafficked ports, like Chicago, Milwaukee or Green Bay (Salzmann 2012:237–240).

Beyond this, harbors limit depth far more often than they do width. A chart similar to Figure 5-1 was created for depth, but a similar pattern is not visible (Figure 5-3). This is likely due to the canals' maximum depth being more limiting than the maximum width. Due to this, the impact of port dimensions on passenger freight propellers cannot be fully explored. In any case, data about the smaller ports and harbors is difficult to come by.

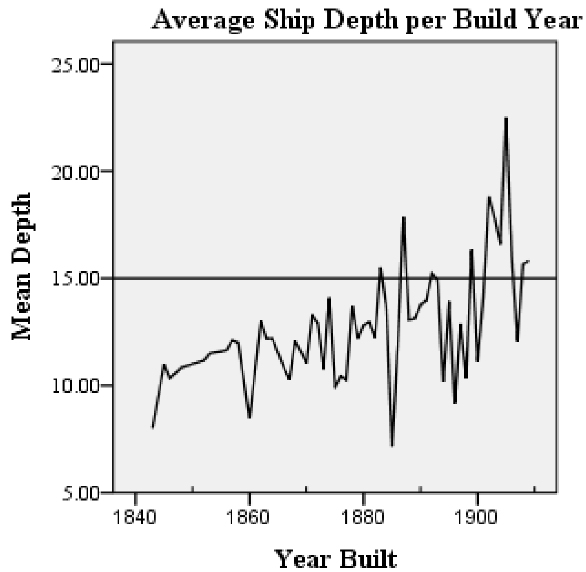


FIGURE 5-3: Average ship depth per build year (Chart by Author).

If the harbors and ports were limiting the size of passenger freight propellers, the split in sizes of the ships after 1870s would be easily explained. While getting at routes for each ship included in this study is impossible, the maps in Figure 5-4 and 5-5 offer a glimpse of the routes larger ship companies considered important and which they left to the smaller lines.

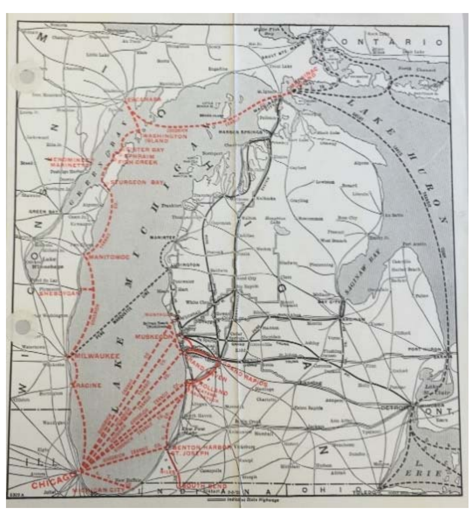


FIGURE 5-4: The 1925 Goodrich Transit Co. Lake Michigan Route Map (Goodrich Transit Co. 1925).

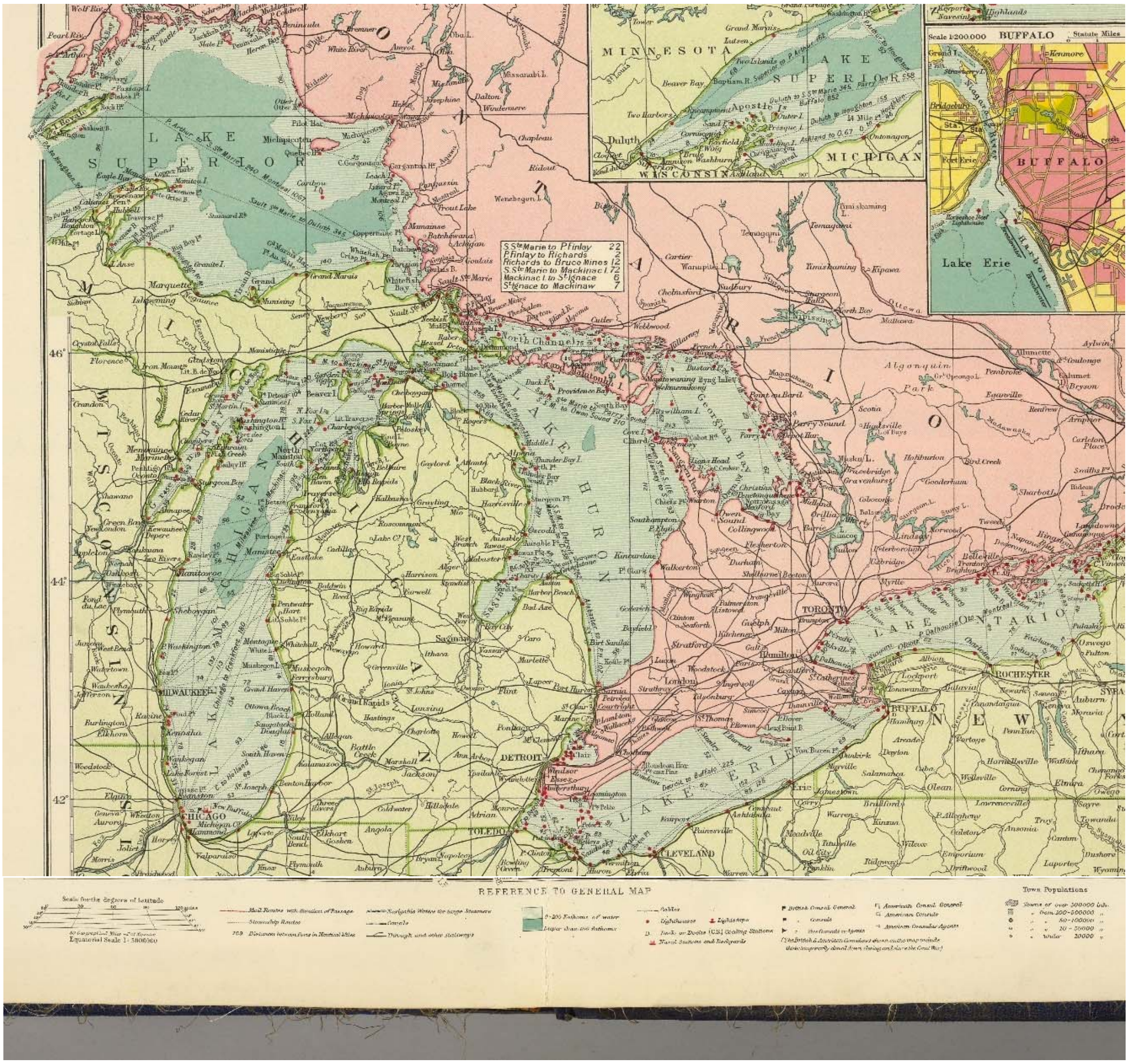


FIGURE 5-5: Excerpt from a 1922 maritime map, showing open ports and steam routes (Phillip 1922).

While these maps were produced outside of the study period, maps that offer as much detail are few and far between for the mid to late 19th century. It is also unlikely that ships' routes would change much in the 12-15 years after this study's research period. In comparing these two maps, Goodrich's routes seem woefully inadequate for Lake Michigan. There are no stops on the western shores of Green Bay. There are no stops north of Sylvan Beach on the eastern shores. Goodrich clearly selected popular destinations for their routes, otherwise, they would not have been able to maintain their iconic, grand ships. Yet, there had to have been propellers serving the ports Goodrich decided were not worth their time. These ports and harbors might not have been physically smaller, but the markets would have been decidedly less so. This is the most likely reason why there were so few "average" sized passenger freight propellers after 1870. A company that tried to directly compete with a passenger line like Goodrich would also require ships as large and ornate as Goodrich's ships. Whereas a company could carve out a spot in the smaller, niche routes and not have to worry about losing business to a corporation with more resources.

Instead of the physical limitations in the routes ships were taking, it is possible that the change in size was more closely related to the engines passenger freight propellers were using. There were several improvements and experiments involving steam engines during the latter half of the 19th century and some of the ships included in this study were used in these experiments (Mills 1910:130–132; Rodgers and Green 2003:27). Unfortunately, the actual engine type of each ship was not included as part of the standard information from the BGSU database. Contemporary sources do make clear that the overall trajectory of engines was faster, safer, and more efficient (Mansfield 1899b:399; Mills 1910:130–132). Yet the problem that existed with assigning the canal system most of the influence on passenger freight propellers also exists for this explanation. Other ships on the Great Lakes were able to reach much larger sizes. The first bulk freighter on the lakes, *R. J. Hackett*, was launched in 1870 and was 205 feet and 34 feet wide, and bulk freighters would only continue to get bigger (Bowling Green State University; Lake Carrier's Association 1910). *R. J. Hackett* was also a propeller and was presumably using the same type of engine that passenger freight propellers were.

One of the ways this study proposed to estimate engine size was the difference in gross and net tonnage. Since net tonnage was defined as the "profitable" space in a ship and the gross tonnage the total, the difference between them is the non-profitable space (Vasudevan 2010:10). Again, the historical record is lacking. The exact definition of the non-profitable spaces on board a ship changed over time, due to revisions in Section 417 of the United States Revised Statutes. As discussed in Chapter 4, this space could potentially include passenger support areas or crew spaces, prior to 1895 and assuming ship owners were taking advantage of certain loopholes. The engine room and fuel storage were legally considered part of the "non-profitable" space; these were probably the most expensive areas on the ship (Department of Commerce Bureau of Navigation 1878; US House of Representatives 1895:741–743).

At first, this author assumed that the changes in the legal definition of net tonnage would obscure any relationship to year. If this was the case, however, there would likely have been no visible pattern in net tonnage or difference in tonnage. Instead, there is a clear, significant relationship between build year and net tonnage. More importantly, there is a clear, significant, positive relationship between build year and difference in tonnage. For some reason, the non-profitable space gets larger over time instead of smaller. Without examples of passenger freight propellers with known distribution of internal structures, the cause behind this relationship will remain unclear. With the current evidence, it is still possible that the relationship to difference in tonnage and year was not a physical one, but a legal one; later ships could have had similar distribution of space as younger ones, with those spaces defined differently. As discussed in Chapter 4, if the ships really did have less profitable space proportionally over time, they would easily have lost their competition to other transportation methods.

There seems to be no external physical reason behind the growth over time in difference in tonnage. Unlike the other markers of size, this statistic would not be constrained by factors such as canal size. Potentially, ship owners were artificially inflating the amount of non-profitable space on board to lower their tax burden (Navigation 1894:45). Ideally, future research would take the framework of this study and apply it to other ship classes and time periods. It is still very likely that this pattern is not unusual for ships within the Great Lakes.

The final change considered by this study is the drastic switch to iron and steel ships after 1883. As Figure 5-6 demonstrates, 1883 was the first year iron and steel ships were available on the lakes. After 1883, steel ships represent a far greater amount of gross tonnage than any of the other hull materials, excluding 1885, when iron-hulled ships had a larger proportion of the gross tonnage.

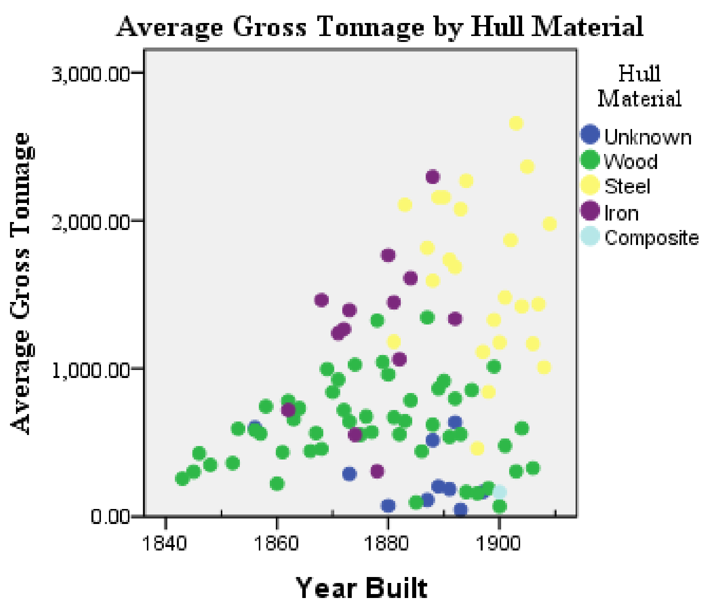


FIGURE 5-6: Average gross tonnage of each hull material by year (Chart by Author).

There does not seem to be as much preventing the construction of iron ships before 1883. The first iron passenger freight propeller launched on the Great Lakes was *Merchant* in 1862. David Bell built *Merchant* for the Anchor Line in Buffalo and it steamed on the Great Lakes for 20 years before sinking (Mansfield 1899a:416). 1862 was not a random date for the first iron propeller on the Great Lakes; owners of iron mines on the western shores had struggled to establish themselves during the first half of the 19th century. 1863 was the first year substantial profits were reported (Lake Carrier's Association 1910). 1863 also marked the 20th year anniversary of the launch of *USS Michigan*, the first iron steamship of the American Navy. While initially a risky and bold experiment, *Michigan* was known by this time as an important political tool and lifesaving vessel (Rodgers 1996).

The amount of time between the first steel propeller and the first steel passenger freight propeller was much shorter. The Globe Works in Cleveland built the first steel propeller bulk freighter, *Onoko*, in 1882 (Mansfield 1899a:744). In 1883, three passenger freight propellers, *Algoma*, *Athabasca*, and *Alberta* were brought over from Scotland (Mansfield 1899a:471). The first steel American built passenger freight propeller, *Columbian*¸ was built in Pennsylvania in 1890 (American Bureau of Shipping 1893:334). The question then becomes what happened in 1889 or 1890 that encouraged the building of American steel ships.

One potential cause is that American pig iron production finally surpassed United Kingdom production in 1890 (Naknoi 2008:1). This was just in time; 1890 was also the peak year of white pine production in the Great Lakes. The amount of available lumber in the region greatly declined after this year and the shipbuilding industry was forced to switch to hardwoods as an alternative by 1900. During the 1890s, lumber companies in the Great Lakes region experienced a pattern similar to the transportation businesses in the 1930s. Desperate to control as much of the resources as possible and protect profits, lumber revenues ended up in the hands of a few elite (Stearns 1997:13). After 1900, the amount of American lumber available for shipbuilding was significantly lower than the amount of American steel, which is neatly diagrammed in Figure 5-6 as the decreasing average wooden gross tonnage and the increasing average steel tonnage.

While the regressions in Chapter 4 showed a strong relationship between width, depth, hull material and build year, it is possible that the relationship was more to the number of ships built per year. However, the number of ships built does not appear to have a positive, linear relationship to build year that depth, width, or hull material did (Figure 5-7). There are several spikes in ships built per year worth comparing to the historic record. The highest spikes in production are 1888 (21 ships), 1873 (18 ships), and 1901 (12 ships). Each of these spikes are followed by an immediate decrease in production and are preceded by lows in production.

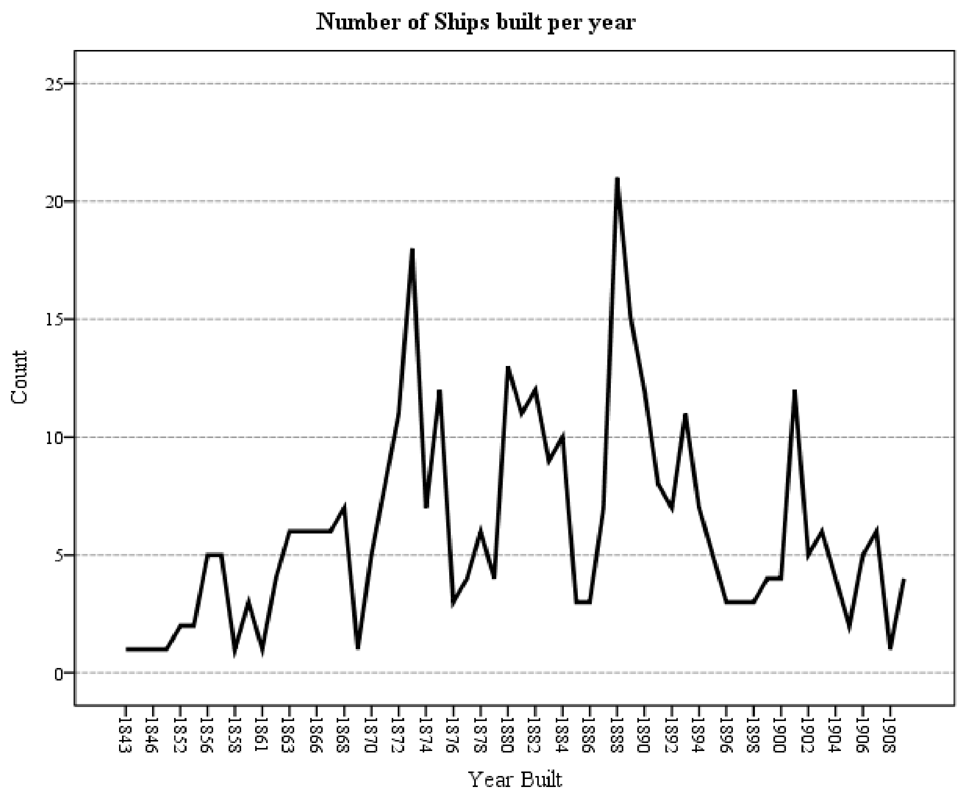


FIGURE 5-7: Number of ships built per year (Chart by Author).

The spike in production of 1873 coincides with an economic panic. The Panic of 1873 is considered as an expected result of the boom in speculative investment into railroads during the five years prior (Nitschke 2018:224). As stated in Chapter 2, railroad companies often also controlled the passenger freight trade in the Great Lakes region (The Evening Argus 1895;

Association of American Railroads 1946). While a decrease in production is expected, and seen after the start of the panic, the high levels are an indication of the boom continuing strong until September 10, when Jay Cooke, an important Philadelphia banker, suddenly declared bankruptcy (Nitschke 2018:223). Cooke's bankruptcy sent shockwaves throughout the investing community, leading to a sudden drop in stocks and production rates (Augustin Cote 1874:2). This panic clearly had an impact on the production of passenger freight propellers. The railroad companies that owned these ships or partnered with the passenger freight companies of the Great Lakes would not recover until 1879, which corresponds to a slight increase in production in 1880, which holds steady until the spike in 1888 (Shachmurove 2011:221, Figure 5-7).

1888 also saw spikes in production of other related materials and products: freight cars, grain, and lumber (Door County Advocate 1888:2). This spike drops down to 1893, which corresponds with another economic panic (Shachmurove 2011:223). This particular panic was partially caused by a similar condition of the Panic of 1873, compounded by European economic problems, and lack of security in the gold standard. The boom in railway production occurred in 1888. Confidence in the gold standard was also at its height in 1888, given the amount of available gold funds in the US treasury during that year. Further, the European economic panic and decrease in investment did not occur until 1890 (Lauck 1907:118–120; Calomiris and Carlson 2017:473). This peak is also likely the result of a boom in transportation investment before the eventual drop.

The spike in 1901 does not correspond to any particular panic. As opposed to the two earlier spikes, the recovery from an economic panic is the likely culprit. The Panic of 1893 was one of the most devastating panics in American history, with after-effects present up until 1900. Most related to passenger freight propellers was the dramatic increase in unemployment to its peak at 11% in 1898, and the bankruptcy of roughly 150 railroad companies (Ramírez 2009:2187). As stated in Chapter Two, railroad companies were heavily involved in passenger freight propellers, both directly as owners, and indirectly as partners. The massive hit railroad companies took during the Panic of 1893 would also be indicative of problems in the passenger freight propeller industry. By 1901, railroad construction had finally increased to pre-1893 levels (The Advocate 1901:4). After this peak, there is yet another decline towards an economic panic, this time in 1907 (Hansen 2014:546).

The pattern of peaks and falls in passenger freight propeller production numbers clearly follows the pattern of economic stability and instability in the US. Unlike the gross dimensions of these vessels, the number of ships produced had little to do with technological development, improvements to the Great Lakes, or available materials. While the overall development of the passenger freight propeller can be explained by industry-specific factors, the actual production of new ships on the lakes does not fit these explanations. Of course, further research into passenger freight propeller owners' costs and profits is needed. Small scale economic studies have been conducted on individual companies, but research should be conducted into the industry as a whole (Heier 1999).

CHAPTER 6: FINAL CONCLUSIONS

For nearly a century, the passenger freight propeller was an integral part of Great Lakes trade, immigration, and culture. In the early part of the 19th century, these ships brought over scores of immigrants in response to growing interest in the upper lakes. During the mid-19th century, they allowed railroads to extend their lines beyond their financial and geographic limitations. By the end of the 19th century, these ships were a vital part of the transportation network in the Great Lakes, connecting larger cities like Chicago and Milwaukee to smaller, rural harbors. After the turn of the 20th century, they took a back seat to new transportation methods as railways and highways started to stretch across the Midwest, and they became a combination recreational and practical mode of transportation. While they could not survive the Great Depression, their impact on the history of the Great Lakes cannot be understated.

The statistics in this thesis initially created a somewhat complicated view of the development of passenger freight propellers. Seemingly contradictory statistics, like the growing difference in tonnage and negative relationship between time and gross tonnage, made it seem that these ships were merely mismanaged. These results at first appeared at odds with the rest of the statistics generated and the traditional understanding of the passenger freight propeller's changes. By comparing these statistics to both the historical record and example ships, the apparent contradictions were clarified.

The primary question posed in Chapter One, "What were the economic and social forces that led to the creation of the passenger freight propeller?", was best answered by the comparison to historic sources in Chapter Five. Passenger freight propellers took the place of the grander Palace steamers after the Panic of 1857 and the end of the Civil War, although not arriving in great numbers until the investment boom before the Panic of 1873 (Nitschke 2018:222). This investment boom, plus the opening of the Great Lakes by the creation of the canal system, and the discovery of copper on the shores of Lake Superior facilitated the spread of these new ships. Firstly, the desire to settle even the most remote and rugged shores of the Great Lakes required a ship class that was capable of safe navigation on the Lakes and transporting a mix of goods and people. While the palace steamers were excellent for luxury transportation, the amenities on board often priced out the laboring class.

The comparison to the historic record determined that the size of passenger freight propellers was driven by the demand potential consumers had for ship travel, and the level of investment into travel industries as whole. Prior to the completion of the Midwest railroads, passenger freight propellers were the fastest, safest way to travel. These ships combined the comforts of daily life with the convenience of ship travel. Once the railway system neared completion, passenger freight propellers acted as line extenders, so passenger capacity was emphasized over daily comforts. After the upper Great Lakes were fully settled, successful passenger freight propellers became something like a pleasure vessel. Ultimately, it was this focus on leisure travel that led to their demise. During the Great Depression, customers did not have money to go on vacation, and passenger freight propellers could no longer compete with land travel in the areas of safety or convenience.

One of the initial goals of this research was to define and describe passenger freight propellers as a ship class. Looking at the class as a whole, the “average” passenger freight propeller was around 200 feet long, 30 feet wide, and 13 feet deep. The majority were built within 13 years of 1882. Most were made from wood and had below deck hogging trusses. If the shipowner could justify the cost, they preferred to make these ships longer rather than wider, but these ship dimensions rarely approached the maximum limits of the canals (Table 6-1).

Table 6-1: The descriptive statistics for all the ships included in this study (Table by Author).

	N	Minimum	Maximum	Mean	Std. Deviation
Length	353	55.00	362.00	177.5875	66.97231
Width	353	10.00	56.00	30.3206	7.76430
Length:Width	353	3.00	9.00	5.7337	1.05928
Depth	340	3.00	28.00	13.0329	4.93481
Gross Tonnage	352	24.00	5265.00	923.3809	840.57985
Net Tonnage	237	12.00	2652.00	783.1980	640.47897
Difference in Tonnage	353	.00	1905.00	185.4290	284.99698
Hull Material	353	.00	4.00	1.3003	.63998
Year Built	353	1843	1909	1882.54	13.826
Hogging Truss?	349	0	2	1.35	.883
Valid N (listwise)	234				

Since there were so few passenger freight propellers built in the 1840s and 50s, it would not be useful to describe the "average" passenger freight propeller in these decades. The 1860s produced 42 of these ships, with an increase in production to 1890. The average 1860s passenger freight propeller was smaller than the rest of the decades. Limited by technology and lagging interest in the settling the upper lakes, these ships were about 170 feet long, 28 feet wide, and 6 feet deep. They likely did not deviate too far from the ship lines of early steamships, although later in the decade they acquired finer hull lines, as shipbuilders started to understand the importance of guiding water towards the propellers.

The 1870s started to hint at how popular passenger freight propellers would become in the 1880s. This is also when the split between small and large port passenger freight propellers began. The standard deviation for gross tonnage doubled between 1860 and 1870, indicative of the growing variation (Figure 6-1). This split does make interpreting the nature of the "average" 1870 ship difficult; the split likely dragged down the norm for each of the dimensions considered. With that in mind, the "average" passenger freight propeller in 1870 was a little smaller, around 168 feet long, 29 feet wide, and 12 feet deep. Again, most of these ships were wood, and hogging trusses of all kinds were becoming more common.

The sudden popularity of passenger freight propellers is likely due to the number of roles this ship could fill. Whether it was taking wealthy passengers to vacation spots, or moving fruit to and from the rural ports, passenger freight propellers were a common sight on the Great Lakes in the 1880s. There was an even more extreme level of variation in the 1880s than there was in the 1870s. The "average" passenger freight propeller in the 1880s was roughly 180 feet long, 30 feet wide and a depth of hold of 13.5 feet deep. For the first time, steel passenger freight propellers appeared on the Great Lakes, and would soon overtake wood as the most common hull type.

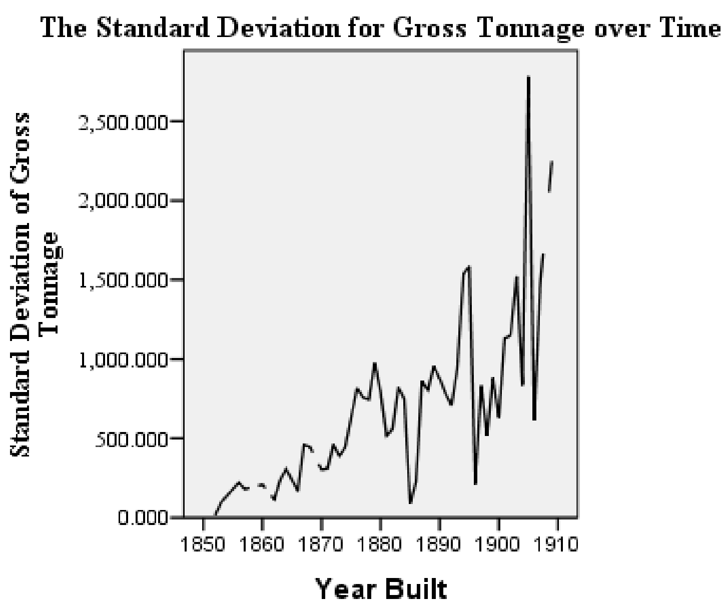


Figure 6-1: The standard deviation for gross tonnage over time (Graph by Author).

The 1890s was the beginning of the end for the passenger freight propeller. While they would persist until the Great Depression, it was in increasingly smaller numbers and more niche markets. The average 1890s passenger freight propeller was not all that different from the average 1880s ship, almost as if ship owners were desperately trying to make the old formula work. The spike in the standard deviation of gross tonnage in 1895 is quickly followed by a reduction in variation, which is potentially the result of the completion of railroads to major travel centers throughout the Midwest (Figure 6-1). The typical 1890s passenger freight propeller was about 177 feet long, 30.5 feet wide, and had a depth of hold of about 13 feet.

Only 45 passenger freight propellers were built between 1900 and 1910, almost the same as the 1860s. There were no more new routes to carve out, and major companies like the Goodrich Transit Company and Western Steamship Lines had control over the most profitable routes. Even with a near monopoly on some of the most common courses, these major companies required the addition of fun "excursion" trips during the ships off-hours to stay profitable. Accordingly, these ships get bigger, almost as a call-back to the palace steamers of the early 19th century. The average 1900s passenger freight propeller was about 210 feet long, 35 feet wide, and had a depth of hold of 15 feet.

The first secondary question examined the role of the canal improvements in the gross dimensions of passenger freight propellers. Again, this question was best answered in the historical comparison found in Chapter 5. Figure 5-2 noted the changes in the size of the Great Lakes canals against changes in the average width of the passenger freight propeller. This showed that while the canals had at least some impact on the dimensions of these vessels, the average dimensions never began to approach the limits the canals imposed. Ship builders during the 19th century often built other ship classes as close as possible to this limit (Shaw 1990).

Chapter 5 discussed a few potential reasons why passenger freight propellers were small in comparison to other Great Lakes ship classes, with concern for passenger comfort and the law of diminishing returns being the most likely causes.

The second secondary question, “what were passenger freight propellers primarily used for” was a little more difficult to answer. While Chapter 2 discussed the changes within the Goodrich Transportation Company’s business practices and the role of railroads in the passenger freight trade, the actual dimensions of these vessels offers little evidence for the primary purpose of passenger freight propellers. The problem with the definition of passenger freight propellers noted in Chapter 1 still stands. A ship class defined by its multi-use purpose allows for too much variation of both use and construction. While this thesis helped to clarify the construction elements common in passenger freight propellers, the changes in their use is not evident in their dimensions. Firstly, commonly recorded ship dimensions do not include a breakdown of passenger versus cargo areas. Secondly, based off the Goodrich advertisements in Chapter 2, the same passenger freight propeller could easily be used for either cargo centric or passenger centric activities (Figure 2-4, Figure 2-5). Finally, several passenger freight propellers, including one of the ship comparisons discussed in Chapter 5, were converted into other ship classes near the end of their use life. These ships were designed to be extremely flexible in their use, and owners apparently took advantage of that fact. The primary use of these vessels shifted over time with the size and nature of the customer base. When there were plenty of people desiring travel across the lakes, passenger freight propellers focused on speed and convenience. During the end of the 19th century and beginning of the 20th century, after the railroads were well-established in the areas, passenger freight propellers could no longer simply be convenient; they had to be entertaining for passengers and useful for rural ports.

The final secondary question "Is the size change of passenger freight propellers the result of economic changes in the Great Lakes?" can be answered with a resounding yes. These ships were created to fill an economic need, and the changes in their dimensions cannot be adequately explained by any other recorded factor. While available technologies, such as engine size and available materials, had an impact on the overall size of passenger freight propellers, ship builders and owners did not simply build these ships as large as possible, and there was no direct relationship between increases in the average size and known changes in ship technology. While examining the explicit economic details of these ships was outside the scope of this study, the results do indicate a relationship worth further research. The next step in exploring the economics of passenger freight propellers would require gathering as much financial data from passenger freight propeller companies as possible. If the relationship between economics and the size of passenger freight propellers was real, the size and number of passenger freight propellers produced should correspond with rises and falls in profits.

This thesis also uncovered trends in the sizes of passenger freight propellers that were not initially predicted. These trends also support the claim that the primary factor impacting their construction was economics. The statistical analysis discussed in Chapter 4 uncovered a split in passenger freight propellers after the 1880s, with a marked decrease in the number of ships with "average" sizes (Figure 4-2, Figure 4-3, Figure 4-4). As discussed in Chapter 4 and Chapter 5, this was likely due to the development of the railroads in the Great Lakes region, and the establishment of large passenger freight propeller companies. As the railroads developed, less and less ports on the Great Lakes were dependent on passenger freight propellers to move people and package freight, leaving only the most rural towns for companies that could not provide the service for high-volume ports. As discussed in Chapter 2, the larger companies that did service high-population ports with develop rail stations only survived by increasing the amount of entertainment on board and partnering with resort towns. More rural companies, like Samuel Neff & Co., did not have the customer base to justify entertainment on board, nor the connections to partner with resort towns (Heier 1999).

The story of the passenger freight propeller is more complex than initially thought. Without the statistical component, the split in purposes and sizes likely would have remained unnoticed. Comparing the statistics to the historical record provided answers, but there is still more research to be done. The growing difference in tonnage still needs to be explained. Ideally, this would involve several archaeological studies of preserved passenger freight propellers from a variety of the decades included in this study. The growing size in fuel storage should be visible in the archaeological record. The specific impact of harbors on the size of passenger freight propellers should also be explored. This research might be best suited for ArcGIS, to map out changes in harbor and port sizes using satellite imagery and historic maps. Generally speaking, these ships deserve more attention from maritime archaeologists and historians as they reflect a period in Great Lakes history when the movement of people was as important as the movement of commodities (Rodgers 2018, elec. comm.).

Passenger freight propellers helped shape the history of the Great Lakes. These ships were equally impacted by the people, economics, and technologies of the 19th century. In comparison to other ship classes they may not have been as large or have been used for as long, but they are no less significant. Hopefully, the statistics and "snapshot" view of the passenger freight propellers creates a better understanding and appreciation for these once grand ships.

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APPENDIX A: DATA SET IN TABLUAR FORM

Case Number	Name	Official Registration Number	Year Built	Length	Width	Length to Width Ratio	Depth	Net Tonnage	Gross Tonnage	Difference in Tonnage	State Built	Hull Material	Hogging Truss
1	Acadia	77697	1882	136	25	5	7	372	612	240	Ontario	Wood	Below Deck
2	Adrienne	106249	1884	74	16	5	7	31	63	32	Michigan	Wood	None
3	Africa	92285	1873	135	25	5	12	0	352	0	Ontario	Unknown	
4	Albany	106306	1884	267	38.42	7	13.66	1677	1917	240	Michigan	Iron	Below Deck
5	Alberta	85765	1883	263.42	38.16	7	23.25	1552	2282	730	Scotland	Steel	Below Deck
6	Alderson, William, M.	73920	1884	98	21	5	8	0	121	0	Ontario	Wood	None
7	Aletha	107748	1901	107.33	19.58	5	5.42	90	171	81	Ontario	Wood	None
8	Algoma		1883	262.66	38.16	7	23.25	1148	1773	625	Scotland	Steel	Below Deck
9	Algoma2	111803	1901	104	26.25	4	11	107	157	50	Ontario	Steel	None
10	Algomah	106022	1881	127	33	4	11.08	359	486	127	Michigan	Wood	None
11	Alice	122260	1907	125.42	25.66	5	10.66	239	403	164	Ontario	Steel	None
12	Amazon	105252	1873	230.08	34.42	7	14.16	0	1406	0	Michigan	Wood	Below Deck
13	America		1863	134	24	6	10	0	418	0	Ontario	Wood	Below Deck
14	America3	107367	1898	164.5	31	5	11	283	486	203	Michigan	Steel	Below Deck

Case Number	Name	Official Registration Number	Year Built	Length	Width	Length to Width Ratio	Depth	Net Tonnage	Gross Tonnage	Difference in Tonnage	State Built	Hull Material	Hogging Truss
15	American Eagle	105936	1880	104.66	24.23	4	9	80.62	161.24	80.62	Ohio	Wood	None
16	Americana	205096	1908	203	45	5	15.66	558	1009	451	New York	Steel	Below Deck
17	Arabia	105254	1873	221.66	34.42	6	14.16	1202	1395	193	New York	Iron	Below Deck
18	Argo	107157	1895	192	35	5	12.66	490.26	721.26	231	Michigan	Wood	Below Deck
19	Argyle	90537	1872	135	23	6	0	396.91	625.65	228.74	Ontario	Wood	Below Deck
20	Ariel	106032	1881	95.75	28.75	3	11	119.82	201.91	82.09	Michigan	Wood	None
21	Armenia	74388	1873	136	23	6	11	0	601	0	Ontario	Wood	Below Deck
22	Armour, Philip D.	150459	1889	264	40.5	7	21	1452	1990	538	Michigan	Wood	Below Deck
23	Armstrong, William	80613	1876	100	30	3	6	90.62	181.28	90.66	New York	Wood	None
24	Arundell	105784	1878	136.5	23.33	6	11	199.18	306.12	106.94	New York	Iron	None
26	Asia		1873	136	23.33	6	11	0	364	0	Ontario	Wood	Below Deck
27	Athabasca	85764	1883	262.66	38.16	7	23.25	1545	2269	724	Scotland	Steel	Below Deck
28	Atlanta	106823	1891	200	32.16	6	13.5	958.06	1129.17	171.11	Ohio	Wood	Below Deck
29	Atlantic	298	1863	177.58	28.16	6	11.83	0	564.5	0	Ohio	Wood	Below Deck
30	Aucocisco	107286	1897	107.66	24.75	4	8.75	94	167	73	Maine	Unknown	None

Case Number	Name	Official Registration Number	Year Built	Length	Width	Length to Width Ratio	Depth	Net Tonnage	Gross Tonnage	Difference in Tonnage	State Built	Hull Material	Hogging Truss
31	Aurora	106493	1887	290	41	7	22.33	1859	2282	423	Ohio	Wood	Below Deck
32	Australasia	106302	1884	282	36	8	21.16	1539	1829	290	Michigan	Wood	Below Deck
33	Averell, WM. J.	81027	1884	241.58	36.58	7	14.42	1425.43	1603.14	177.71	Michigan	Wood	Below Deck
34	Avon	105733	1877	251	35.33	7	15	1538.84	1702.33	163.49	New York	Wood	Below Deck
35	Aztec	106627	1889	180	33.25	5	13.75	653.44	834.5	181.06	Michigan	Wood	Below Deck
36	Badger State	2111	1862	210.33	32.33	7	13.25	0	860.42	0	New York	Wood	Below Deck
37	Bain, Jessie	76741	1888	72.42	13	6	5.16	19.52	39.03	19.51	New York	Wood	None
38	Baldwin, S. C.	23957	1871	160	30	5	11	0	418	0	Michigan	Wood	Below Deck
39	Ballentine, Davis	6768	1873	221	37	6	13.42	595	972	377	Michigan	Wood	Below Deck
40	Bannockburn	102093	1893	245	40	6	21	1035	1620	585	Great Britain	Steel	Below Deck
41	Barber, J.	12981	1856	125.66	26.33	5	8.5	0	263	0	Ohio	Wood	None
42	Barker, Gracie	85587	1879	87.33	17.66	5	7	49.07	73.32	24.25	Michigan	Wood	None
43	Barker, S. B.	115837	1882	92.42	18.42	5	7.25	52.73	77.88	25.15	Michigan	Wood	None
44	Barnum, William H.	80342	1873	218.5	34.66	6	16.16	0	937.15	0	Michigan	Wood	Below Deck
45	Bay City	3451	1867	152	26.42	6	10.25	0	262.63	0	Michigan	Wood	Below Deck

Case Number	Name	Official Registration Number	Year Built	Length	Width	Length to Width Ratio	Depth	Net Tonnage	Gross Tonnage	Difference in Tonnage	State Built	Hull Material	Hogging Truss
46	Bay State		1852	137.25	25.58	5	11.33	0	372	0	New York	Wood	Below Deck
47	Beard, James	80343	1873	73.42	17.16	4	6.25	67.85	86.79	18.94	Michigan	Unknown	None
48	Bedell, Ossian	155414	1901	104.42	28	4	9.5	192	296	104	New York	Steel	None
49	Belle	2159	1860	90	19.56	5	7	0	129	0	Michigan	Wood	None
50	Belle (2)	3324	1885	60	13.42	4	5.5	18.84	37.54	18.7	Michigan	Wood	None
51	Benton	2145	1867	146	28	5	8.58	0	418	0	New York	Wood	Below Deck
52	Berkeley	3930	1902	201.16	39	5	16.16	648	1075	427	Virginia	Steel	Below Deck
53	Berks	2905	1874	189	29	7	14.33	0	553.09	0	Pennsylvania	Iron	Below Deck
54	Bessie	3122	1880	97.16	20.5	5	6.33	44.61	89.22	44.61	Michigan	Wood	None
55	Bielman, C. F., JR	204485	1907	67.42	14	5	7.25	23	33	10	Michigan	Steel	None
56	Bigelow, H. P.	96269	1893	67	14.66	5	8.42	37	46	9	New York	Unknown	None
57	Bissel, George W.	10665	1866	152	26.16	6	10.25	264	278	14	Michigan	Wood	Below Deck
58	Blanchard, B. W.	2806	1870	212.25	32.33	7	12.16	0	1173.01	0	Ohio	Wood	Below Deck
59	Bloomer Girl	3679	1894	109.16	21.75	5	8.25	64.85	95.43	30.58	Michigan	Wood	None
60	Bon Ami	3626	1894	108.16	21.66	5	6.33	149.69	226.95	77.26	Michigan	Wood	None

Case Number	Name	Official Registration Number	Year Built	Length	Width	Length to Width Ratio	Depth	Net Tonnage	Gross Tonnage	Difference in Tonnage	State Built	Hull Material	Hogging Truss
61	Bon Voyage	3497	1891	153.25	30	5	17.16	360.85	500.26	139.41	Michigan	Wood	Below Deck
62	Bonavista	87966	1884	240.33	33.42	7	18.25	837	1306	469	Great Britain	Iron	Below Deck
63	Bonner, J.	77521	1901	83.25	19.42	4	5.16	39	74	35	Wisconsin	Wood	None
64	Boston	3140	1880	263.16	36	7	15.33	1669	1829	160	Michigan	Iron	Below Deck
65	Bothnia	100661	1895	178	37	5	12	0	833	0	Ontario	Wood	Below Deck
66	Boyce, Isabella J.	100446	1889	138	29.5	5	11	316.95	368.28	51.33	Wisconsin	Wood	Below Deck
67	Boyce, Mary H.	92033	1888	181.33	34.16	5	14	607	700	93	Michigan	Wood	Below Deck
68	Bradshaw, Mabel	92096	1889	135	26	5	9	177	331	154	Michigan	Wood	Below Deck
69	Brandon	3915	1902	200.42	37	5	17.25	639	1062	423	Deleware	Steel	Below Deck
70	Britannic	3400	1888	219.16	39.16	6	17	904	1121	217	Michigan	Wood	Below Deck
71	Briton	3493	1891	296.16	40.33	7	21	1875	2348	473	Ohio	Steel	Below Deck
72	Brittain, R.C.	110327	1877	105.16	22	5	8	0	286.04	0	Michigan	Wood	None
73	Brittannia	203237	1906	164	45	4	17.75	401	791	390	Michigan	Steel	Below Deck
74	Brockville	107421	1898	105	21.42	5	5.58	0	191	0	Ontario	Wood	None
75	Brown, W. L.	80767	1880	140	28	5	13	224.58	336.1	111.52	Wisconsin	Wood	Below Deck

Case Number	Name	Official Registration Number	Year Built	Length	Width	Length to Width Ratio	Depth	Net Tonnage	Gross Tonnage	Difference in Tonnage	State Built	Hull Material	Hogging Truss
76	Buckman	3904	1901	253	38.33	7	22.66	1237	1820	583	Ohio	Steel	Below Deck
77	Buell, F.R.	120720	1888	194	36.33	5	22.66	1199	1438	239	Michigan	Wood	Below Deck
78	Buffalo	3076	1878	258.66	35.75	7	16.16	1662	1762	100	Ohio	Wood	Below Deck
79	Bulgaria	3381	1887	280.25	39	7	21	1486.35	1888.87	402.52	Michigan	Wood	Below Deck
80	Burlington	2157	1857	137.33	25.5	5	11.75	0	384.66	0	New York	Wood	Below Deck
81	Burton, IDA	100073	1873	72.42	18.66	4	3.25	0	36.22	0	Michigan	Wood	None
82	Business	3163	1881	191	34.7	5	17.58	772.54	985.62	213.08	Wisconsin	Wood	Below Deck
83	Buttironi, Kate	14393	1881	174.42	31	6	20.33	693	865	172	Michigan	Wood	Below Deck
84	California	85309	1873	137	23.5	6	13.42	0	667	0	Ontario	Wood	Below Deck
85	Calumet	126237	1884	256.66	37.16	7	19.66	1180	1526	346	New York	Wood	Below Deck
86	Calvin, D.D.	83298	1883	166	32	5	15	483	750	267	Ontario	Wood	Below Deck
87	Cambria	126420	1887	280	40	7	20	1377.33	1878.1	500.77	Ohio	Steel	Below Deck
88	Campbell, Gordon	85184	1871	205.42	32.42	6	13	709	996	287	Michigan	Wood	Below Deck
89	Canada	100392	1872	142.1	23.9	6	13	408	644	236	Ontario	Wood	Below Deck
90	Caribou	116249	1904	144.66	26.5	5	10.42	0	597	0	Ontario	Wood	Below Deck

Case Number	Name	Official Registration Number	Year Built	Length	Width	Length to Width Ratio	Depth	Net Tonnage	Gross Tonnage	Difference in Tonnage	State Built	Hull Material	Hogging Truss
91	Carpenter, O.O	155198	1891	127.5	30.5	4	9.42	268.28	364.07	95.79	Michigan	Wood	None
92	Cartagena	127526	1901	241	40	6	19.66	1418	1532	114	Michigan	Wood	Below Deck
93	Castalia	126610	1890	292.42	40.5	7	21.5	1840	2512	672	Ohio	Steel	Below Deck
94	Cayuga	126556	1889	290	40.66	7	13.5	1939	2669	730	Ohio	Steel	Below Deck
95	Cayuga (2)	122219	1907	305	36.58	8	14.25	1168	2196	1028	Ontario	Steel	Below Deck
96	Celtic	71151	1874	140	37	4	12	0	440	0	Ontario	Wood	Below Deck
97	Chaffey	71083	1875	59	14	4	6	29	42	13	Ontario	Wood	None
98	Champlain	5848	1870	135.16	26	5	11.5	356.82	437.92	81.1	New York	Wood	Below Deck
99	Charlotte	125835	1880	65.42	12	5	6.33	50	73	23	New York	Unknown	None
100	Chemung	126495	1888	325.58	41.16	8	14.66	1943	2615	672	New York	Steel	Below Deck
101	Chequamegon	127764	1903	101	22.33	5	9.5	112	141	29	Wisconsin	Wood	None
102	Cherokee	126590	1889	208.58	35.58	6	14.42	749	1002	253	Michigan	Wood	Below Deck
103	Cherokee (2)	125973	1907	120	23	5	7.16	0	328	0	Ontario	Steel	None
104	Chicago (2)	125751	1879	265	36.66	7	16.33	1721.42	1847.37	125.95	Ohio	Wood	Above Deck
105	Chicago (3)	127590	1901	324.16	44	7	14	2546	3195	649	New York	Steel	Below Deck
106	Chicora	126902	1892	198.42	35	6	13.5	708	1122	414	Michigan	Wood	Below Deck

Case Number	Name	Official Registration Number	Year Built	Length	Width	Length to Width Ratio	Depth	Net Tonnage	Gross Tonnage	Difference in Tonnage	State Built	Hull Material	Hogging Truss
107	China	5792	1871	210	32.5	6	14	931	1239	308	New York	Iron	Below Deck
108	Chippewa	127440	1900	200	34.33	6	19.66	677	996	319	Ohio	Steel	Below Deck
109	Chishold, Henry	95610	1880	256.42	39.25	7	20.25	1332	1775	443	Ohio	Wood	Below Deck
110	Chub	100756	1894	71.42	18.25	4	5.58	0	57	0	Ontario	Wood	None
111	City of Boston	4375	1863	136	25.75	5	11.75	0	392.14	0	Ohio	Wood	Below Deck
112	City of Chatham	92734	1888	125.5	28.42	4	9	232	341	109	Ontario	Wood	None
113	City of Collingwood	94766	1893	213	34	6	13	893	1387	494	Ontario	Wood	Below Deck
114	City of Concord	5538	1868	135.16	25.66	5	11	388	440	52	Ohio	Wood	Below Deck
115	City of Detroit	4378	1866	167	27.58	6	12	0	652	0	Michigan	Wood	Below Deck
116	City of Duluth	125278	1874	202	36	6	13.42	882.9	1110.18	227.28	Michigan	Wood	Above Deck
117	City of Fremont	4379	1866	153.66	27	6	11.33	0	598.81	0	Ohio	Wood	Above Deck
118	City of Grand Rapids	125743	1879	125.5	26.33	5	9.25	251.22	335.64	84.42	Michigan	Wood	None
119	City of Holland	126967	1893	141.5	29.33	5	10	331	439	108	Michigan	Wood	Below Deck
120	City of Kalamazoo	126949	1893	161.58	31.66	5	12.42	563	728	165	Michigan	Wood	Below Deck
121	City of London	258	1866	145	27	5	11	0	450	0	Ontario	Wood	Below Deck
122	City of Ludington	125873	1880	179.75	35.33	5	12	738	842	104	Wisconsin	Wood	Above Deck

Case Number	Name	Official Registration Number	Year Built	Length	Width	Length to Width Ratio	Depth	Net Tonnage	Gross Tonnage	Difference in Tonnage	State Built	Hull Material	Hogging Truss
123	City of Madison	4350	1857	134.75	25.16	5	12	0	394.53	0	New York	Wood	Below Deck
124	City of Marquette	126614	1890	114.16	25.25	5	9	295.89	341.52	45.63	Wisconsin	Wood	None
125	City of Midland	97111	1890	176.33	28.25	6	10.58	662	974	312	Ontario	Wood	Below Deck
126	City of New Baltimore	125408	1875	94	20	5	6.75	60.4	80.3	19.9	Michigan	Wood	None
127	City of Owen Sound	71181	1875	172	31	6	13	0	1093	0	Ontario	Wood	Below Deck
128	City of Racine	126551	1889	203.42	40	5	13.42	801.39	1041.02	239.63	Wisconsin	Wood	Below Deck
129	City of Saint Joseph	126125	1883	152.42	28	5	11	372.48	464.16	91.68	Michigan	Wood	Below Deck
130	City of South Haven	127731	1903	247.58	40.25	6	21.58	1169	1719	550	Ohio	Steel	Below Deck
131	City of St. Catharines	72715	1874	139	26	5	10.8	516	606	90	Ontario	Wood	Below Deck
132	City of Superior		1857	187.66	29.25	6	11	0	578.67	0	Ohio	Wood	Below Deck
133	City of Toledo	5586	1868	135.42	26	5	10.75	0	413.27	0	New York	Wood	Below Deck
134	City of Traverse	5928	1871	214.42	33.16	6	12.66	925.98	1153.33	227.35	Ohio	Wood	Above Deck
135	City Queen	111561	1900	70	15	5	4	0	69	0	Ontario	Wood	None
136	Clara	5220	1860	71.25	17.33	4	7	0	77.37	0	Michigan	Wood	None
137	Clarion	125937	1881	240.75	36	7	15.42	1513.33	1711.97	198.64	Michigan	Iron	Below Deck

Case Number	Name	Official Registration Number	Year Built	Length	Width	Length to Width Ratio	Depth	Net Tonnage	Gross Tonnage	Difference in Tonnage	State Built	Hull Material	Hogging Truss
138	Cleveland	4376	1860	136	25.75	5	11.42	0	461	0	Ohio	Wood	Below Deck
139	Clyde, George W.	85189	1872	220	35	6	24	0	1032.64	0	Pennsylvania	Iron	Below Deck
140	Coban	86071	1882	230	33	7	16	0	1063	0	Great Britain	Iron	Below Deck
141	Coburn, R.G.	21954	1870	193.33	30.66	6	8.42	0	867	0	Michigan	Wood	Below Deck
142	Codorus	126886	1892	275.42	40	7	26	1802	2165	363	New York	Steel	Below Deck
143	Colorado	4267	1867	254.5	35	7	13	1321.78	1470.5	148.72	New York	Wood	Below Deck
144	Columbia		1873	137	24	6	0	408	629	221	Ontario	Wood	Above Deck
145	Columbia (2)	127665	1902	200	45	4	18	549	968	419	Michigan	Steel	Below Deck
146	Columbian	126860	1892	175	33.42	5	9	431.67	706.85	275.18	Pennsylvania	Steel	Below Deck
147	Columbus, Christopher	126952	1893	362	42	9	24	945	1511	566	Wisconsin	Steel	Below Deck
148	Comet	5683	1857	181.16	29	6	12.33	0	621.9	0	Ohio	Wood	Above Deck
149	Commodore	125452	1875	265.33	42.16	6	15.33	1927	2082.02	155.02	Ohio	Wood	Below Deck
150	Conemaugh	125858	1880	251	36	7	15.25	1453.11	1609.53	156.42	Michigan	Wood	Above Deck
151	Conestoga	125669	1878	252.66	36	7	16.16	1562.24	1726.21	163.97	Ohio	Wood	Below Deck
152	Constance	100412	1891	115.58	19.58	6	11.25	0	185	0	Ontario	Unknown	None

Case Number	Name	Official Registration Number	Year Built	Length	Width	Length to Width Ratio	Depth	Net Tonnage	Gross Tonnage	Difference in Tonnage	State Built	Hull Material	Hogging Truss
153	Craig, Annie L.	1892	1870	184.25	31.58	6	12.08	0	889	0	Michigan	Wood	Above Deck
154	Crescent	126641	1890	77.16	16	5	6	50.32	71.83	21.51	Michigan	Wood	None
155	Crysler, Walter	80904	1882	55	10	6	5	20.56	27	6.44	New York	Wood	None
156	Cuba	71153	1875	142	26	5	0	0	576	0	Ontario	Wood	Below Deck
157	Cuyahoga	4264	1856	187.33	27.66	7	12	0	601	0	Ohio	Unknown	
158	Dayan, J.F.	75827	1875	58	11	5	3	12	24	12	New York	Wood	None
159	Delaware	6961	1878	252	36	7	16.25	1526.53	1731.7	205.17	Ohio	Wood	Below Deck
160	Denver	157268	1890	222.33	37	6	19	1028	1295	267	Wisconsin	Wood	Below Deck
161	Depere	6849	1873	165	29	6	10	639	736	97	Wisconsin	Wood	Above Deck
162	Dewar, John D	76571	1885	72	15.42	5	7	41	52	11	Michigan	Wood	None
163	Dixon, Hiram R.	95731	1883	118	20.42	6	9.58	97.24	155.99	58.75	Connecticut	Wood	None
164	Dormer, Grace	10997	1868	76	18	4	5.83	0	100.94	0	New York	Wood	None
165	Douglas	157064	1882	120.16	22.75	5	8.58	225.96	278.96	53	Michigan	Wood	None
166	Douglas (2)	157204	1888	82.5	18.33	5	7.58	61.29	104.24	42.95	Ohio	Wood	None
167	Duluth	157279	1890	98	29.75	3	10	163.05	247.41	84.36	Ohio	Wood	None
168	Dunbar, George	10890	1867	133.42	25.25	5	9	190	238	48	Michigan	Wood	Below Deck

Case Number	Name	Official Registration Number	Year Built	Length	Width	Length to Width Ratio	Depth	Net Tonnage	Gross Tonnage	Difference in Tonnage	State Built	Hull Material	Hogging Truss
169	East Saginaw	8106	1866	135	26.16	5	10	0	235.4	0	Michigan	Wood	Below Deck
170	Eastland	2000031	1903	265	38.16	7	19.42	1218	1961	743	Michigan	Steel	Below Deck
171	Easton	136568	1896	154.66	30	5	9.58	313.44	460.94	147.5	Maryland	Steel	Below Deck
172	Empire State	7229	1862	210.83	32.33	7	13.16	0	860.83	0	New York	Wood	Above Deck
173	Empress Victoria	100766	1894	76	17	4	0	0	72.23	0	Ontario	Wood	None
174	Europe	85243	1870	136	23	6	0	0	0	0	Ontario	Wood	Below Deck
175	Excelsior	135209	1876	116	29.25	4	10.66	129	229	100	Michigan	Wood	None
176	F & PM NO 1	120499	1882	145.42	30.16	5	12	453.81	533.8	79.99	Michigan	Wood	Below Deck
177	F & PM NO 2	120500	1882	144	30.16	5	12	0	537.42	0	Michigan	Wood	Below Deck
178	F & PM NO 3	120677	1887	190	32.66	6	12.33	678.27	924.6	246.33	Michigan	Wood	Below Deck
179	F & PM NO 4	120719	1888	186.5	34.42	5	12.33	680.25	941.28	261.03	Michigan	Wood	Below Deck
180	F & PM NO 5	120812	1890	226	38	6	24.16	1296.71	1722.9	426.19	Michigan	Wood	Below Deck
181	Favorite	9201	1864	143.25	28.16	5	8.58	0	326.3	0	Wisconsin	Wood	Above Deck
182	Favorite (2)	94762	1889	130	25	5	10	0	491	0	Ontario	Wood	Below Deck
183	Foster, EM	85471	1882	98	19	5	0	0	94	0	Ontario	Wood	None
184	Fountain City	9680	1857	209.92	30.25	7	13.5	0	820.4	0	Ohio	Wood	Above Deck

Case Number	Name	Official Registration Number	Year Built	Length	Width	Length to Width Ratio	Depth	Net Tonnage	Gross Tonnage	Difference in Tonnage	State Built	Hull Material	Hogging Truss
185	Frederica	120979	1894	117.66	26	5	6.66	256.1	293.88	37.78	Pennsylvania	Steel	None
186	Frontenac	107668	1899	119.5	28	4	9.5	0	304	0	Quebec	Steel	None
187	Frost, Walter L	80973	1883	235.58	36.75	6	12.75	1203	1322	119	Michigan	Wood	Below Deck
188	Garden City	100035	1892	177.75	26	7	10	0	637	0	Ontario	Unknown	
189	Garland	85619	1880	107.16	29.33	4	11.58	171.69	248.26	76.57	Michigan	Wood	None
190	Gault, John C	76204	1881	218	32.5	7	13.33	1093.54	1212.71	119.17	New York	Wood	Below Deck
191	Gazelle	85272	1873	123	25	5	9.42	131.05	182.52	51.47	Michigan	Wood	None
192	Geneva	72558	1875	93	20	5	0	0	107	0	Ontario	Wood	None
193	Georgetown	86536	1900	243	40.16	6	15.25	919	1358	439	New York	Steel	Below Deck
194	Germania	85435	1875	136	28	5	11.16	175.74	263.1	87.36	Michigan	Wood	Below Deck
195	Germanic	107164	1899	184	32	6	12	676	1014	338	Ontario	Wood	Below Deck
196	Gladys	85422	1875	135.33	22.5	6	9.42	0	337	0	Michigan	Wood	Below Deck
197	Glasgow	85199	1872	138.5	26	5	11.33	226.79	303.84	77.05	Michigan	Wood	Below Deck
198	Glenn	86045	1889	108.5	21.66	5	8.33	126.24	203.69	77.45	Michigan	Unknown	None
199	Gordon, RJ	110504	1881	103.5	23	5	8.16	143.91	186.81	42.9	Michigan	Wood	None
200	Gould, George J	86267	1893	265.5	40.5	7	25	1790	2237	447	New York	Steel	Below Deck

Case Number	Name	Official Registration Number	Year Built	Length	Width	Length to Width Ratio	Depth	Net Tonnage	Gross Tonnage	Difference in Tonnage	State Built	Hull Material	Hogging Truss
201	Gould, Jay	75117	1869	213.66	33	6	11.58	836.76	996.53	159.77	New York	Wood	Above Deck
202	Granite State	10815	1852	137.33	24.92	6	11	0	351.75	0	Ohio	Wood	Below Deck
203	Haggart, John	92387	1887	100	18	6	0	0	112	0	Ontario	Unknown	None
204	Hall, John E	76790	1889	139	28.5	5	10.75	279.27	343.14	63.87	Wisconsin	Wood	Below Deck
205	Hamonic	122553	1909	349.58	50	7	24	0	5265	0	Ontario	Steel	Below Deck
206	Harlech	109995	1898	236.42	34.25	7	14.42	728	1199	471	Great Britain	Steel	Below Deck
207	Harlem	95972	1888	288	41	7	22.58	1858	2299	441	Michigan	Iron	Below Deck
208	Hart, Eugene C.	136131	1890	126.42	25	5	9.42	361.04	407.56	46.52	Wisconsin	Wood	None
209	Hart, Fannie C.	120718	1888	142.66	30	5	10.4	394	476	82	Wisconsin	Wood	Below Deck
210	Hartford	96172	1892	220	40	6	13	985	1337	352	Pennsylvania	Iron	Below Deck
211	Havana	95278	1874	205.58	34	6	17.33	874	1041	167	Ohio	Wood	Below Deck
212	Hecla	95684	1882	224	34.25	7	17.5	908.63	1110.26	201.63	New York	Wood	Below Deck
213	Helena	95970	1888	275.42	40.16	7	20.25	1578.66	2083.23	504.57	Wisconsin	Wood	Below Deck
214	Hercules		1843	136.25	24.83	5	8	0	256.4	0	New York	Wood	Below Deck
215	Hickox, C.	125133	1873	130.58	24.66	5	9	0	314.35	0	Ohio	Wood	Below Deck
216	Hill, Cecilia	127154	1896	93	19.42	5	7.42	32	44	12	Wisconsin	Wood	None

Case Number	Name	Official Registration Number	Year Built	Length	Width	Length to Width Ratio	Depth	Net Tonnage	Gross Tonnage	Difference in Tonnage	State Built	Hull Material	Hogging Truss
217	Hinckley	96578	1901	107.58	24.16	4	8	128	141	13	New York	Wood	None
218	Holland, Robert	110043	1875	149.5	28.16	5	11.66	0	339.72	0	Michigan	Wood	Below Deck
219	Houghton, H.	96006	1889	126	27	5	8.16	151	210	59	Michigan	Wood	None
220	Hudson	95953	1888	288	41	7	22.58	1853	2294	441	Michigan	Iron	Below Deck
221	Hunter	95471	1877	109.25	18	6	9	44.81	89.63	44.82	Pennsylvania	Wood	None
222	Huronic	107168	1902	321	43	7	23.33	2211	3330	1119	Ontario	Steel	Below Deck
223	Idaho	12069	1863	220.5	31.33	7	13.58	0	915.45	0	Ohio	Wood	Above Deck
224	Illinois	100680	1899	225	40	6	24.58	1468	2427	959	Illinois	Steel	Below Deck
225	Imperial	90571	1886	109	22	5	7	0	245	0	Ontario	Wood	None
226	India	100008	1871	210	32.5	6	14	932.02	1239.46	307.44	New York	Iron	Below Deck
227	Indiana		1848	146.5	23	6	10.83	0	349.35	0	Ohio	Wood	Below Deck
228	Indiana (2)	100471	1890	201	35.33	6	14.25	961	1177	216	Wisconsin	Wood	None
229	Indianapolis	200920	1904	180	32	6	18.5	520	765	245	Ohio	Steel	Below Deck
230	Ironsides	12091	1864	218.66	30.75	7	12.75	0	937	0	Ohio	Wood	Above Deck
231	Iroquois	100730	1901	214	34.33	6	21.16	795	1169	374	Ohio	Steel	Below Deck
232	Islander	111567	1900	100	17.33	6	5.58	0	165	0	Ontario	Composite	None

Case Number	Name	Official Registration Number	Year Built	Length	Width	Length to Width Ratio	Depth	Net Tonnage	Gross Tonnage	Difference in Tonnage	State Built	Hull Material	Hogging Truss
233	Islander	100601	1895	114.66	23.5	5	9.33	174.55	291.15	116.6	Michigan	Wood	None
234	Japan	75323	1871	210	32.5	6	14	932.02	1239.45	307.43	New York	Iron	Below Deck
235	Jones, JH	90769	1888	107	21.33	5	10	98	152	54	Ontario	Wood	None
236	Joys	76537	1884	131	28.16	5	9.75	221.55	268.07	46.52	Wisconsin	Wood	Below Deck
237	Juniata	201768	1905	346	45	8	28	2619	4333	1714	Ohio	Steel	Below Deck
238	Kathleen	92390	1888	120	27	4	7	0	516	0	Ontario	Unknown	None
239	Keenora	103680	1897	119.5	28	4	8.25	0	486	0	Ontario	Steel	None
240	Keewatin	125985	1907	336.42	43.66	8	23.58	0	3856	0	Great Britain	Steel	Below Deck
241	Lac La Belle	15803	1864	217.5	31.5	7	13.25	0	872.5	0	Ohio	Wood	Above Deck
242	Lake Erie		1873	136	23.33	6	7.25	0	427	0	Ontario	Unknown	
243	Lakeside	90778	1888	121	26	5	9.25	0	348	0	Ontario	Wood	None
244	Lakeside (2)	141738	1901	128.42	28	5	9.42	194	285	91	Ohio	Steel	None
245	Lawrence	15450	1868	135.42	25.66	5	11	334.34	447.37	113.03	Ohio	Wood	Below Deck
246	Lehigh	140424	1880	238.16	36	7	15.33	1503	1704	201	Michigan	Iron	Below Deck
247	Lora	140537	1882	161	32	5	17.58	466.69	616.69	150	Michigan	Wood	Below Deck
248	Lotus	141298	1893	110.42	22	5	8.58	188.4	219	30.6	Wisconsin	Wood	None

Case Number	Name	Official Registration Number	Year Built	Length	Width	Length to Width Ratio	Depth	Net Tonnage	Gross Tonnage	Difference in Tonnage	State Built	Hull Material	Hogging Truss
249	Lycoming	140416	1880	251	36	7	15.25	1423.45	1609.53	186.08	Michigan	Wood	Above Deck
250	Macassa	93932	1888	155	24	6	16.25	459	574	115	Scotland	Steel	Below Deck
251	Maganettawan	71112	1877	100	21	5	9	0	208	0	Ontario	Wood	None
252	Mahoning	92454	1892	274	40.16	7	23.16	1744	2189	445	Michigan	Steel	Below Deck
253	Majestic	100950	1895	209	35	6	12.5	1073	1578	505	Ontario	Wood	Below Deck
254	Manistee	90311	1867	155	27	6	10	0	561.39	0	Ohio	Wood	Below Deck
255	Manitoba	94879	1889	303	38	8	14.58	0	2616	0	Ontario	Steel	Below Deck
256	Manitou	92521	1893	274.58	42.16	7	20.66	2391	2944	553	Illinois	Steel	Below Deck
257	Manitou (2)	107140	1903	137.16	24.16	6	9	0	470	0	Ontario	Wood	Below Deck
258	Manitoulin	85491	1880	147	30	5	11	0	706	0	Ontario	Wood	Below Deck
259	Maywood	202202	1905	130	28	5	17	309	398	89	Wisconsin	Steel	None
260	McVea, Charles	126517	1888	123	24	5	10	200	264.62	64.62	Michigan	Wood	None
261	Medora	100754	1893	123	25	5	0	0	299	0	Ontario	Wood	None
262	Menominee	90720	1872	184	34	5	11	712.52	796.31	83.79	Wisconsin	Wood	Above Deck
263	Merchant	16332	1862	189.25	29.16	6	13.66	0	720.66	0	New York	Iron	Below Deck
264	Messenger	16654	1866	150	25	6	10.5	341.62	444.57	102.95	Ohio	Wood	Below Deck

Case Number	Name	Official Registration Number	Year Built	Length	Width	Length to Width Ratio	Depth	Net Tonnage	Gross Tonnage	Difference in Tonnage	State Built	Hull Material	Hogging Truss
265	Miami	92830	1897	239.16	40	6	21.66	1311	1741	430	Pennsylvania	Steel	Below Deck
266	Michigan	91382	1881	203.75	35	6	11.58	1024.18	1183.19	159.01	Michigan	Iron	Below Deck
267	Mineral Rock	166222	1856	171.58	27.16	6	12.5	0	555	0	New York	Wood	Above Deck
268	Minnie M.	91674	1884	133.25	26	5	10.66	295.67	447.83	152.16	Michigan	Wood	Below Deck
269	Missouri	200861	1904	225	40	6	24.42	1484	2434	950	Illinois	Steel	Below Deck
270	Modjeska	96058	1889	178	31	6	12.25	461	678	217	Scotland	Steel	Below Deck
271	Monarch	96843	1890	240	35	7	14.66	1372	2017	645	Ontario	Wood	Below Deck
272	Montana	90501	1872	236.25	36.42	6	14	1382.51	1535.59	153.08	Michigan	Wood	Above Deck
273	Moore, CW	125924	1881	124	24.33	5	9.25	158.06	207.64	49.58	Michigan	Wood	None
274	Morena	95226	1890	230	34	7	13	807	1292	485	Scotland	Steel	Below Deck
275	Munro, Alma	71239	1873	136	23	6	0	0	688	0	Ontario	Wood	Below Deck
276	Navarino	18703	1871	183.5	35	5	13.5	0	760.64	0	Wisconsin	Wood	Above Deck
277	Neptune	18115	1856	186	30	6	12	0	636.65	0	New York	Wood	Above Deck
278	New York	130157	1879	268.75	36.75	7	16.16	1751.59	1921.68	170.09	New York	Wood	Below Deck
279	North		1864	137	26	5	0	0	388	0	Quebec	Wood	Below Deck

Case Number	Name	Official Registration Number	Year Built	Length	Width	Length to Width Ratio	Depth	Net Tonnage	Gross Tonnage	Difference in Tonnage	State Built	Hull Material	Hogging Truss
280	North Land	130690	1895	358.42	44	8	23.16	2339	4244	1905	Ohio	Steel	Below Deck
281	North West	130661	1894	358.42	44	8	23.16	2339	4244	1905	Ohio	Steel	Below Deck
282	Northern Light	18114	1858	211	30	7	12	0	744.44	0	Ohio	Wood	Above Deck
283	Northman	130906	1901	242	42.16	6	23.16	1496	2157	661	Illinois	Steel	Below Deck
284	Northumberland	96937	1891	220	33	7	20.33	0	1255	0	Great Britain	Steel	Below Deck
285	Nyack	130125	1878	231	33	7	14.58	1024.85	1257.35	232.5	New York	Wood	Above Deck
286	Ocean	88633	1872	137	23	6	11.33	0	641	0	Ontario	Wood	Below Deck
287	Oconto	19369	1872	143	32	4	10	447.6	505.35	57.75	Wisconsin	Wood	Below Deck
288	Ontario	71211	1874	181	35	5	12.16	910	1338	428	Ontario	Wood	Below Deck
289	Ossifrage	155124	1886	123	24.5	5	10.16	247.63	383.58	135.95	Michigan	Wood	None
290	Oswegatchie	19189	1867	135.16	25.66	5	10.75	0	436.55	0	New York	Wood	Below Deck
291	Oswego Belle	71068	1875	137	26.25	5	9	0	378	0	Ontario	Wood	Below Deck
292	Owen, Ira H.	100410	1887	262	39	7	19	1497	1753.22	256.22	Ohio	Steel	Below Deck
293	Pacific	85323	1883	179	31	6	11	0	918	0	Ontario	Wood	Below Deck
294	Peerless	20470	1872	211	39.75	5	12.42	0	1275.57	0	Ohio	Wood	Above Deck

Case Number	Name	Official Registration Number	Year Built	Length	Width	Length to Width Ratio	Depth	Net Tonnage	Gross Tonnage	Difference in Tonnage	State Built	Hull Material	Hogging Truss
295	Pere Marquette 18	150972	1902	338	56	6	19.42	1722	2909	1187	Ohio	Steel	Below Deck
296	Pere Marquette 17	150906	1901	338	56	6	19.42	1658	2775	1117	Ohio	Steel	Below Deck
297	Pere Marquette 19	200459	1903	338	56	6	19.42	1548	2626	1078	Ohio	Steel	Below Deck
298	Persia	97013	1873	144	23	6	0	500	757	257	Ontario	Wood	Below Deck
299	Persian		1874	243.58	40	6	18.66	0	1629	0	Ohio	Wood	Below Deck
300	Petoskey	150425	1888	171.25	30.33	6	12.16	544.51	770.96	226.45	Wisconsin	Wood	Below Deck
301	Pewabic		1863	200.25	31	6	12.42	0	738.8	0	Ohio	Wood	None
302	Philadelphia	20142	1868	236	34.25	7	14	1230.15	1463.6	233.45	New York	Iron	Below Deck
303	Phoenix		1845	144	26	6	11	0	302.92	0	Ohio	Wood	Below Deck
304	Pilgrim	150433	1888	119	23.16	5	9.16	186.47	226.19	39.72	Michigan	Wood	None
305	Pilot	88303	1884	109	33	3	14	0	427	0	Quebec	Wood	None
306	Pocahontas		1846	171.75	24.92	7	10.33	0	426.66	0	New York	Wood	Below Deck
307	Porto Rico	150836	1899	220.16	32	7	19.25	854	1257	403	Ohio	Steel	Below Deck
308	Portsmouth	19619	1853	176.33	29	6	10.83	0	525.6	0	New York	Wood	Above Deck
309	Promise	150590	1892	119.42	38.66	3	12	295.67	473.13	177.46	Michigan	Wood	None

Case Number	Name	Official Registration Number	Year Built	Length	Width	Length to Width Ratio	Depth	Net Tonnage	Gross Tonnage	Difference in Tonnage	State Built	Hull Material	Hogging Truss
310	Prussia		1873	138	24	6	0	0	710	0	Ontario	Wood	Below Deck
311	Puritan	150396	1887	172	23	7	12.66	163	289.67	126.67	Michigan	Wood	Below Deck
312	Raleigh	203422	1906	222.42	33	7	21.25	805	1185	380	Maryland	Steel	Below Deck
313	Rapids King	122407	1907	239	40	6	9.42	0	1801	0	Ontario	Steel	Below Deck
314	Richmond, Dean	6102	1864	238.66	34.75	7	13.42	0	1083.5	0	Ohio	Wood	Above Deck
315	Riverside	110058	1872	114.25	25	5	8.66	102.9	153.82	50.92	Michigan	Wood	None
316	Roberts, EK	135700	1883	117	24.66	5	10.58	189.75	264.9	75.15	Michigan	Wood	None
317	Rochester	110438	1880	266.75	40	7	16	2046.3	2220.05	173.75	New York	Wood	Below Deck
318	Rochester (2)	207073	1909	246	42	6	15.5	867	1603	736	Michigan	Steel	Below Deck
319	Roosevelt, Theodore	202941	1906	275.5	40	7	23.33	1330	1955	625	Ohio	Steel	Below Deck
320	Russia	110063	1872	231.58	35.58	7	13.35	1334.57	1501.77	167.2	New York	Iron	Below Deck
321	Sagamo	122218	1906	152	29	5	9.58	0	744	0	Ontario	Steel	Below Deck
322	Sage, Russel	110472	1881	218	32.66	7	13.33	1104.75	1224.25	119.5	New York	Wood	Below Deck
323	Sailor Boy	116393	1891	91	24	4	6.42	111.91	162.96	51.05	Michigan	Wood	None
324	Saranac	116318	1890	290	40.66	7	13.5	1939.26	2669.47	730.21	Ohio	Steel	Below Deck
325	Seaman	117082	1906	111	24	5	8.42	223	328	105	Ontario	Wood	None

Case Number	Name	Official Registration Number	Year Built	Length	Width	Length to Width Ratio	Depth	Net Tonnage	Gross Tonnage	Difference in Tonnage	State Built	Hull Material	Hogging Truss
326	Seneca	116277	1889	290	40.66	7	13.5	1939.26	2669.17	729.91	Ohio	Steel	Below Deck
327	Smith, Gov.	86066	1889	240	42	6	23.33	1547.18	2044.49	497.31	Michigan	Wood	Below Deck
328	Soo City	116217	1888	171	33.42	5	12	438.56	670.79	232.23	Michigan	Wood	Below Deck
329	St. Albans	23514	1868	135.5	25.66	5	11	0	435.75	0	Ohio	Wood	Below Deck
330	St. Louis	233356	1864	203.5	31.16	7	13	0	788.1	0	Ohio	Wood	Above Deck
331	St. Paul	23755	1868	203	31	7	21	662.23	909.62	247.39	Michigan	Wood	Above Deck
332	Starucca	115381	1875	218.25	34.42	6	13.5	1155.2	1313.09	157.89	New York	Wood	Above Deck
333	Stewart, RG	110341	1878	100	23	4	8.16	121.66	149.26	27.6	New York	Wood	None
334	Swift, James	96920	1893	107	23.33	5	6	197	266	69	Ontario	Wood	None
335	Telegram	85479	1885	108	21	5	9	134	198	64	Ontario	Wood	None
336	Tionesta	145958	1903	340	45.16	8	28	2652	4329	1677	Michigan	Steel	Below Deck
337	Toledo	24112	1862	180.5	39.33	5	12	0	622	0	Ohio	Wood	Above Deck
338	Tonawanda	24110	1856	202.25	32.25	6	13.25	0	882	0	New York	Wood	Above Deck
339	Trerice, Byron	83028	1882	102.25	26	4	8.58	0	268	0	Ontario	Wood	None
340	Turbina	112201	1904	250	33	8	13	0	1064	0	Great Britain	Steel	Below Deck
341	Union	25048	1861	163.42	26	6	10.75	0	434.9	0	Wisconsin	Wood	Below Deck

Case Number	Name	Official Registration Number	Year Built	Length	Width	Length to Width Ratio	Depth	Net Tonnage	Gross Tonnage	Difference in Tonnage	State Built	Hull Material	Hogging Truss
342	Unique	25299	1894	163	20.42	8	11	190.67	381.34	190.67	Michigan	Wood	Below Deck
343	United Empire	80776	1882	253	36	7	23	1296	1960	664	Ontario	Wood	Below Deck
344	Vanderbilt	25855	1871	223.16	34	7	14.33	1157.28	1303.85	146.57	Michigan	Wood	Above Deck
345	Vernon	161557	1886	158.58	25.42	6	18.66	560.41	694.94	134.53	Illinois	Wood	Below Deck
346	Virginia	161654	1891	269.16	38.25	7	12.66	979	1606	627	Ohio	Steel	Below Deck
347	Waubic	122555	1909	134	25	5	9.33	0	504	0	Ontario	Steel	None
348	Wauketa	206077	1909	175	38.33	5	14.42	267	543	276	Ohio	Steel	Below Deck
349	Westmoreland		1853	202.16	28.16	7	12.16	0	662.85	0	Ohio	Wood	Below Deck
350	Williams, HW	95952	1888	140	28	5	10.25	172.96	249.92	76.96	Michigan	Wood	Below Deck
351	Winslow	26174	1863	220	32.33	7	13.5	0	919.66	0	Ohio	Wood	Above Deck
352	Wisconsin	80861	1881	203.75	35	6	11.58	1020.19	1181.66	161.47	Michigan	Steel	Below Deck
353	Wissahickon	80598	1876	238.16	35.5	7	14.66	1423.37	1619.53	196.16	New York	Wood	Above Deck
354	Woods, Frank	120709	1896	120	25.5	5	10.5	214.96	269.89	54.93	Michigan	Wood	None

APPENDIX B: SOURCES BY SHIP

Name	Registration Number	Source
Acadia	77697	BGSU/000125
Adrienne	106249	BGSU/000152; AMS 1895 Pg 214
Africa	92285	BGSU/000158
Albany	106306	BGSU/000185
Alberta	85765	BGSU/000192
Alderson, William, M.	73920	BGSU/000199
Aletha	107748	BGSU/000206
Algoma		BGSU/000217
Algoma2	111803	BGSU/000218
Algomah	106022	BGSU/000219; AMS 1895 Pg 216
Alice	122260	BGSU/000236
Amazon	105252	BGSU/000265; AMS 1878 Pg 274
America		BGSU/000271
America3	107367	BGSU/000274
American Eagle	105936	BGSU/000282; AMS 1895 Pg 217
Americana	205096	BGSU/000288; AMS 1910 Pg 138
Arabia	105254	BGSU/000350; AMS 1878 Pg 275
Argo	107157	BGSU/000374; AMS 1895 Pg 219
Argyle	90537	BGSU/000377
Ariel	106032	BGSU/000379; AMS 1895 Pg 219
Armenia	74388	BGSU/000387
Armour, Philip D.	150459	BGSU.000390; AMS 1895 Pg 288
Armstrong, William	80613	BGSU/000392
Arundell	105784	BGSU/000404
Asia		BGSU/000415
Athabasca	85764	BGSU/000423
Atlanta	106823	BGSU.000427; AMS 1895 Pg 220
Atlantic	298	BGSU/000429; AMS 1878 Pg 276
Aucocisco	107286	BGSU/000439
Aurora	106493	BGSU/000451; AMS 1895 Pg 220
Australasia	106302	BGSU/000453; AMS 1895 Pg 220
Averell, WM. J.	81027	BGSU/000458
Avon	105743	BGSU/000463; AMS 1878 Pg 277
Aztec	106627	BGSU/000470; AMS 1895 Pg 220
Badger State	2111	BGSU/000500; AMS 1878 Pg 277
Bain, Jessie	76741	BGSU/000509; AMS 1895 Pg 263
Baldwin, S. C.	23957	BGSU/000515
Ballentine, Davis	6768	BGSU/000522
Bannockburn	102093	BGSU/000532
Barber, J.	12981	BGSU/000540
Barker, Gracie	85587	BGSU/000543
Barker, S. B.	115837	BGSU/000546; AMS 1895 Pg 295
Barnum, William H.	80342	BGSU/000560
Bay City	2451	BGSU/000580; AMS 1878 Pg 277
Bay State		BGSU/000583
Beard, James	80343	BGSU/008154
Bedell, Ossian	155414	BGSU/000607

Name	Registration Number	Source
Belle	2159	BGSU/000622; AMS 1878 Pg 277
Belle (2)	3324	BGSU/000624; AMS 1895 Pg 221
Benton	2145	BGSU/000643; AMS 1878 Pg 278
Berkeley	3930	BGSU/000646; AMS 1903 Pg 202
Berks	2905	BGSU/000647; AMS 1878 Pg 278
Bessie	3122	BGSU/000665; AMS 1895 Pg 222
Bielman, C. F., JR	204485	BGSU/000681; AMS 1910 Pg 152
Bigelow, H. P.	96269	BGSU/000686; AMS 1895 Pg 253
Bissel, George W.	10665	BGSU/000699
Blanchard, B. W.	2806	BGSU/000718
Bloomer Girl	3679	BGSU/000724
Bon Ami	3626	BGSU/000746; AMS 1895 Pg 223
Bon Voyage	3497	BGSU/000748; AMS 1895 Pg 223
Bonavista	87966	BGSU/000749
Bonner, J.	77521	BGSU/000752;
Boston	3140	BGSU/000767; AMS 1895 Pg 223
Bothnia	100661	BGSU/006982
Boyce, Isabella J.	100446	BGSU/000783; AMS 1895 Pg 259
Boyce, Mary H.	92033	BGSU/000785
Bradshaw, Mabel	92096	BGSU/000793; AMS 1895 Pg 273
Brandon	3915	BGSU/000797; AMS 1903 Pg 204
Britannic	3400	BGSU/000829; AMS 1895 Pg 223
Briton	3493	BGSU/000831; AMS 1895 Pg 223
Brittain, R.C.	110327	BGSU/000832
Brittannia	203237	BGSU/000828; AMS 1910 Pg 150
Brockville	107421	BGSU/000833
Brown, W. L.	80767	BGSU/008334
Buckman	3904	BGSU/000875; AMS 1903 Pg 205
Buell, F.R.	120720	BGSU/000878; AMS 1895 Pg 244
Buffalo	3076	BGSU/000882
Bulgaria	3381	BGSU/000890; AMS 1895 Pg 224
Burlington	2157	BGSU/000904; AMS 1878 Pg 280
Burton, IDA	100073	BGSU/000917
Business	3163	BGSU/000922; AMS 1895 Pg 224
Buttironi, Kate	14393	BGSU/000930
California	85309	BGSU/000976
Calumet	126237	BGSU/000982
Calvin, D.D.	83298	BGSU/000989
Cambria	126420	BGSU/000990; AMS 1895 Pg 225
Campbell, Gordon	85184	BGSU/000998
Canada	100392	BGSU/008337
Caribou	116249	BGSU/001074
Carpenter, O.O	155198	BGSU/001095; AMS 1895 Pg 284
Cartagena	127526	BGSU/001107; AMS 1903 Pg 208
Castalia	126610	BGSU/001127; AMS 1895 Pg 226
Cayuga	126556	BGSU/001141
Cayuga (2)	122219	BGSU/001143

Name	Registration Number	Source
Celtic	71151	BGSU/001151
Chaffey	71083	BGSU/003502
Champlain	5848	BGSU/003522; AMS 1878 Pg 282
Charlotte	125835	BGSU/003574; AMS 1895 Pg 228
Chemung	126495	BGSU/003600; AMS 1895 Pg 224
Chequamegon	127764	BGSU/003604; AMS 1903 Pg 210
Cherokee	126590	BGSU/00306; AMS 1895 Pg 228
Cherokee (2)	125973	BGSU/003607
Chicago (2)	125751	BGSU/003617
Chicago (3)	127590	BGSU/003619; AMS 1903 Pg 210
Chicora	126902	BGSU/003625
China	5792	BGSU/003641
Chippewa	127440	BGSU/003674; AMS 1903 Pg 211
Chishold, Henry	95610	BGSU/003656
Chub	100756	BGSU/003668
City of Boston	4375	BGSU/001172
City of Chatham	92734	BGSU/001176
City of Collingwood	94766	BGSU/001182
City of Concord	5538	BGSU/001183; AMS 1878 Pg 284
City of Detroit	4378	BGSU/001184
City of Duluth	125278	BGSU/001190; AMS 1878 Pg 284
City of Fremont	4379	BGSU/001194; AMS 1878 Pg 284
City of Grand Rapids	125743	BGSU/001198
City of Holland	126967	BGSU/001201; AMS 1895 Pg 229
City of Kalamazoo	126949	BGSU/001202; AMS 1895 Pg 229
City of London	258	BGSU/008338
City of Ludington	125873	BGSU/001206; AMS 1895 Pg 229
City of Madison	4350	BGSU/001209; AMS 1878 Pg 284
City of Marquette	126614	BGSU/001211; AMS 1895 Pg 229
City of Midland	97111	BGSU/001212
City of New Baltimore	125408	BGSU/001219; AMS 1878 Pg 284
City of Owen Sound	71181	BGSU/001222
City of Racine	126551	BGSU/001226; AMS 1895 Pg 230
City of Saint Joseph	126125	BGSU/001231
City of South Haven	127731	BGSU/001234; AMS 1903 Pg 212
City of St. Catharines	72715	BGSU/008339
City of Superior		BGSU/001235
City of Toledo	5586	BGSU/001237
City of Traverse	5928	BGSU/001244; AMS 1874 Pg 284
City Queen	111561	BGSU/001248
Clara	5220	BGSU/001249; AMS 1878 Pg 285
Clarion	125937	BGSU/001259; AMS 1895 Pg 231
Cleveland	4376	BGSU/001280
Clyde, George W.	85189	BGSU/001296
Coban	86071	BGSU/001317
Coburn, R.G.	21954	BGSU/001320
Codorus	126886	BGSU/001324; AMS 1895 Pg 231

Name	Registration Number	Source
Colorado	4267	BGSU/001360; AMS 1878 Pg 286
Columbia		BGSU/001365
Columbia (2)	127665	BGSU/001373; AMS 1903 Pg 215
Columbian	126860	BGSU/001376
Columbus, Christopher	126952	BGSU/001379; AMS 1895 Pg 228; AMS 1910 Pg 1
Comet	5683	BGSU/001383
Commodore	125452	BGSU/001391; AMS 1878 Pg 286
Conemaugh	125858	BGSU/001405; AMS 1895 Pg 233
Conestoga	125669	BGSU/001407
Constance	100412	BGSU/001429
Craig, Annie L.	1892	BGSU/003673
Crescent	126641	BGSU/003696; AMS 1895 Pg 234
Crysler, Walter	80904	BGSU/003536
Cuba	71153	BGSU/003539
Cuyahoga	4264	BGSU/003717
Dayan, J.F.	75827	BGSU/001612
Delaware	6961	BGSU/001631; AMS 1878 Pg 289
Denver	157268	BGSU/001644; AMS 1895 Pg 236
Depere	6849	BGSU/001646; AMS 1878 Pg 289
Dewar, John D	76571	BGSU/001671
Dixon, Hiram R.	95731	BGSU/001694; AMS 1895 Pg 256
Dormer, Grace	10997	BGSU/001732
Douglas	157064	BGSU/001739; AMS 1895 Pg 237
Douglas (2)	157204	BGSU/001740; AMS 1895 Pg 237
Duluth	157279	BGSU/001779; AMS 1895 Pg 237
Dunbar, George	10890	BGSU/001782
East Saginaw	8106	BGSU/003742; AMS 1878 Pg 291
Eastland	2000031	BGSU/002687
Easton	136568	BGSU/003747
Empire State	7229	BGSU/001834; AMS 1878 Pg 293
Empress Victoria	100766	BGSU/001839
Europe	85243	BGSU/001893
Excelsior	135209	BGSU/001905; AMS 1878 Pg 294
F & PM NO 1	120499	BGSU/001916; AMS 1895 Pg 244
F & PM NO 2	120500	BGSU/001917; AMS 1895 Pg 244
F & PM NO 3	120677	BGSU/001918; AMS 1895 Pg 244
F & PM NO 4	120719	BGSU/001919; AMS 1895 Pg 244
F & PM NO 5	120812	BGSU/001920; AMS 1895 Pg 244
Favorite	9201	BGSU/001957; AMS 1878 Pg 296
Favorite (2)	94762	BGSU/001959
Foster, EM	85471	BGSU/002126
Fountain City	9680	BGSU/002142; AMS 1878 Pg 297
Frederica	120979	BGSU/002173; AMS1895 Pg 247
Frontenac	107668	BGSU/002193
Frost, Walter L	80973	BGSU/002202; AMS 1895 Pg 309
Garden City	100035	BGSU/002239
Garland	85619	BGSU/002245; AMS 1895 Pg 248
Gault, John C	76204	BGSU/002256
Gazelle	85272	BGSU/002262; AMS 1878 Pg 298
Geneva	72558	BGSU/002284
Georgetown	86536	BGSU/002291; AMS 1903 Pg 236
Germania	85435	BGSU/002299; AMS 1878 Pg 300
Germanic	107164	BGSU/002300

Name	Registration Number	Source
Gladys	85422	BGSU/002336; AMS 1878 Pg 300
Glasgow	85199	BGSU/002339; AMS 1878 Pg 300
Glenn	86045	BGSU/008176
Gordon, RJ	110504	BGSU/002417; AMS 1895 Pg 291
Gould, George J	86267	BGSU/002429; AMS 1895 Pg 249
Gould, Jay	75117	BGSU/002430
Granite State	10815	BGSU/002467; AMS 1878 Pg 301
Haggart, John	92387	BGSU/003846
Hall, John E	76790	BGSU/003855; AMS 1895 Pg 264
Hamonic	122553	BGSU/003870
Harlech	109995	BGSU/003900
Harlem	95972	BGSU/003901; AMS 1895 Pg 253
Hart, Eugene C.	136131	BGSU/003920; AMS 1895 Pg 243
Hart, Fannie C.	120718	BGSU/003921; AMS 1895 Pg 244
Hartford	96172	BGSU/003924; AMS 1895 Pg 254
Havana	95278	BGSU/003944; AMS 1878 Pg 303
Hecla	95684	BGSU/003968; AMS 1895 Pg 254
Helena	95970	BGSU/003981; AMS 1895 Pg 255
Hercules		BGSU/002550
Hickox, C.	125133	BGSU/002569
Hill, Cecilia	127154	BGSU/002578
Hinckley	96578	BGSU/002589; AMS 1903 Pg 244
Holland, Robert	110043	BGSU/002606
Houghton, H.	96006	BGSU/002640; AMS 1895 Pg 252
Hudson	95953	BGSU/002664; AMS 1895 Pg 257
Hunter	95471	BGSU/002684; AMS 1878 Pg 304
Huronic	107168	BGSU/002702
Idaho	12069	BGSU/002736; AMS 1878 Pg 305
Illinois	100680	BGSU/002741
Imperial	90571	BGSU/002748
India	100008	BGSU/002773; AMS 1878 Pg 306
Indiana		BGSU/002777
Indiana (2)	100471	BGSU/002778; AMS 1895 Pg 258
Indianapolis	200920	BGSU/002782
Ironsides	12091	BGSU/002819
Iroquois	100730	BGSU/002821; AMS 1903 Pg 248
Islander	100601	BGSU/002850; AMS 1895 Pg 259
Islander	111567	BGSU/002851
Japan	75323	BGSU/002893; AMS 1878 Pg 309
Jones, JH	90769	BGSU/002953
Joys	76537	BGSU/002960; AMS 1895 Pg 266
Juniata	201768	BGSU/002971; AMS 1910 Pg 225
Kathleen	92390	BGSU/001204
Keenora	103680	BGSU/003020
Keewatin	125985	BGSU/003024
Lac La Belle	15803	BGSU/003200
Lake Erie		BGSU/003312
Lakeside	90778	BGSU/004175
Lakeside (2)	141738	BGSU/004177; AMS 1903 Pg 259
Lawrence	15450	BGSU/004215; AMS 1878 Pg 315
Lehigh	140424	BGSU/004242; AMS 1895 Pg 269
Lora	140537	BGSU/004359; AMS 1895 Pg 271
Lotus	141298	BGSU/004372; AMS 1895 Pg 271
Lycoming	140416	BGSU/004419; AMS 1895 Pg 272
Macassa	93932	BGSU/004509

Name	Registration Number	Source
Maganettawan	71112	BGSU/004531
Mahoning	92454	BGSU/004549; AMS 1895 Pg 274
Majestic	100950	BGSU/004560
Manistee	90311	BGSU/004586; AMS 1878 Pg 319
Manitoba	94879	BGSU/004590
Manitou	92521	BGSU/004591; AMS 1895 Pg 274
Manitou (2)	107140	BGSU/004592
Manitoulin	85491	BGSU/004595
Maywood	202202	BGSU/004803; AMS 1910 Pg 248
McVea, Charles	126517	BGSU/004480; AMS 1895 Pg 227
Medora	100754	BGSU/004815
Menominee	90720	BGSU/004826; AMS 1878 Pg 321
Merchant	16332	BGSU/004831; AMS 1878 Pg 321
Messenger	16654	BGSU/004850; AMS 1878 Pg 321
Miami	92830	BGSU/004868
Michigan	91382	BGSU/004874
Mineral Rock	166222	BGSU/004922
Minnie M.	91674	BGSU/004939; AMS 1895 Pg 278
Missouri	200861	BGSU/004972
Modjeska	96058	BGSU/004988
Monarch	96843	BGSU/005003
Montana	90501	BGSU/005014; AMS 1878 Pg 323
Moore, CW	125924	BGSU/005034; AMS 1895 Pg 225
Morena	95226	BGSU/005055
Munro, Alma	71239	BGSU/005100
Navarino	18703	BGSU/005153; AMS 1878 Pg 324
Neptune	18115	BGSU/005178; AMS 1878 Pg 324
New York	130157	BGSU/005207
North		BGSU/005293
North Land	130690	BGSU/005303; AMS 1895 Pg 283
North West	130661	BGSU/005314; AMS 1895 Pg 283
Northern Light	18114	BGSU/005322
Northman	130906	BGSU/005332; AMS 1903 Pg 279
Northumberland	96937	BGSU/005335
Nyack	130125	BGSU/005381
Ocean	88633	BGSU/004011
Oconto	19369	BGSU/004015; AMS 1878 Pg 326
Ontario	71211	BGSU/004069
Ossifrage	155124	BGSU/004107
Oswegatchie	19189	BGSU/004109; AMS 1878 Pg 327
Oswego Belle	71068	BGSU/004111
Owen, Ira H.	100410	BGSU/006035; AMS 1895 Pg 258
Pacific	85323	BGSU/006158
Peerless	20470	BGSU/006239; AMS 1878 Pg 378
Pere Marquete 18	150972	BGSU/005423; AMS 1903 Pg 285
Pere Marquette 17	150906	BGSU/005422; AMS 1903 Pg 285
Pere Marquette 19	200459	BGSU/005425; AMS 1903 Pg 285
Persia	97013	BGSU/005441
Persian		BGSU/005442
Petoskey	150425	BGSU/005451; AMS 1895 Pg 288
Pewabic		BGSU/005459
Philadelphia	20142	BGSU/005464; AMS 1878 Pg 329
Phoenix		BGSU/005471

Name	Registration Number	Source	Name	Registration Number	Source
Pilgrim	150433	BGSU/005484; AMS 1895 Pg 288	St. Albans	23514	BGSU/005991; AMS 1878 Pg 335
Pilot	88303	BGSU/005490	St. Louis	23356	BGSU/006010; AMS 1878 Pg 335
Pocahontas		BGSU/006240	St. Paul	23755	BGSU/006019; AMS 1878 Pg 335
Porto Rico	150836	BGSU/006294	Starucca	115381	BGSU/006790; AMS 1878 Pg 338
Portsmouth	19619	BGSU/006295; AMS 1878 Pg 330	Stewart, RG	110341	BGSU/006829
Promise	150590	BGSU/007005; AMS 1895 Pg 290	Swift, James	96920	BGSU/006923
Prussia		BGSU/00707	Telegram	85479	BGSU/006956
Puritan	150396	BGSU/007023; AMS 1895 Pg 290	Tionesta	145958	BGSU/007116; AMS 1910, Pg 306
Raleigh	203422	BGSU/005562; AMS 1910 Pg 276	Toledo	24112	BGSU/007121; AMS 1878 Pg 342
Rapids King	122407	BGSU/005589	Tonawanda	24110	BGSU/007129; AMS 1878 Pg 342
Richmond, Dean	6102	BGSU/000035	Trerice, Byron	83028	BGSU/007171
Riverside	110058	BGSU/005706; AMS 1878 Pg 333	Turbina	112201	BGSU/007198
Roberts, EK	135700	BGSU/005727	Union	25048	BGSU/007253; AMS 1878 Pg 343
Rochester	110438	BGSU/005738; AMS 1895 Pg 294	Unique	25299	BGSU/007256; AMS 1895 Pg 306
Rochester (2)	207073	BGSU/005740; AMS 1910 Pg 281	United Empire	80776	BGSU/007257
Roosevelt, Theodore	202941	BGSU/000036; AMS 1910 Pg 300	Vanderbilt	25855	BGSU/007290; AMS 1878 Pg 344
Russia	110063	BGSU/005836; AMS 1878 Pg 334	Vernon	161557	BGSU/007318
Sagamo	122218	BGSU/005977	Virginia	161654	BGSU/007350; AMS 1895 Pg 307
Sage, Russel	110472	BGSU/005981; AMS 1895 Pg 295	Waubic	122555	BGSU/007485
Sailor Boy	116393	BGSU/005990; AMS 1895 Pg 296	Wauketa	206077	BGSU/007488; AMS 1910 Pg 314
Saranac	116318	BGSU/006390; AMS 1895 Pg 297	Westmoreland		BGSU/007558
Seaman	117082	BGSU/006486	Williams, HW	95952	BGSU/007646
Seneca	116277	BGSU/006507; AMS 1895 Pg 298	Winslow	26174	BGSU/007688; AMS 1878 Pg 348
Smith, Gov.	86066	BGSU/006667; AMS 1895 Pg 251	Wisconsin	80861	BGSU/007694; AMS 1895 Pg 313
Soo City	116217	BGSU/006706; AMS 1895 Pg 300	Wissahickon	80598	BGSU/007700; AMS 1878 Pg 348
			Woods, Frank	120709	BGSU/007729

APPENDIX C: ANOVA RESULTS FROM THE MULTIVARIATE LINERA REGRESSIONS

Gross Tonnage versus Year Built, Depth, and Hull Material

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	160470524.400	3	53490174.790	215.004	.000[b]
	Residual	83592206.790	336	248786.330		
	Total	244062731.200	339			

Net Tonnage versus Year Built, Depth, and Hull Material

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	61459556.110	3	20486518.700	134.718	.000[b]
	Residual	34975928.980	230	152069.256		
	Total	96435485.090	233			

Difference in Tonnage versus Year Built, Depth, and Hull Material

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12339051.200	3	4113017.066	91.799	.000[b]
	Residual	10305087.160	230	44804.727		
	Total	22644138.360	233			

Length-to-width ratio versus Year Built, Depth, and Hull Material

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	164.229	3	54.743	81.928	.000[b]

	Residual	224.510	336	.668		
	Total	388.738	339			

Gross Tonnage versus Year Built, Hull Material, Depth; New York

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	17511000.980	3	5837000.328	27.191	.000[b]
	Residual	10089512.100	47	214670.470		
	Total	27600513.080	50			

Net Tonnage versus Year Built, Hull Material, Depth; New York

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9219209.522	3	3073069.841	14.134	.000[b]
	Residual	6740164.328	31	217424.656		
	Total	15959373.850	34			

Difference in Tonnage versus Year Built, Hull Material, Depth; New York

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	588591.173	3	196197.058	15.006	.000[b]
	Residual	405307.171	31	13074.425		
	Total	993898.343	34			

Length-to-width Ratio versus Year Built, Hull Material, Depth; New York

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	24.619	3	8.206	11.276	.000[b]
	Residual	34.205	47	.728		
	Total	58.824	50			

Gross Tonnage versus Year Built, Hull Material, Depth; Michigan

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	42382676.390	3	14127558.800	121.496	.000[b]
	Residual	11744259.700	101	116279.799		
	Total	54126936.100	104			

Net Tonnage versus Year Built, Hull Material, Depth; Michigan

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	23636133.750	3	7878711.249	93.995	.000[b]
	Residual	7208560.115	86	83820.466		
	Total	30844693.860	89			

Difference in Tonnage versus Year Built, Hull Material, Depth; Michigan

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2572660.575	3	857553.525	42.626	.000[b]
	Residual	1730159.635	86	20118.135		
	Total	4302820.209	89			

Length-to-Width Ratio versus Year Built, Hull Material, Depth; Michigan

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	47.674	3	15.891	24.863	.000[b]
	Residual	64.555	101	.639		
	Total	112.229	104			

Gross Tonnage versus Year Built, Depth, Hull Material; Ohio

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	42817043.230	3	14272347.740	37.949	.000[b]
	Residual	23693771.260	63	376091.607		
	Total	66510814.490	66			

Net Tonnage versus Year Built, Depth, Hull Material; Ohio

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9675627.504	3	3225209.168	12.856	.000[b]
	Residual	8780681.227	35	250876.607		
	Total	18456308.730	38			

Difference in Tonnage versus Year Built, Depth, Hull Material; Ohio

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4571318.795	3	1523772.932	11.462	.000[b]
	Residual	4652821.727	35	132937.764		
	Total	9224140.523	38			

Length-to-width Ratio versus Year Built, Depth, Hull Material; Ohio

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	29.465	3	9.822	19.819	.000[b]
	Residual	31.222	63	.496		
	Total	60.687	66			

Gross Tonnage versus Year Built, Depth, Hull Material; Ontario

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	33962113.790	3	11320704.600	51.869	.000[b]
	Residual	11785828.140	54	218256.077		
	Total	45747941.930	57			

Net Tonnage versus Year Built, Depth, Hull Material; Ontario

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4692757.326	3	1564252.442	16.587	.000[b]
	Residual	1697487.992	18	94304.888		
	Total	6390245.318	21			

Difference in Tonnage versus Year Built, Depth, Hull Material; Ontario

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1400722.965	3	466907.655	12.985	.000[b]
	Residual	647210.353	18	35956.131		
	Total	2047933.318	21			

Length-to-width Ratio versus Year Built, Depth, Hull Material; Ontario

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	19.067	3	6.356	10.351	.000[b]
	Residual	33.157	54	.614		
	Total	52.224	57			

Gross Tonnage versus Year Built, Depth, Hull Material; Wisconsin

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4734228.934	3	1578076.311	31.772	.000[b]
	Residual	1092720.364	22	49669.107		
	Total	5826949.298	25			

Net Tonnage versus Year Built, Depth, Hull Material; Wisconsin

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2481010.964	3	827003.655	23.183	.000[b]
	Residual	677797.770	19	35673.567		
	Total	3158808.734	22			

Difference in Tonnage versus Year Built, Depth, Hull Material; Wisconsin

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	374284.201	3	124761.400	24.607	.000[b]
	Residual	96333.339	19	5070.176		
	Total	470617.540	22			

Length-to-width Ratio versus Year Built, Depth, Hull Material; Wisconsin

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13.451	3	4.484	9.455	.000[b]
	Residual	10.433	22	.474		
	Total	23.885	25			

Gross Tonnage versus Year Built, Depth, Hull Material; 1870s

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	19694552.970	3	6564850.991	46.893	.000[b]
	Residual	10499739.820	75	139996.531		
	Total	30194292.790	78			

Net Tonnage versus Year Built, Depth, Hull Material; 1870s

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	15180286.740	3	5060095.579	45.381	.000[b]
	Residual	5686607.825	51	111502.114		
	Total	20866894.560	54			

Difference in Tonnage versus Year Built, Depth, Hull Material; 1870s

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	307551.346	3	102517.115	20.311	.000[b]
	Residual	257414.549	51	5047.344		
	Total	564965.895	54			

Length-to-width ratio versus Year Built, Depth, Hull Material; 1870s

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	38.710	3	12.903	24.583	.000[b]
	Residual	39.366	75	.525		
	Total	78.076	78			

Gross Tonnage versus Year Built, Depth, Hull Material; 1880s

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	42796930.020	3	14265643.340	75.062	.000[b]
	Residual	18435015.310	97	190051.704		
	Total	61231945.330	100			

Net Tonnage versus Year Built, Depth, Hull Material; 1880s

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	22846756.530	3	7615585.509	66.966	.000[b]
	Residual	9780146.420	86	113722.633		
	Total	32626902.950	89			

Difference in Tonnage versus Year Built, Depth, Hull Material; 1880s

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2322881.259	3	774293.753	41.318	.000[b]
	Residual	1611619.706	86	18739.764		
	Total	3934500.965	89			

Length-to-width Ratio versus Year Built, Depth, Hull Material; 1880s

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	58.780	3	19.593	30.167	.000[b]
	Residual	63.002	97	.650		
	Total	121.782	100			

Gross Tonnage versus Year Built, Depth, Hull Material; 1890s

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	35125133.430	3	11708377.810	38.859	.000[b]
	Residual	14763994.130	49	301306.003		
	Total	49889127.550	52			

Net Tonnage versus Year Built, Depth, Hull Material; 1890s

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14747842.820	3	4915947.605	42.225	.000[b]
	Residual	4540463.295	39	116422.136		
	Total	19288306.110	42			

Difference in Tonnage versus Year Built, Depth, Hull Material; 1890s

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3042890.606	3	1014296.869	10.249	.000[b]
	Residual	3859773.447	39	98968.550		
	Total	6902664.053	42			

Length-to-width Ratio versus Year Built, Depth, Hull Material; 1890s

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	38.468	3	12.823	15.596	.000[b]
	Residual	40.287	49	.822		

	Total	78.755	52			

Gross Tonnage versus Year Built, Depth, Hull Material; 1900s

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	46518223.100	3	15506074.370	21.915	.000[b]
	Residual	29009892.140	41	707558.345		
	Total	75528115.240	44			

Net Tonnage versus Year Built, Depth, Hull Material; 1900s

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13066258.740	3	4355419.580	17.440	.000[b]
	Residual	7991402.898	32	249731.341		
	Total	21057661.640	35			

Difference in Tonnage versus Year Built, Depth, Hull Material; 1900s

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4219272.351	3	1406424.117	13.857	.000[b]
	Residual	3247938.399	32	101498.075		
	Total	7467210.750	35			

Length-to-width Ratio versus Year Built, Depth, Hull Material; 1900s

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	27.771	3	9.257	10.541	.000[b]
	Residual	36.007	41	.878		
	Total	63.778	44			