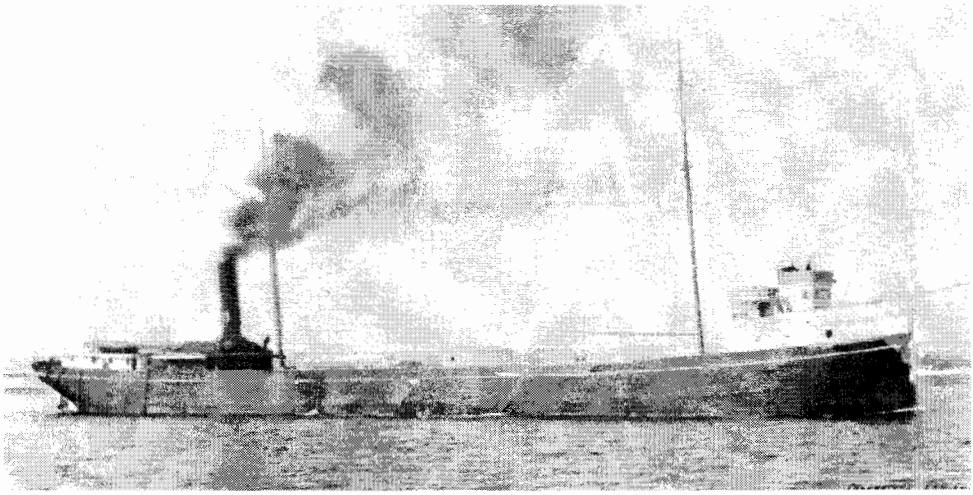
Research Report No. 12

EAST CAROLINA UNIVERSITY

The Bones of a Bulk Carrier:

The History and Archaeology of the Wooden Bulk Carrier/Stone Barge *City of Glasgow*



Bradley A. Rodgers

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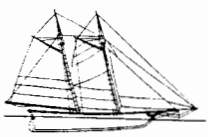

WISCONSIN HISTORICAL SOCIETY

Sea Grant
University of Wisconsin

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The Bones of a Bulk Carrier:
The History and Archaeology of the Wooden Bulk Carrier/Stone Barge *City of Glasgow*

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1

Introduction

The *City of Glasgow* was one of the largest Great Lakes wooden bulk carriers of its day. Constructed by James Davidson in 1891, the *City of Glasgow* steam navigated in numerous trades on the Great Lakes until 1907, when it ran aground and burned in Green Bay. The vessel was raised, put into service with the Leatham and Smith Quarry in 1908 and converted to a stone barge by 1911. Misfortune struck again in 1917 during a fierce storm, when the barge broke its tow and beached itself in Lilly Bay along the shore of Lake Michigan. In a strange twist of fate the disaster that befell the ship actually saved it in history, allowing archaeologists to study the bones, while giving it a place in the historical spotlight that it deserves.

During the fall of 2000, students and staff from East Carolina University (ECU) and the State Historical Society of Wisconsin (SHSW) conducted an archaeological survey in Lilly Bay. The *Glasgow* wreck site was mapped and the ship's condition analyzed. It was found that a large portion of the vessel's forward section remained intact, from the turn of the bilge to the keel. The overall goal of the 2000 field season on the *Glasgow* was to complete a phase II pre-disturbance survey. The object of a Phase II survey is a detailed site map, photographic imaging and interpretation of the site as well as an examination of individual artifacts for diagnostic purposes. Although bad weather forced archaeologists off the site for two out of the six days initially scheduled for the project, much was accomplished.

The *City of Glasgow*, and ships like it, played a significant role in Great Lakes maritime heritage, and this report is aimed toward shedding some light on the vessel's historic and intrinsic cultural value. The *City of Glasgow* represents a seldom studied class of ship know as a wooden bulk carrier. This class of ship and the system of loading and unloading that developed around it greatly reduced the costs of shipping raw mineral and agricultural products. In their own efficient way, bulk carriers contributed to the 20th century economic and industrial boom in the U. S. and demonstrates that this boom is largely the result of technical innovations as represented by the *City of Glasgow*.

The ship also represents a link in Great Lakes Maritime history between the 19th century, dominated by sailing schooners, and the 20th century, dominated by enormous steel steamers. Wooden bulk carriers are an important transition between the two, and as such, they contain enormous amounts of information about the maritime transition of wood to steel and how the two seemingly incompatible materials do influence one another in marine architecture. A closer look at the *City of Glasgow*, and its history and archaeology, will help us understand both the times and the people who influenced them.

2

Environmental Overview

Geography

The most pronounced coastal feature of northeastern Wisconsin is the Door Peninsula. The Door Peninsula is bordered on its western side by Green Bay and on its eastern side by Lake Michigan. This peninsula, which makes up all of Door County, may be divided into a southern and a northern half, with Sturgeon Bay and the Sturgeon Bay Ship Canal serving as the dividing line (Figure 1). In its entirety the peninsula is about 84 miles (135.185 km) long from the north shore of Rock Island to its base. The peninsula is also between 3 to 10 miles (4.83 to 16.093 km) wide and has a total shoreline of approximately 200 miles (321.869 km) (Cooper 1989:7; Mason 1966:1).

The northeastern border of Wisconsin and the Lake Michigan basin has a varied geological history. Before the Ice Age, the Lake Michigan basin was occupied by an extensive river that flowed southward to the Gulf of Mexico. Ice Age glaciers, however, greatly modified the topography of eastern Wisconsin and sculpted the land and the basin to its present form. In a geologic sense, the Lake Michigan of today is a rather recent phenomena (Martin 1965:236, 294).

Modern day Lake Michigan is characteristic of a basin that was carved out by ice, instead of a valley eroded by a river. A longitudinal profile of the lake bottom suggests glacial scooping, which produces rock basins in all glaciated valleys (Martin 1965:238-239). The basin has abrupt walls that descend to a depth of 500 to 900 feet (152.40 to 274.32 m) and into a broad, flat, and rocky bottom.

There are a variety of sediments present in Lake Michigan. The exposed beaches of the lake and the bluffs cut by glaciers are frequently composed of gravel while silts and clays are present along the deeper portions of the basin. The most common material throughout Lake Michigan, however, is sand. Sand is found along the lake beaches and on the lake bottom, in some areas to a depth of more than 300 feet (91.44 m), and this is the dominant geological sediment found at the *Glasgow* site. On the bottom of Lake Michigan the size of the sand grains generally decreases as the distance from shore and the depth of water increases. The *City of Glasgow* lies in a band of large course sand which is present in shallow depths down to 60 or 100 feet (18. 288 to 30.48 m) (Hough 1958:65-70).

Ice greatly affects the *City of Glasgow* site. Portions of Lake Michigan often freeze throughout the winter, closing lake ports and most of the connecting waterways. Sheet ice mainly forms in the more protected channels and embayments. In the central sections of the lake, however, only a relatively small percentage of the surface is covered with ice, even during the coldest periods of winter. Shore ice may also form in shallow water along the lake's edges. Ice flows may then be

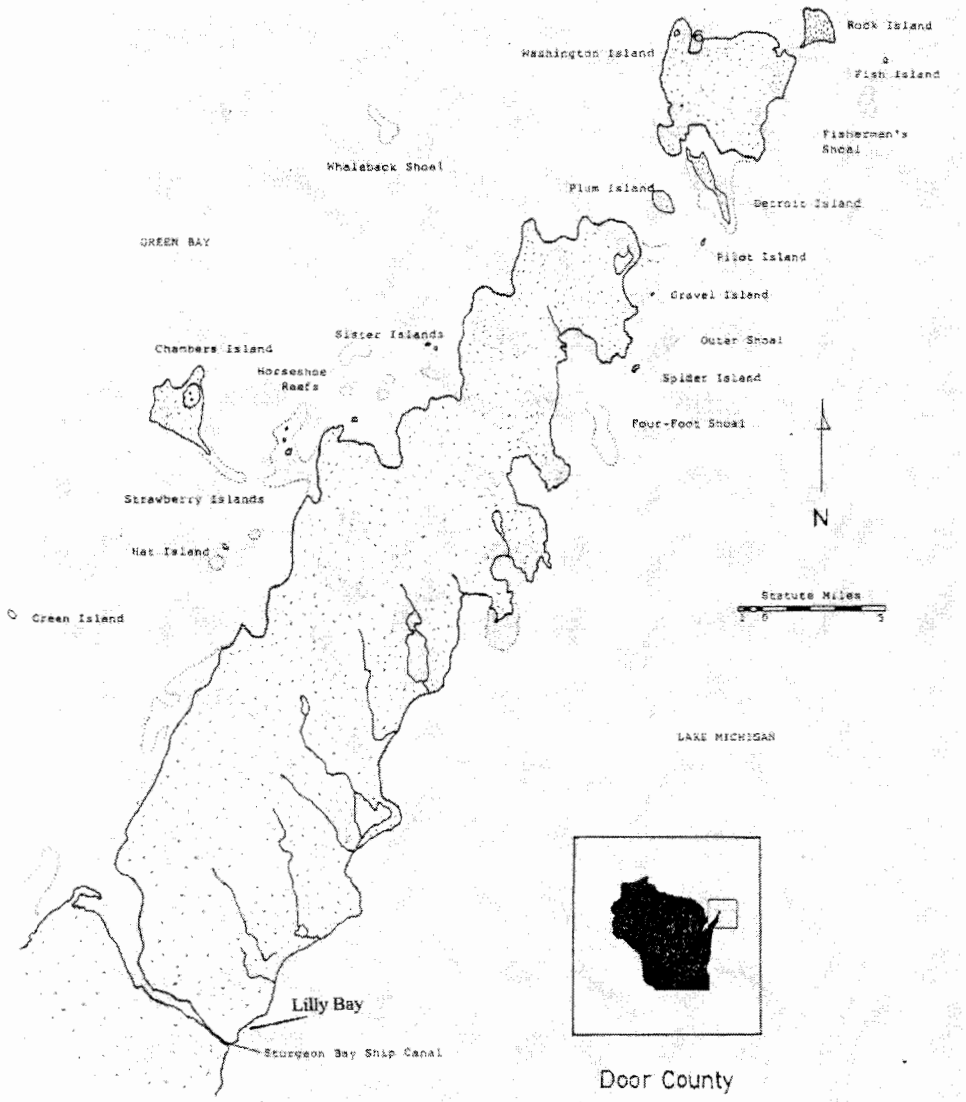

Figure 1. Map of the Upper Door Peninsula, Wisconsin (Cooper 1989: 3).

blown against the shore and become immobilized there by freezing to the shore ice. In this manner, a belt of ice can form that may extend offshore for half a mile or more (Hough 1958:49). This shore ice may protect the *City of Glasgow* from wind blown ice flows, which are rare on the west shore of the lake since the predominant wind is from the west. Portions of the *City of Glasgow* site which lie furthest off shore lie on bare rock, dolomitic limestone.

The industrial history of Door County is closely linked to the quarrying and use of dolomite. Stone quarrying in the Sturgeon Bay area began in 1832 soon after government geologists discovered the natural dolomite deposits. From the year 1840 until the early 1900s, quarries around Sturgeon Bay cut out slabs of

dolomite, which were then crushed so the stone could be shipped to other cities around the Great Lakes via barges.

The rock that dominates the Door Peninsula is part of the Niagara Dolomite cuesta. During the latter portion of the Cambrian period a shallow sea advanced from the south and covered what is today known as Wisconsin. This sea was still present during the Silurian period, when the Niagara Dolomite was deposited. In this shallow sea, lime precipitated from shells, corals, and plant detritus. The lime was compressed in layers by overlying sediment composed mostly of calcium carbonate ($CaCO_3$), also known as limestone. Over millions of years the magnesium content of the limestone increased as magnesium was deposited from groundwater. The high magnesium content converted the calcium carbonate into calcium magnesium carbonate ($CaMg(CO_3)_2$), which is dolomite (Peterson 1965:59-60).

The Niagara Dolomite deposit forms the western shore of Lake Michigan and stretches across the state of Wisconsin for over 230 miles (370.149 km). This dolomite deposit also runs along the northern shore of Lake Michigan and extends eastward toward Lake Ontario and New York (Figure 2). The Niagara Dolomite cuesta ranges from 450 to 800 feet (137.16 to 243.84 m) in thickness and always forms a highland. In Door County, the cuesta rises 160 to 220 feet (48.768 to 67.056 m) above Green Bay (Hough 1958:15-16; Martin 1965:227-228).

Dolomite is most widely known for its imperviousness to physical and chemical weathering. Even though dolomite possesses many qualities that are similar to limestone, dolomite itself is much harder and denser. This stone is a useful building material and may be crushed and baked to produce quicklime, which was used as mortar before the mass production of portland cement (Rodgers 1995:3).

The story of the *City of Glasgow* is linked to the limestone industry of the Great Lakes. Large dolomite slabs were used for harbor construction, bridge building, foundations, breakwaters, and piers or crushed, baked, and used for mortar (Aerts 1993:4; Rodgers 1995:3). The largest quarry located in Sturgeon Bay was the Leathem and Smith Quarry, which operated from 1893 to 1927 (the quarry was known as the Smith Quarry by 1914). Due to the quarry's production capacity and size, which amounted to about twenty acres, many barges were needed to transport its dolomite slabs and crushed stone. During the quarry's early years, each dolomite slab was hand cut from 4 to 10 inches (10.16 to 25.40 cm) thick, 18 inches (45.72 cm) long, and 8 to 12 inches (20.32 to 30.48 cm) deep. These slabs were just the right size for hand loading and unloading operations (Aerts 1993:5; Rowe 1979: 50).

Ecology

The waters surrounding the Door Peninsula are relatively rich in shellfish, crayfish, perch, bass, pickerel, great northern pike, and other fresh water fish species (Mason 1966:2). Exotic animals have inadvertently been introduced into the Great Lakes and surrounding waterways. Probably the most aggressive species introduced to date is the zebra mussel.

Underwater archaeologists have only recently expressed grave concern over the irreversible damage that colonies of zebra mussels are causing to historic shipwrecks. Shipwrecks in the Great Lakes have been remarkably well preserved

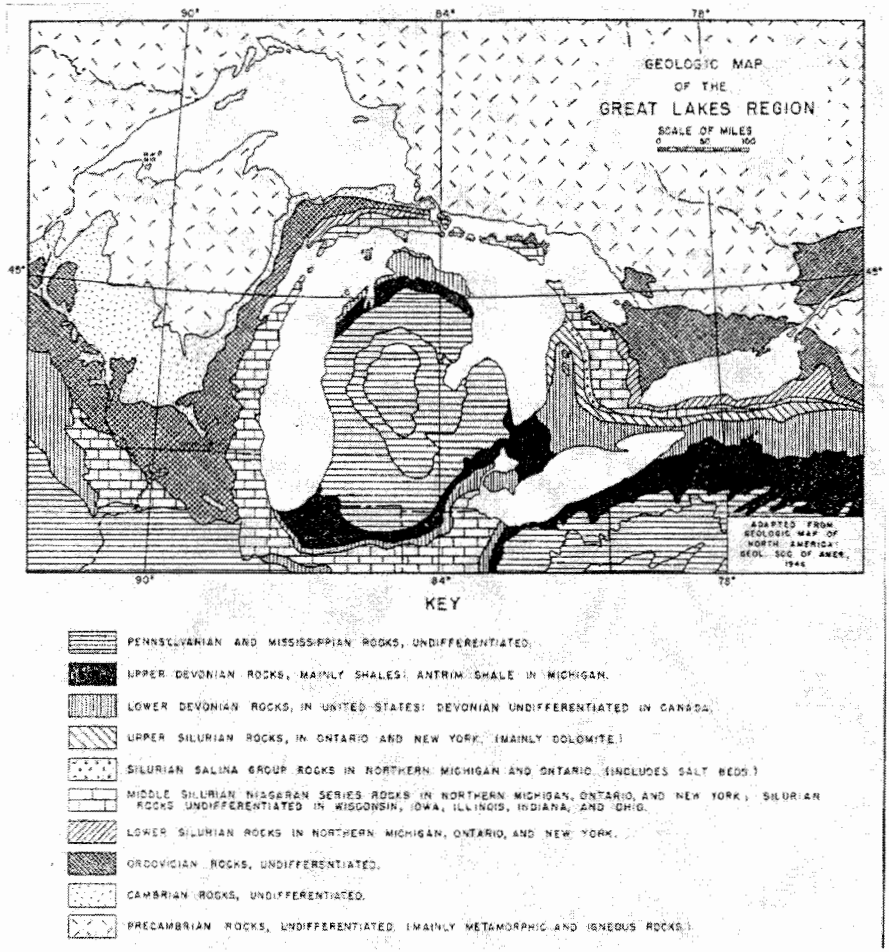

Figure 2. Geologic Map of the Great Lakes (Hough 1958: 14).

due to cold, deep, fresh waters, but zebra mussels are now rapidly degrading these vessels. Results from a recent four-year study conducted by researchers at the University of Vermont and the Lake Champlain Maritime Museum have determined that zebra mussel colonies promote anaerobic sulfate-reducing bacteria. These bacteria break down and disintegrate iron fastenings of shipwrecks, which eventually cause the vessels to fall apart. In addition, the weight of the colonies themselves, which may contain hundreds of thousands of mussels per square meter, may be enough to collapse the wrecks. Exacerbating the other problems is the fact that the mussels tenaciously attach themselves through filaments to the smooth surfaces afforded by shipwrecks. Any attempt to detached these creatures from their holdings, removes pieces of their host object; causing the gradual disintegration of wood on the shipwrecks in the Great Lakes. Unfortunately, no practical methods currently exist for controlling the rapid growth of zebra mussel populations (Claiborne 2000:A3; Lewis 2000:C9).

3

Historical Background

The history of the *City of Glasgow* begins with James Davidson. Davidson was born in Buffalo, New York in 1841, and became an orphan after his parents died in 1852. For many of his early years, Davidson relied on his own resourcefulness. He started sailing at an early age and was a licensed master by age 19 (Cooper and Jensen 1995:7).

Davidson learned the trade of ship building at Buffalo's Bidwell and Banta shipyard in the late 1850s and early 1860s. In 1862, Davidson traveled east and worked for a time as a master for the Black Ball Line of sailing packets. This took him to many parts of the world and gave him a glimpse of some of the best examples of wooden ship construction (Cooper and Jensen 1995:7).

After nearly a decade Davidson returned to the Great Lakes and built the schooner *Laura Belle* in 1870. In 1871, his second vessel was built in Wenona, Michigan, and launched as the *E. M. Davidson*. Wenona later became West Bay City, Michigan. Davidson continued to build large sailing vessels and in 1873, he opened his own yard in Bay City. This area provided the most important raw material for shipbuilding at the time, wood. The Saginaw River Valley was rich with pine, oak, and other timbers that numerous local mills processed (Cooper and Jensen 1995:12).

James Davidson was a seasoned mariner, master shipbuilder, and imaginative businessman. When other Great Lakes builders were vocal and adopted change, Davidson remained in the background saying little if anything. He continued to build wooden ships even after iron had proved more efficient. Two reasons for this resistance to change were wood supplies and ship size. The area around Bay City continued to be rich in timber resources. This allowed wooden ships to be built economically until the mid-1880s. Size, however, was one factor that seemed to sway most ship owners toward iron and later steel vessels. The greater the size, the more cost effective the ship. This is particularly true of steamships as overhead costs now include engines, boilers, and fuel. With this in mind, it became increasingly imperative to move as much bulk commodity with as little expense as possible, hence increased ship size. Iron and steel ships, because of their strength, could be built on much larger proportions than wood. Yet Davidson knew that the maximum size that wooden ships could be built had yet to be fully realized because of the introduction of large quantities of iron fasteners, internal bracing, and new construction techniques. In 1891, Davidson launched four large wooden steam bulk carriers. The *City of Glasgow* and *City of London* would be the first; both at 297 feet (91.38 m). The *City of Berlin* and *City of Paris* were next, both at 298 feet (91.69 m) (Devendorf 1996:78). In 1900, Davidson's productions in wood reached their zenith with the launch of the 338 foot (104 m) long *Pretoria*, making her one of the longest and largest schooners ever built (Comtois 2002).

Construction

The *City of Glasgow* was built as hull number 42 and was classified as a propeller with the official number 126729. The vessel was 297.0 feet (91.38 m) in length, 41.0 feet (12.62 meters) wide, and had a moulded draft of 20.42 feet (6.28 m). Her gross tonnage was 2,002.86 and her net tonnage was 1,672.03 (Great Lakes Vessel Index 2002). These dimensions allowed the ship to pass over the 21 foot (6.4 m) sill of the Sault Locks, which were deepened in 1886, and lengthened to 800 feet (243.84 m).

The *City of Glasgow* was powered by a single triple expansion engine with cylinders rated at 20, 33, and 54 inches (51, 84, 137 cm) in diameter with a 42 inch (107 cm) stroke. The engine produced 1,175 horsepower turning the propeller at 84 revolutions per minute. The engine was constructed by the Dry Dock Engineering Works of Detroit, Michigan (Historical Collections Files).

City of Glasgow was equipped with two 11 ½ by 13 foot (3.54 x 4 meters) coal fired cylindrical Scotch boilers. Each of the boilers could produce 150 pounds (68.04 kilograms) of pressure per square inch; they were constructed by the Lake Erie Boiler Works of Buffalo, New York (Runge 2002).

The *City of Glasgow*'s layout followed the style of the *R. J. Hackett*, which was built in 1869. The *Hackett* set a precedent for Great Lakes bulk carrier construction that continued into the 1970's. Like the *Hackett*, *City of Glasgow* was arranged with her pilothouse forward with some cabins for the officers and crew below. The engine room, galley, and the rest of the crew cabins were aft. This arrangement allowed for the cargo hold to be placed in the mid section of the ship while the pilothouse was left with an unobstructed view forward (Thompson 1994:23-24).

As with all bulk carriers constructed on the model of the *R. J. Hackett*, the *City of Glasgow* had two laid cargo decks though it is likely that the lower or main deck was not planked. The deck beams of the main deck helped stiffen the sides of the ship while the lack of planking allowed freer access in the hold for loading and unloading. Loading a ship on the lakes at the time involved positioning it under the spillways of a hopper loader, also known as a pocket dock, so the bulk cargo could simply cascade from the elevated hopper into the hold. Unobstructed access in the hold was critical to this operation so no bulkheads or decking could be permitted. Likewise, unloading was carried out by large clam buckets of a Brown Hoist, also know as an unloading bridge. The buckets needed free access to both decks in order to make the process efficient. Crews and heavy machinery were placed in the holds to finish unloading. Their job was simply to serve up the remaining cargo to the clam bucket for removal.

The *City of Glasgow* was built with an iron reinforced oak hull and rigged with three masts. These masts had no running rigging but could be rigged for unloading cargo at the smaller un-provisioned ports that had no unloading bridges. Though inefficient compared with a Brown Hoist, the mast and boom rig was used throughout maritime history to accomplish the same task.

The *City of Glasgow* had 9 hatches measuring 8 feet (2.46 m) long that were placed on 24 foot (7.38 m) centers so that she could be loaded at the iron ore chute

docks such as the one built in 1859 at Marquette, Michigan. The 9 hatches opened up on one central hold with a capacity of 3,100 gross tons (Runge 2002; Thompson 1994:22).

Launching

The *City of Glasgow* was launched on Saturday May 16, 1891. Davidson had intended to launch a few days earlier but other yard work forced him to postpone. The *Bay City Tribune* recorded the event:

> The "City of Glasgow", the second of the "Big Four" building at Davidson's shipyard, was launched yesterday. The launch yesterday was a little premature, Captain Davidson intended that it should not occur until 4 o'clock sharp, but ten minutes before that time, before all blocks had been removed from under her keel, the strain of the vessel on the ropes caused some of them to brake and she started down the ways.
> As soon as the first rope broke and it became evident that the vessel could not be held any longer, the signal was given to cut the remaining lines, but some of the men were not ready, an the result was an very uneven launch. The stern of the vessel had got almost half way into the water before the bow began to move, and it looked as if one end of the vessel would stick, but at last the bow started and the launch ended and without an accident. (*Bay City Tribune* 1891).

Most Great Lakes sailors would see this as a bad omen. In their belief, ships that have difficult launches usually end up wrecked. As the sailing career of the *City of Glasgow* would show, this omen may have had validation (Figure 3).

Sailing Career

The *City of Glasgow* and her sister ships were to be sold to Ferdinand Schlesinger of Milwaukee. This deal, however, fell through and Davidson ultimately added the four ships to his own fleet. By July 4, 1891, the *City of Glasgow*, *City of Berlin*, and *City of London* were on their way north to load iron ore at Two Harbors, Minnesota. On July 8, however, the *City of Glasgow* had her first brush with disaster. While making the lock wall at Sault Ste. Marie, Michigan, the *City of Glasgow* collided with the schooner *Page* carrying away the latter's jib boom, bow spirit, and all her headgear (*Bay City Tribune* 1891). *City of Glasgow*, however, escaped heavy damage in the incident and proceeded north.

Davidson continued to run the *City of Glasgow* until April 20, 1893 when the ship was sold to Thomas Cranage. On October 11, 1895 the vessel was again sold, this time to the Buckeye Steamship Company, which was run by Hutchinson & Company. During the winter of 1896 and 1897, the *City of Glasgow* had its rig changed from three masts to two. The main mast was taken down, in all likelihood,

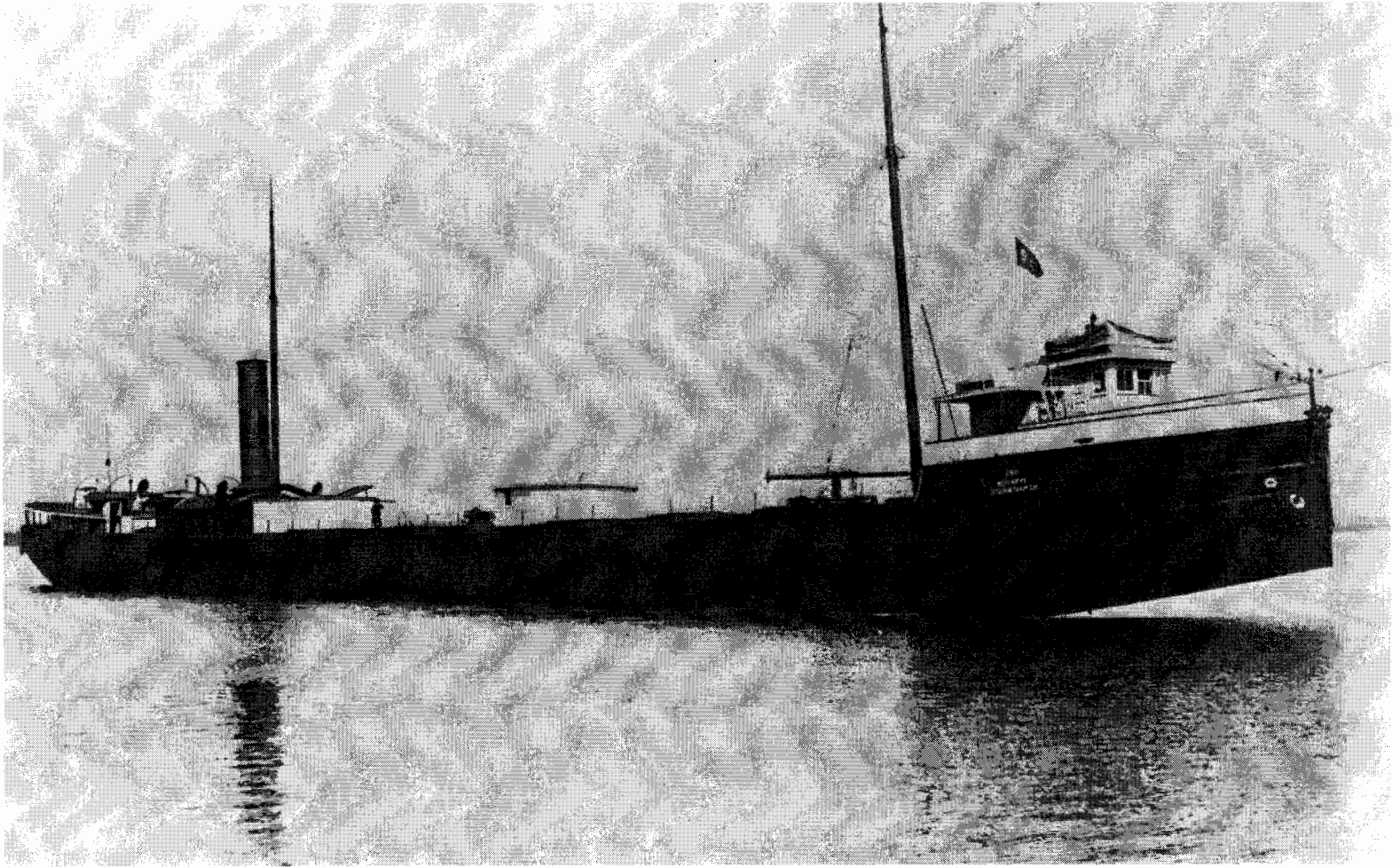

Figure 3. The *City of Glasgow* before conversion to a stone barge (Historical Collections of the Great Lakes, Bowling Green State Univ.).

because the ship could be loaded or unloaded more efficiently without it. Records show that by February 12, 1897, the *City of Glasgow* was registered as having two masts (National Archives RG 41, PE no. 5, 12 Feb. 1897).

During the ship's later years few records have been found pertaining to the *City of Glasgow*. On April 18, 1901, her dimensions officially changed with the addition of 3.74 feet (1.15 m) to her moulded draft. This increased her gross tonnage to 2,400 and her net tonnage to 1,797 (Great Lakes Vessel Index 2002). It seems likely that this was a technical change to her load line rather than an actual physical addition to the ship. In other words, *City of Glasgow* was simply allowed to load deeper than before in order to take advantage of the deeper sill on the Poe Locks on the Canadian side of the Sault, finished in 1895.

Like all ships, the *City of Glasgow* ran into its share of hard luck and trouble. The notion that all working ships lead a charmed life until the day of their demise is patently false. All ships run into trouble, most run aground on a regular basis, though groundings in which help is not needed are generally not even recorded. Some groundings are serious, however. The *City of Glasgow* made the news in October of 1904 after she went aground off La Pointe, Madeleline Island, Wisconsin. The ship had just loaded 2,891 tons of iron ore at the Allouez docks in Superior, Wisconsin, bound for Buffalo, New York, on one of her last trips of the season. She was scheduled to stop in Ashland, Wisconsin, and pick up her consort, the *Abyssinia*. Sometime either late Thursday night or early Friday morning of the 14th, the ship went ashore while negotiating the Apostle Islands. The tugs *B. B. Inman* and *Crosby* were dispatched from Duluth, Minnesota, to aid the stricken *City of Glasgow*. On Sunday, October 16, after 300 tons of ore had been lightered, the tugs were able to pull the ship free. The *City of Glasgow* sustained little damage as the bottom where she grounded was sandy and her position sheltered her from wind and waves. The ship finished the season with winter layup in Milwaukee (*Duluth News Tribune* 1904; *Duluth Evening Herald* 1904; *Door County Advocate* 1904).

The next sailing season was uneventful until Sunday September 17, 1905. At this time the *City of Glasgow* was scheduled for Milwaukee harbor to drop off the *Abyssinia*. After the stop in Milwaukee, the *City of Glasgow*, was bound for Chicago with a cargo of coal. Unfortunately, she ran into a fog and wound up on the rocks just a mile or so off Milwaukee. Assistance was signaled and the tugs *Welcome* and *Knight Templer* were sent out with a gang of stevedores who proceeded to unload 325 tons of coal into a lighter. It was not until the next day that the ship was finally refloated. Damage to the *City of Glasgow* would not be known until the ship unloaded in Chicago but estimates at the time set the damage at $1,500 (*Milwaukee Sentinel* 1905; *Door County Advocate* 1905).

1906 appears to be an uneventful year for the *City of Glasgow*, as no incidents are reported. On Thursday November 28, 1907 however, the *City of Glasgow* went aground on Peshtigo Reef in Green Bay. She was laden with coal which had been loaded in Buffalo and was headed for the city of Green Bay. The captain stated that the reason for this stranding was the seasonal removal of the reef lightship and a snow squall, which made visibility difficult and caused the ship to go off course. The tugs *W. S. Taylor*, of Green Bay, and the *O. M. Field* of Marinette, Michigan were dispatched to the ship to help in her release. On Friday, rising water

levels and the lightering of a small portion of her cargo allowed the tugs to free the *City of Glasgow* quite easily with little damage to the hull (*Marine Review* 1907; *Door County Advocate* 1907).

The *City of Glasgow* proceeded into the Fox River in Green Bay to discharge her 3,500 tons of coal at the Cargill Dock. At one o'clock in the afternoon on Tuesday December 3, the ship left her moorings in Green Bay and was bound in ballast for Escanaba, Michigan. Unfortunately, while navigating the Fox River channel, it ran aground again near the first Grassy Island lighthouse. The tug *Taylor* was sent out to assist the stranded vessel. The *City of Glasgow* was released, but a far more serious problem had developed by four o'clock (*Green Bay Semi-Weekly Gazette* 1907).

Fire!

Before the crew of the *City of Glasgow* could enjoy the fact they were underway again a far more dangerous situation transpired. Apparently, sparks or cinders had gotten into the coal bunkers starting a large shipboard fire. This seems a frequent occurrence for grounded wooden steamers. The scenario seems to start when the boilers are fired extra hot to supply the engines with enough steam to pull the ship free. The overly zealous firing of the boilers however, inevitably rains sparks from the stack causing the fires. The crew fought the fire until 5 o'clock that evening but it was to no avail. A north wind had fanned the flames aft forcing the men out of the engine room. Unfortunately, this left no one to run the ship's water pumps or stoke the boilers, which were essential in the battle. The *Taylor* returned and used her own water hoses to stream water on the burning ship but the heat became too intense and she was forced to withdraw. The captain and crew of 18 escaped in a yawl boat and were picked up by the *Taylor* (*Green Bay Semi-Weekly Gazette* 1907).

The *City of Glasgow* continued to burn down to the waterline along the entire length of the ship with the boilers eventually falling into her cargo hold. It sank in the shipping channel and became an obstruction to navigation. Insurance underwriters declared her a total loss of about $85,000 (Stabelfeldt 1981:85; *Green Bay Review* 1907).

Salvage

Since the *City of Glasgow* was blocking part of the navigation channel in and out of the city of Green Bay, the removal of the hull became an urgent matter. Bids were taken in December of 1907 for a contract to remove it and do any dredging that may have been needed to clear the channel for spring navigation. Many people at the time felt that the ship was beyond salvage and suggested the idea of using dynamite to blow her up. Nonetheless, Leathem and Smith Towing and Wrecking Company of Sturgeon Bay, bid on and were awarded the salvage contract. Leathem and Smith reasoned that an easily acquired hull would make a good stone barge. The company agreed to remove the vessel by the time the Straits of Mackinac opened in the spring. The contract also stipulated that any day of work needed beyond May 1st would be liable to a $100.00 penalty (*Door County Advocate* 1907, 1908).

Work on the *City of Glasgow* did not begin until April and by the end of that month, a spring storm tore open the patches at the stern delaying the work and forcing Leathem and Smith to miss the May 1st deadline. Bad weather plagued the operation until May 28th when the *City of Glasgow* was finally raised. The wreck was first taken into the city of Green Bay where machinery was removed and additional planking was attached to strengthen her hull. On June 4, 1908, the *City of Glasgow* was towed to Sturgeon Bay and placed at the Leathem and Smith wharf. The next day, it was moved to a berth at the foot of Liberty Street where she would remain tied up as a burned out hull until her conversion to a barge (*Door County Advocate* 1908) (Figure 4).

By June 25, 1908, the last parts of the ship's engine had been removed and she sat abandoned until 1910. During this time, Leathem and Smith decided to turn the *City of Glasgow* into a unpowered stone scow. As stated earlier, the company owned a large limestone quarry in Sturgeon Bay and converted their own stone barges to transport the stone around the Great Lakes. Sections of the ship were still in good working order, so by January of 1910 work began on the conversion (*Door County Advocate* 1908).

A New Life

The conversion of the *City of Glasgow* to a stone barge took over a year to complete. The aft engineering section of the ship took the brunt of the fire and was completely gutted. The forward two-thirds of the ship, was untouched below the waterline and her bottom remained strong. Marine architects, therefore, determined that the forward section would form the basis for the reconstructed barge. Although historical evidence concerning how a ship is converted to a barge is sparse, archaeology on the *City of Glasgow*, has determined that the stern section was removed in a simple procedure which knifed straight across the hull 173 feet (52.73 m) from the bow. Afterward, the *City of Glasgow* had a reported gross tonnage of 958. The barge, now referred to as *Glasgow*, would be towed by the tug *John Hunsader* in its normal transport duties for Leatham and Smith (*Door County Advocate* 1910; Merchant Vessels of the United States 1912).

Over the next six years, the *Glasgow* was towed by the *Hunsader* with other barges to ports around the Great Lakes, carrying limestone and occasionally bringing coal into Sturgeon Bay. In 1912, Leathem and Smith burned what was left of the aft end of the old ship for the metal parts and in 1916, the company sold the ship's engine for $3,000.00. The following year, however, would prove to be the last for the *Glasgow* as a merchant vessel (*Door County Advocate* 1912, 1916).

Lilly Bay

The *Glasgow* stayed busy throughout 1917, as the quarry had plenty of orders to be shipped. Yet the hull began to give the Leathem and Smith engineers some concern. On September 23, 1917, the *Glasgow* sprung a leak while heavily laden and sank at the company dock in Sturgeon Bay. She was lightered and raised on September 26. Despite her sinking, she appeared to be seaworthy as no extraor-

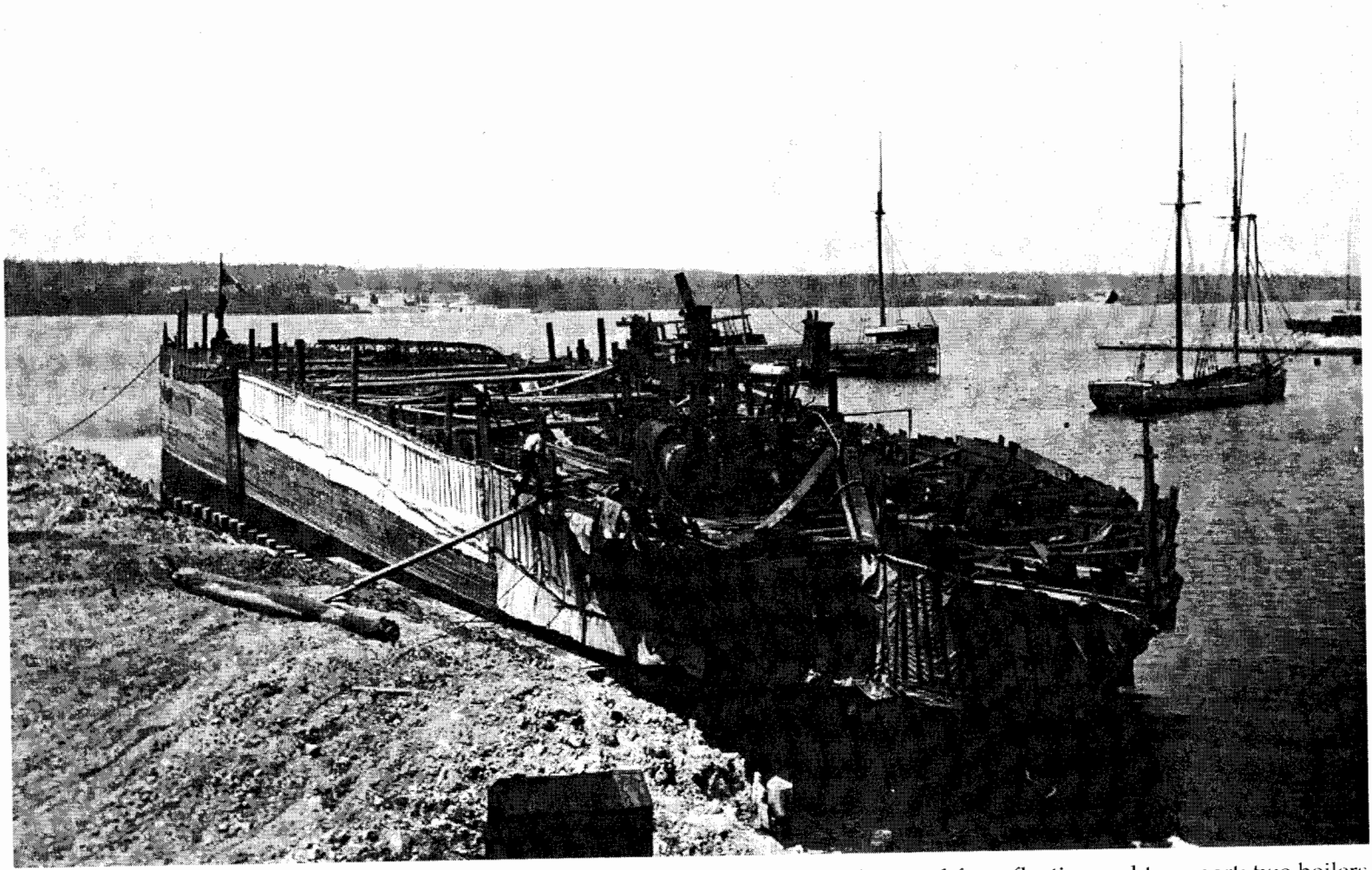

Figure 4. The *City of Glasgow* in Sturgeon Bay after salvage. Note the canvas patches used for refloating and transport; two boilers visible (Collection of Jon Van Harpen).

dinary repairs took place (*Door County Advocate* 1917). As barges were of course often unmanned, pumping them out occurred at sporadic intervals. A barge sinking at a dock was apparently not considered an unusual event. Engineers in this instance simply concluded that the settling of the barge was due to neglect and was not an indicator of a serious leak or weakness in the hull.

Shortly thereafter, on October 6, 1917, the *Hunsader* proceeded north in Lake Michigan with the *Glasgow* and the self unloading barge *Adriatic* in tow. The *Glasgow* had delivered a cargo of stone to Milwaukee and the *Adriatic* was picked up at Manitowoc, Wisconsin, for a return to Sturgeon Bay when the three vessels were caught in a storm blowing out of the south. Towing in a following sea is a difficult task, turning with 2 barges in tow is even more difficult. As they approached the ship canal, the order was given to shorten the towlines. In the process, the line broke between the *Hunsader* and *Glasgow* leaving the barges on their own at the mercy of the lake. Efforts to pass another towline to the barges proved useless and the wind continued to push all the ships toward the Door County shore (*Door County Advocate* 1917).

When all efforts to reacquire the barges failed, the *Hunsader* proceeded under power to the nearby Coast Guard station to get assistance. In the meantime, the crew of the heavier *Adriatic* had dropped both anchors in the hopes of holding both her and the *Glasgow* away from shore. The *Hunsader* returned shortly after alerting the Coast Guard and was able to remove the two crewmen from the *Glasgow*. The *Adriatic*, however, could not be approached and the five men and one woman crew were left on board. Despite *Adriatic*'s anchors, the *Glasgow* continued to drift further toward shore and came to rest in beach sand about 150 yards (137.16 m) from the shore in Lilly Bay just north of the ship canal. The *Adriatic* ended up in the same general vicinity but farther out, due to her deeper draft. *Adriatic*'s crew was removed on October 7 (*Door County Advocate* 1917).

Efforts immediately commenced to free both of the barges. The *Adriatic* was released on October 13 after she was pumped out and pulled to deeper water by the *Hunsader*. She was taken into Sturgeon Bay where she was repaired and returned to service (*Door County Advocate* 1917).

Salvage focus then turned to the *Glasgow*. The hull was easily pumped but efforts to pull her free were not successful. Kedging, in which anchors are hauled and dropped some distance from the vessel by the tugs, and a steam or hand operated windlass used to pull on the anchor chain, was attempted to no avail. One last attempt was made to free the vessel in November of 1917 by the *Hunsader*, but the *Glasgow* remained hard aground in Lilly Bay. It was listed as being officially abandoned in 1922. Over time, wind, waves, and ice have worn the ship to her present condition (*Door County Advocate* 1917; Merchant Vessels of the United States 1922).

4

Archaeological Investigations

Although the *Glasgow* is a well known wreck, with a well documented historical past, little archaeological work has been done on the site until the present project was completed. This can partially be attributed to the lowly maritime status and low importance placed upon abandonments as legitimate wreck investigations by the archaeological community. Nonetheless, abandonments have proven to be invaluable sources of ship construction information.

The first major underwater archaeological work undertaken in Wisconsin waters took place in 1984, when the National Park Service's Submerged Cultural Research Unit conducted a survey of the schooner *Noquebay* in Lake Superior. The *Noquebay* was a 205 foot (62.484 m) schooner barge, built at Trenton, Michigan. The barge was lost off of Superior Island, part of the Apostle Island Chain, in 1905 (Carrell 1985: 19-35; Cooper 1987:2). Fortunately, the national initiative to investigate the *Noquebay* site sparked several other projects on the lakes.

Between August 4 and August 15, 1986, the ECU Program in Maritime History and Underwater Research, with support of the State Historical Society of Wisconsin (SHSW), began a Phase II investigation of the schooner *Fleetwing*, in Garrett Bay, Wisconsin (Cooper 1987:107). This project was only the second shipwreck to be investigated in Wisconsin, and was important for several reasons. Schooners formed the majority of the shipping on the Great Lakes during the nineteenth century, and giant schooner barges were still being constructed well into the first part of the twentieth century. Consequently, such vessels played an important role in Wisconsin history. Results of the *Fleetwing* investigation included several important site maps, and a catalogue of the artifacts observed in the vicinity of the hull wreckage (Cooper 1988).

Most importantly, the *Fleetwing* investigation prompted the SHSW to officially set-up an underwater branch to promote underwater archaeological work in Northern Wisconsin. In July and August 1989, staff and students from ECU and archaeologists from the State Historical Society of Wisconsin conducted a marine magnetometer survey of Death's Door Passage. The Door, as it is known, was until the construction of the Sturgeon Bay Canal in 1879, the only way to travel into Green Bay from Lake Michigan. The extensive proton precession magnetometer survey covered 5.84 square miles (9.39 square kilometers) between Plum and Pilot Islands. Archaeologists eventually investigated 16 possible targets and discovered several wooden shipwrecks (Cooper and Rodgers 1990: 10).

Other investigations that led to the *City of Glasgow* project include a project in July and August 1990, when staff and students from ECU, and archaeologists from the State Historical Society of Wisconsin surveyed several wrecks in the Apostle Island chain. In this project a dozen wrecks were recorded and mapped.

Three of them are of great interest relative to the construction of the *City of Glasgow* because of their similarity of design. These wrecks include the bulk steamer *Fedora*, the bulk steamer *H.D. Coffinberry*, and the schooner barge *Pretoria*.

The *Fedora* was built in West Bay City, Michigan, by F.W. Wheeler. She was powered by a 900 horsepower triple expansion engine and was launched on April 17, 1889, two years before the *City of Glasgow*. Like the *City of Glasgow* the *Fedora* was largely constructed of wood, with iron strapping running the length of the keel (Figure 5). Interestingly, the *Fedora* was lost to fire, on the 20th of September, 1901 (Cooper 1991:86).

The *H.D. Coffinberry* was an earlier wooden bulk freighter, of the same type as the *City of Glasgow*. The *H.D. Coffinberry* wrecked in Red Cliff Bay, in 1917 (Figure 6). Site investigations revealed that the wreck had badly deteriorated. Only the keel, keelson, floors, lower starboard futtocks, stringers and some exterior planking remained (Cooper 1991:96).

Of these vessels, perhaps the closest link to the *City of Glasgow* is the *Pretoria*. It was built by James Davidson nine years after completion of the *City of Glasgow*. The *Pretoria* was the largest wooden schooner barge to sail the Great Lakes. She was 338.4 feet (103.144 m) long, with a 44 foot (13.41 m) beam, and 23 foot (7.01 m) depth of hold. The vessel was driven over a reef and sank in 52 feet (15.85 m) of water, during a storm in 1905 (Figure 7). Archaeological work in 1990 laid the groundwork for continued mapping that took place in 1991 and 1992 (Cooper 1991:137). Archaeological investigations on the *Pretoria* revealed that it was constructed with a massive keelson with no sisters or riders. Typical Davidson building techniques were revealed that include triple timbered frames below the keelson, and double timbered above the turn of the bilge. Four floor keelsons were placed on either side of the keel. Fasteners consisted of iron bolts, some of which were peened over steel clinch rings (Cooper and Jensen 1995:57).

1991 also marked the SHSW's investigation of another Davidson built ship, the *Frank O'Connor*, which lies in 60 to 70 feet (18.29 to 21.34 m) of water, 2 miles (3.22 km) off the Cana Island Light (Figure 8). The *Frank O'Connor* was built in 1892, a year after the *City of Glasgow*. At 300 feet (91.44 m) long the *Frank O'Connor* was slightly larger than her predecessor, however she was basically built to the same design, including the use of a triple expansion steam engine as the power plant. Like the *City of Glasgow* and the *Feodora*, the *Frank O'Connor* was lost due to fire, in 1919.

Archaeological investigations revealed that the *Frank O'Connor* had triple timbered floors, as well as several additional floor keelsons parallel to the main keelson. As in most Davidson designs, the triple timbered frames became double timbered above the turn of the bilge. Fasteners consisted of peened drift bolts, spikes, and nails. Most of the steam machinery of the *Frank O'Connor* is intact and upright on the bottom of the wreck (Cooper and Jensen 1995:39).

Ultimately, two more archaeological projects were undertaken in Door County, prior to the investigation of the *City of Glasgow*. The first of these, in 1994, was an investigation of the wreck and pier that was located at Claflin Point in Little Sturgeon Bay, Wisconsin. Once again, the project was a joint collaboration between the WSHS and ECU. At Claflin students mapped a stone barge, and the remains of

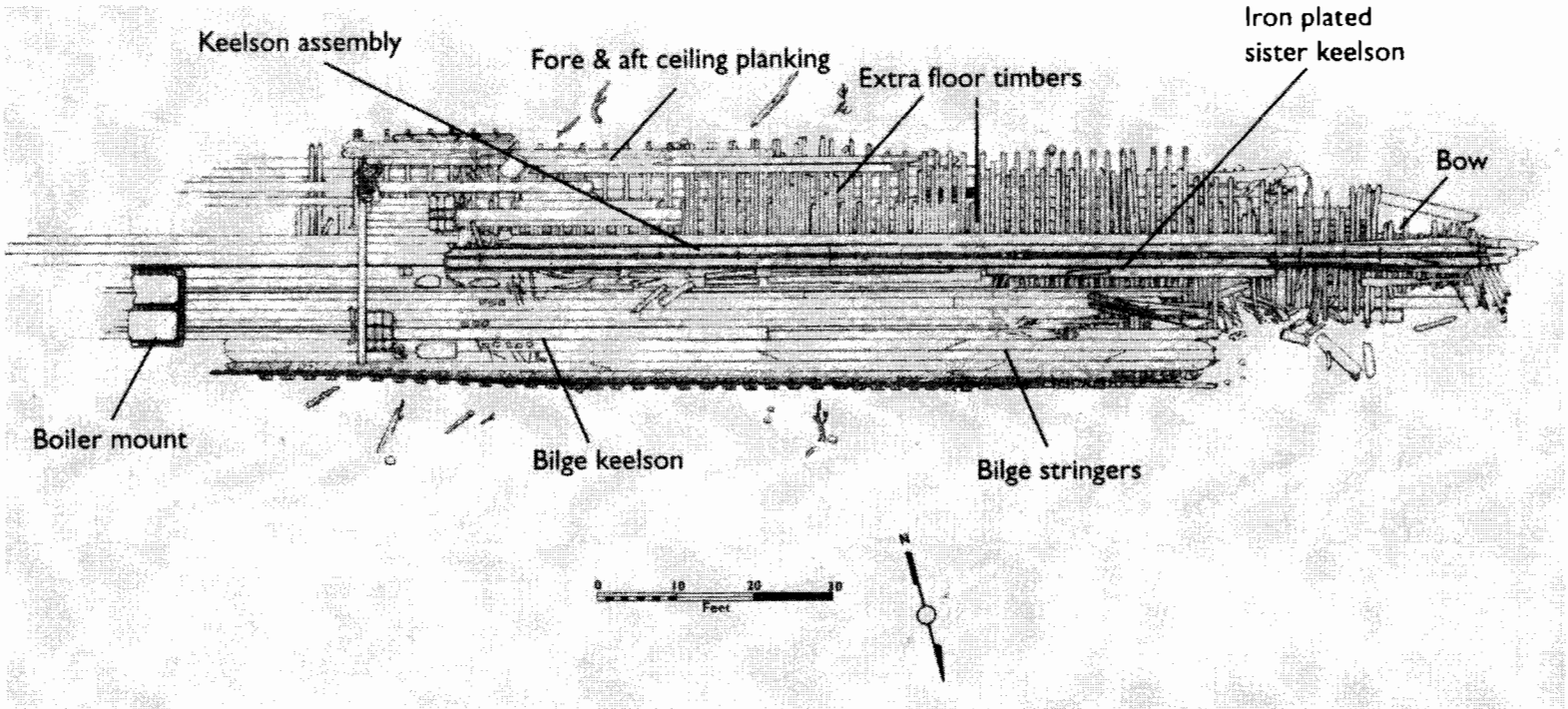

Figure 5. The wooden bulk carrier *Fedora* (Wisconsin Sea Grant and the Wisconsin State Historical Society).

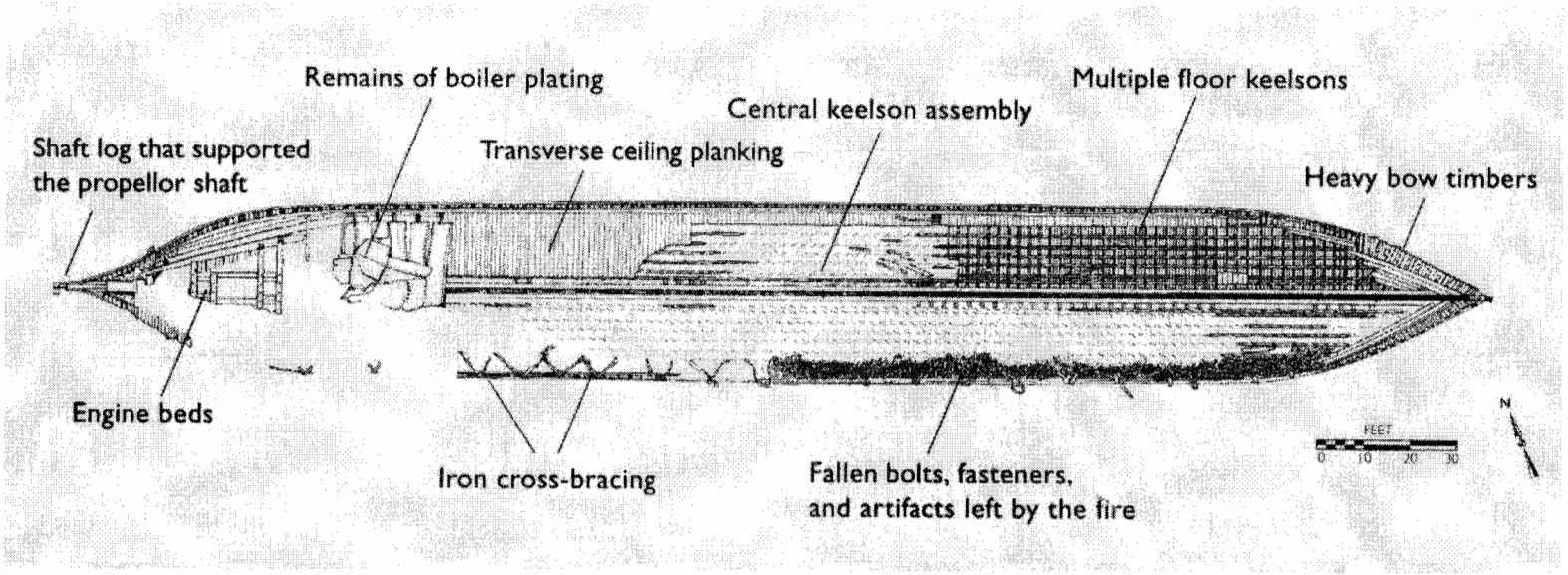

Figure 6. The wood bulk carrier *H. D. Coffinberry.* Note *Coffinberry,* unlike *City of Glasgow,* carries traditional fore and aft ceiling (Wisconsin Sea Grant and the Wisconsin State Historical Society).

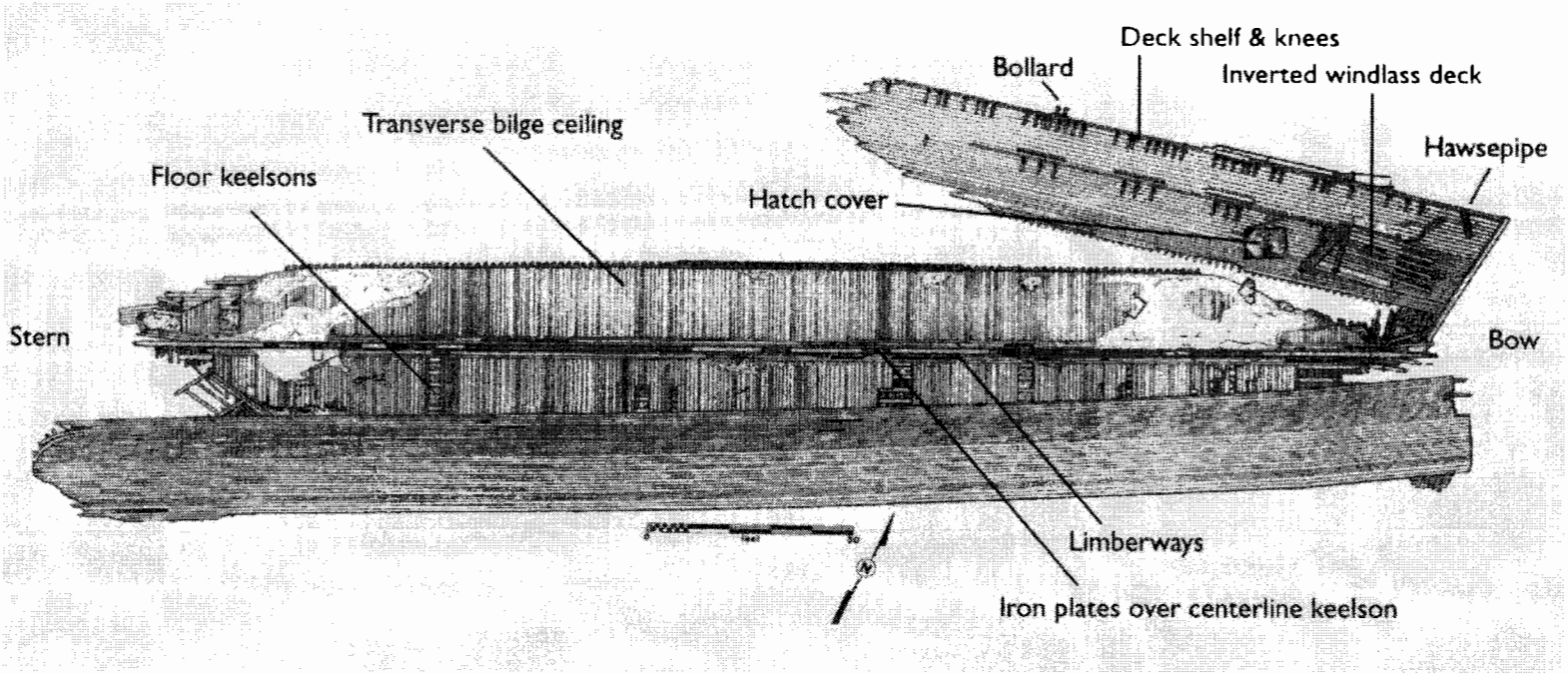

Figure 7. The Davidson built wooden schooner barge *Pretoria*. Note, it was the largest on the Lakes (Wisconsin Sea Grant and the Wisconsin State Historical Society).

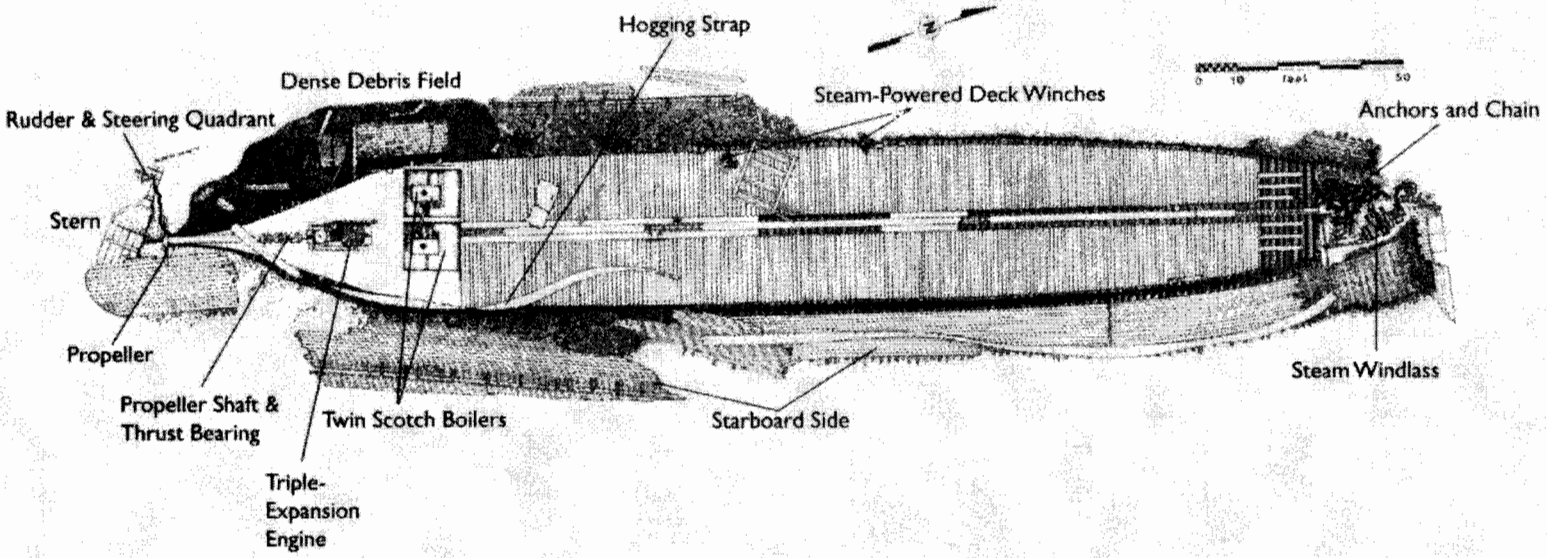

Figure 8. The Davidson Built wooden bulk carrier *Frank O'Connor* (Wisconsin Sea Grant and the Wisconsin State Historical Society).

a pier from the mid to late nineteenth century. The unidentified wreck lying at Claflin point was identified as a converted steam ship between 168 and 173 feet (51.21 and 52.73 m) long, with a beam of 22 feet (6.71 m). She proved to be a former passenger freight propeller, which was later converted to a barge. None of the machinery remained, and evidence indicated that all of the through hull fittings had been plugged, a standard procedure in converting a steamship into a barge (Rodgers 1996:15; Gray 1998: 8).

In 1999 ECU and the state of Wisconsin undertook an investigation at Bullhead Point, in Sturgeon Bay, where three wrecks and one large wharf structure were archaeologically documented. Two of these wrecks turned out to be the schooners *Ida Corning* and *Oak Leaf*, which were later converted to stone barges, while the third was identified as the former steamship *Empire State*. The *Empire State* was found to be 212 ft (65.23 m) long, by 32.7 ft (10.06 m) in beam, with a depth of hold of 12.2 feet (3.75 m). In 1906 the craft had been converted to a stone barge (Rodgers 2000: 23).

Finally, in 2001 and 2002, ECU and the SHSW conducted their 7th and 8th joint projects by investigating a site adjacent to Birmingham's Cottages in Sturgeon Bay. The project confirmed the identification of the 115 foot (35.05m) scow schooner *Dan Hayes*, which sank near shore in Sturgeon Bay, on August 6, 1904 (Rodgers 2001:22) and three more vessels forming the end of a wharf in McCracken's Cove (Rodgers 2002).

Site Location and Description

The *Glasgow* currently lies 100 yards (92.3 m) offshore, in Lilly Bay (Figure 9). It can be clearly seen both from shore, as well as from the air, and appears to have moved little since its grounding, in 1917 (Figure 10). The wreck now rests in between 4 and 10 feet (1.23 and 3.08 m) of water.

The site consists of the bow section of the original vessel. The stern was removed for its conversion to a barge and is not present in the archaeological record. There is little evidence of cargo, which is to be expected, as the craft was empty when she sank. The shallow water and high winds, blowing across Lake Michigan subject the site to a good deal of energy. Ice damage is also a concern. Beach sands in the area can shift rapidly, and zebra mussels are present in large quantity.

Methodology

On the first day of the project a steel cable baseline was established down the center of the wreck with 0 near the stem. The baseline lets archaeologists divide the wreck into manageable sections. In this case, staff and students were each assigned a 20 foot section of wreck to map. In addition to the baseline, a datum point was set up on shore. The two ends of the baseline, the shore, and all nearby prominent features were mapped from the datum with the use of a transit and electronic distance meter. This mapping technique is accurate to .1 inch (0.25 cm) over the distance measured. The datum was located at 44 degrees 50 minutes and 16 seconds North by 87 degrees 16 minutes and 26 seconds West, on the SE corner of a

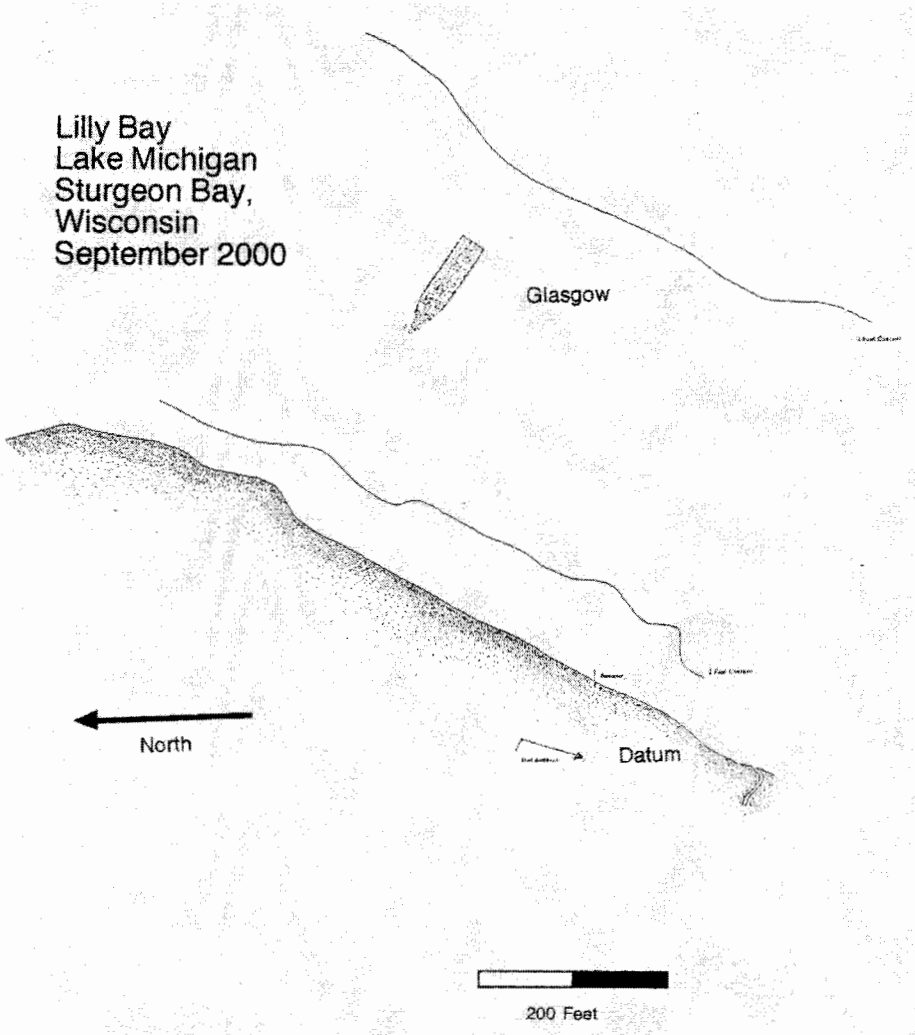

Figure 9. September 2000 survey depicting *Glasgow*'s relationship to shoreline and datum (Maritime Studies Program, East Carolina University © 2000).

Figure 10. Aerial view of the *Glasgow* site showing relationship to the shoreline (Maritime Studies Program, East Carolina University © 2000).

metal bulkhead protecting the front of the Tolan cottage. The coordinates for the *Glasgow* were established by GPS at 44 degrees 50 minutes and 16 seconds north by 87 degrees 16 minutes and 25 seconds west.

Measured sketches and points in each drawing were related to the baseline via trilateration. Measurements were taken in feet and tenths. Aerial photography was also used to document the site. A large PVC scale was laid out next to the site to create a scale, and two students were sent aloft in a small, rented aircraft. Using 100 and 400 ASA film, photos were taken of the shipwreck from several different angles. These photos verified the measured sketches of the overall site map (Figure 11).

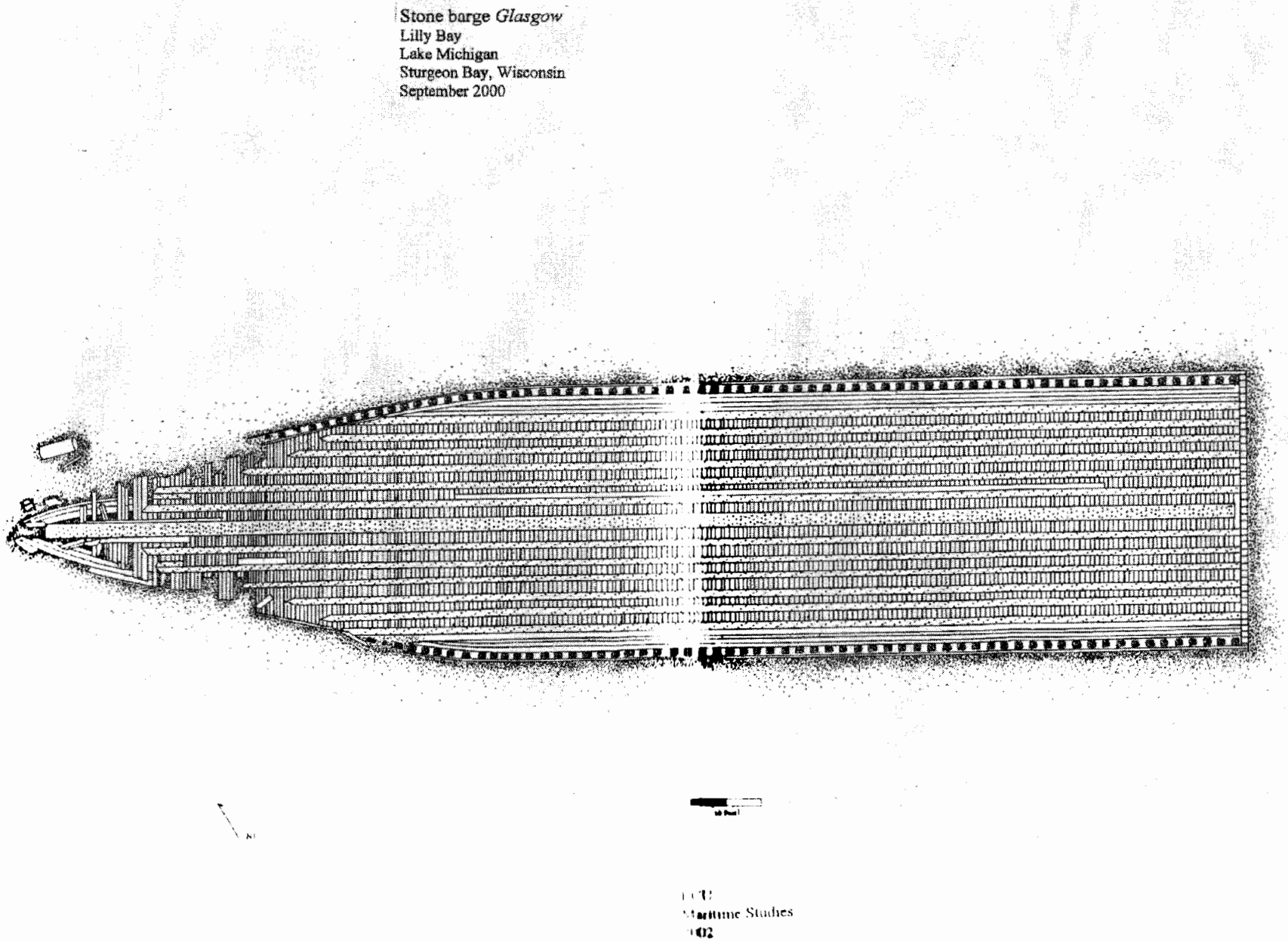

Figure 11. Plan view site map of the *Glasgow*. Note the squared stern (Maritime Studies Program, East Carolina University © 2000).

Results

After her initial sinking, 180 feet (54.86 m) of the *City of Glasgow*'s bow was removed and used to convert her to a stone barge. After the conversion was completed it was recorded that *Glasgow* measured 196 feet (59.74 m) in length with a beam of 41 feet (12.50 m) (Merchant Vessels of the United States 1912). The wreck was found to conform roughly to the recorded beam dimensions but the wreck measured only 173 feet (52.73 m). The 23 foot (7.01 m) discrepancy in the historic record verses the archaeological recorded length is difficult to explain. Clearly the barge was sawn across evenly at 173 feet (52.73 m) in length. So, either the historic record is inaccurate, or modifications were made to *Glasgow* after its initial 196 foot (59.74 m) conversion. The odd flat stern is described at the end of this section but shows no sign of a stern post or any method for attaching a rudder.

Details of the *Glasgow*'s construction indicate that she was once very similar to several other of the Davidson built wrecks that have been examined and may also have be similar to other wooden bulk carriers of the time. There were six bilge keelsons on either side of the main keelson (Figure 12). All were 1 foot (.305 m) sided and 1 foot (.305 m) molded. The main keelson was 2 feet (.610 m) sided and 1.5 foot (.305 m) molded and was held in place with drift pins driven through the floors and keelson in a 2 - 3 - 2 pattern.

One inch by 4 inch (2.54 by 10.16 cm) iron strapping proceeds diagonally up the sides of the hull at 8 foot (2.44 m) intervals in a lattice or basket weave fashion between the frames and outer hull. Drift bolts were driven through the outer hull at the intersection of each iron strap (Figure 13). These bolts penetrate the outer hull, frame, and ceiling.

This basket weave iron bracing appears historically for the first time in the clipper ship *Challenge* built by William H. Webb of New York in 1851. It is unclear whether *Challenge*'s iron basket truss extended to the floors of the ship or was simply added to the sides, but the basket truss certainly did extend to the floor heads in the clippers *Comet* and *Invincible* both built later the same year (Crothers 2000: 196). The early clipper basket truss was installed between the frames and the ceiling planking and was an ideal way to distribute diagonal and flexible support throughout the length of a clipper. Clippers were built primarily for speed and were, therefore, very long lean vessels with typically high length to beam ratios (between 5 and 7 to 1), were prone to hogging and sagging at the ends which were relatively unsupported since they were so sharp of line. Wooden ships from time immemorial were built with bluff bows and sterns for added buoyancy on the ends to combat hogging and sagging.

Webb's concept of the basket truss circumvented the problems associated with bracing wood with iron, namely that the two materials work differently under stress. Typically, wood and iron structures flex differently and while this happens the wood can be crushed against the iron. The iron compressed wood eventually leaves gaps around fasteners and supports, such as iron knees, loosening the structure. Webb's basket truss, however, supported a ship the way a basket can support any flimsy material, from underneath.

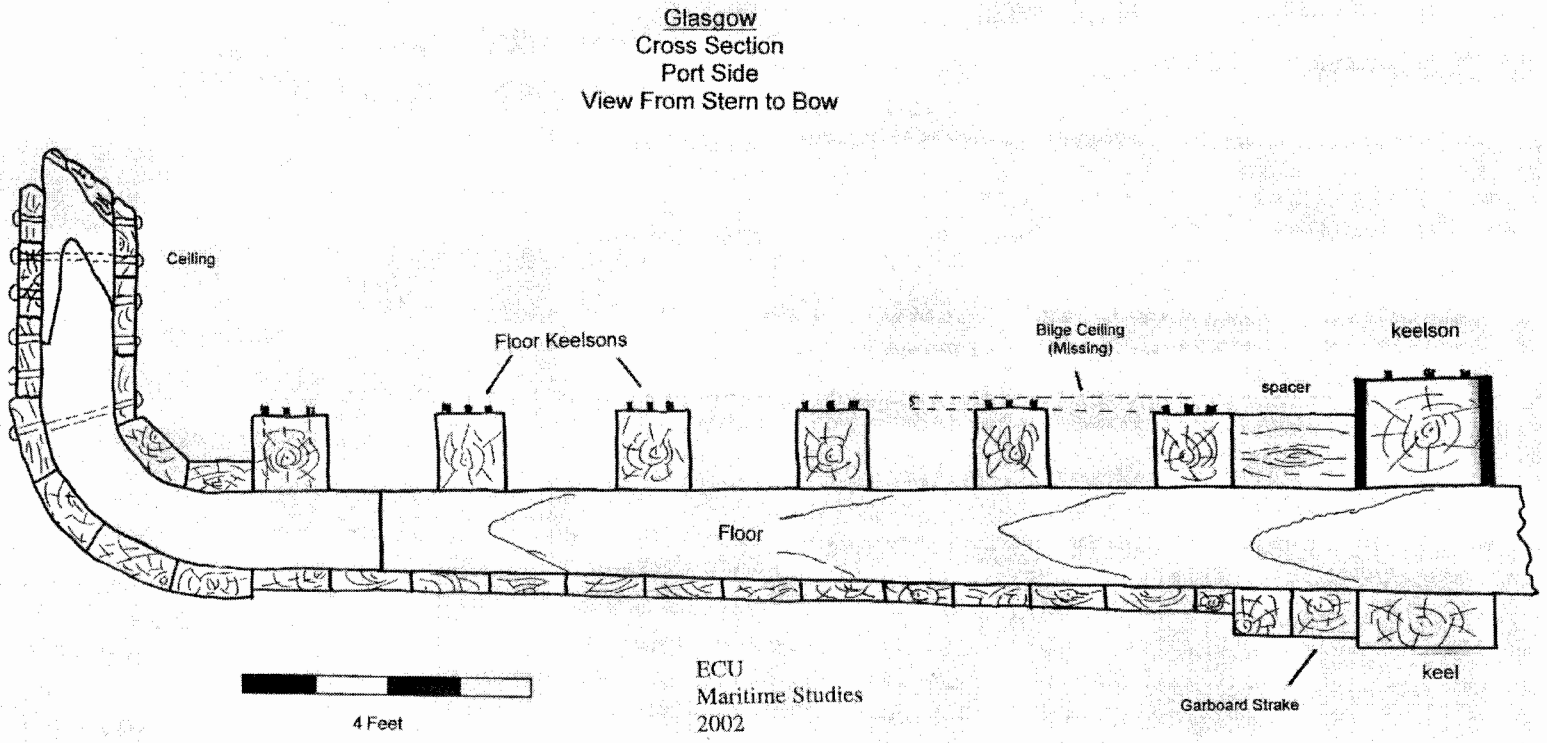

Figure 12. Cross section of the *Glasgow*. Note missing bilge ceiling (Maritime Studies Program, East Carolina University © 2000).

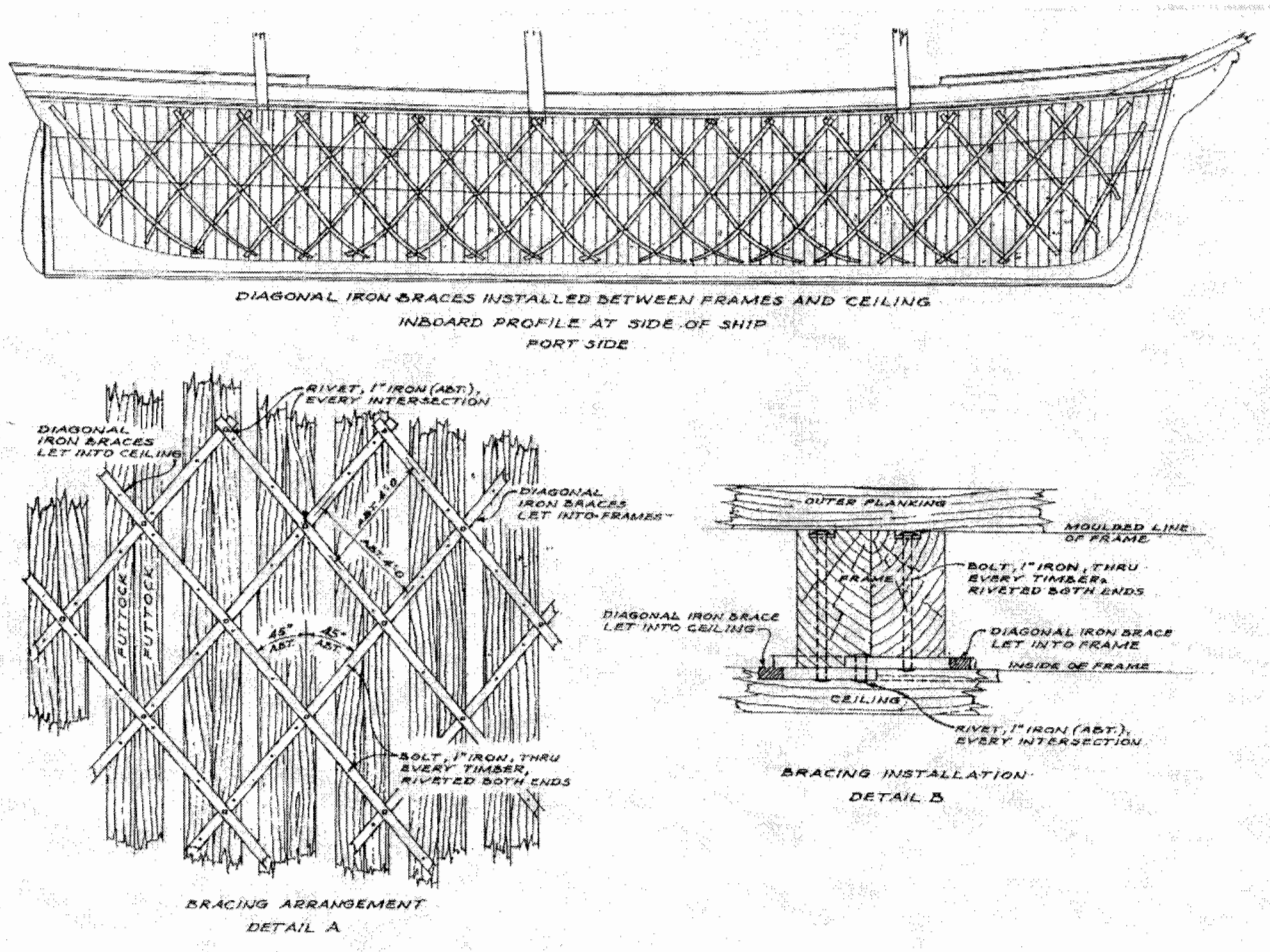

Figure 13. Example of diagonal iron bracing as seen in the clipper ship *Ocean Monarch*. Note unlike *Glasgow* bracing is between frames and ceiling (Crothers 2000: 197).

The basket truss no doubt underwent improvements from its introduction but remains essentially the same on the *City of Glasgow* as it was on the *Challenge*. Interestingly, the *City of Glasgow*'s length to beam ratio of 7.2 would place it ahead of most clippers in sharpness, an odd irony since it was not built for speed. Davidson no doubt borrowed the basket truss concept as an ideal way to improve the strength of his bulk carriers while integrating the flexibility of the chief materials, iron and wood. The iron basket truss was able to flex with the wood, loaning it support from beneath while it did no harm to the relatively soft material that made up the ship's hull.

Two differences do appear, however, on the *City of Glasgow* from the earlier versions of the basket truss. First it is placed between the frames and the outer hull, encompassing the frames of the ship. In the earlier clippers it simply enclosed the ceiling and, therefore, the hold of the ship. The new location of the truss makes greater sense in that it loans support to the entire ship's skeleton from beneath. Secondly the basket truss on the City of Glasgow runs with straps at 8 foot (2.44 m) intervals rather than 4 foot (1.22 m). This both lightens the structure of the ship and saves time and expense in the ship yard. Eight foot (2.44 m) intervals likely detracted little from the strength imbued by 4 foot (1.22m) intervals.

Outer hull planking is held in place on the *City of Glasgow* with through pins and clinch rings. The pins extend through the ship's side from the outer hull to the ceiling and through the frames. This is a highly unusual feature but seems to be consistent with other Davidson built vessels. The purpose of this expensive fastening system is the added strength it gives the ship. Normally a ship's hull planking is simply nailed to the frames and on the lakes the ceiling is nailed with roves over the nail heads. The reason for this tradition is historically unclear, however, it seems certain that roves on the outer hull may introduce added drag like a sort of artificial fouling. Nails are generally considered a good fastener, yet should the ship be stressed by heavy seas and begin to work or flex, nails were subject to working out, resulting in sprung planking and a resultant, and often catastrophic, leak. The compression washers on the heads of the pins and the pins themselves, installed by Davidson could not pull out of the side of the ship as it worked, since they were held in through to the hold of the ship by yet another compression washer. The resultant contrasting strength would compare to bolting the hull together rather than nailing it. A bolt or through pin would likely break before it pulled through the wood.

The extreme bow of the *City of Glasgow* was double floored in much the same manner as *Pretoria* and *Frank O'Conner*. In addition the basket truss did not extend all of the way to the bow, ending some 70 feet (21.33 m) from the stem but running all the way to the flat barge stern. It is logical to assume that the basket truss ended or was fixed in the bow and stern much as it is depicted on the *Shenandoah* (Figure 14). Decreasing the number of floors and discontinuing the basket truss saved weight in the bow and stern in order to reduce hogging and sagging. Frames above the turn of the bilge were set at 2 foot (.61 m) centers with the frame pair comprising 1.2 feet (0.37 m) sided dimension with a 0.8 foot (0.24 m) space between the frame sets.

Ceiling planking on the sides of the ship are found to be 3.6 inches (10.16

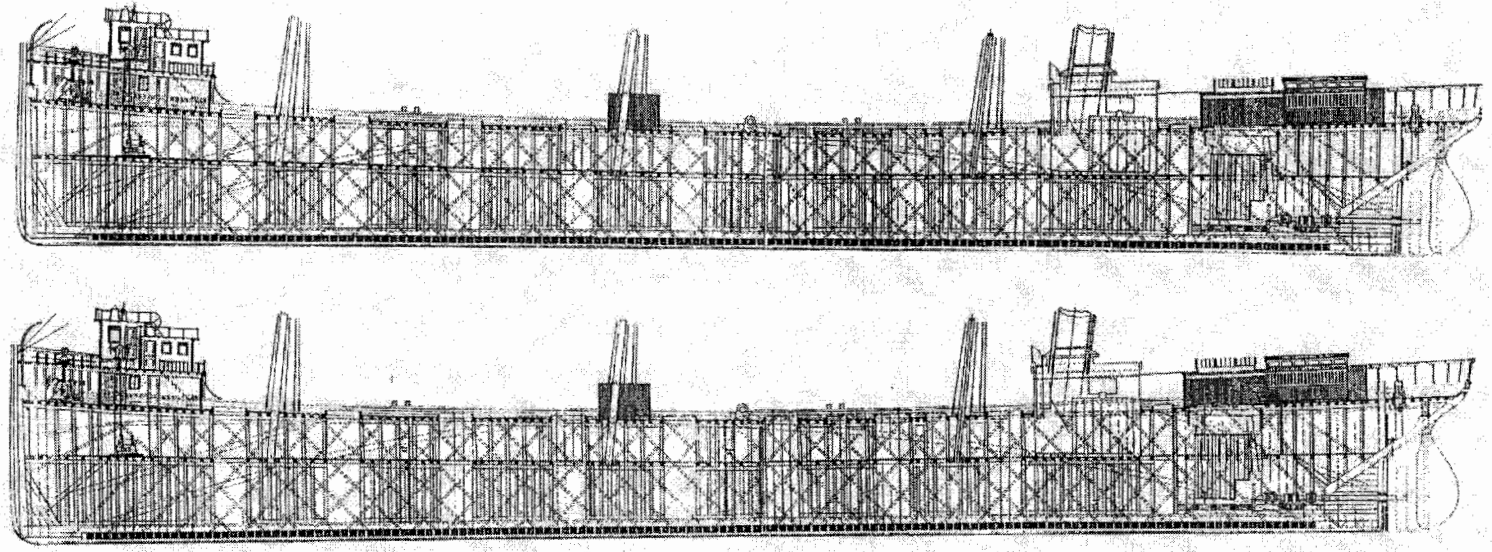

Figure 14. Profile of the wooden bulk carrier *Shenandoah*. Note basket truss and hogging arch (From March Supplement, United States Standard Register of Shipping, nd).

cm) thick, while outer hull planking was 4.8 inches (12.20 cm) thick. No bottom ceiling planks remain. Planking was found to be between 10 inches (25.4 cm) and 1 foot (31.2cm) wide. As mentioned, the majority of the fasteners found were iron drift pins, which had been roved and peened.

Longitudinal floor keelsons are not unusual in a steam powered vessel. These keelsons support the weight of the steam machinery and offer secure anchor points. The floor keelsons also offer good longitudinal support against hogging and sagging greatly stiffening the bottom of the ship. This stiffening is particularly important in propeller driven vessels with a relatively high length to beam ratio such as the *City of Glasgow*. When these ships sail in ballast (in this case empty), most of the weight of the ship lies with the boilers and engines in the stern. The weight can lift the bow section in teeter-totter fashion placing great strain on the length of the ship. In similar fashion, the thick ceiling and outer hull planking at the turn of the bilge helps resist both longitudinal strain, nearly 90° to one another, the greatest stress is placed at the turn of the bilge. Wood's relatively weak ability to resist tension and compression in this area has been traditionally alleviated by the construction of a round or very gradual turn of the bilge, a shape that is not desired in a bulk carrier intended to carry as much cargo as possible on a specific and somewhat shallow draft.

It also seems fairly certain, though it is not reflected in the archaeological record, that *City of Glasgow* carried both main and upper deck beams (Figure 15). These beams would stiffen the sides of the ship and support the decking. It is unclear wether the main deck would be planked, as depicted in the *Shenandoah* cross section, but certainly the weather deck was planked. The two laid deck arrangement seems to be the main evolutionary change between steam barges (the predecessor to the bulk carrier) and bulk carriers.

An unusual aspect of the *City of Glasgow* and her sisters is the athwartship ceiling planking, a feature made possible by the floor keelsons. Normally wooden ships are planked for and aft with the ceiling following suit, this is not the case in the *City of Glasgow*. Athwart ship planking was easier to install and shorter planks could be used, lessening costs. The ceiling planks were not expected to contribute to the ship's longitudinal strength which was carried by the multitude of floor keelsons aided by the basket truss and the keelson sandwich plates. It is also likely that these planks could be more easily replaced than traditional for and aft planking and were, therefore, more desirable at the bottom of the cargo hold, an area that needs constant repair from heavy use.

Taken as a package, the *City of Glasgow* reflects several design characteristics that likely reflect on all wooden bulk carriers of the day. These characteristics do not appear to be true innovations from builders such as Davison but were most certainly borrowed and combined to produce these large ships. Wooden bulk carriers were invariably plumb bowed with a short fantail stern. They were built with a rectangular cross section to the dimensions and draft of the locks at Sault Ste. Marie. On deck the ships had a pilot house and some cabins forward with galley, engineering and cabins aft with uninterrupted deck and cargo hatches between. The hatches were set at 24 foot (7.31 m) intervals for loading at the pocket docks. Internally, these ships are heavily floored and framed in traditional wooden ship

Wooden Freight Steamer for Lake Service.

From March Supplement, United States Standard Register of Shipping. Dimensions 320 x 41 x 26 Feet.—(See Page 7.)

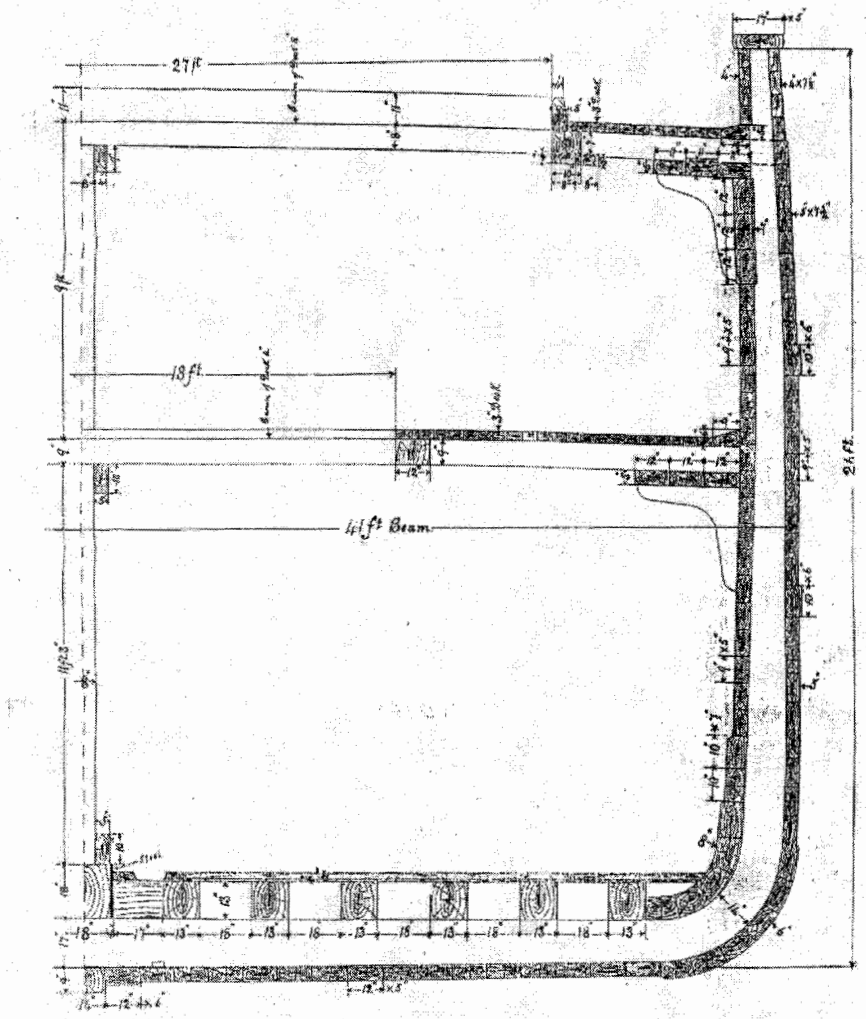

Figure 15. Cross section of the wooden bulk carrier Shenandoah. Note main deck is planked unlike most wooden bulk carriers of the day (From March Supplement, United States Standard Register of Shipping, nd).

building fashion, with the exception of the triple flooring. Their high length to beam ratio, however, dictates the use of 1) multiple floor keelsons plus central keelson, 2) iron straps that sandwich the keelson, 3) a basket truss outside the frames, 4) planking secured by roved through pins, not nails, 5) and iron hogging arch (not evident in the *City of Glasgow* archaeological record - see *Shenandoah* Figure 14), 6) athwart ship ceiling planking, 7) two laid cargo decks, only one of which may be planked, allowing for a large open cargo hold. It also seems likely that iron straps were laid down beneath the weather deck planking on top of the weather deck beams from bow to stern outside the line of cargo hatches to help alleviate hogging and sagging. All of these measures were absolutely necessary in the construction of wooden ships of this size, for this function. It therefore, seems unlikely that the *City of Glasgow*, or any of the other Davidson built vessels, represent or display unique construction techniques or design innovations beyond their vessel class.

The most unusual aspect of the barge *Glasgow* is the converted stern. It appears the hull was simply sawed off flat. Then a bulkhead like partition was installed on the flat end. The working of the hull would have continually twisted this stern partition, leading to leaks and sprung planking lessened to some degree by the basket truss. It is interesting to note that none of the stern planking has survived, indicating the weakness of the conversion. As constructed, this stern would likely not have been able to support a rudder; even if a rudder were installed the wake fraction or water vacuum created by the flat stern would make it all but useless. How the *City of Glasgow* could be towed under control with no rudder is a matter of conjecture but it would likely have made life interesting for both the crew onboard and the pilot of the *John Hunsader*.

Conclusion

The *City of Glasgow* is not an unusual ship for its day on the Great Lakes, nor was its life unusual or associated with famous people or events. Its true value lies in the fact that it was an average wooden bulk carrier – a generic work-a-day ship that reflects every-day life on the lakes. Wooden bulk carriers became an important ship type, but so generic and ubiquitous to the Great Lakes, that few noticed their yeoman service, their passing, or the fact that we know so little about them. This is partially due to the fact that in everything but size, their steel predecessors looked exactly like them. This could not be said for the passing of wooden sailing ships, whose appearance was drastically different, and whose passing has actually detracted a small bit of the beauty of the Inland Seas.

Bulk carriers were an original contribution to maritime architecture. They were designed and defined by the uniqueness of the Great Lakes environment, the cargoes they carried, and the ingenuity of industrialist marine architects like James Davidson. In this light the *City of Glasgow* is likely a direct reflection of the first bulk carrier, *R. J. Hackett*. As a credit to these builders, the bulk carrier has been so successful over the years that it has changed only by small degree, even though built of steel rather than wood The vessel's sole purpose is to move large quantities of bulk commodities such as ore, coal, stone, and later wheat and corn without the need to receive the cargo packaged for shipment.

Requirements needed to service these fresh water oxen drove new innovations in loading and unloading technology eventually developing what might be termed, the integrated bulk carrier system. Innovations such as gravity feed pocket docks and self unloading systems can load and unload large shipments in a matter of hours. The efficiency of the integrated bulk carrier system, greatly reduced the cost to move bulk agricultural and mineral commodities to the east coast, and is, therefore, largely responsible for the affluence of America's heartland and east coast. Yet very little research has concentrated on the history or archaeology of the integrated bulk carrier system, and less energy still has been spent to record and detail, individual vessels like the *City of Glasgow* (the one exception being the study, *Davidson's Goliaths*, by David Cooper and John Jensen).

Thus, bulk carriers are an integral part of America's hidden transportation and logistical system, a system hidden only because it is so common that average people no longer pay any attention to it. The roots of the bulk carrier system lie in the wrecks of wooden bulk carriers like the *City of Glasgow*. They represent a transitional type of vessel spanning the gap between all wooden schooners and schooner barges of the 19th century to the all steel giant bulk carriers of the 20th century. Their layout and large size were dictated by both the economics of moving

ever larger amounts of bulk commodities, and the need for seaworthy practical designs that inland sailors could easily sail, handle, load and unload.

As originally constructed by James Davidson, the *City of Glasgow* represented a typical wooden steam-propelled bulk freighter. Wooden bulk carriers, as a ship class, persisted for close to 40 years, nearly the same amount of time as some other marine trends, such as the clipper ship. Yet bulk carriers did not disappear like the clipper, they simply transformed in size and hull material. Her internal construction shows the lengths to which Davidson and other builders had to go to brace a wooden design for this duty and extreme size. Wooden ships can rarely exceed 200 feet (60.96 m) in length as the weight of such a structure would soon exceed the strength of the wood to carry the weight. Another factor limiting the size of wooden ships is simple economics. The extreme size of the supporting internal structures and hull thickness, insured that they could not compete in internal carrying capacity with similar sized steel vessels; and they certainly could not, in the end, easily double in size to 600 feet (182.88 m) and larger, as the steel vessels eventually did. So cargo capacity became the one limiting factor in the final use of wood as a hull material for such vessels as the *City of Glasgow*.

Other factors which insured the decline of wooden ships included the expense of wood, and safety of wooden hulls. By the turn of the century the cost of wood was rising dramatically. The forests of the midwest could no longer support the almost inexhaustible demand for the material in the growing country, and steel prices fell with each new technical innovation in production efficiency. Ironically, this included the use of bulk carriers to carry the raw ore from the ranges on Lake Superior to the industrial centers in and around Gary, Indiana. Bulk carriers like the *City of Glasgow*, sowed the seeds of their own obsolescence by lessening the cost of steel.

As can be seen in the historic record, safety was an issue with wooden steam ships. Many other examples of these vessels such as the *Fedora*, *Frank O'Connor*, and *Louisiana* (Figure 16) were destroyed by fire. Other classes of wooden steamers seemed equally helpless in the face of this danger. Only the switch to iron and later steel hulls seems to obviate the fire hazard.

Although the *Glasgow* has been adequately surveyed, further preservation may be necessary to prevent the wreck from disappearing completely. Numerous other wrecks from this time period exist, but few have such a rich history as the *Glasgow*. Wrecks such as the *Pretoria*, *Frank O'Connor* and *Glasgow* allow archaeologists to piece together an accurate picture of the shipbuilding techniques employed by James Davidson and others to push the limits of wooden hull size. *Glasgow* also sheds light on the barge conversion techniques of Leathem and Smith. The *Glasgow* is a site that lies in a highly dynamic, high energy environment, and can be expected to deteriorate quite quickly. The documentation of the site, therefore, will provide future archaeologists and historians with critical clues concerning 19th century wooden bulk carrier construction on the Great Lakes.

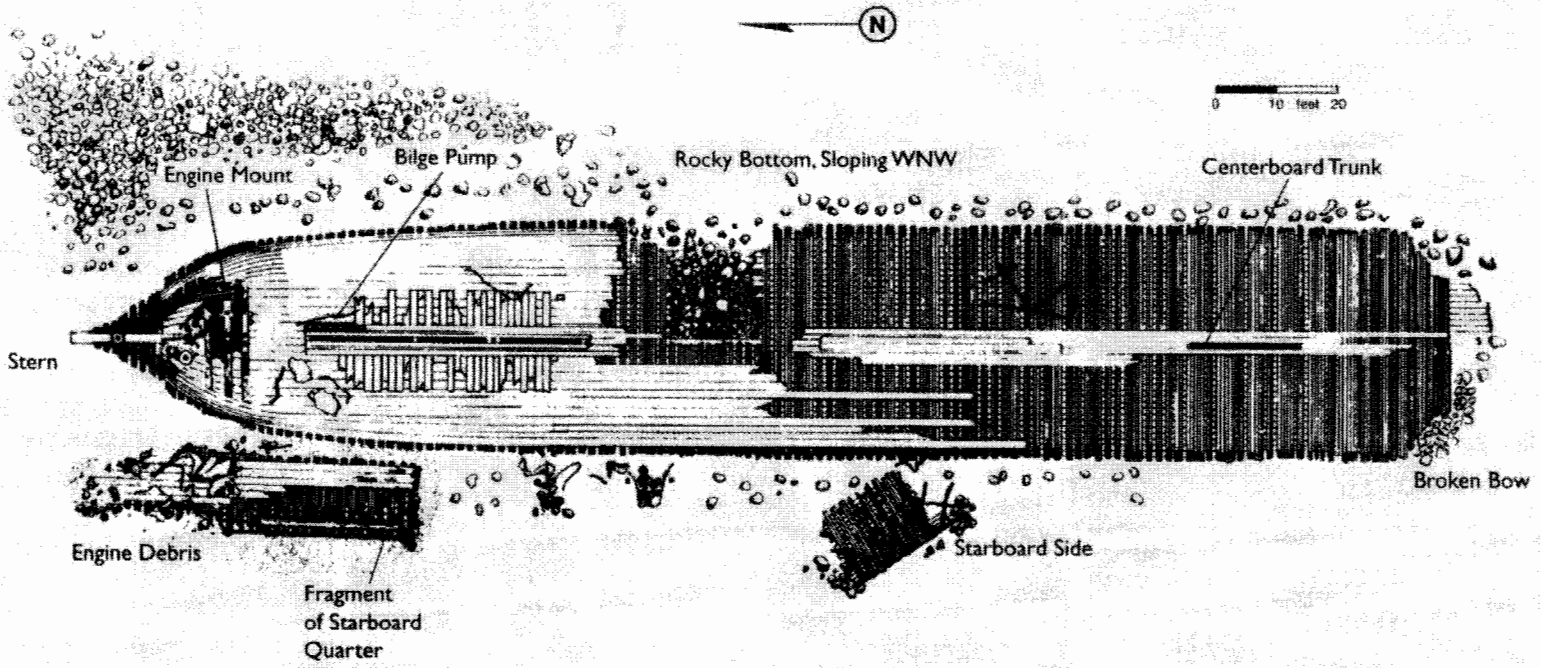

Figure 16. The wooden bulk carrier *Louisiana*. Burned and wrecked on Washington Island. Note centerboard trunks and fore and aft ceiling planking (Wisconsin Sea Grant and the Wisconsin State Historical society).

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