NORMAN AND *GRECIAN:*

A COMPARATIVE ARCHAEOLOGICAL SITE FORMATION ANALYSIS OF TWO STEEL-HULLED GREAT LAKES BULK CARRIERS IN LAKE HURON

By

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Program in Maritime Studies, Department of History

Abstract

Thunder Bay National Marine Sanctuary (TBNMS) in Alpena, Michigan contains the remains of approximately 200 shipwrecks. Located within the sanctuary are two vessels, *Norman* (1890-1895) and *Grecian* (1891-1906). Both built by Globe Iron Works in the early 1890s, they present an opportunity for a comparative archaeological site formation analysis study. Using historical and archaeological data from *Norman* and *Grecian*, several 3D models were created to showcase how they ships transformed as shipwreck sites. Model data is used to communicate the various environmental and anthropogenic factors that have altered these wrecks through time.

Norman and *Grecian*:

A Comparative Archaeological Site Formation Analysis of Two Steel-Hulled Great Lakes Bulk Carriers in Lake Huron

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By

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Introduction

The Great Lakes are one of the most important regions for shipping in the United States. As a result of the large trade fleet that has sailed the lakes, there is also an abundance of shipwrecks. To bring national attention to some of this nationally significant assemblage of shipwrecks, the federal government created Thunder Bay National Marine Sanctuary (TBNMS) in Lake Huron under the management authority of the National Oceanic and Atmospheric Administration (NOAA) and the State of Michigan in 2000 (TBNMS 2022). Two of the many vessels included in the sanctuary are *Norman* and *Grecian.* These nearly identical vessels were constructed in the 1890s by Globe Iron Works for the purpose of shipping iron ore for the Chapin Iron Mining Company. Both vessels were then lost within 16-years of their construction (Mansfield 1899:450).

While timber resources were being exploited in the Great Lakes region in the mid-1800s, iron was also discovered. In 1844, the first iron deposit was discovered on Lake Superior in the Upper Peninsula of Michigan (MI). The Great Lakes iron industry, however, remained small until the 1870s, when the Menominee Range was discovered and the number of iron mines grew. In the 1880s two more significant iron deposits were discovered and the final iron range was discovered in the 1890s (Mansfield 1899:163). The development of the Lake Superior iron mines also led to an increase in the number of ships and the number of commodities being shipped (Hartmeyer 2016:11). In 1888, iron ore surpassed timber as the most shipped commodity of the Great Lakes (Lake Carriers Association 1911:123). In 1890, Lake Superior iron composed

56.95% or 9,132,526 tons of iron produced in the United States (United States Department of the Treasury 1892:xxii).

Owing to the amount of shipping coming from Lake Superior to the steel mills in Ohio and Pennsylvania, several ports were developed to load the raw iron ore. One of these ports was Escanaba, MI. As a result of a variety of factors, both natural and humanmade, Escanaba grew larger than other ports on the lakes. This port developed more than other ports for several reasons. First, railroads were constructed from the various mines to the town, which allowed quick transport of ore to the port. Second, since Escanaba is located on the southern shore of the Upper Peninsula, it was able to avoid the bottleneck that occurred in the canal locks connecting Lake Huron to Lake Superior at Sault St. Marie. Third, due to not having to travel through the Soo Locks (the previously mentioned canal at Sault St. Marie) and being closer to the steel mills, the shipping time was shorter from Escanaba (Figure 1). Last, due to their slightly more southern location, the port remained ice-free for approximately two weeks longer than Lake Superior ports, which prolonged the shipping season (Hartmeyer 2016:12).

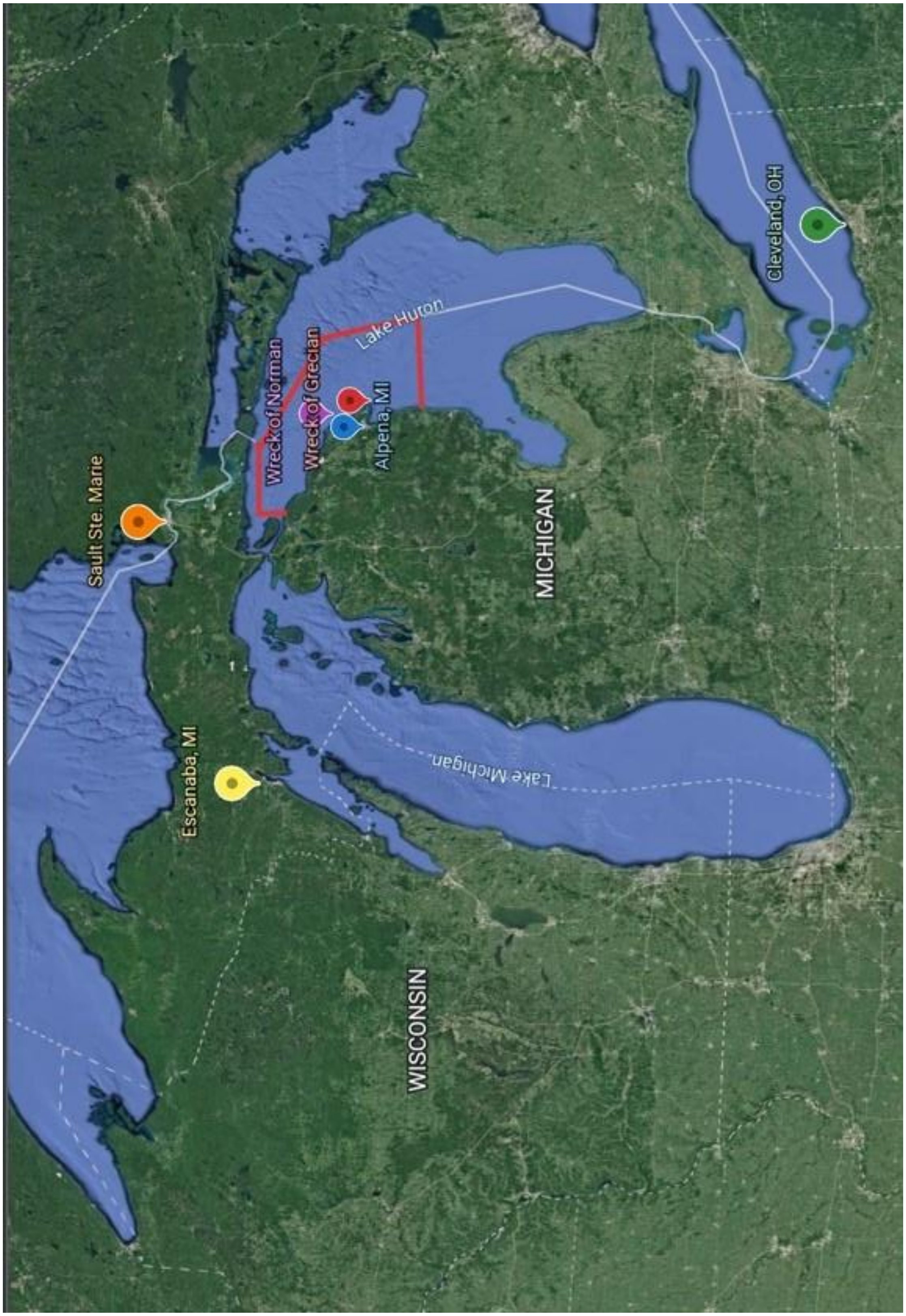

Figure 1: Map showing locations relevant to this project including an outline of Thunder Bay National Marine Sanctuary (Image by Caleb O'Brien).

Several mining corporations opened in the region due to Escanaba's advantages. The area's largest producer was the Chapin Mining Company, founded in 1879. In the first decade of its operation, the Chapin Mine relied on contracts to ship their iron ore. By the late 1880s, however, the mining companies realized that it would be more profitable to own all aspects of iron production, including transportation. As a result, in 1890 the Chapin Iron Company founded the Menominee Transit Company with the help of two brothers already involved in the shipping of iron ore. That same year, the Menominee Transit Company ordered the construction of six nearly identical vessels from Globe Iron Works: *Norman, Saxon, German, Briton, Grecian,* and *Roman* (Mansfield 1899:450).

These vessels were all built to the standard design of lake freighters, with the technology of the time. Like the vessels that came before them, this series of watercraft saw the cabins forward and aft, allowing a large midsection for holding cargo. This configuration also saw increased visibility and helped prevent collisions since the pilothouse was located at the bow of the vessel. Unlike most other watercraft on the lakes, this series of ships were powered by triple-expansion steam engines that gave significantly more power than compound or single cylinder steam engines. Constructed only two years after the first steel-hulled and triple expansion engine lake freighter, *Corona*, and only four years after the first steel laker, *Spokane,* these vessels were part of the first generation of steel bulk freighters (Mansfield 1899:450; Hartmeyer 2016:14-17).

The two vessels being examined as part of this study are *Norman* and *Grecian. Norman* was the first of the vessels for the Menominee Transit Company. Commissioned in 1890, it worked for five years hauling ore before sinking. On May 30, 1895, *Norman* was sailing back to Escanaba carrying a small cargo of coal when it was struck by the Canadian steamship, *Jack*. Within minutes of the collision, *Norman* sank to its present location, roughly 200 feet underwater near Alpena, MI. A salvage operation was planned in 1897, but never materialized (*Duluth Evening Herald* 1897). Because this vessel was not salvaged like other ships of this area, NOAA has reported that *Norman* remains very intact (Hartmeyer 2016:5-7).

Grecian was constructed one year after *Norman* in 1891. On June 7, 1906, *Grecian* struck a rock near DeTour, MI while sailing to the steel mills on Lake Erie. This caused the vessel to take on water forcing it to sail into DeTour. The vessel sank while docked, settling approximately 21 feet underwater (*Buffalo Evening News* 1906). A few days later the vessel was patched and pumped before it was to be towed to Detroit for repairs. En route to Detroit, the patch failed, causing *Grecian* to sink in 100 feet of water near Alpena, MI (*Door County Advocate* 1906). Three years after its sinking, the owners of *Grecian* commissioned a salvor to recover the vessel. Unlike the proposed salvage attempts for *Norman*, two recovery attempts occurred. On October 6, 1909, one of the devices needed to recover the vessel failed, causing a safety hazard for the salvors, and decreasing the chances for success (*Alpena Argus Pioneer* 1909; *Door County Advocate* 1909). Following another failed attempt in 1910, the salvage company ran out of funds to recover the vessel, ended salvage efforts, and the wreck faded from public knowledge until it was rediscovered in 1971 (Hartmeyer 2017:5-6; Thunder Bay National Marine Sanctuary 2022, Research Collection, *Grecian*).

Despite the salvage attempts, *Norman* and *Grecian* remain where they sank. Currently, they lie within the boundaries of TBNMS, whose goal is to protect these wrecks:

> To provide authority for comprehensive and coordinated conservation and management of these marine areas, and activities affecting them, in a manner

which complements existing regulatory authorities (National Marine Sanctuaries Act, United States Congress 2000).

Because TBNMS has the purpose of protecting and managing the shipwrecks within the sanctuary boundaries, understanding site preservation conditions are crucial for ensuring their long-term preservation. As will be discussed in more detail, an archaeological site formation analysis is a form of study in which the causes for change on archaeological sites are discovered and analyzed. Using three-dimensional models (3D) and an understanding of the cultural and environmental transformations affecting *Norman* and *Grecian* allows for the development of management plans for these sites. Furthermore, archaeological site formation analyses may be used to propose future disintegration models of these wrecks.

The reason that *Norman* and *Grecian* are excellent candidates for an archaeological site formation analysis study is that they are nearly identical ships lost under different circumstances. By studying near-identical ships, an archaeological site formation analysis would lend itself to isolating any potential common and site-specific transformation processes affecting each wreck – whether culturally- or environmentally-derived. Emphasizing similarities and differences may illuminate the general transforms affecting shipwrecks in the Great Lakes, potentially allowing new knowledge to be applied to other shipwrecks in the TBNMS (and possibly other areas within the Great Lakes). Additionally, because TBNMS is jointly managed by NOAA and the State of Michigan, there is a vested interest in protecting these shipwrecks for the benefit of the American people. These agencies would be helped by understanding what factors may contribute to future deterioration at the archaeological sites.

An archaeological site formation analysis on these two vessels also expands the knowledge of Great Lakes archaeological maritime site preservation in general. As discussed later, most of the previous research has been primarily focused on the compilation of site histories and mapping individual shipwrecks. As a result, this study contributes greatly to the knowledge of Great Lakes maritime archaeology since it is the first comparative archaeological site formation analysis study on submerged cultural heritage in the Great Lakes.

Research Questions

This study examined how environmental and cultural factors have altered *Norman* and *Grecian*. This knowledge can be used to determine the best practices for the management of these shipwrecks. Since there are many other wrecks within TBNMS, these practices may also be applied to these other vessels.

Primary Research Question

- Can 3D models created using historically accurate data, recent multibeam sonar imagery, and an understanding of the archaeological site formation processes affecting shipwreck sites explain the present-day appearance of the shipwrecks *Norman* and *Grecian,* and illuminate the sequence of disintegration to date and into the future?

Secondary Research Questions

- What primary environmental processes (*n-transforms*) caused *Norman* and *Grecian* to transform from ship to shipwreck, and may cause future alteration to the archaeological sites?

- What primary anthropogenic processes (*c-transforms*) caused *Norman* and *Grecian* to transform from ship to shipwreck, and may cause future alteration to the archaeological sites?

Previous Research

Past research on *Norman* and *Grecian* focused on the history of these two sites. As shown by Philip Hartmeyer's National Register of Historic Place Nominations, the history of both vessels has been extensively researched (Hartmeyer 2016, 2017). Archaeological study of these two vessels, however, has been quite limited.

In the year of TBNMS's creation (2000), two sonar surveys were conducted at the *Grecian* site which gave a general understanding of the size, extent, and orientation of the shipwreck. This information was then used in 2003 to design a mooring system for the bow and stern of *Grecian,* allowing divers to easily access the site. Between 2003 and 2009, yearly inspections monitored changes in the site. In 2009, maritime archaeologists working as part of TBNMS created a site plan of the wreck. Since then, high-definition photographs, videos, and 360-degree panorama images have been collected. These images are to monitor the site condition and are displayed within the Great Lakes Maritime Heritage Center (Alpena, MI) for public outreach purposes (Hartmeyer 2017:7).

The extent of research on *Norman* is much less than that concerning *Grecian*. Despite the lack of documentation, however, significant fieldwork at the site has resulted in an orthomosaic photograph, a photogrammetric model, and sonar scans (Figure 2) (Hartmeyer, pers. comm. 2020). Beyond NOAA's archaeological research and interpretative products, a private company, 3Deep, has created a virtual rendering of both sites. These renderings appear to be based on photogrammetric models of the shipwrecks and will be helpful in understanding the construction of the ships as they appear today.

Figure 2: Orthomosaic of Norman. *(Courtesy of TBNMS).*

Thesis Structure

This project is an archaeological site formation study, combining historical and archaeological research on two steel-hulled bulk freighters located in Lake Huron. The resulting thesis is structured in the following manner. This chapter gives a brief overview of the history of *Norman* and *Grecian* along with previous research on them that has taken place. It also lists the questions that guided the project and provides the structural layout of this thesis. Chapter Two is focused on archaeological site formation theory and examines the works of Michael Schiffer and Keith Muckelroy, as well as those who have added to their theoretical works. Within this chapter the cultural and noncultural transformations affecting the wrecks are highlighted and their effects discussed. The contents of this chapter then guided development of the methodologies employed in the project, which are discussed in Chapter Three. The methodologies include the collection of sources and the construction of the models that were crucial for this project's interpretation. Chapter Four provides the results of the historical research. The historical results created for this chapter were guided primarily by the theoretical and methodological approaches laid out in the previous chapters. This history details the contextual history of these two ships and the site-specific histories of *Norman* and *Grecian*.

Chapter Five combines archaeological site formation theory, historical context, and the methodology used in modeling the two vessels by unveiling the 3D models. Examining these two vessels individually allows. Chapter Six then compares the deterioration of these wrecks, allowing common and dissimilar deterioration processes to be examined. These deteriorations are then compared with the deteriorations of other archaeological sites located within TBNMS and sites outside the Great Lakes. Lastly, Chapter Seven provides a summary of the project and its conclusions. This final chapter also presents potential future research opportunities based on the work of this thesis.

Chapter Two: Archaeological Site Formation Theory

Introduction

The theoretical perspective used for this study is archaeological site formation analysis as derived from Behavioral Archaeology. To understand how this theoretical perspective is used in this project, this chapter will begin by tracing the history of archaeological site formation research. This approach was originally delineated by the parallel works of Michael Schiffer (1972, 1987) and Keith Muckelroy (1978). Although this theory was originally intended for terrestrial sites (Schiffer) and wooden wrecks (Muckelroy), it has since been applied to ferrous-hulled vessels (e.g., McCarthy 1994; Fox 2015). Later authors such as Stewart (1999), Ward, Larcombe, and Veth (1999), and Gibbs (2006) expanded the theory into new directions by considering factors such as sedimentary changes and the role of disaster events. Once the history of site formation theory is presented, this chapter will take a closer look at the *pre-depositional*, *depositional*, and *post-depositional* factors that alter wrecks through various *c-transforms*, or *c-transforms*, and noncultural transforms, or *n-transforms*. The use of these factors in this study will enable the analysis of how the *Norman* and *Grecian* archaeological sites were formed (and continue to transform).

Background

In the 1960s the predominant archaeological theory was ‘processualism’ or the ‘New Archaeology.’ This line of thinking was considered more scientific, however, it also brought forward the idea of the ‘Pompeii Premise’ (Schiffer 1985:18; Johnson 2020:63). Although the ‘Pompeii Premise’ is generally seen as treating archaeological sites as time capsules, Michael

Schiffer, a terrestrial archaeologist in the American Southwest, argued that the 'Pompeii Premise' views artifacts as found in their *systemic context* and not their *archaeological context.* Due to this conflict, Schiffer proposed a modification to processual approaches where artifacts are studied in both contexts and named the new approach 'Behavioral Archaeology.' From 'Behavioral Archaeology' a subfield known as 'archaeological site formation' evolved to focus on the movement of artifacts through their systemic and archaeological contexts (Schiffer 1985:18).

In the 1970s, Schiffer postulated that the archaeological record is formed by diverse processes from both people and nature. These processes transform sites and artifacts from their *systemic context,* or the objects in use, to their *archaeological context,* or the objects as archaeologists find them. Schiffer separated these processes into two varieties: *cultural formation processes* (*c-transforms*) and *noncultural formation processes* (*n-transforms*) (Schiffer 1987:7). Schiffer recognized that these different processes occur on archaeological sites but argues that they happen in a systematic fashion that allows archaeologists to understand how objects transition from their *systemic context* to their *archaeological context.* To make this argument, Schiffer asserted that both *cultural* and *noncultural transformation processes* are regular in regard to causative variables and consequences. Causative variables, he argues, determine certain formation processes. To highlight this, Schiffer used an analogy of an archaeological site in the woods being altered by tree roots. Consequences or effects of processes are predictable, and he used the example of artifacts being crushed, broken, or worn by people, animals, or other forces on a hardpacked surface such as a floor (Schiffer 1987:21-22).

The principal parts of site formation theory, according to Schiffer, are the processes transforming sites. Schiffer defines *cultural formation processes* or *c-transforms* as "the processes of human behavior that affect or transform artifacts after their initial period of use in a given activity" (Schiffer 1987:7). *C-transforms* are broken into reuse processes, cultural deposition processes, reclamation processes, and disturbance processes (Schiffer 1987:7). Reuse processes are described as an object getting a new owner or gaining a new use. This reuse can occur both to broken and serviceable objects. Broken objects can develop new purposes, like a broken pot becoming an aggregate in concrete. Serviceable items such as clothing that become too small can become someone's new clothes (Schiffer 1987:28). A cultural deposition process entails humans depositing an object that is no longer in use, like someone taking out the trash (Schiffer 1987:47). The third type of *c-transforms* are the reclamation processes. These processes involve humans taking an object that has been previously deposited and using it for another purpose. Schiffer believes that the primary reasons for reclamation are salvaging, scavenging, and collecting (Schiffer 1987:99-120). The fourth and final type of *c-transforms* are disturbance transformations. These transformations are characterized by earth-moving transformations, planning stage transformations, construction stage impacts, and operation stage transformations. Earth-moving transformations are those transformations that occur through actions such as trampling the ground and plowing a field. The last three subgroups are described as a result of all other human activity. Planning stage transformations can include survey crews building roads to get to a new area or drilling holes to ground-truth mineral resources. Construction stage transformations include the changes from the construction processes, support activities, and even things such as collecting from the construction crew (Schiffer 1987:121-136). As Schiffer notes, this list of processes is not exhaustive, but it gave future archaeologists insight into the kinds of *c-transforms* that could affect archaeological sites.

Alongside *c-transforms,* Schiffer argues that archaeological sites are also affected by *noncultural formation processes* or *n-transforms,* which are “any and all events and processes of the natural environment that impinge upon artifacts and archaeological deposits” (Schiffer 1987:7). These events are then subdivided as those that decay objects, those that disturb objects, and those that deposit new things on the artifacts (Schiffer 1987:7). When it comes to the decay of objects, Schiffer considers three different reasons for decay: chemical agents, physical agents, and biological agents. For an individual object, any combination of these agents can be a contributing factor in decay. When it comes to describing these changes in objects, Schiffer goes through the various materials from which an object can be made (like wood, stone, or iron) and then discusses the different deterioration methods that can decay that material (Schiffer 1987:147-197). When it comes to processes adding and altering sites, Schiffer breaks them into two categories: those that affect the local site and those that affect the region. Local changes include ‘turbations’ caused by a variety of reasons such as freezing and thawing (cryoturbation), plants (floralturbation), and animals (faunalturbation). Each of these factors has the potential to add to an archaeological site or alter it in some manner. Floralturbations, for instance, can include plants leaving pollen on a site and having roots rearrange it into a more scattered pattern (Schiffer 1987:199-234). Regional transformations include things such as volcanic and hydrological processes. These processes are like local processes but occur at a much larger scale on a bigger area. When it comes to *n-transforms,* Schiffer notes that many different types of processes are involved that occur on both an individual object, site, and regional level. As previously noted, each of these processes are predictable and regular, thus allowing archaeologists to rewind the temporal clock to see how an artifact has transformed from its *systemic context* to its *archaeological context* (Schiffer 1987:251-267).

Around the same time Michael Schiffer began recognizing that terrestrial sites were altered through formation processes, maritime archaeologist Keith Muckelroy developed a system for how ships became shipwrecks. In his book *Maritime Archaeology* (1978), he lays out the idea that when a ship becomes a shipwreck it goes through an alteration changing the pre-depositional ship into the post-depositional wreck (Muckelroy 1978:158). This process is highlighted below (Figure 3). The reason that Muckelroy developed these ideas is due to his recognition that the processes involved in terrestrial site formation are radically different than those for underwater sites. Specifically, he notes that the environmental factors of being underwater are different from those on land. Secondly, and perhaps most importantly, he states that the biggest alteration for site formation, human interaction, is much less prevalent on maritime sites. He continues by stating that even if there is human interaction affecting a site, the interaction will be highly noticeable since salvage is more significant than normal human interactions (Muckelroy 1978:159).

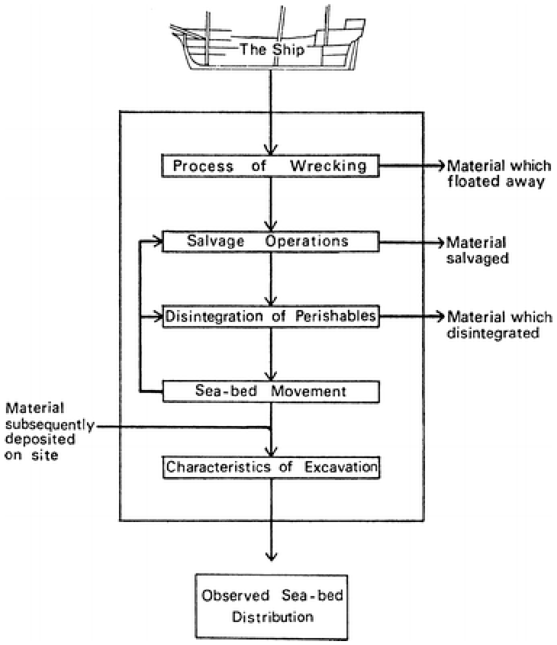

Figure 3: Flow diagram on the evolution of a ship to a shipwreck (Muckelroy 1976:158).

When it comes to the processes illustrated in Figure 3, Muckelroy notes that two major types of processes occur: *extracting filters* and *scrambling devices*. Extracting filters are described by Muckelroy as “processes which lead to the loss of material from a wreck-site” (Muckelroy 1978:165). In the above diagram, these processes are the wrecking event, any salvage operations, and the disintegration of perishables (Muckelroy 1978:165). Scrambling devices are the processes in which the organization of the site is altered. This occurs when the wrecking event happens since the organized ship is changed into the wreck, and when the wreck itself is changed due to the movement of the seabed (Muckelroy 1978:159).

As noted above, Muckelroy identified the wrecking event, salvage operations, and disintegration of perishables as extracting filters. When it comes to the wrecking event, he sees it as being an extracting filter since during the wrecking event, some of the materials and artifacts on the wreck will float while others will sink. He thus argues that archaeologists must be able to examine the wreck and see what artifacts are present and what is missing. This examination will allow researchers to determine certain aspects of the sinking such as if it was a rapid or slow sinking. The other form of extraction devices discussed by Muckelroy is salvage. As he notes, certain wrecks, namely those in deeper waters and uninhabited areas, are less likely to be salvaged. Many wrecks were salvaged, however, and an archaeologist must search the historical record or site for signs of salvage and see what was extracted from the site. Lastly, Muckelroy, like Schiffer, recognizes that the environment disintegrates objects. Unlike Schiffer, Muckelroy does not get into the science of corrosion and simply says research is needed to determine the corrosion rates of various materials underwater (Muckelroy 1978:166-167).

Muckelroy also discusses scrambling factors that occur from the wrecking event and sea-bed movement. When it comes to the wrecking event, he states that it takes a highly organized structure (the ship) and disarticulates it both in the process of sinking and its movement until it gets to the seabed. During this process, it becomes likely that various artifacts and segments of the wreck move from their systemic context to their archaeological context. He also notes that some wrecking events do not scramble the ship as much as others, which is seen in the case of *Vasa* (Muckelroy 1978:169-170). Sea-bed movement is also a recognized factor since he states that tidal currents, which occur at any depth, and waves, which occur at shallower depths, move the seabed and thus can change the position of the components of an archaeological site. Much like the work on environmental disintegration, Muckelroy also states that more research is needed to understand the various effects of sea-bed movement on wrecks (Muckelroy 1978:175-176).

After Muckelroy and Schiffer laid out the ideas for archaeological site formation theory, other archaeologists began applying the theory and adding to it on their own. In 1996, Michael

McCarthy added to general archaeological theory with his argument for studying ferrous and steam ships that previous researchers had discounted. He also added to site formation theory by applying it to ferrous and steam-powered vessels. In his study, McCarthy recognized several differences between iron/steel vessels and wooden vessels. The first of these differences is the deposition of the wreck itself. As he notes, ferrous ships, unless carrying extremely buoyant cargo, will sink directly to the bottom. The strength of the iron also leads to a change in how the wreck will lay on the bottom. As opposed to wooden wrecks which generally collapse and get covered by sediment, ballast, and other materials, ferrous wrecks generally remain upright even in coastal zones (McCarthy 1996:203-204). The biggest change between ferrous and wooden wrecks that McCarthy notes is that ferrous wrecks will undergo different corrosion processes compared to wooden wrecks since iron/steel is more prone to chemical corrosion (McCarthy 1996:206-211).

Another archaeologist who added to archaeological site formation theory is David Stewart (1999). Although Stewart did not directly add to the ideas of site formation, he summarized the work that has occurred since Muckelroy wrote his theory and what aspects of it are relevant to underwater archaeological sites. The most important of the changes he discussed is the honing that occurred in some of the processes laid down by Schiffer. For example, *c-transforms* affecting post-depositional sites have been identified as reclamation (salvage), construction, fishing, dredging, and lastly disposal of refuse. By identifying specific transforms, maritime archaeologists can easily apply site formation theory to underwater sites. Furthermore, Stewart showed that Muckelroy and Schiffer are describing the same theory and that their theories work well when combined (Stewart 1999:566-578).

In 1999, researchers Ingrid Ward, Piers Larcombe, and Peter Veth published an article entitled "A New Process-Based Model for Wreck Site Formation." In it the authors suggested a new model for *n-transforms*. The model that they proposed, which is significantly more scientific than previous ones, is based on sedimentary budget and rates of deterioration. As a result of this new model, they also created an updated flow chart based on Muckelroy's flow chart (Figure 4). Their new chart contains the sedimentary budget and environment type as evolutionary steps from ship to shipwreck.

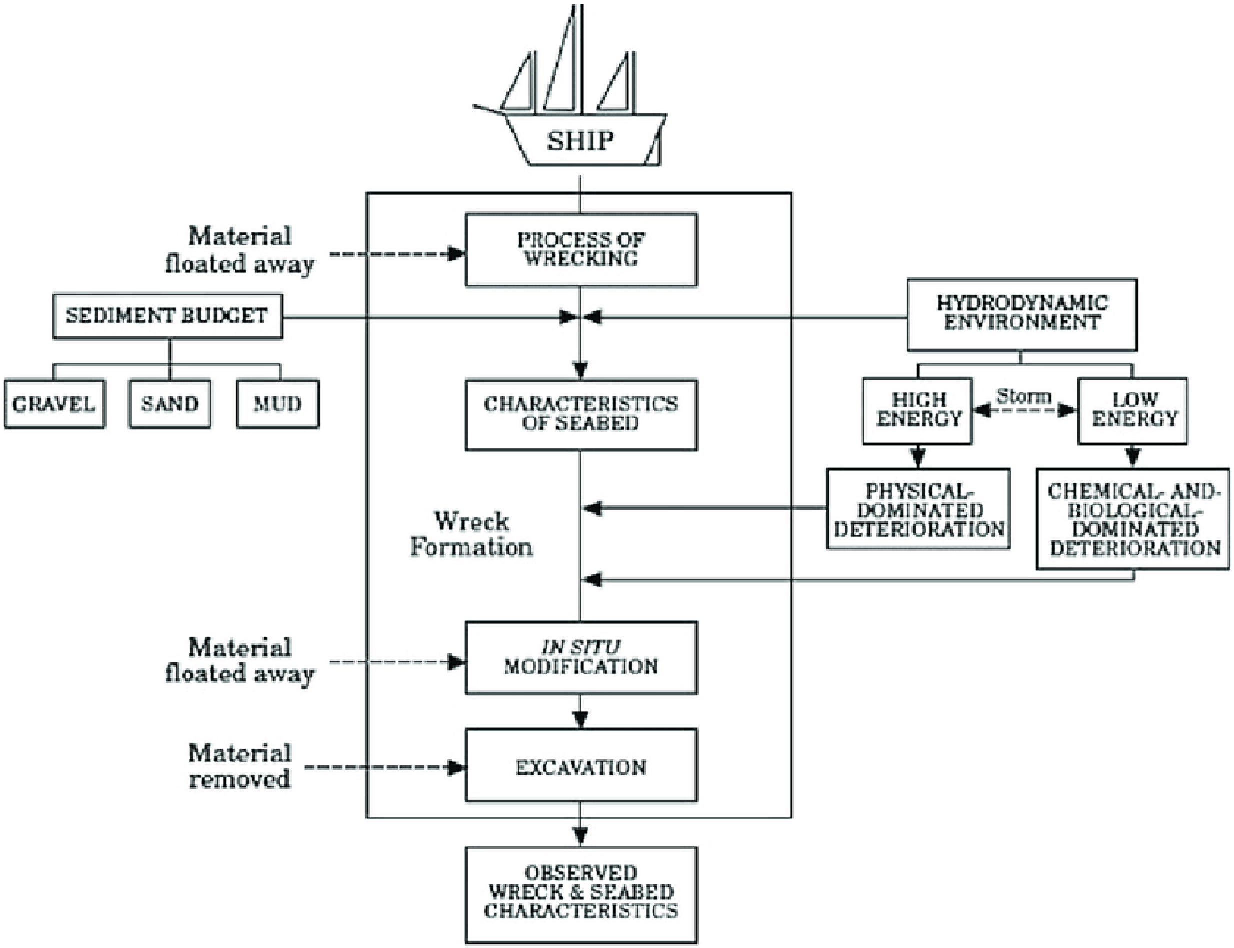

Figure 4: Ward et al.'s updated flowchart (Ward et al. 1999:564).

The sedimentary budget is described by the authors as "the rate of net supply or removal of different types and sizes of sediment grains to the wreck area" (Ward et al. 1999:564). According to the authors, a large sediment (in reference to particle size) environment or an environment with eroding sediment will see fewer intact shipwrecks due to the lack of cover they receive. On the other hand, a wreck that is in accumulated sediment with smaller particle sizes will have more preservation as it is better protected. Lastly, sediment that quickly accumulates will supply better preservation since it prevents an aerobic environment from forming. The authors posited that the hydrodynamic environment plays a major role in impacting wrecks, with high energy environments affecting a wreck in more physical means, while a low energy environment leads to more chemical and biologic deterioration (Ward et al. 1999:564-565). The authors then suggested that it is possible to quantify the deterioration rate from the physical, biological, and chemical processes and obtain an average deterioration rate per year. This average can then be compared to the sedimentary budget to determine the percentage of the wreck preserved. Despite this attempt at quantification via three examples of deterioration, the authors still have difficultly explaining exactly the rate of deterioration over time (Ward et al. 1999:568).

In 2006 Martin Gibbs presented another addition to site formation theory. In his article "Cultural Site Formation Processes in Maritime Archaeology: Disaster Response, Salvage and Muckelroy 30 Years on," Gibbs looked at the wrecking event as a series of phases that affect the site formation through the perspective of *disaster studies* (Figure 5). The phases identified are pre-impact, impact, recoil, rescue, and post-disaster stages. Each of these stages can leave traces in the archaeological record and thus can be included in the site formation of shipwrecks. The pre-impact stage includes factors that occur leading up to the wrecking event and includes both the planning of the voyage and attempts to avoid the wrecking event itself. The impact stage deals with the actual wrecking event and can last only minutes to several hours depending on the wrecking event occurring. The recoil stage is described as the period after the actual wrecking event but can overlap closely with the impact stage. The rescue stage deals with the survivors of the ship either setting up a survivor's camp or being saved by other people. The final stage is the post-disaster stage and includes the rehabilitation of the crew and potential salvage and recovery that may occur on the wreck (Gibbs 2006:8-15).

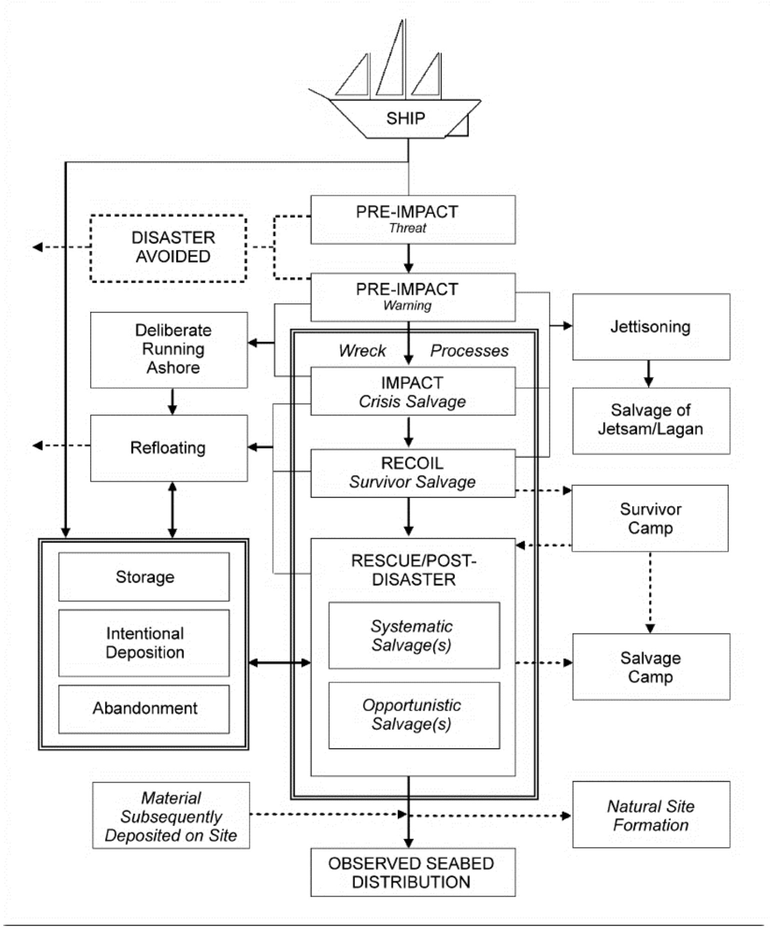

Figure 5: Site-formation model highlighting disaster processes (Gibbs 2006:16).

Pre-Depositional Factors

As several authors above have mentioned, site formation processes begin before the site goes from its *systemic context* to its *archaeological context.* This is first pointed out by Michael Schiffer when he discusses pre-depositional factors:

> All artifacts begin as materials procured from the natural environment. Environmental materials are usually modified by additive processes (i.e., mixing of clay and temper for pottery) or reductions processes (chipping of flint to produce tools) or a combination of both in the manufacture stage (Schiffer 1987:14).

In the above quote Schiffer demonstrates that transforms do occur before the creation of the artifact or site and seems to imply that these are mostly *c-transforms*. This belief can be directly applied to the construction of a steel vessel as the process of making steel and then using that steel for shipbuilding involves both additive and reduction processes. Additive processes are those that ‘add’ substances together, such as adding mixing elements to iron to create steel. Reduction processes, meanwhile, are those that reduce materials. In the case of steel manufacturing this would be seen as refining the iron and steel by removing the impurities. If the techniques of construction or even forging the steel were poor that could lead to the possibility that the wreck will deteriorate at a faster rate than a vessel with better construction techniques (Schiffer 1987:14).

Schiffer states that *c-transforms* occur during the life of an object. He notes that artifacts generally fall into three different functions: techno-function, socio-function, and ideo-function. Each of these functions then leads people to use the objects in various activities. Schiffer then claims that activities occurring during the lifespan of an object usually leave trace modifications on the artifact (Schiffer 1987:14). For *Norman* and *Grecian*, this may manifest in the wearing down of high-use areas of the vessels through the transportation of the various materials, like the decks.

Pre-depositional factors also occur up to the moment of wrecking, according to Martin Gibbs. This pre-impact phase of the wrecking event can be broken into two sub-phases: the threat phase, and the warning phase. These phases differ since the threat phase begins when the possibility of wrecking is identified, while the warning phase is when the potential for wrecking is imminent (Gibbs 2006:7).

When analyzing the pre-impact threat phase, Gibbs points out that there are both long-term and short-term actions in this phase. Examples of long-term actions would be the knowledge developed to avoid potential wrecking events and the planned route to avert them. Short-term actions would be sudden changes in course or other signs of preparedness. Gibbs implies that this phase would be the hardest to detect on an archaeological site since it could lead to disaster avoidance and have no wreck or only small changes showing that the crew was prepared for a wrecking event (Gibbs 2006:8-10).

The pre-impact warning phase occurs immediately before the wrecking event and is characterized by drastic actions. Such actions include extreme changes in course, sudden stopping or acceleration, and potentially even jettisoning cargo to prevent the wrecking event. Gibbs suggests that this stage will lead to more archaeological remains as there may be a debris field of jettisoned material next to the wreck, or if the wreck was avoided, just a debris field on its own (Gibbs 2006:10-11).

Depositional Factors

The next set of transforms that can be seen on an archaeological site are the processes involved in the wrecking event or depositional factors. The two depositional factors that are identified are the impact and recoil phases in Martin Gibbs' work (Gibbs 2006:7).

The impact phase is the period where the wrecking processes occur and thus includes the first transforms of changing the ship to a shipwreck. The most critical of the transforms of this stage will be either the *c-transforms* or *n-transforms* which caused the vessel to sink. This will manifest on the archaeological site as proof of the damage that the ship sustained in the wrecking event itself. Alongside the wrecking event, the people's response to the impact may also be seen on the site. During this period many of the people on the vessel, around 75% will be unable to respond in an effective way; while only around 20% will respond with actions to save the vessel, cargo, crew, and passengers. This could lead to minimal cultural action being seen in the remains of the vessel. Events such as the launching of lifeboats, crisis salvage, or salvage to save the most valuable or personal cargo, may manifest on the site as objects being taken off the ship before it sinks (Gibbs 2006:11-12).

The recoil phase of the deposition involves the immediate aftermath of the wreck. This period of the wreck is characterized by the survivors no longer under the threat of the shipwreck but still in danger from other factors. Other characteristics that are in this phase are immediate repair and potential re-floating of the vessel. In the archaeological record, these transformations will be shown by the removal of the wreck if the repair is successful (Gibbs 2006:13)

Post-Depositional Factors

Post-depositional factors are the transformations that occur following the wrecking event and change the ship to the shipwreck that archaeologists investigate. Unlike the previous transforms which are primarily *c-transforms*, post-depositional factors include both *c-transforms* and *n-transforms*.

C-transforms

As previously mentioned, Schiffer (1987) separated archaeological site formation into two types. The first of the types that apply to the post-depositional factors are the *cultural formation processes* or *c-transforms* (Schiffer 1987:7). Even though he is writing in the context of terrestrial sites, Schiffer notes several relevant cultural transformations that can be applied to a shipwreck. Specifically, he discusses the cultural processes involved in reclamation. The process of reclamation is described as one in which artifacts or a site are brought back into a *systemic context.* Within this group of processes, he mentions the specific process of *reincorporation* and *salvage*. The example that is used to highlight this process is people coming back and re-inhabiting a town they previously abandoned (Schiffer 1987:99-106).

While Schiffer introduces the idea of salvage and reclamation for archaeological sites, Martin Gibbs expands upon and applies them directly to maritime archaeology. He states that there are two post-depositional stages, both of which include salvage: the rescue stage and the post-disaster stage. Although the rescue stage is focused on removing the survivors from danger, it also deals with the first potential period of systemic and opportunistic salvage. The post-disaster stage is the period when the vessel and its cargo are completely abandoned and left derelict. This is the period that salvage is most likely to occur. Gibbs differentiates opportunistic salvage from systemic salvage by how they are accomplished. Opportunistic salvage is defined as salvage with no forethought and may not be legally sanctioned. Items taken from such a salvager are accessible items and minor structural pieces. Although this form of salvage is generally looked at as being done by ancient salvagers, it can occur at any point in time. For more modern wrecks, opportunistic salvage could be seen as recreational scuba divers removing small objects from the wrecks. Systemic salvage, on the other hand, is planned out and more intensive. It generally has the goal of removing large amounts of cargo and major structural components of the wreck. Unlike opportunistic salvage which may leave few traces on the archaeological site, systemic salvage can leave obvious traces such as clear removal of sections of the site or even the equipment used to undertake such an operation (Gibbs 2006:14-15).

N-transforms

Besides *c-transforms* there are also *noncultural transformation processes* or *n-transforms*. Coined by Michael Schiffer (1972), these transforms relate to processes caused by the environment that affect archaeological sites and artifacts. These transforms, per Schiffer are then grouped into the method of deterioration: chemical, physical, or biological. Chemical deterioration occurs at a molecular level that involves chemical reactions between the wreck and other substances, such as water and oxygen. Physical deterioration is the most noticeable deterioration and occurs through physical means, such as waves, currents, and sediment transport. Biological deterioration is caused by various means such as microbes, plants, corals, and other animals such as teredo, commonly known as shipworm (Schiffer 1987:143-147).

When it comes to the *n-transforms* acting upon shipwreck remains, the biggest factor is what transforms occur and how they occur. These transformations begin with how the wreck lays on the seafloor or lakebed. Generally, when a vessel sinks and lands flat on a sandy bottom, it will sink in the sand to its waterline. This observation is known as 'waterline theory' and has been shown to work for both wooden and ferrous wrecks (Riley 1988:191-197; McCarthy 1996:216-217). If a vessel does not land flat on the ground, it will generally sink to "a line drawn laterally between the top of the keel (on one side), to the sheer strake (on the other) and in a longitudinal direction between the first and last of the cant frames" (McCarthy 1996:226). Upon settling on the bottom of the seafloor (or lake floor), sediment will either deposit on the site or erode from the site. As noted by Ward et al. (1999) a site covered by sediment will generally be better preserved than an exposed site. The logic behind this is that an eroding or slow accumulating sediment will leave the wreck exposed to physical deterioration while a wreck that is quickly covered by sediment will be mainly affected by chemical and biologic deterioration (Ward et al. 1999:565).

When it comes to the deterioration at play on ferrous-hulled wrecks, there seems to be a disagreement about the most important deterioration methods. Schiffer argues that iron is most prone to chemical and biological deterioration (Schiffer 1987:148). Ward et al. states that ferrous-hulled shipwrecks are prone to chemical and physical deterioration (Ward et al. 1999:564). Although there seems to be a discrepancy, it is explained as Schiffer was looking at iron on terrestrial sites, while Ward et al. are looking at iron on shipwrecks, which is perpetually submerged, and the target of biological processes not found on land. Despite this discrepancy, all three potential deterioration methods will be closely examined in this study, as they all contribute to the deterioration of a ferrous-hulled vessel.

Chemical deterioration is defined as degradation caused by chemical reactions, such as oxidation. These processes can be exacerbated by several factors including temperature and sunlight. A general rule is that deterioration doubles every increase in 10 degrees Celsius. Sunlight, which generally affects biological decay processes, can increase the temperature of artifacts and sites which then can lead to an increase in decay as previously mentioned (Schiffer 1987:148). Furthermore, the presence of salts and acidic conditions (pH below 3.0) increase corrosion rates. When it comes to salt, this turns water into an electrolyte that allows corrosion to occur (Schiffer 1987:196). Chemical deterioration that affects ferrous wrecks most commonly results in corrosion. When ferrous materials are submerged in sea water, they are altered by an encrustation that encapsulates them. These encrustations and their effects have been extensively documented on USS *Arizona* (Johnson et al. 2018). The study on encrustations is best described as:

> Experience with materials from historical marine shipwrecks indicates that most ferrous materials are protected from continual corrosion by the formation of encrustation, a complex interaction of chemical and biological processes. Encrustation substantially reduces or stops active corrosion (Murphy 1987:57).

Biological deterioration occurs from all forms of biology including bacteria and animals. When it comes to biological deteriorations in the Great Lakes, the biggest threat was sulfate-reducing bacteria. These bacteria are found in anaerobic environments and can quickly deteriorate iron and steel (Singley 1988:29). For a vessel in the Great Lakes, this generally limited biological corrosion since detrimental organisms have been minimized in the Great Lakes.

However, that changed with the introduction of zebra mussels (*dreissena polymorpha*) followed by quagga mussels (*dreissena bugensis*). These mussels, native to Eastern Europe, arrived as a result of commercial ships unknowingly carrying them in their ballast tanks to the Great Lakes (Benson et al. 2022a; 2022b). These mussels have since covered the bottom of the Great Lakes and its shipwrecks. Although they will attach to all surfaces, it has been suggested that they prefer iron and other ferrous surfaces (Watzin et al. 2001:2). When these mussels first attach to an area, they begin affecting the wrecks through their attachments which causes pits to form on the surface. In Lake Champlain, these pits average around .01 inches per year on iron plates and bars, with some pits up to .03 inches (Watzin et al. 2001:33-36). Although being a greater concern in smaller pieces of iron, the pitting does reduce the structural integrity which leads to a higher and faster rate of failure. The mussels also excrete deposits of organic and inorganic matter which causes bacteria to thrive and lowers the pH of the water. When the excrements of the mussels decompose, oxygen is rapidly depleted and an environment supporting sulfate-reducing bacteria is created. Furthermore, chemical deterioration increases in acidic environments, as stated above, they are also increasing the speed of corrosion as the mussels lower the water's pH (Watzin et al. 2001:41). The effects of zebra and quagga mussels can be summarized as first pitting the artifacts/wreck and then lead to an environment that is conducive to other deterioration types. One interesting observation made by Wayne Lusardi suggests that the mussels generally only form a layer of about 6 inches before they all fall off the surface, bringing some of the surface with them (Wayne Lusardi 2022, pers. comms.). If this is a common occurrence, it would be the case that mussels would eventually recolonize the structures leading to a cycle of pitting to general deterioration and then lastly ripping of the top layers off.

The last *n-transform* that can affect ferrous-hulled wrecks is physical deterioration. This deterioration is caused by waves, currents, sediment transport, ice movement, and weight of biological communities (i.e., zebra and quagga mussels) and generally plays the biggest role in large-scale deterioration. As previously studied, ferrous vessels are prone to physical deterioration and several general rules have been noted about it. First, ferrous vessels generally flatten out when they deteriorate, leaving the boilers on either side of the vessel or on the remains depending on how the ship was laying. Secondly, before the entire vessel flattens out, cargo holds will collapse due to a lack of structural support. When this occurs, the vessel will consist of the bow and stern triangles and areas around the boilers remaining relatively intact since they are reinforced compared to the cargo areas of the vessel (McCarthy 1996:219).

Conclusion

This chapter examined the site formation processes that alter a ferrous-hulled ship from its *systemic context* to the wreck in its *archaeological context.* To be able to understand these transforms the origins of site formation theory were shown as developed by Keith Muckelroy (1978) and Michael Schiffer (1987). This theory was then expanded upon by authors such as McCarthy (1994), Stewart (1999), Ward et al. (1999), and Gibbs (2006). Through the examination of the theory, as laid down by these authors, it is possible to discern what transforms occur on iron ships in Lake Huron and the Great Lakes as a whole. This knowledge can be applied to 3D models of *Norman* and *Grecian* to determine how these specific ships transformed from ship to shipwreck through various *c-transforms* and *n-transforms*. Furthermore, due to the comparative nature of this study, these transforms can be compared to find commonalities.

With the knowledge of the transforms affecting these specific wrecks, it may be possible to predict the trajectory of the sites and see how the wrecks will continue to deteriorate. This prediction can then be used to make a 3D model of the future wreck sites. The comparative nature of this study allows the common transforms to be identified which may then be able to be applied to other wrecks in the area around TBNMS. Site formation models created in this study then can be used to determine best management practices to minimize deterioration on *Norman* and *Grecian* and potentially other wrecks in the sanctuary.

Chapter 3: Methodology

Introduction

As discussed in the previous chapter, the process of conducting an archaeological site formation analysis involves knowing all potential transforms changing an archaeological artifact (in this case, *Norman* and *Grecian*) into the archaeological site that exists today. To closely examine these transforms, research focused on the historical and archaeological datasets that exist for *Norman* and *Grecian*. For this study, these sources were used to create 3D models to display the transformations affecting the shipwrecks. After creating these models, an in-depth analysis was conducted on the different models to illuminate what transformations have occurred and to see how these wrecks have deteriorated in both similar and dissimilar ways.

The first part of this chapter discusses the historical and archival research that took place to make this project possible. This section deals with collecting the sources and images used in the joint historical model that represents both *Norman* and *Grecian*. The next section focuses on the archaeological research that has taken place at these wrecks since 2000. The information presented here was then used to break down the historical model into the respective *Norman* and *Grecian* archaeological models. The third section provides an in-depth guide on the modeling processes for both the historical and archaeological models of *Norman* and *Grecian.* The last section in this chapter offers a detailed look at how the analysis in this project was conducted.

Historical Research

The first part of creating the dataset needed to do this archaeological site formation study was collecting information relating to the history of *Norman* and *Grecian*. This data collection primarily dealt with finding builders' plans for these vessels, in addition to other primary and secondary sources. While the builders' plans for *Norman* and *Grecian* were not located, those for similar vessels built immediately before them were found. Other primary documents that were used include newspapers to get the history of the vessels, the Menominee Transit Company, and Globe Iron Works. Treatises that were written on steel-ship building around the time *Norman* and *Grecian* were constructed, insurance records for these vessels, Mansfield's *General History* (1899) (a contemporary history book of the Great Lakes), and photographs of the vessels and Globe Iron Works were also collected. Secondary and tertiary sources include the National Register of Historic Place nominations for *Norman* and *Grecian*, books written about Globe Iron Works, and books discussing the context of early steel lakers.

These historical sources were first used in the joint historical model of *Norman* and *Grecian*, which showcased how these vessels were built and served as the base for archaeological models. This data was also used to create a completed history of the ships, which illuminates the potential cultural and *n-transforms* that could manifest on the site through the history of their working lives, sinking events, and post-wrecking lives. The history of each vessel was then used to alter the joint historical model into the individual pre-depositional models.

Builders' Plans

Since this project involved the creation of 3D models of *Norman* and *Grecian*, the most important part of historical research was finding the builders' plans for these vessels. This process seemed at first easy since TBNMS had copies of the builders' plans for what was listed as *Norman* and *Grecian*. Upon further investigation it was determined that these plans were for *Maruba* (1890) and *Matoa* (1890) which were built immediately before the Menominee Transit Company's vessels that included *Norman* and *Grecian*. The repository holding the builders' plans of *Maruba* and *Matoa*, Bowling Green State University, was contacted about plans on *Norman, Grecian,* or any of the other ships in this series. This led to the discovery of a 1918 refitting plan for *Roman* (1891), *Saxon* (1891)¸ *Maruba* (1980), and *Manola* (1890) (Figure 6). This plan thus showed that the series of ships built for the Menominee Transit Company were identical enough to *Maruba* for engineers of the time to rearrange the superstructure in 1918. This conclusion led to the builders' plans of *Maruba* and *Matoa* being used in place of the those of *Norman* and *Grecian*. The complete set of plans of *Maruba* and *Matoa* received from Bowling Green State University included the Outboard Profile (Figure 7), Inboard Profile (Figure 8), Main Deck Plan (Figure 9), Spar Deck Plan (Figure 10), Midships Plan (Figure 11), and a plan of details (Figure 12). Missing from these plans, however, were a set of lines that would be used to create the hull shape. Once again, the repository at Bowling Green State University had lines of a similar-sized vessel built in 1889 by Globe Iron Works (Figure 13). When comparing the lines of this vessel to the deck plans and midships of the obtained builders' plans, only a very small discrepancy was found which was within an acceptable margin of error, thus allowing these lines to be used in place of the originals.

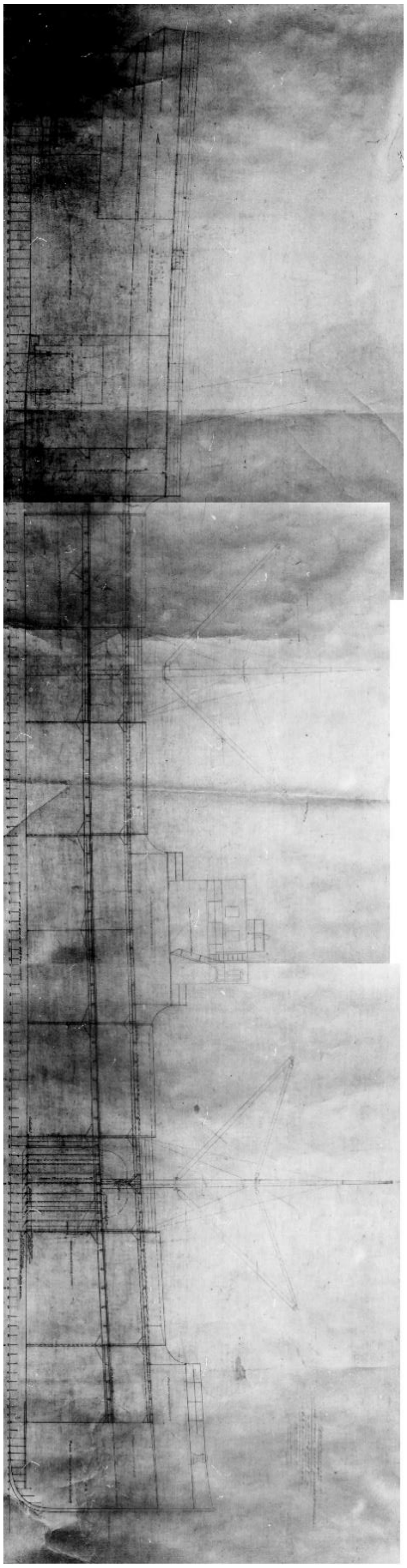

Figure 6: Refitting Plan of Roman, Saxon, Maruba, *and* Manola *(Courtesy of BGSU Library).*

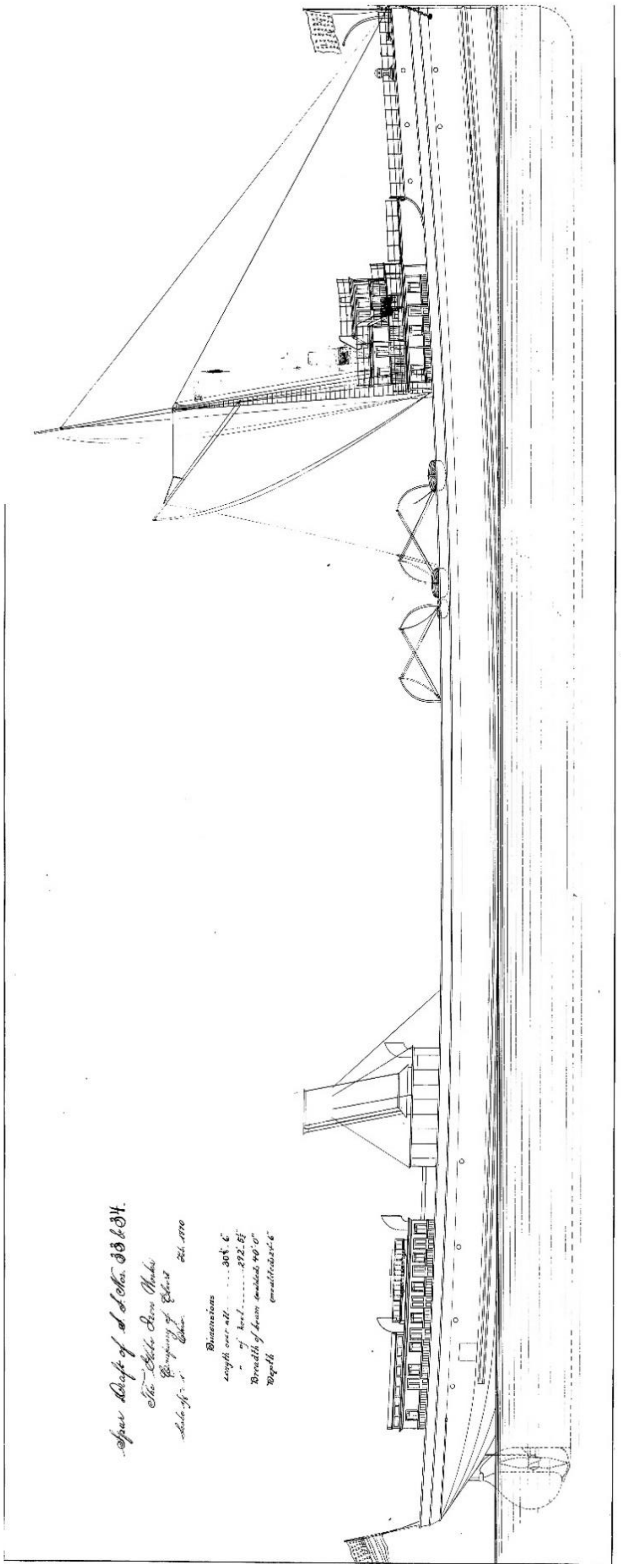

Figure 7: Outboard Profile of Maruba *and* Matoa *(Courtesy of BGSU Library).*

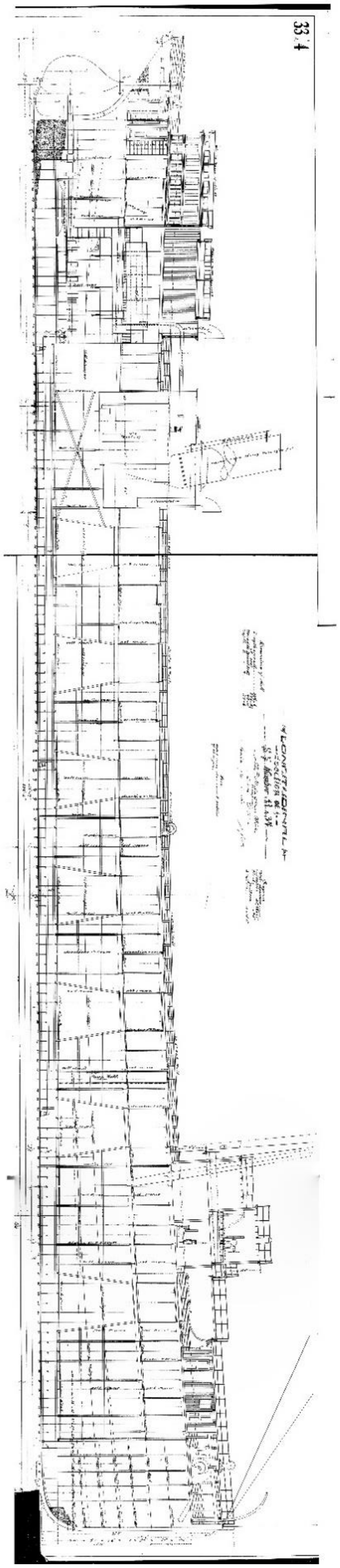

Figure 8: Inboard Profile of Maruba *and* Matoa *(Courtesy of BGSU Library).*

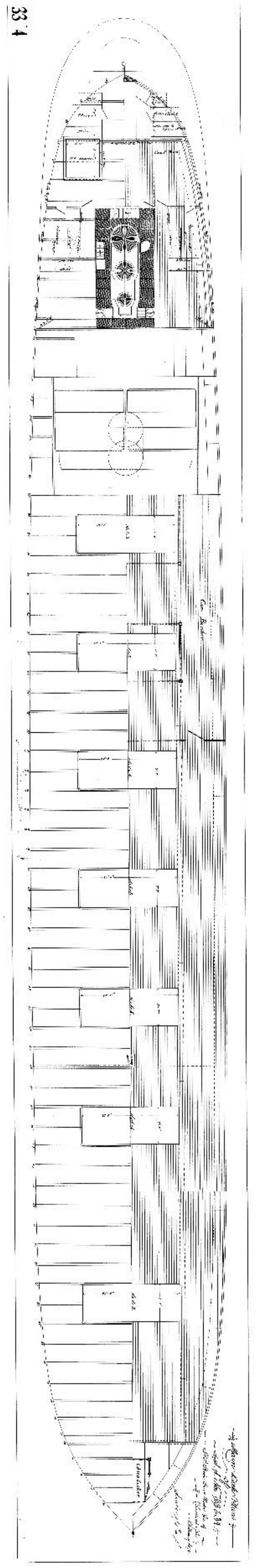

Figure 9: Main Deck Plan of Maruba *and* Matoa *(Courtesy of BGSU Library).*

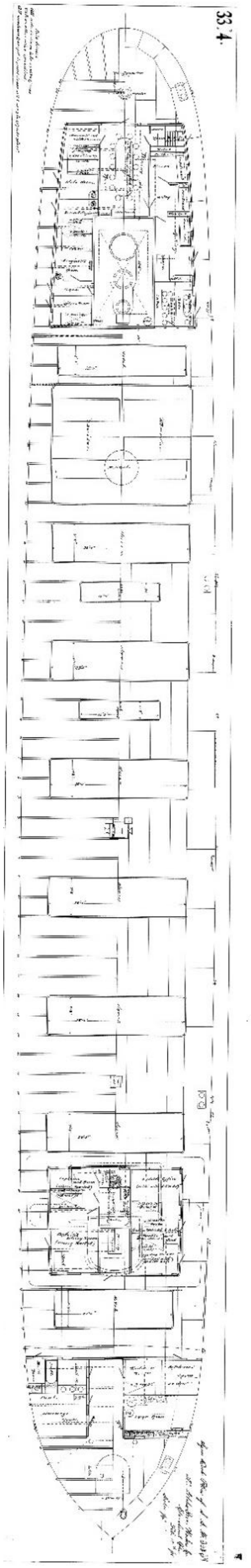

Figure 10: Spar Deck Plan of Maruba *and* Matoa *(Courtesy of BGSU Library).*

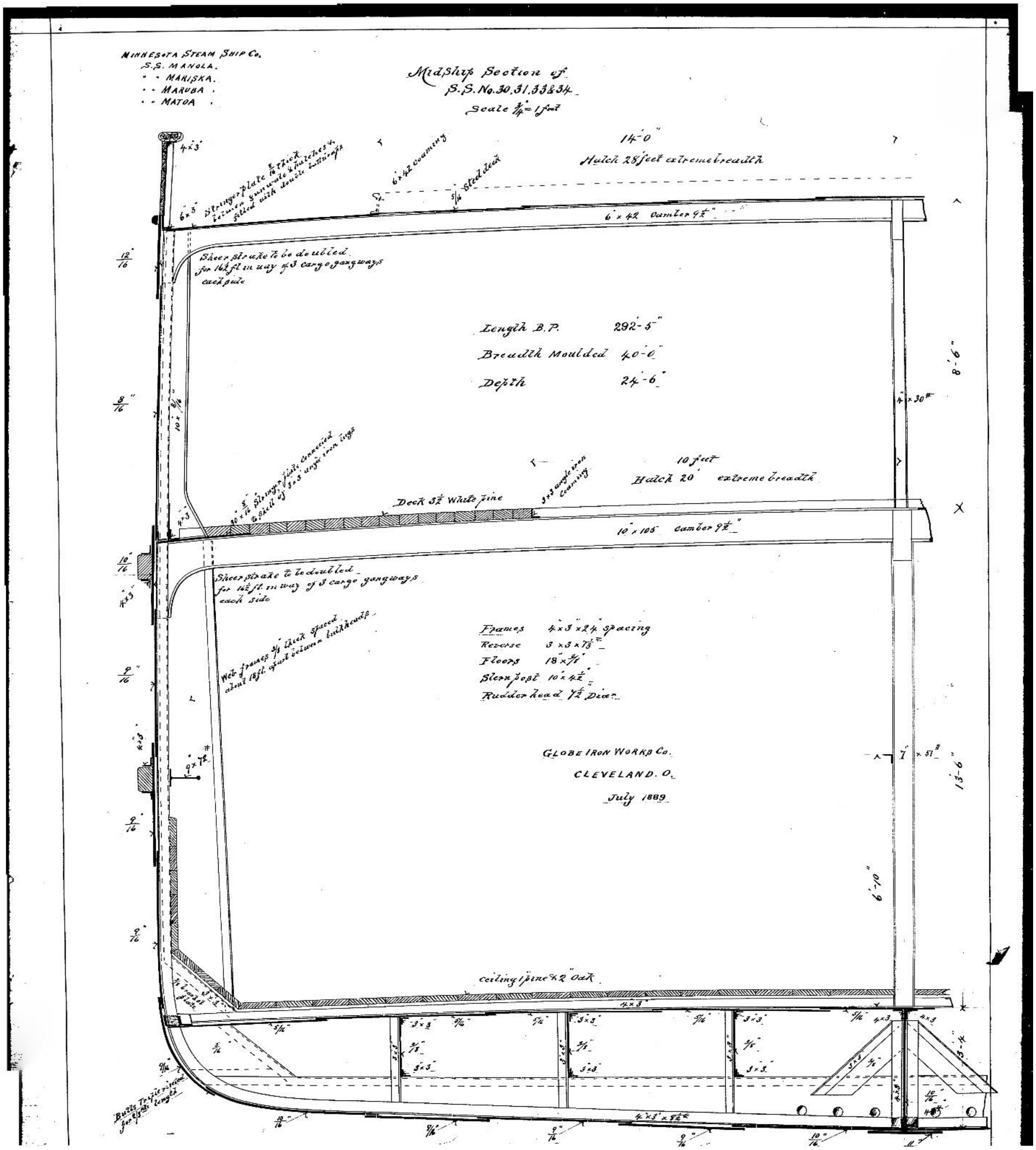

Figure 11: Midships of Maruba *and* Matoa *(Courtesy of BGSU Library).*

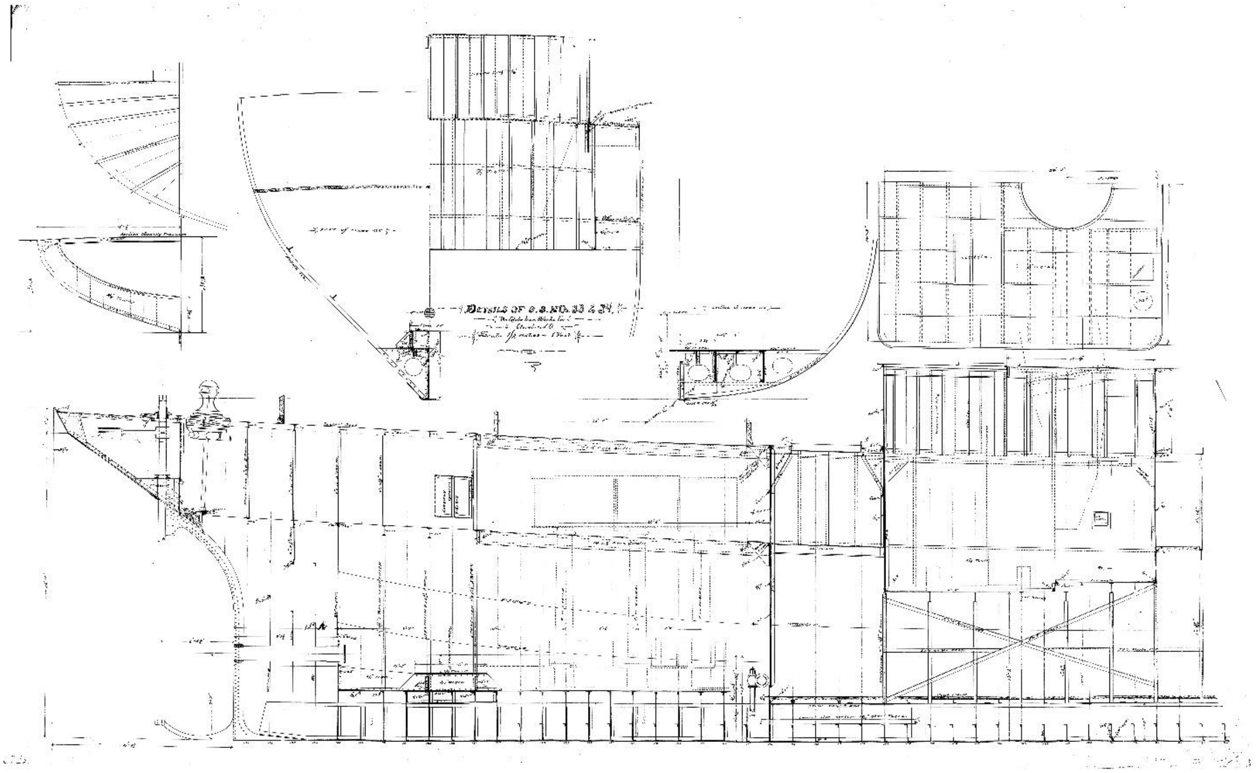

Figure 12: Details of Maruba *and* Matoa *(Courtesy of BGSU Library).*

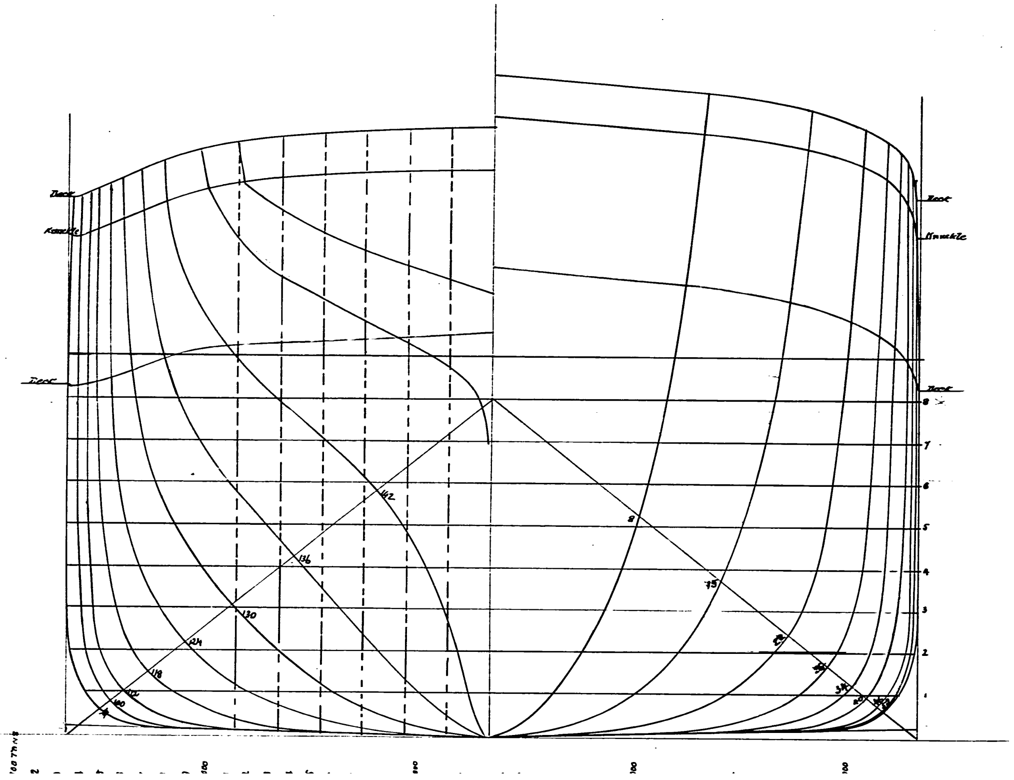

Figure 13: Lines Plan of Globe Iron Works hulls 16, 24, 25, 29, 32 (Courtesy of BGSU Library).

Other Primary Source Documents

Although this topic revolved around the creation of models of *Norman* and *Grecian*, information such as the history of these vessels, the context in which they sailed, and their construction was also needed to recreate the historical context for these vessels.

The largest source of information regarding the life, sinking, and salvage of *Norman* and *Grecian* were various newspaper and magazine articles. To locate these newspaper articles systematic searches were conducted on "newspapers.com" and "maritimehistoryofthegreatlakes.ca" to find articles written in the 1890s to 1910s about *Norman, Grecian*, the Menominee Transit Company, and Globe Iron Works. This led to many relevant articles that pertained to the life, sinking, and salvage of these vessels. Newspapers used for this history include *The Argus Reflector, The Benton Advocate, The Bucyrus Evening Telegram, The Buffalo Enquirer, Bureau County Tribune, The Chicago Chronicle, Chicago Tribune, The Cincinnati Enquirer, Cleveland Leader, The Daily Herald, Detroit Free Press, The Fort Wayne News, Green Bay Press-Gazette, The Inter Ocean, The News-Palladium, The Representative, The Sandusky Star-Journal, The Sheboygan Press, St. Joseph Daily Press, The Superior Times, The Times Herald,* and *The Weekly Palladium*. Alongside the newspapers, a magazine/journal of the time, *Marine Review,* was located which contained many statistics relating to the vessels as it detailed cargo totals and had many advertisements geared towards mariners on the Great Lakes. To supplement information discussed in newspapers, insurance records from *Inland Lloyd's Register* were used to decide if the insurance ratings of the vessels changed throughout their lifespan from the various accidents that occurred.

Alongside the builders' plans, contemporary steel shipbuilding treatises and other documents relating to steel shipbuilding around the turn of the century and images of Globe Iron

Works drydocks were used to understand how these ships were built. The specific treatises used for this research were Samuel Thearle's *The Modern Practice of Shipbuilding in Iron and Steel* (1891) and A. Campbell Holme's *Practical Shipbuilding* (1918). Due to these treatises being written in field-specific jargon, Heinrich Paasch's *From Keel to Truck: A Marine Dictionary* (1901) was used to decode them. Since the Great Lakes developed regional-specific building techniques, W.M. Gregory's article "Steel Shipbuilding on the Great Lakes" (1908) was used to understand the context of Great Lakes shipbuilding.

To get the context of the period and region that *Norman* and *Grecian* were sailing in, Mansfield's *General History* (1899) was used. This book has been extensively used by previous researchers dealing with the maritime history of the Great Lakes and gives information regarding the companies and vessels that were operating on them, the industries that were developing on the lakes, and the general history of the region from the original explorations of the area to the 1890s.

The final type of primary source material that was used for this project were original images of *Norman, Grecian,* and the dockyards at Globe Iron Works. For *Norman,* only one image of the vessel was found at the Alpena County George N. Fletcher Public Library's Thunder Bay Research Collection. *Grecian,* on the other hand, had several images that were found. Four images of *Grecian* are located at the Thunder Bay Research Collection in Alpena, MI alongside the image of *Norman*. Four more images of *Grecian* were found as part of the Edward J. Dowling Collection at the University of Detroit-Mercy. The last image found of *Grecian* is in the William MacDonald Collection at the Dossin Great Lakes Museum in Detroit, MI. Alongside the images of *Norman* and *Grecian,* the National Archives possesses two images of Globe Iron Works. These images show the potential shipyard that *Norman* and *Grecian* were constructed in, with one image showing a vessel under construction.

Secondary Sources

Alongside the primary sources that were used to understand the history of *Norman* and *Grecian*, several secondary sources were used to better understand these ships and put them into the context of the late 1800s to early 1900s. Most importantly these sources are the National Register of Historic Places (NRHP) nominations (Hartmeyer 2015, 2016) and a book that detailed the history of Globe Iron Work and the American Shipbuilding Company (Wright 1969).

After using the NRHP nominations as a starting point for historical research it was soon discovered that this secondary source was insufficient for the archaeological site formation modeling that was completed as part of this project. The reason for this is a lack of focus on the history of these vessels from a site formation perspective, and in some areas errors that could have negatively impacted the modeling. As a result of this, the history chapter (Chapter Four) on *Norman* and *Grecian* was written entirely from primary sources until the modern period, which used the NRHP nominations and personal communications to discuss the modern research history of the sites.

Archaeological Research

Due to the joint effects of COVID-19 and the depths at which *Norman* rests, field research on *Norman* and *Grecian* were not possible. Despite this, there was no hurdle to collecting archaeological data from these wrecks. In 2000 TBNMS was established off the coast of Alpena, MI, and included the wreck of *Grecian*. Since the creation of the sanctuary, *Grecian* has been the subject of many scientific research missions. Furthermore, *Grecian* has been used extensively as a location for TBNMS training. *Norman* on the other hand has been part of TBNMS since the expansion of the sanctuary in 2014. Since becoming part of TBNMS, *Norman* has also been the subject of several scientific surveys (Clevenger 2014).

The data collected by those surveys was used to create 'archaeological models' of *Norman* and *Grecian*. This modeling was completed using the collected 3D photogrammetric models, multibeam echosounder data (MBES), side-scan sonar data, a site map, and photographic data.

Archaeological Research regarding Norman

Due to the location of *Norman* being outside the original boundaries of TBNMS, scientific investigations of the wreck were delayed until there was a proposal to expand the sanctuary. In 2010, TBNMS sent divers to *Norman* to obtain the first dataset on the wreck in the form of a photomosaic image of the site (Figure 14) (John Bright 2021, elec. comm.; Phil Hartmeyer 2021, elec. comm.).

Figure 14: Photomosaic of Norman *(2010) (Courtesy of TBNMS).*

The following year, TBNMS used R/V *Storm*'s onboard systems to obtain sonar data of the wreck. The first set of data obtained in 2011 was a side-scan sonar survey. Using the R/V

Storm’s onboard Klein 3000 series side scan, researchers from TBNMS captured 500kHz sonar data of *Norman* (Figure 15). In 2014, researchers took multibeam echosounder (MBES) data of *Norman* (Figure 16). It is important to note that this MBES data was not meant to properly map *Norman* but was instead used to set up the with and *Norman* selected as the test subject. As a result, this data is of low resolution, as the MBES was not properly connected to R/V *Storm*’s motion and positioning system at the time. This incorrect positioning and no motion correction caused the site to be distorted in the dataset (John Bright 2021, elec. comm.; Phil Hartmeyer 2021, elec. comm.).

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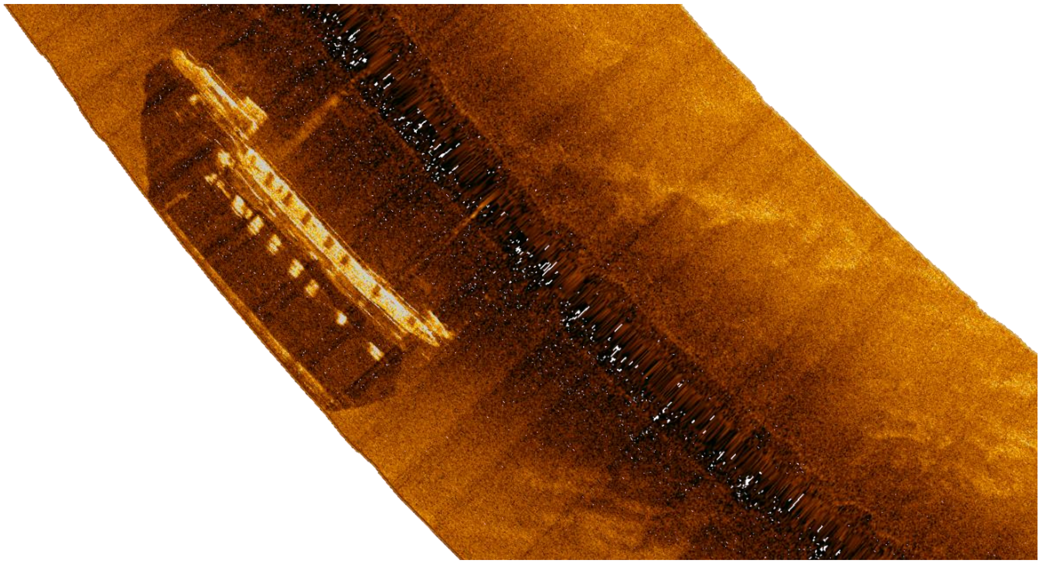

Figure 15: 500kHz Sonar Image of Norman *(2011) (Courtesy of TBNMS).*

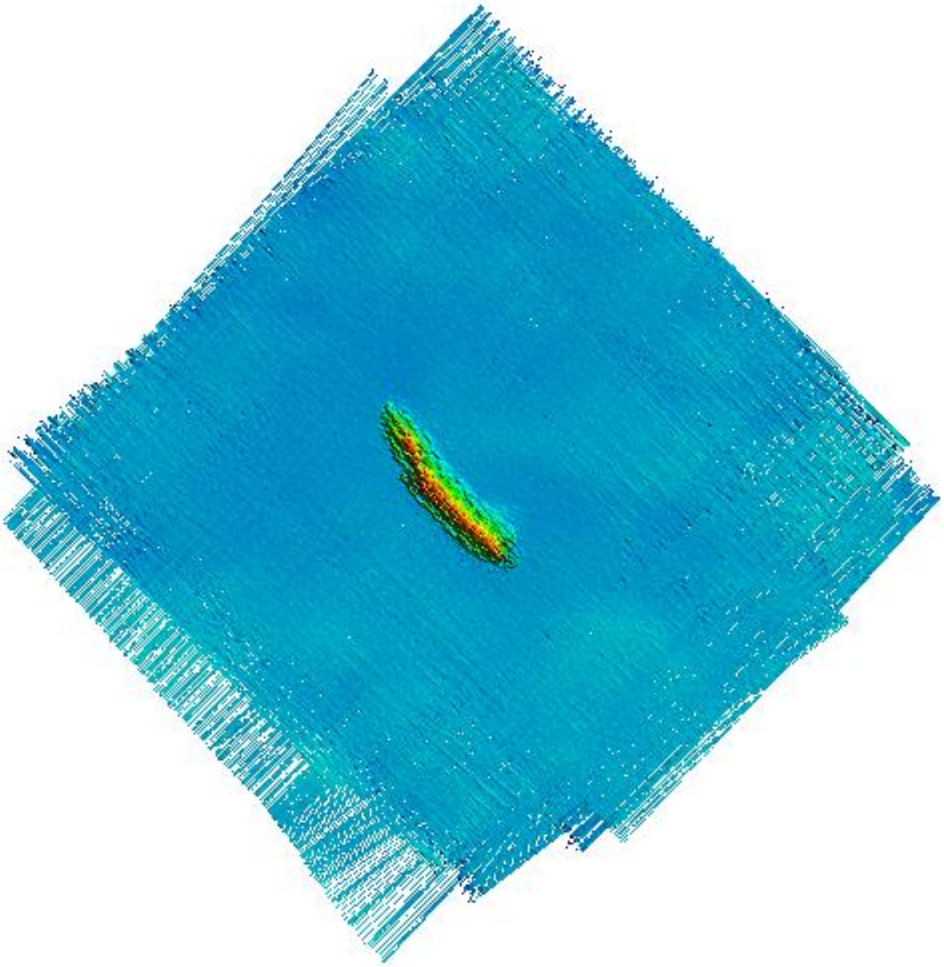

Figure 16: Multibeam Data at 1m Resolution of Norman *(2014) (Courtesy of TBNMS).*

In 2017 the most recent scientific study of *Norman* took place. Researchers for TBNMS once again dove to the site to create a photogrammetric model. After collecting the photographs, the image set was rendered using Agisoft's Metashape to create a 3D model of the site as it appeared in 2017 (Figure 17). Also, that year, Michigan Technological University (MTU) deployed an Autonomous Underwater Vehicle (AUV) that took scans of *Norman*. The project involved an IVER3 AUV with an onboard Edgetech 2205 to take side-scan sonar data of the site (Figure 18). Since this wreck is significantly deeper than *Grecian* and requires specialized technical dive training and equipment, it has not been the focus of many diver-based investigations, but it still has datasets that can be used to create an archaeological model of the site (John Bright 2021, elec. comm.; Phil Hartmeyer 2021, elec. comm.).

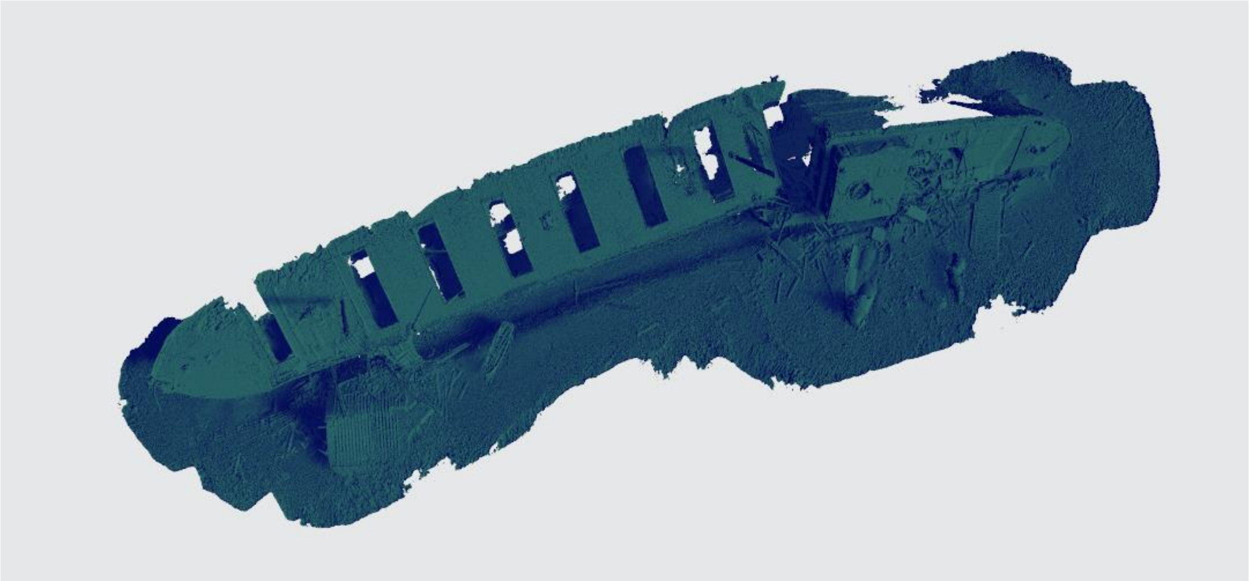

Figure 17: Photogrammetric Model of Norman *(2017) (Courtesy of TBNMS).*

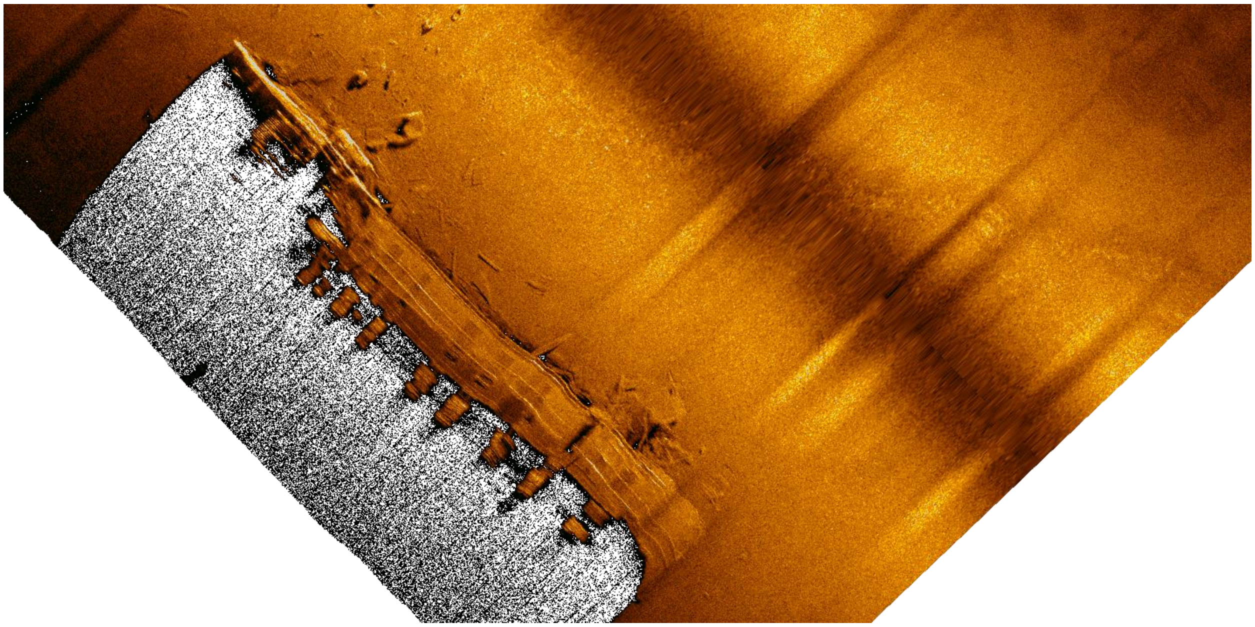

Figure 18: Michigan Technological University's AUV Sonar Image of Norman *(2017) (Courtesy of MTU/TBNMS).*

Archaeological Research regarding Grecian

The first scientific study on *Grecian* occurred in 2001 as part of a project conducted by Dr. Robert Ballard and the Institute for Exploration (IFE). This project used a low-resolution side-scan sonar to get a general layout of the site for future management plans. For this research, a 100-200kHz side-scan sonar was used, which provides a rough overview of the site (Figure 19). Although the resolution of this sonar data is low, it was used by TBNMS to understand the distribution of the site. Due to its popularity with recreational divers, two mooring buoys were placed on the wreck. These mooring buoys were constructed out of train wheel anchors, polypropylene, and chains. The installed mooring buoys provided easy access to *Grecian* and allowed divers to get to the site without fear of damaging the wreck through anchoring (Hartmeyer 2017:7; John Bright 2021, elec. comm.).

The installation of these mooring buoys provided easy access for divers, both scientific and recreational, to *Grecian* which has opened the site up to more scientific investigations. In 2009 a team of maritime archaeologists with TBNMS used traditional baseline-offset methods to create a site map of *Grecian* (Figure 20). These buoys also led to *Grecian* being the location of NOAA ‘checkout dives,’ training dives, and site condition dives. As a result of all this diving on the site, photograph sets from 2003, 2004, 2007, 2009, 2010, 2011, 2012, 2016, 2019, and 2021 were taken by TBNMS (John Bright 2021, elec. comm.; Hartmeyer 2017:7; 2021, elec. comm).

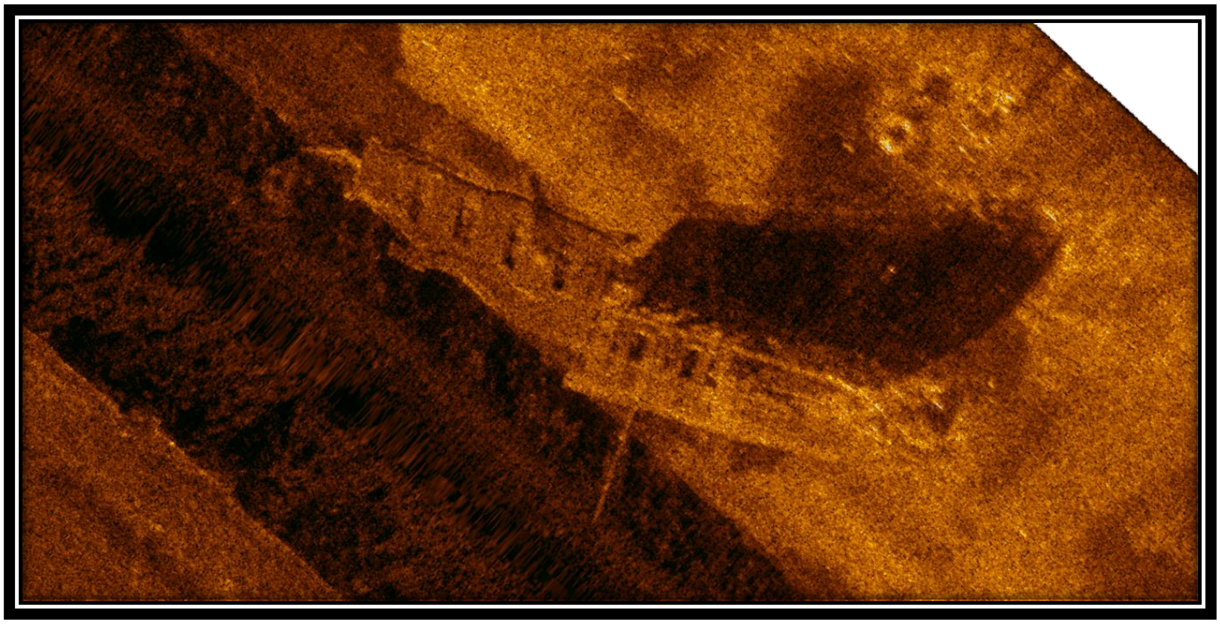

Figure 19: 100/200kHz Sonar Image of Grecian *(2001) (Courtesy of IFE/TBNMS).*

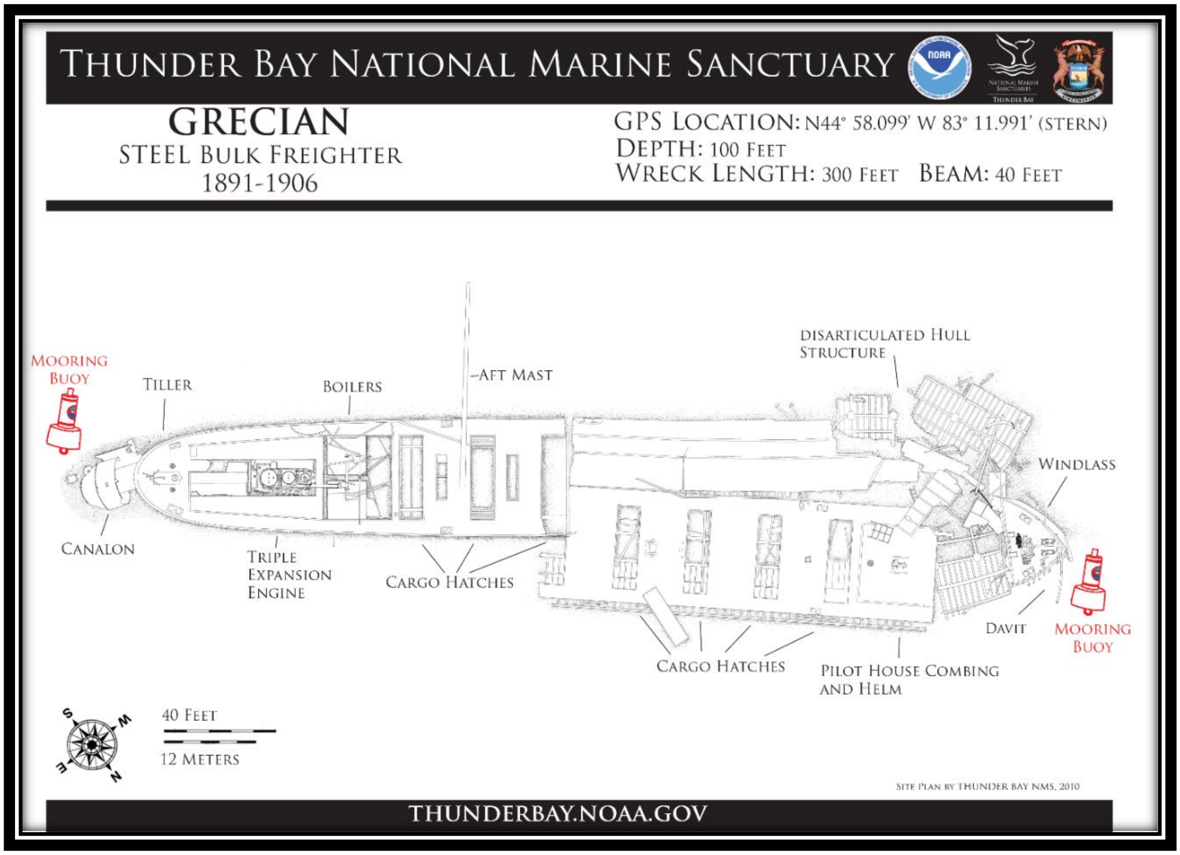

Figure 20: Site Map of Grecian *(2009) (Courtesy of TBNMS).*

The last archaeological investigation of *Grecian* used in this project was a higher resolution side-scan sonar survey of the wreck. This survey was undertaken in 2014 and involved TBNMS researchers using R/V *Storm*'s onboard Klein 3000 series side-scan sonar for a 500kHz scan of *Grecian* (Figure 21). Compared to the 2000 side-scan data of *Grecian,* this image set shows the wreck in much greater detail and showcases the remains of salvage equipment (John Bright 2021, elec. comm.; Phil Hartmeyer 2021, elec. comm.).

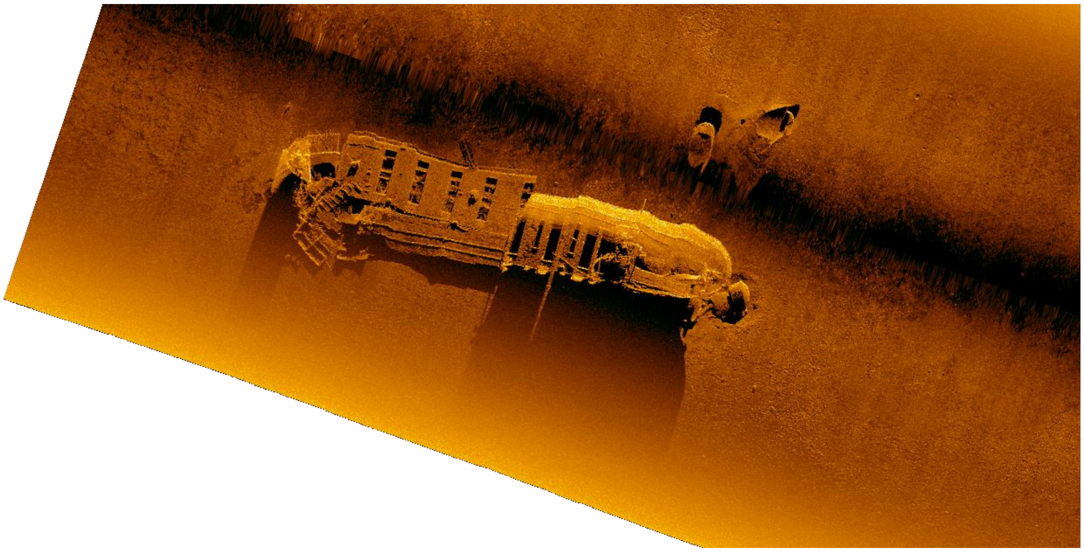

Figure 21: 500kHz Sonar Image of Grecian *(2014) (Courtesy of TBNMS).*

Model Building

Since this archaeological site formation analysis study is based on the use of 3D models, modeling software was especially important to create these models. For this project, McNeel's *Rhinoceros 6* (*Rhino)* was chosen to create the 3D models. This is a CAD (computer-aided-design) software commonly used in designing objects. This software was chosen due to the extensive history of it being used in creating similar projects (e.g., Fox 2016; Smith 2020) and the fact that it possesses features that can easily render ships and boats for this kind of work.

While working on the modeling project, *Rhinoceros 7* was released and included upgrades from the previous version. Despite this, the work for this project continued with *Rhinoceros 6* as it had already been purchased and contained all the relevant features needed for this project.

Historical Modeling

To begin modeling the ships as they were constructed, the plans obtained from BGSU Library were uploaded into Adobe *Photoshop*. In *Photoshop* several image scans were combined to recreate the complete page of plans. This was done by uploading a set of images, going to the automate section, and completing a 'photo merge.' The process was then repeated until each set of plans (Outboard Profile, Inboard Profile, Spar Deck Plan, Main Deck Plan, Midship Plan, and Detail Plan) was created as shown above. After creating the complete builders' plans from the set of images obtained, the images were uploaded into *Rhinoceros 6.* After importing these images into *Rhino*, they were lined up to create a 3D rendering of the builders' plans (Figure 22).

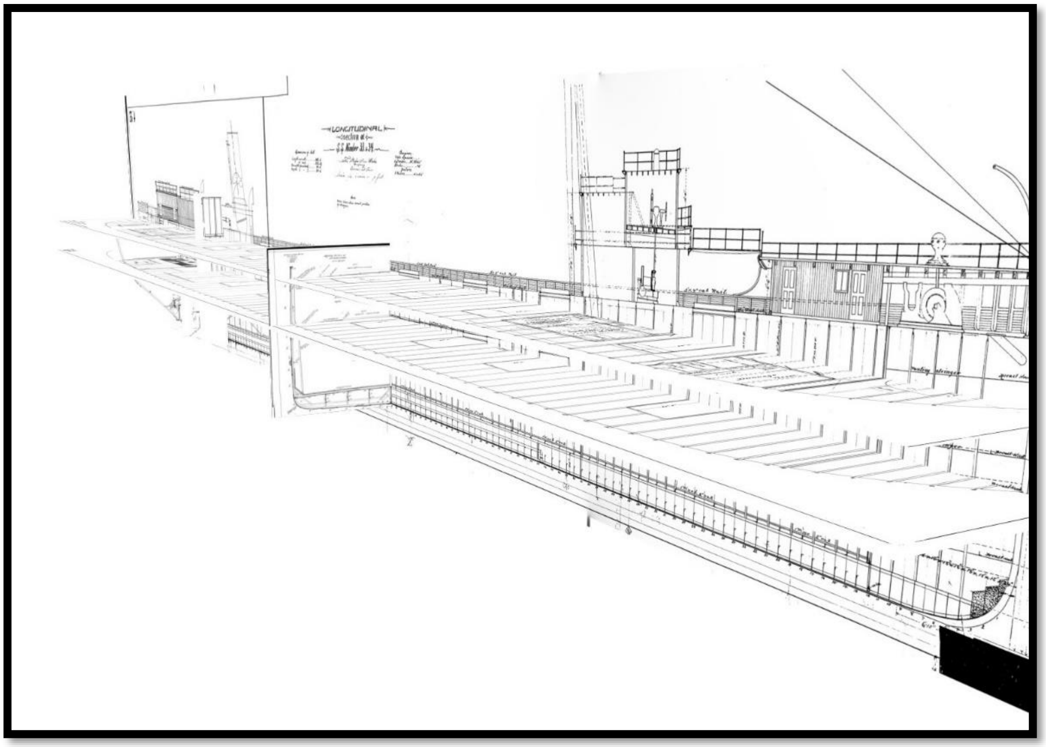

Figure 22: Builders' plans lined up (Image by Caleb O'Brien).

Although ships built during this period would have followed a frame-first construction method, this model was built using a shell first method. The uploaded builders' plans were traced and used to create the outline of the hull (Figure 23).

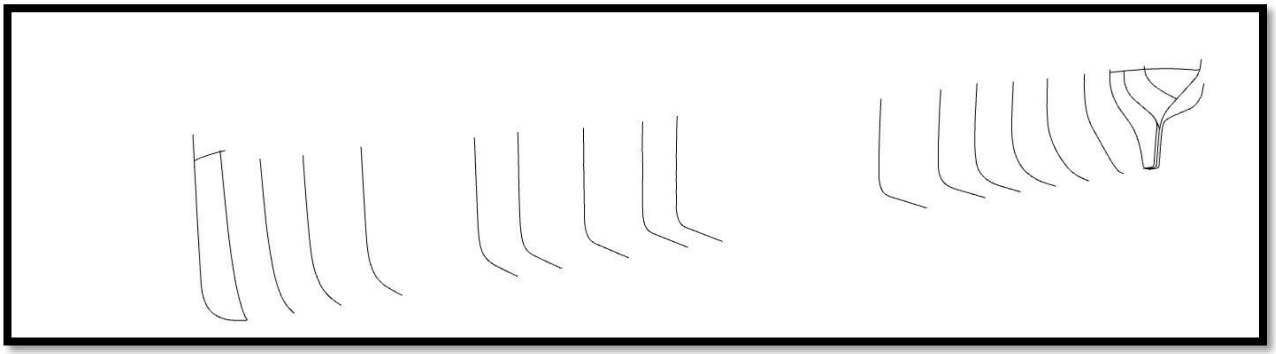

Figure 23: Lines used to create the hull (Image by Caleb O'Brien).

These lines were then lofted to create the shape of the hull. With the shape of the hull constructed, the other features of the ship, such as the decks, frames, and walls, were added and trimmed to fit within the hull of the vessel (Figures 24 and 25).

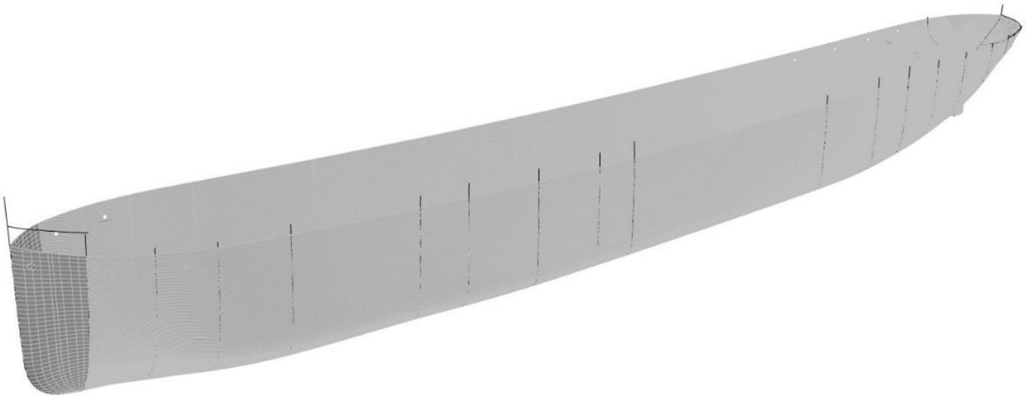

Figure 24: Completed hull (Image by Caleb O'Brien).

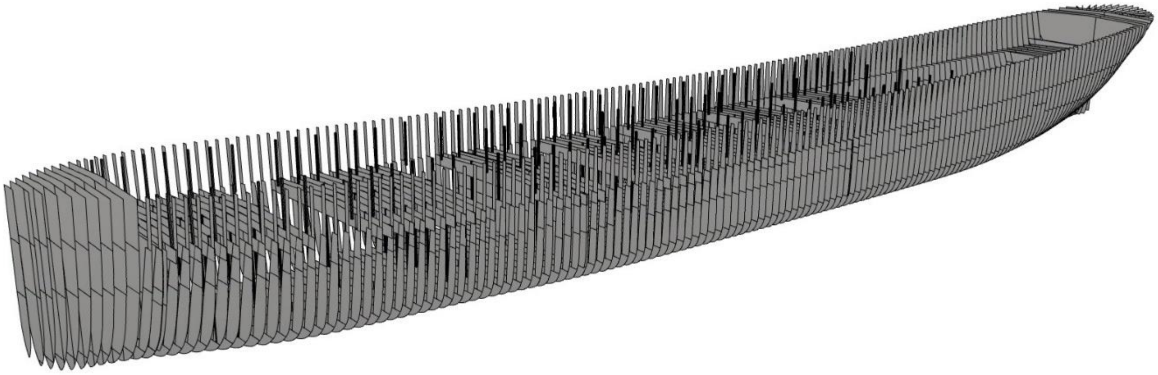

Figure 25: Interior frames (Image by Caleb O'Brien).

After creating all the main features of the ship, details were added including hatches, furniture, and ladders. In general, these features of the model were created by drawing two-dimensional lines and then extruding them to create three-dimensional surfaces (Figure 26).

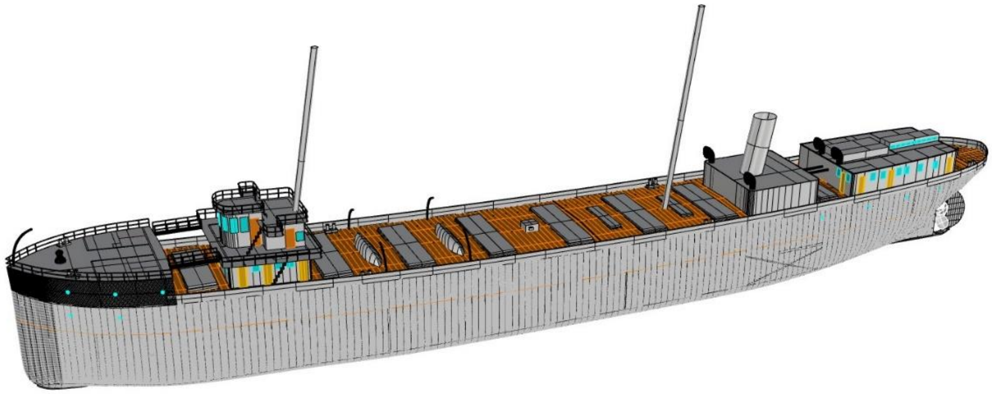

Figure 26: Completed joint historical model (Image by Caleb O'Brien).

While constructing the historical model, organization of what was rendered was highly important. Each different feature on the ship was rendered into its own layer that allowed it to be turned on or off regardless of the other layers. This allowed the model to be displayed with layers turned off to show internal features. For example, it is possible to turn off the hull layer to see the frames underneath or turn off the spar deck to see the main deck. This process (which will be explained in more detail in a later chapter) culminated in an accurate 3D rendering of the builders' plans.

Archaeological Modeling

After creating the joint historical model from the builders' plans, two separate historical or pre-depositional models were created, one of *Norman* and one of *Grecian*. Due to the datasets from each of the wrecks being different, the methods of creating the archaeological model are drastically different. The model for *Norman* was constructed using mainly the photogrammetric data of the site, while *Grecian*'s model was created using photographs, side-scan sonar data, and the site plan.

Unlike the historical model, which was constructed from the ground up, the archaeological model of *Norman* was constructed by breaking down the historical model in comparison to the photogrammetric model depicted above (Figure 17). During the process of creating the archaeological model, historical sources were consulted to recreate the order in which the vessel deteriorated. For example, the split caused by the wrecking event was modeled before other changes that were caused after the wrecking event. After the historical sources were consulted and their effects rendered into the wreck, the model was completely broken down to fit the modern photogrammetric model of the site (Figure 27). This breaking down involved cutting, splitting, and bending objects to get them to as closely match the photogrammetric model and images of the wreck of *Norman*. During the breakdown of the historical model into the wreck model, several intermediate stages of the model were saved showing the various 'snap shots' of the transformation of *Norman*.

Figure 27: Norman *wreck model overlayed with the photogrammetric model (Image by Caleb O'Brien).*

To create the archaeological model of *Grecian* the site plan and some of the side-scan sonar data were uploaded into *Rhino*. The site plan and side-scan sonar data were then scaled. Then the historical model of the vessels was brought into *Rhino* and was cut, split, and bent to fit the archaeological model. Unlike the archaeological model of *Norman* which saw no additions from the historical model to the wreck models, this model also saw the addition of salvage equipment which is present on the site in the form of three salvage devices. This model also considered the historical record and made separate models for the ship as soon as it sank, the days following when the cabins were picked up by the United States Life Saving Service, the wreck after salvage, and then finally the archeological site as it is depicted in the site plan (Figure 28).

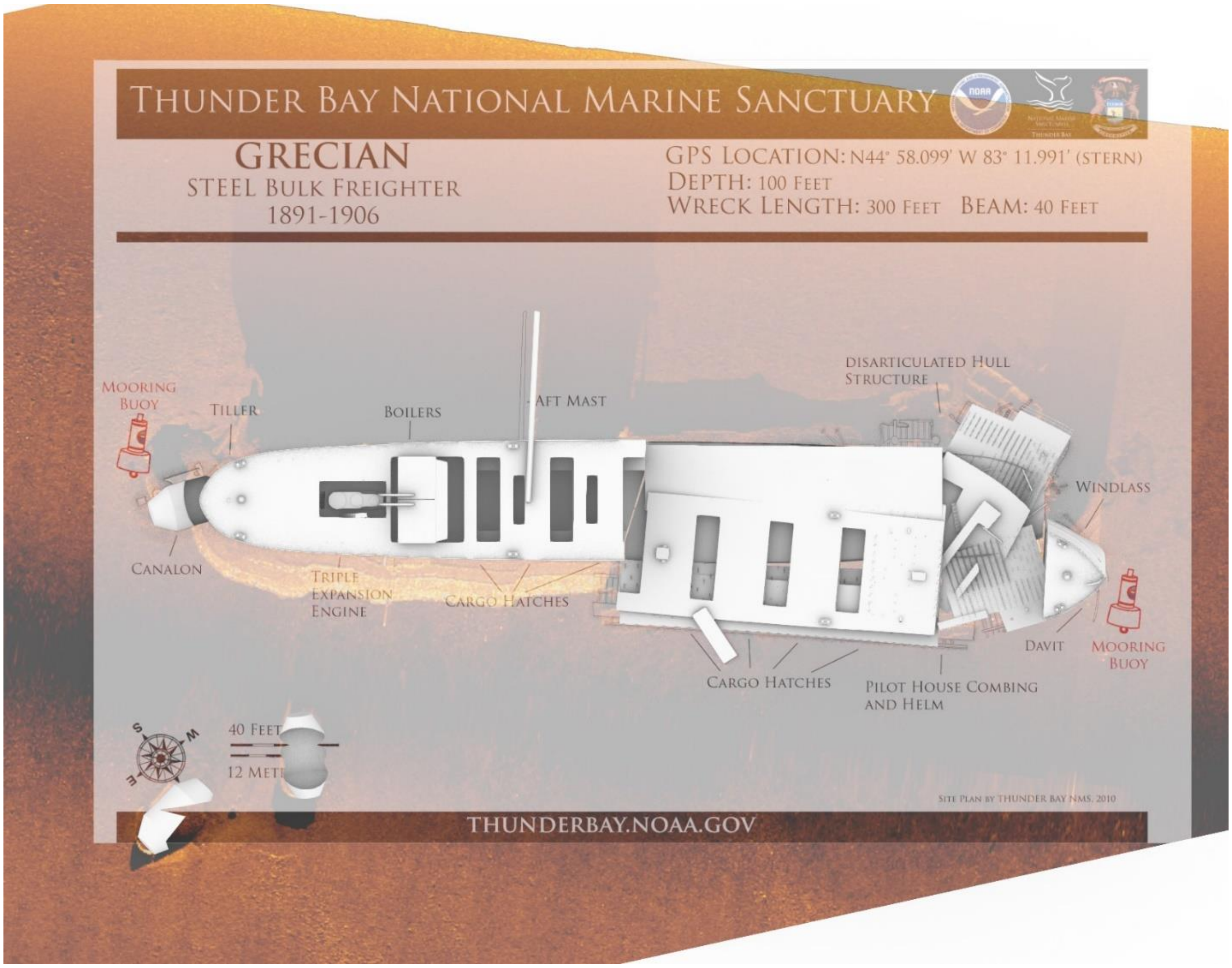

Figure 28: Grecian *model overlayed with the site plan and the side-scan sonar data (Image by Caleb O'Brien).*

Although this process did not create perfectly modeled wrecks (this will be discussed in greater detail in Chapter 5), the models do complete the task of creating realistic representations that can be used to create an accurate archaeological site formation study. The creation of these models and the details are explained in greater detail in Chapter Five.

Results

After creating these models, archaeological site formation theory and details from site histories were examined and applied to understand what transformations were likely causing specific changes at the shipwrecks. These deteriorations are explained chronologically. This chronology begins with the joint historical model, which is the model created from the builders' plans, with alterations to make it more accurate to *Norman* and *Grecian*. Next, the pre-depositional models of *Norman* and *Grecian* were analyzed showing and explaining the damage they had sustained during their working lives. After the pre-depositional model, the depositional model underwent a similar study to understand how the wrecking event altered the pre-depositional model to look more like the modern wreck. Finally, the post-depositional model was analyzed to show how the initial wreck completed its journey from ship to shipwreck.

Analysis

After studying the *Norman* and *Grecian* models independently it was finally possible to compare the deterioration of these wrecks. In this comparison, the deteriorations of the three stages (pre-depositional, depositional, and post-depositional) of *Norman* and *Grecian* along with the reason for these changes are compared to show how these vessels have undergone similar deterioration. Furthermore, these deteriorations were compared to the general trends seen at TBNMS where dozens of other wrecks are located. This comparison shows that *Norman* and *Grecian* are undergoing similar deteriorations from similar processes to the other vessels in TBNMS. When it comes to the post-depositional *n-transforms*, it was necessary to compare *Norman* and *Grecian* to vessels outside of TBNMS. Thus, the comparison at this stage was broadened to include other wrecks in drastically different environmental condition (such as those of the Atlantic Ocean).

After completing this comparison and understanding how deterioration occurs in other environments, it is then possible to take archaeological site formation theory and observations and create predictive future models for *Norman* and *Grecian*. These models showcase one possible future of these wrecks based on the deterioration that has already occurred and the deterioration observed on vessels in less preservative environments.

Chapter Four: The History of Two Steel-Hulled, Great Lake Freighters

Introduction

When it comes to conducting an archaeological site formation study it is imperative to create an accurate history of the sites to understand the cultural and *n-transforms* that could be affecting the wreck. Although both *Norman* and *Grecian* have had their histories told by Phil Hartmeyer's (2015, 2016) nomination to the NRHP, this history is more conducive to putting these vessels into the context of Great Lakes shipping. During the research, some inconsistencies were found in the written history which will be explored here. These clarifications are important when analyzing the transformation of *Norman* and *Grecian* from ships operating on the Great Lakes to the archaeological sites they represent today.

A new history detailing the lives of *Norman* and *Grecian* is presented in this chapter to understand what transforms affected these vessels in their pre-depositional, depositional, and post-depositional lives. As detailed in the methodology chapter, this chapter uses many primary sources such as newspaper accounts and insurance records. Using these sources, this chapter will first go through the context of construction and operation of *Norman* and *Grecian*. This information is crucial to understanding the construction of *Norman* and *Grecian* and the roles they filled on the Great Lakes. After providing this context, the chapter focuses on the life histories of *Norman* and *Grecian*.

Context of the Construction and Operation of *Norman* and *Grecian* (1854-1934)

The history of *Norman* and *Grecian* begins before the vessels were constructed with the formation of the Chapin Iron Mine followed by its subsidiary transportation company: the Menominee Transit Company. The formation of these companies led to the construction of

Norman and *Grecian* and determined their layout. However, it is also relevant to discuss Globe Iron Works (later the American Shipbuilding Company) to see how these vessels were constructed to begin the baseline for modeling for this archaeological site formation analysis.

Menominee Transit Company and the Chapin Iron Mine (1879-1934)

The Chapin Iron Mine was founded in 1879 in the Menominee Range. Discovered in the early 1870s, it remained virtually untouched until the late 1870s when a railroad was created between the iron range and the city of Escanaba, Michigan. The Chapin Mine quickly rose to become one of the largest iron mines in the Lake Superior area and the most profitable mine in the state of Michigan. The reason that this mine became so profitable was that unlike those located along Lake Superior, it was not burdened by shipping routes through the canal locks at Sault Ste. Marie. The location of this mine also gave a longer shipping season as the port of Escanaba remained ice-free a few weeks longer than the ports of Lake Superior (Cummings n.d.:7; Lawton 1887:34; Hartmeyer 2016:12). Not only was the Chapin Mine highly prized due to its location, but the iron ore from this mine was also said to be some of the best in the Great Lakes:

> No finer body of ore has ever been found in the State [sic] than the Chapin. It is so large, of such uniformity, of such excellent quality, so easily broken in the mine, so fully tested, with no diminution, that it certainly is not excelled, if equaled, by any other deposit that has ever been found in the Lake Superior Region (Lawton 1887:34).

In 1901 the Chapin Iron Mine was bought by a subsidiary of United States Steel Corporation. Despite being controlled by one of the largest companies in the United States, the Great Depression caused the Chapin Iron Mine to permanently close. Before its closing, the Chapin Iron Mine was one of the most successful since between its founding in 1879 to when it closed in 1934 it remained the most profitable iron mine in Michigan (Cummings n.d.:7; Hartmeyer 2016:13).

As mentioned above, the Chapin Iron Mine was founded in 1879 to work in the Menominee Iron Range. Originally mining corporations relied on independent shipping contractors. These contractors fluctuated between shipping different products, usually determined by what was the most profitable to ship, driving up shipping prices. Iron companies soon realized that this method of shipping was neither the most efficient nor the most profitable for them as it let contractors set the price for shipping items from the mines to the foundries on Lake Erie. This issue became so problematic that by the late 1880s, many of the iron mines began operating transit lines tasked with shipping their ore to the foundries; and the Chapin Mine Company was no different. Ferdinand Schlesinger was the controlling owner of the Chapin Mine Company; he partnered up with two brothers, Marcus and Howard Hanna, who had been involved in shipping for over 20 years. With this partnership, Schlesinger founded the Menominee Transit Company in 1890 as the main shipping company of the Chapin Iron Mine (Mansfield 1899:450; Hartmeyer 2016:14).

To ship ore from Escanaba to the foundries on Lake Erie, ships were needed. Alongside the company's founding in 1890, an order for six massive steel-hulled, bulk lake freighters was created to be fulfilled by Globe Iron Works of Cleveland, Ohio. The same year of this order saw the construction of the first ship of the series, *Norman,* while the other five ships, *Saxon*, *German*, *Briton*, *Grecian*, and *Roman*, were commissioned a year later in 1891 (Bureau of Marine Inspection and Navigation 1890a, 1890b, 1891a, 1892b; Mansfield 1899:450).

Globe Iron Works and the American Shipbuilding Company (1854-1899)

To fully understand the history of *Norman* and *Grecian*, it is paramount to understand the history of the company that constructed the ships. Globe Iron Works opened in Cleveland in 1854 as a partnership formally known as Cowle, Cartwright, and Company, which was a small local machine shop. Following the American Civil War, a Union veteran named Henry Coffinberry created a rival machine shop with partners named Wallace, Pankhurst, and Company in 1867. By 1869 this new company became wealthy enough to purchase a controlling share of Cowle, Cartwright, and Company (Orth 1910:955; Wright 1969:19-20).

Also, during the 1860s, it was recognized that Cleveland had all the resources needed to be a successful shipbuilding city. In response to these conditions, another partnership, Presley and Stephens, began producing small numbers of wooden ships for service on the Great Lakes. By the 1870s these two men soon became overwhelmed as the need for shipbuilding dramatically increased. Presley and Stephens then sold their business in 1876. The buyers for this small company were Globe Iron Works, who renamed this reconstituted shipbuilding company the Globe Dry Dock Company. It was during this time that Globe Iron Works began producing steam engines for vessels while Globe Dry Dock Company started producing wooden vessels with increasing frequency (*Cleveland Leader* 1872; Mansfield 1899:431; Wright 1969:22-23).

As the 1880s progressed, iron-hulled vessels became more and more popular in the United States, however, they had yet to make their appearance in the ore trade on the Great Lakes. Despite not being present on the Great Lakes, iron ships became an interest of one of the owners of Globe Iron Works. This led to Globe Iron Works consolidating Globe Dry Dock Company and Globe Iron Works into Globe Ship Building Company in 1881. Globe Ship Building Company then built the first iron-hulled vessel on the Great Lakes, *Onoko* in 1882. Globe Ship Building Company spent the next four years constructing iron-hulled vessels for use on the Great Lakes. In 1886, the company designed *Spokane*, yet another iron-hulled freighter. Before construction commenced, however, the company noticed that the difference between building the vessel with steel instead of iron was only an increase of $10,000. This discovery led to Globe Ship Building Company producing the first steel-hulled vessel on the Great Lakes in 1886 and this ended up as the last ship that Globe Ship Building Company constructed (Orth 1910:956; Mansfield 1899:431; Wright 1969:23-25).

After a disagreement between the owners of Globe Ship Building Company, some shareholders sold their shares to Marcus and Howard Hanna. This new partnership led to a reorganization of the company as Globe Iron Works in 1886. Between this reorganization and the creation of the American Shipbuilding Company in 1899, Globe Iron Works became a premier shipbuilding company on the Great Lakes and built hundreds of vessels (Figure 29), including the steel bulk carriers *Norman* and *Grecian* (Wright 1969:25-34).

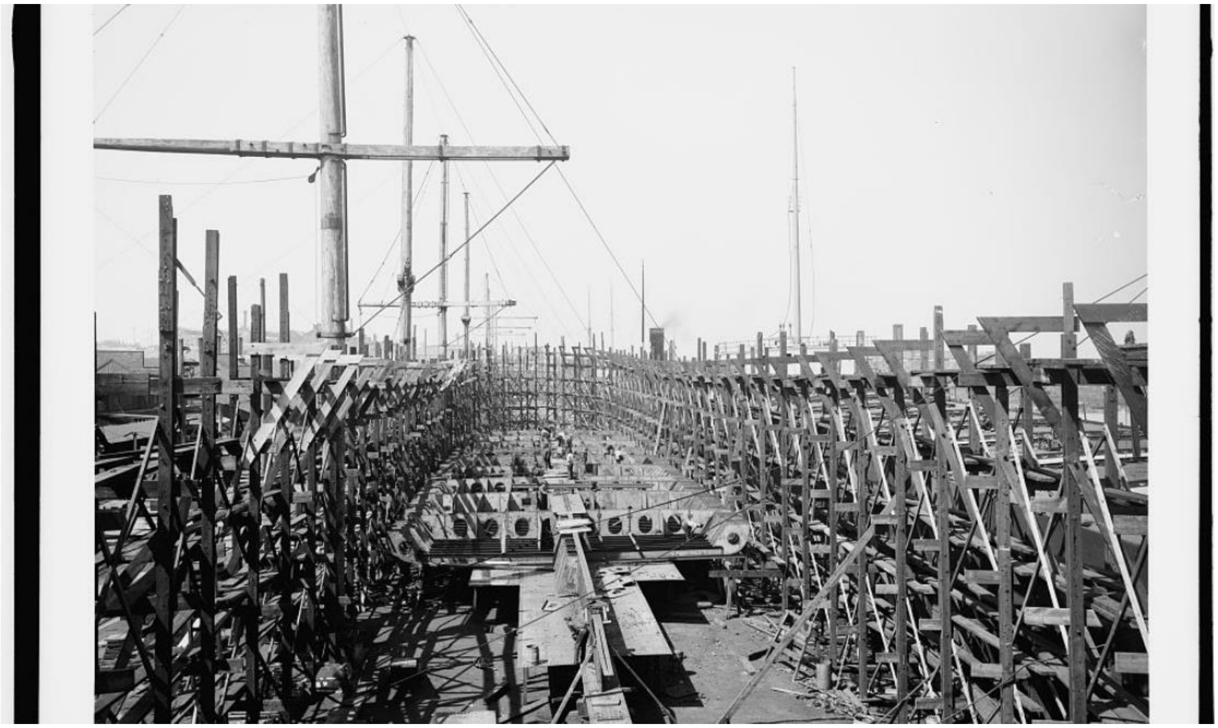

Figure 29: Hull 400 being constructed at Globe Iron Works Shipyard (Detroit Publishing Co. ca.1900).

History of *Norman* (1890-1895)

On 30 August 1890, *Norman* was launched (Figure 30). The vessel had an overall length of 296.5 feet, a beam of 40.4 feet, a depth of hold of 21 feet, and a gross tonnage of 2,304 tons. This steel-hulled vessel also incorporated a triple expansion steam engine, with the pistons being 24, 38, and 62 inches in diameter (Globe Iron Works 1890; Bureau of Marine Inspection and Navigation 1890a, 1891a). *Norman* and the other vessels of the Menominee Transit Company were part of the first collection of steel-hulled bulk freighters (Hartmeyer 2016:15; Wright 1969:23-25). Per *Norman*'s insurance record the vessel was constructed out of steel, had a double-bottom hull, an iron boiler housing, and had steam-powered pumps (*Inland Lloyds Register* 1891:67).

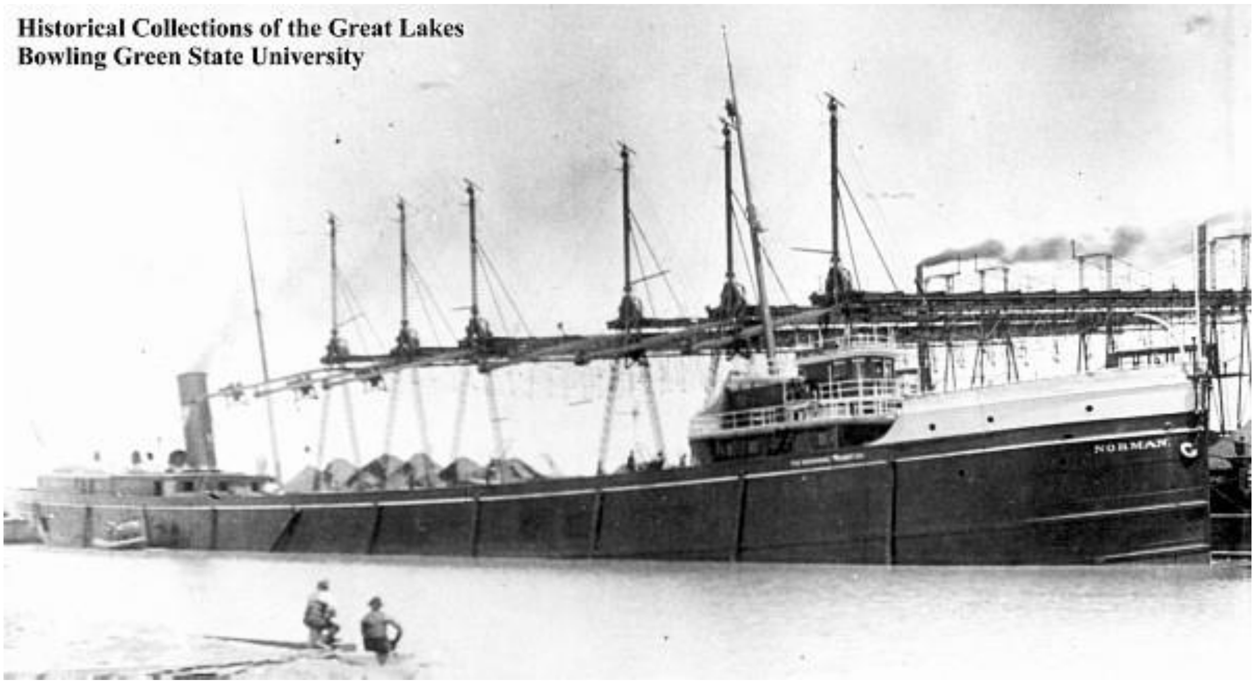

Figure 30: Image of Norman *(Courtesy of BGSU Libraries).*

Not much is reported on the operational life of *Norman*, though sources provide insight into a range of events. In August 1891, one of the firemen working on board *Norman* jumped overboard and drowned when the vessel was passing Windmill Point Light. Sometime during the 1891 season *Norman* and the other Menominee Transit Company vessels had Steel Plate French Range Ovens installed by the Born Steel Range and Manufacturing Company (*Marine Review* 1892b). In the following year, *Marine Review* featured *Norman* in detail giving various data about this ship. Of note is that *Norman* made 27 trips in the 1891 shipping year, 26 of which were between Escanaba, MI, and Lake Erie ports carrying an average of 2,575 gross tons of ore per trip (totaling 66,951 tons of ore for the year). On the only non-ore carrying trip *Norman* carried 2,163 tons of grain between Duluth, MN to Buffalo, NY (*Marine Review* 1892c).

In 1892 *Norman*, along with the other Menominee Transit Company ships, was electrified with incandescent lighting plants. This modification was completed by the Fisher

Electric Company and consisted of five circuits that were controlled by an automatic mechanism. When the president of the Menominee Transit Company, L.C. Hanna, experienced the lighting provided by the Fisher Electric Company for a single season on other vessels, he ordered that the same system be installed on his vessels (*Marine Review* 1892a). Later in the year, *Norman* was involved in a collision that occurred near Sault Ste. Marie, MI with the lake freighter *Republic*:

> Sault Ste. Marie, Oct. 6 – The steamer REPUBLIC, bound down, ore laden, owned by W. D. Rees of Cleveland and the NORMAN of the Menominee Transit company, up-bound, light, came into collision at 7:30 this morning at the turn of Lake Geoarg [sic] Flats, near where the SUSAN E. PECK sunk last season. They struck stem on, on the starboard side. The NORMAN is cut down to the water's edge ten feet back from the stem. She turned back for Cleveland with the tug BROCKWAY following her. The REPUBLIC was crushed twenty feet back from the stem to her bridge, but proceeded on her trip.
>
> According to the Inland Lloyds, both these vessels were built by the Globe Iron Works and were almost exactly the same size, being about 1,870 tons register and valued at $200,000 each (*Buffalo Enquirer* 1892).

Following the collision, *Norman* was sent to Cleveland for repairs. The total time for repair was detailed in *Marine Review* as only being two weeks with a cost of around $5,000. *Marine Review* also notes that the damage suffered by these two vessels was not as bad as reported (*Marine Review* 1892d). Despite the damages that occurred during the collision, *Norman* maintained its 'Class A' rating in *Inland Lloyds Register* (1894:52). During this entire shipping year, *Norman* made 30 trips carrying a total of 76,226 tons of ore with only 18 days and 19 hours being laid up in dock due to repairs, despite the collision with *Republic* (*Marine Review* 1893).

During the shipping season of 1893, *Norman* made 23 trips carrying a total of 63,926 tons of iron. It was also reported that *Norman* had zero days down due to repairs or in drydock further solidifying that the 1893 year was uneventful for the vessel (*Marine Review* 1894a).

In 1894, *Norman* was involved in a legal issue from the Treasury Department because of its lifeboats being carried on the deck and not readily deployable on davits. This incident occurred in late July and resulted in a $1,000 fine since the vessel was carrying passengers in one of its two staterooms. Despite this fine being issued, the Lake Carriers Association believed it would be rescinded since *Norman* was not a passenger vessel (*Marine Review* 1894b). Only a few days later, the fine was rescinded as the Secretary of Treasury agreed that *Norman* was not a passenger vessel since it only was designed to carry at most four guests in two rooms (*Marine Review* 1894c). The only other mention of *Norman* in 1894 is the data of its shipping in the first issue of *Marine Review* in 1895. For the entirety of the 1894 shipping season, *Norman* made 22 trips carrying a total of 53,682 tons of ore and 12,644 tons of coal. This data also notes that the vessel had no delays from repairs, drydocking, or other emergencies, showing that other than the incident over the lifeboats, *Norman* had a normal shipping year (*Marine Review* 1895a).

Despite *Norman* being one of the most modern vessels during the 1890s on the Great Lakes, it still had a tragically short lifespan. On 30 May 1895, while steaming north from Lake Erie carrying a small cargo of coal, *Norman* collided with the Canadian steamer, *Jack* (Figure 31). The captain of *Norman* stated that he saw *Jack* and gave the required whistles to the other vessel. *Jack* then disappeared into the fog and did not reappear until extremely close to *Norman*.

This led the captain of *Norman* to once again whistle and turn hard to port, however, it was too late as *Jack* hit *Norman* between the stern and midships (*Detroit Free Press* 1895a):

> When I sighted her again she was very close. I then gave one blast of the whistle, but this time the Jack answered with two blasts. I immediately turned the Norman hard aport and thought Jack would pass all right. Immediately after she loomed right up close under our port bow, showing her green light. I heard her captain give the order to put her hard a-starboard, then she struck us amidships with a horrible crash (*Detroit Free Press* 1895a).

Following the collision, *Norman*'s captain ordered the men to wake and get on the yawl boat or life raft. These two boats then lashed themselves together and spent two hours looking for three missing crewmen, which was unsuccessful. Soon the steam barge *Sicken* arrived on scene and picked up the survivors of *Norman. Sicken* also found *Jack* flooded but still afloat and took most of the crew off the sinking vessel. This rescue vessel soon left the scene and reported the accident to a nearby lighthouse which dispatched the Thunder Bay US Life-Saving Service (*Detroit Free Press* 1895a).

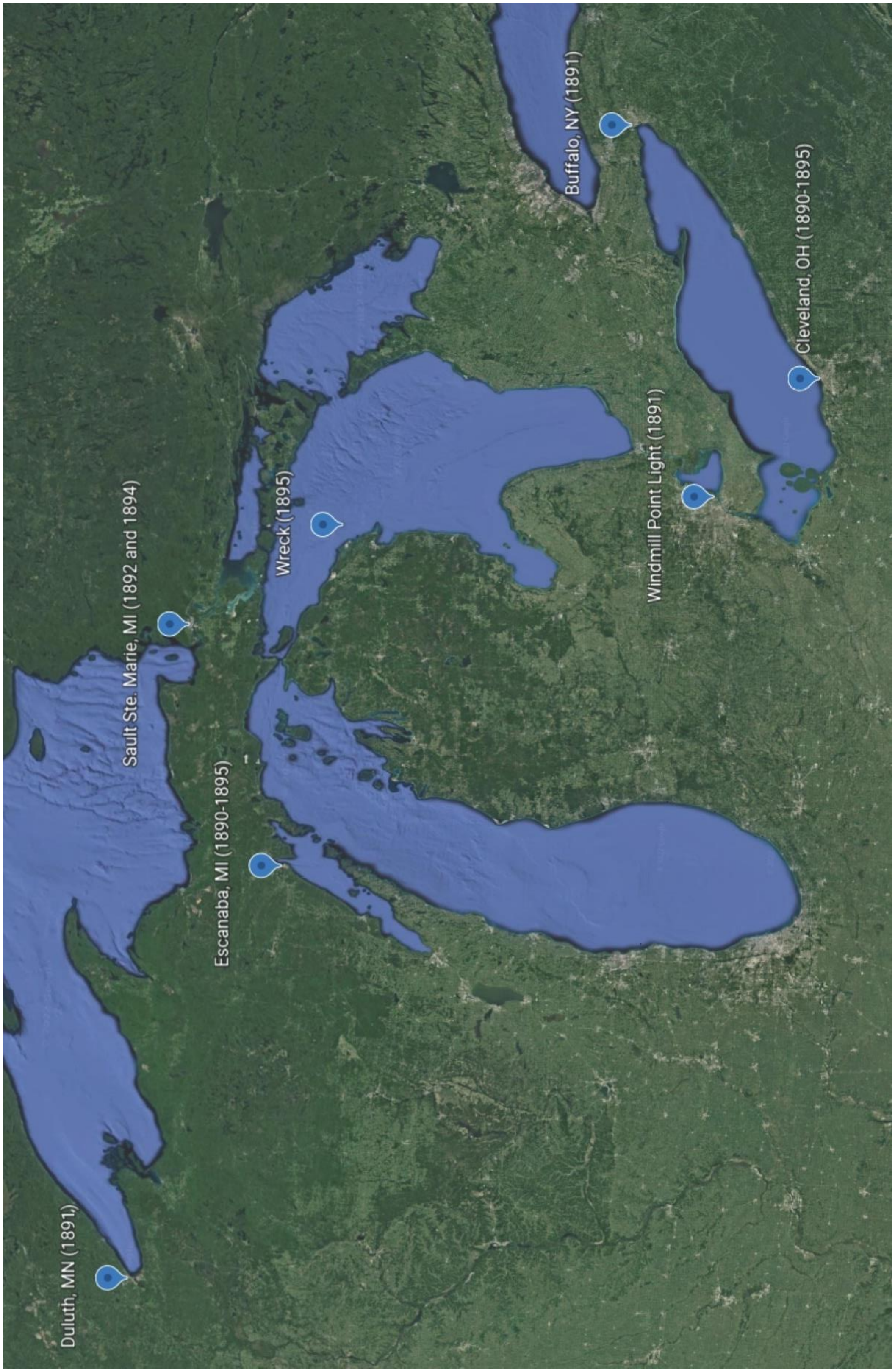

Figure 31: Map showing Norman*'s travels (Image by Caleb O'Brien).*

As there are two sides to every story, the above statement from the captain of *Norman* was countered by the captain of *Jack*. The day following the publication of the above article, Capt. Simmons stated that *Jack* was sailing south/southeast and due to the fog was sounding three whistles constantly and going at a slow speed of only 5 knots. Suddenly *Norman* appeared in front of them, and the captain ordered the vessel to reverse and turn to port. Since *Jack* received no warning from *Norman* the vessel did not have enough time to avoid collision and the vessels collided. Capt. Simmons then ordered *Jack* to be abandoned since he believed it was sinking. During this time Capt. Simmons of *Jack* believed that *Norman* was fine, and *Jack* was the vessel most in danger. The crew (minus the captain and engineers) of *Jack* was then rescued by *Sicken* just as the crew of *Norman* was (*Detroit Free Press* 1895b). The United States Life-Saving Service based at Thunder Bay Island dispatched two vessels to the scene later the next day and found *Jack* still afloat with the captain and engineers aboard. One of these rescue craft then towed *Jack* to nearby Presque Isle, where it finally sank in 24 feet of water. *Jack* was raised later for repairs (*Detroit Free Press* 1895a).

After *Jack* was raised it was repaired at Alpena, MI. On 7 June, the vessel made a last-minute escape as it left the Alpena, MI dock hours before a libel suit was filed against the owners and the vessel would have been impounded. To avoid this lawsuit *Jack* is reported to have stayed in Canadian waters and outside of US jurisdiction (*The Chicago Chronicle* 1895). This lawsuit ended up failing as the owners successfully argued they could not claim liability for the vessel (The Menominee Transit Company vs. Steamer *Jack*, 1895).

Luckily, *Norman* was saved from salvagers. This was due mainly to depth, although an attempt was made to salvage it. Two years later, another attempt was planned by Captain Charles D. Myers (*Duluth Evening Herald* 1897). Like the previous attempt at salvage, however, this one also seems to have not occurred and the vessel remained undisturbed and lost until the late 1900s when discovered by recreational divers (Hartmeyer 2016:17).

Since being discovered *Norman* has been the subject of scientific data collection in the 2010s corresponding with the expansion of Thunder Bay National Marine Sanctuary to include the area off Presque Isle County. The first of the scientific studies on *Norman* was a photomosaic of the vessel in 2010 by TBNMS. The following year using R/V *Storm* side-scan sonar data was collected at the site by TBNMS alongside an attempt at a multibeam echo sounder survey. In 2017, TBNMS once again collected photographic data and made a photogrammetric model of the site, showing in detail its current condition. Also, in 2017, Michigan Technological University obtained side-scan sonar data using an AUV (John Bright 2021, elec. comm.).

History of *Grecian* (1891-1906)

Grecian was the fifth bulk freighter of the Menominee Transit Company constructed by Globe Iron Works (Figure 32). Launched on 26 February 1891, *Grecian* had a length of 296.2 feet, a beam of 40.4 feet, a 21-foot depth of hold, and was registered at 2,348 gross tons, giving it a slightly greater capacity than *Norman*. Just like the *Norman*, *Grecian* was powered by a triple-expansion steam engine with 24-inch, 38-inch, and 61-inch cylinders with each having a 42-inch piston stroke (Globe Iron Works 1890; Bureau of Marine Inspection and Navigation 1891b). Per *Inland Lloyds Register* (1892:36)*Grecian* was constructed with steel, had a double-bottom hull, an iron boiler housing, and a steam pump well, like *Norman*.

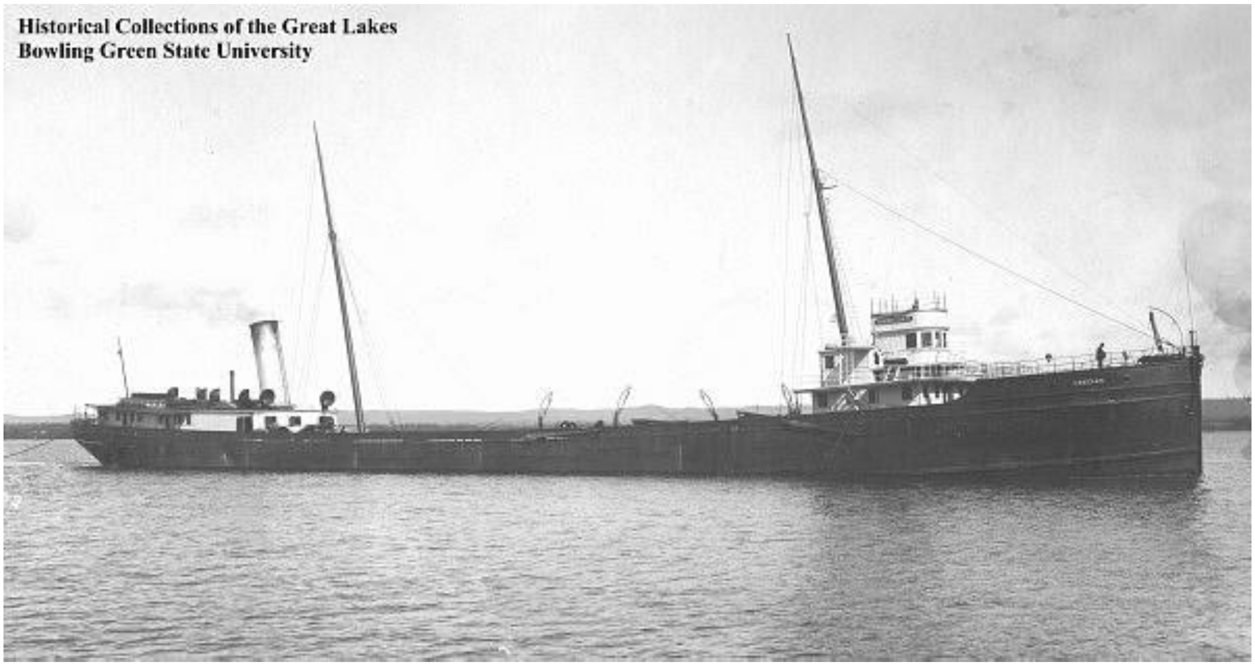

Figure 32: Image of Grecian *(Circa 1900) (Courtesy of BGSU Libraries).*

During the first year of operations, only two records of *Grecian* are extant. On 20 July 1891, *Grecian*'s crew discovered pieces of wood between damaged plates of its hull. *Grecian* also hit an obstruction near Colchester reef in Lake Erie. The captain of *Grecian* believed that this obstruction was a wreck, and a vessel was sent to confirm its existence (*Detroit Free Press* 1891a). The obstruction was later found to be a nest of boulders that extended three-eighths of a mile farther into the shipping channel than indicated on navigational charts. A few months later another laker, *Robert Mills,* struck the same obstruction and sank, despite the area being marked with buoys (*Detroit Free Press* 1891c). Beyond hitting this obstruction, *Grecian* also carried at least one load of ore during the 1891 shipping year as *Detroit Free Press* reported that the vessel delivered 2,650 tons of ore to Cleveland, OH from Escanaba, MI in three days and 19 hours (1891b). Sometime during the 1891 season *Grecian*, like *Norman* had Steel Plate French Range Ovens installed by the Born Steel Range and Manufacturing Company (*Marine Review* 1892b).

In 1892 *Grecian* was electrified with incandescent lighting plants alongside *Norman* and the other vessels in the Menominee Transit Line (*Marine Review* 1892a). On 1 June 1892, *Grecian*, which was laden with ore and headed for Cleveland, ran aground near Detroit, MI below the Flats Canal (*Detroit Free Press* 1892a). After unloading some of the ore and with the assistance of the tug *Wales, Grecian* was refloated and continued on its way (*Detroit Free Press* 1892b). Later the same year, *Grecian* had another issue at the St. Clair Flats Canal in Detroit. On 20 October *Grecian*'s air pump broke down and the tug *Wales* towed it to a port where the air pump was repaired (*Detroit Free Press* 1892c). Also, in 1892, there was an advertisement from the Worthington Condensers and Marine Pump Company that stated *Grecian* and the other vessels of the Menominee Transit Line were equipped with engine condensers (*Marine Review* 1892e). The following year the statistics for *Grecian* were reported by *Marine Review*. In the entire 1892 shipping season, *Grecian* made a total of 34 trips, the highest of any Menominee Transit Line vessel. During these trips, it carried 90,454 tons of ore with an average of 2,660 tons per trip (*Marine Review* 1893).

As with *Norman,* the 1893 shipping year for *Grecian* was uneventful. The only record of *Grecian* from this year is the shipping totals. During this year the vessel made 25 trips carrying a total of 69,220 tons of ore. Further solidifying that the 1893 shipping year was uneventful, *Grecian* spent no days under repair or in dry dock (*Marine Review* 1894a).

During the 1894 shipping year, *Grecian* had one incident while in the locks at Sault Ste. Marie, MI. While traveling through the canal on 9 July the vessel hit a rock while heading to Lake Huron loaded with iron ore. This rock punctured a hole in the 'after compartment,' causing the vessel to seek repairs and lighten the load (*Chicago Tribune* 1894). The obstruction was also detailed in an issue of *Marine Review* as another vessel ran into the same rock and there was a debate regarding if the rock had been properly marked (*Marine Review* 1894b). In the summary statistics of the 1894 shipping year, it was shown that *Grecian* spent six days and 11 hours getting repaired, presumably to have a patch installed over the puncture. Despite this, *Grecian* was able to make 21 trips and carried 48,551 tons of ore (*Marine Review* 1895a).

In 1895, the same year *Norman* sank, *Grecian* was involved in two incidents, one of which nearly caused it to sink. On 2 July, it was reported that *Grecian* had struck an obstruction near Ashtabula, OH (*Chicago Tribune* 1895). The following day, *Grecian* arrived in Cleveland, OH for repairs where it was discovered that four of the hull plates were damaged. Two of these plates were able to be rolled out instead of having to be replaced (*Detroit Free Press* 1895c). Only a few months later, *Grecian* almost sank due to a fire. On 17 November near Pointe Aux Barque, MI, a fire broke out in the aft cabin. By the time the crew had stopped the spread of the fire, nearly the entire aft cabin had been burned off and the electrical plant was damaged. This incident then caused the vessel to go to Port Huron, MI for repairs (*The Inter Ocean Tribune* 1895).

After 1895 there are no primary sources that detail *Grecian* until 4 February 1897. The 4 February article states that *Grecian* was underwent heavy repairs for three weeks in Cleveland, OH. During these repairs, 11 hull plates had to be rolled out and 20 plates had to be replaced (*Marine Record* 1897a). Although no primary sources discuss the events of *Grecian* during the 1896 shipping year, it probably saw an incident that prompted those repairs.

Grecian once again appears in primary sources in 1897. On 5 June Harry Steinan, a recent immigrant from Germany and a first-year deckhand, died after falling through a cargo hatch while loading the vessel with ore at Duluth & Winnipeg Docks (*The Superior Times* 1897). Later that same month, *Grecian* was issued a warning by the United States Treasury Department for violating the sailing and steering rules of the St. Marys River in Sault Ste. Marie when it was in Detroit, MI (*Marine Record* 1897b). In November, *Grecian* once again ran aground, this time near Amherstburg, Ontario. Within the same day of running aground, *Grecian* was freed by *Saginaw* (*Chicago Tribune* 1897).

In the 1898 shipping year, *Grecian* and the other four Menominee Transit Line ships, *Saxon*, *Roman*, *German*, and *Briton*, were contracted out and formed a new transit line between the United States and Canada. The Canada-Atlantic Line was a ship and rail line that connected several grain and package freight centers to the major ports on the Atlantic coast. The Menominee Transit Line ships were vital in bringing the cargo from the ports of Chicago, Duluth, and Milwaukee to Parry Sound. From there the cargo was loaded onto trains to Montreal, Boston, Portland, and New York. These vessels were contracted for a cost of around $20,000 per vessel per year with a $6,000 upfront cost for alterations to allow the vessels to carry package freight (*Marine Review* 1898). In April the alterations of *Grecian* for package freight were completed and on 18 April the vessel left Cleveland to work between Chicago and Parry Sound (*Detroit Free Press* 1898). On 20 April *Grecian* was in Chicago, IL, and suffered a very public incident when it ran into a local bridge. While leaving the city under tow of the tug *D.B. Green*, *Grecian* hit Lake Street Bridge. This accident tore off 10 feet of railing and sidewalk to the bridge and frightened the passengers of two electric trolleys traveling across the bridge. Although the damage amounted to only $800, the Superintendent of Bridges stated that had *Grecian* hit either end of the bridge it would have destroyed the entire structure (*Chicago Tribune* 1898). Following this incident, *Grecian* remained in service and was in Georgian Bay during mid-December. Despite being so late in the year, *Grecian* left Georgian Bay for one last cargo run to Buffalo, NY. Contemporaries in the *Marine Record* noted that this was odd as the waters around Buffalo, NY were already freezing over (1898).

Although *Grecian* and the other Menominee Transit Line freighters had been contracted out for two years as part of the Canada-Atlantic Line, the contract only lasted until July of 1899. At that time M.A. Hanna and Company sold all their transportation and mining assets to the National Steel Company. The assets as part of this deal included Chapin Mining Co., Winthrop Iron Co., Menominee Transit Co., and Mutual Transportation Co. Due to this change in ownership, *Grecian*, along with the other Menominee Transit vessels, were once again put back into the iron trade between Escanaba, MI, and Cleveland, OH (*Marine Review* 1899; *The Iron Wood Times* 1899; *The Representative* 1899). In fact, by December, despite the original contract having the ships carrying grain and package freight to Lake Erie, *Grecian* and *Roman* had already been to Escanaba, MI, and loaded ore bound for Cleveland, OH, while the remaining ships were finishing up their last trips for the contract before heading back to Escanaba (*Marine Record* 1899).

In 1900, *Grecian* was put under new management as it, along with the other Menominee Transit Company vessels, are listed as part of the Mutual Transit Company (*Marine Record* 1900). This seems to be a conglomeration of the two shipping lines that were part of the merger with the National Steel Company. During this year *Grecian* continued working between the iron mines and Cleveland, OH, as evidenced by it running aground at the entrance to Huron Harbor in Cleveland, OH loaded with iron due to strong winds lowering the water levels at the beginning of November (*Detroit Free Press* 1900; *The Daily Herald* 1900). Only a few days after this incident it was reported that *Grecian* would soon be tying up for winter in Cleveland, OH

(*Marine Review* 1900). Sadly, this shows that the last trip of *Grecian* for the season ended with the vessel running aground as it had done multiple times before.

In 1901, the management of *Grecian* once again changed to the Pittsburgh Steamship Company as the National Steel Company was taken over by the United States Steel Company. During this new ownership, *Grecian* continued its work as an ore freighter in the 'Steel Trust Fleet' (Pittsburgh Steamship Company), and it began trips to different ports such as Milwaukee, WI (*Chicago Tribune* 1901; *Fort Wayne News* 1901). In May 1901, *Grecian* ran aground on the Middle Ground of the Pelee Passage near Windsor, Ontario (a city across the river from Detroit). The vessel was noted as being 18 inches out of the water in the bow and 12 inches in the stern, with heavy seas in Lake Erie likely causing significant damage to the hull of the vessel. After several days of unloading cargo to raise the vessel 2 feet, *Grecian* was freed with the assistance of the tugs *Home Rule* and *Wale* (*Chicago Tribune* 1901; *Detroit Free Press* 1901a). While *Grecian* was aground, the Lake Carriers Association met at Sandusky, OH to force the Canadian government to build a lighthouse near where *Grecian* was aground as several other vessels had also run aground there already that year. This problem was severe enough for the Lake Carrier Association to build a lighthouse or other marker there themselves to prevent these accidents from happening (*The Sandusky Star-Journal* 1901a). Despite the length of time spent aground and the worry about the hull, when *Grecian* was inspected in a Detroit drydock, it was discovered that the vessel had sustained no damage to its hull (*Detroit Free Press* 1901b). Only two weeks following this incident, presumably when *Grecian* was leaving Detroit, it was involved in a very peculiar incident. On 16 July a passenger on the steamer *Frank E. Kirby*, W.S. Marsh, was standing on the deck when the vessel passed by Grassy Island in the Detroit River. Suddenly Marsh felt a stinging sensation and put his hand to his head and found a .22 caliber bullet hole. He was taken to a washroom on the vessel where another passenger dug the bullet out of his head and a doctor on board dressed the wound. When the officer on board *Frank E. Kirby* went to investigate the incident, he discovered that a young boy on board the ship had fired a revolver to salute *Grecian* as it passed by heading to Lake Erie. An unknown person onboard *Grecian* reportedly fired a salute back to *Frank E. Kirby* and had not expected the bullet to travel between the two ships due to the distance between the two (*Detroit Free Press* 1901c; *The Weekly Palladium* 1901). Following this very odd incident, *Grecian* is not mentioned in primary sources until 9 December, when it loaded coal in Sandusky, OH as the last vessel to leave Sandusky for the year (*The Sandusky Star-Journal* 1901b). Six days later on 15 December, *Grecian* reached Milwaukee, WI loaded with coal but covered with several inches of ice on the deck after suffering through rough seas and blistering cold temperatures (*Fort Wayne News* 1901).

In October 1902 *Grecian* ran aground at Pension Island near Sault Ste. Marie, MI. On this trip, *Grecian* was laden with ore and was traveling south towards the foundries on the lower lakes. When the vessel ran aground, two of the watertight bulkheads were punctured and the vessel had to be lightened to move the vessel (*The Benton Advocate* 1902). Despite the damage of this event being described as severe, the status of the vessel was not reported nor were any repairs. The only other mention of *Grecian* for the year was an article in 1903 saying that *Grecian* was wintering at Duluth, MN (*Marine Review* 1903).

In 1903, *Grecian* began the year at Duluth, MN, but the movements of the vessel are lacking until October (*Marine Review* 1903). In early October, while entering the harbor at Sandusky, OH, *Grecian* had to veer slightly out of the shipping lane to pass another vessel. Upon leaving the shipping channel *Grecian* ran aground but was quickly able to be freed. After being freed, the captain demanded to see the most modern maps of the harbor to see the listed depths (*The Sandusky Star-Journal* 1903). Since the captain was so interested in the map, it seems that this event was caused not by the captain's error but instead by inaccurate charts.

Only two primary sources were found discussing *Grecian* in 1904 and 1905. In late June 1904, *Grecian* was reported to have unloaded coal at Green Bay, WI. After unloading coal, *Grecian* left Green Bay empty (*Green Bay Press-Gazette* 1904). In September 1905, *Grecian* sailed by Detroit, MI towing one of the other Pittsburgh Steamship Company vessels. *Cambria* reportedly blew an air pump disabling the vessel until *Grecian* arrived (*Detroit Free Press* 1905). These are the last sources written about *Grecian* before its sinking in 1906.

On Friday, 6 June *Grecian* struck a rock 5 miles off the coast of Detour, MI while carrying a cargo of coal to the upper lakes. A rock punctured a hole into the bottom of the bow through the double bottom. The first watertight compartment flooded, and the vessel pulled into the dock at Detour, MI. Overnight, the vessel sank at the dock (*Chicago Tribune* 1906; *Detroit Free Press* 1906a). While in Detour the vessel was patched on the tank top, or the upper layer of a double bottom hull, and the first watertight compartment was pumped out along with emptying the vessel's cargo of coal. On 16 June *Grecian* left Detour, MI to get repaired in Detroit, MI at the Ecorse Shipyard. Around 90 miles away from Detroit, MI it was discovered that the tank top had begun leaking. First, the pumps were able to keep the hull water-free, but soon the water became too much for the pumps, and distress signals were given (*Detroit Free Press* 1906b).

At 6:30 pm, *Bessemer*, another vessel owned by the Pittsburgh Steamship Co., rescued *Grecian* near Thunder Bay:

> We sighted the *Grecian* at 6:30 o'clock in the evening, and saw that she was in trouble, with a bad list to port and her rail awash. We ran alongside and passed cables to her and started for shallow water. We towed her for two hours, hoping to beach her behind a point in Thunder bay [sic], but she settled deeper and deeper, and finally the cables and wires snapped and she took the final plunge. One of her spars fell on our deck as she started. Previous to this we had lowered a ladder and the *Grecian's* crew had boarded the *Bessemer* (*Detroit Free Press* 1906d).

The final plunge of *Grecian* was recorded in slightly more detail by its captain:

> …we headed for Thunder Bay island [sic]. She was settling all the time and snapping lines as fast as put out. Finally she took a heavy list to starboard, so that her sticks tore away the *Bessemer*'s rigging. Then she straightened up, teetered, and her bow shot up in the air, and she went down stern first (*Detroit Free Press* 1906b).

On 18 June Captain Persons of the US Life-Saving Service stationed at Thunder Bay Island discovered the wreck of *Grecian* in 15 fathoms (90ft) of water. Floating above the wreck they discovered debris from the vessel including the pilothouse and cabin. Two other vessels, *Tempest* and *City of Alpena* also reported seeing wreckage floating in the vicinity of the wreck (Figure 33) and even pulled some floating personal effects out of the water (*Detroit Free Press* 1906c). Despite *Grecian* running aground several times, the vessel was still rated as Class A1 and valued at $110,000 in 1906 when it sank (*Inland Lloyds Register* 1906:41).

In 1908, an attempt to raise *Grecian* was started by Dr. Staud of Chicago. After testing his ‘canalon system’ (giant metal lift bags) by removing the machinery and engine of a tugboat with one canalon, he obtained the permits to raise *Grecian* with the intent to sell it once raised (*Detroit Free Press* 1908a). Only a month later, Dr. Staud chartered *Mathew Wilson* to bring the canalons and expedition team to Thunder Bay (*Detroit Free Press* 1908b). In August 1909, the expedition to raise *Grecian* started towards Thunder Bay and divers began searching the waters for the vessel (*Detroit Free Press* 1909a). On 25 August it was announced that 30 August would be the day that *Grecian* would be raised. The method for raising the vessel was to have four canalons: one on either side of the bow and one on either side of the stern with chains connecting the canalons running under the ship. The canalons would then be pumped full of air to raise the ship where it could be towed to shallow water, patched, and brought to port (*The Times Herald* 1909). This original attempt never took place as rough weather soon hit Thunder Bay delaying the project until the weather cleared. As the rough weather continued through September, another issue arose as one of the canalons exploded due to the rough conditions on 27 September. Despite losing one of the canalons, Dr. Staud believed that the three canalons would be enough to raise *Grecian* (*The Daily Herald* 1909; *Detroit Free Press* 1909b). By 1 October it was soon realized by Dr. Staud that three canalons would not be enough to raise *Grecian* so the attempt to raise the vessel was postponed until the following year (*Detroit Free Press* 1909c; *News Palladium* 1909; *St. Joseph Daily Press* 1909).

Figure 33: Map showing Grecian*'s travels (Image by Caleb O'Brien).*

In 1910, Dr. Staud once again tried to raise *Grecian*. In March, he told a Chicago newspaper that the plan was to wait for the water to warm up and be comfortable for working conditions. He then planned to attach two more canalons to the bow of the vessel and raise it

(*Chicago Tribune* 1910). In October 1910, it was reported that Dr. Staud had left Alpena, MI for Chicago, IL with two canalons after being unable to raise *Grecian*. Due to poor weather and another two canalons bursting, it was deemed impossible for the canalons to raise *Grecian* (*The Times Herald* 1910). Only two days after Dr. Staud had abandoned his attempt to raise *Grecian*, Fred Bildhauser, a diver from Chicago stated that *Grecian* would be raised the following year (*The Sheboygan Press* 1910). Whether this statement meant that he would be the one raising the vessel or that there would be another attempt by Dr. Staud is unclear. There are no documents from this year forward on attempts to raise the vessel.

From this final attempt to raise *Grecian* in 1910, it is most likely that the wreck was forgotten about until its rediscovery. In 1971, *Grecian* was relocated by sport divers. In 1980 Thunder Bay became the first shipwreck preserve in the State of Michigan. In 2000, TBNMS was created off the coast of Alpena and included *Grecian* (Hartmeyer 2017:5-7). In 2001, Robert Ballard and the Institute for Exploration (IFE) obtained the earliest known sonar data of the site (John Bright 2021, elec. comm.). Using this data to determine the orientation and layout of the wreck, TBNMS set up two mooring buoys located at the bow and stern. These moorings are constructed and positioned such that they allow easy access to the wreck while also preventing damage to it. In July of 2009, maritime archaeologists of TBNMS used traditional methods (baseline-offset and trilateration recording) to create a site map of *Grecian* (Hartmeyer 2017:7). In 2014 TBNMS collected sonar data of *Grecian*. Furthermore, *Grecian* has been the location for checkout dives and other practice diving for staff of TBNMS. This has resulted in an extensive photographic set of the wreck spanning from 2003 to 2021 (John Bright 2021, elec. comm.).

Conclusion

The lifespans of *Norman* and *Grecian* are not extraordinary. These vessels were just two ships in a large fleet carrying iron ore in one of the most important industries at the turn of the nineteenth century. Although these vessels were only small cogs in this industrial wheel, the circumstances of their sinking, particularly their location, has made them prime candidates for comparative study of archaeological site formation processes underway in Lake Huron.

Examining the lives of *Norman* and *Grecian* is the first step in understanding the cultural and non-cultural archaeological site transformations that are affecting these shipwrecks. By understanding the insurance records of these vessels, it is possible to see the construction standards in place at the time they were constructed. The historical documentation, meanwhile, illuminates some of the changes that can be expected on the vessels from their working lives along with potential changes from salvage. This chapter showcases many of the transformations that will be critical in the next chapters dealing with the results and analysis of this archaeological site formation.

Chapter Five: The Archaeological Site Formation of *Norman* and *Grecian*

Introduction

The purpose of this thesis is to determine whether it is possible to compare the archaeological site formation processes of two steel-hulled bulk freighters in TBNMS: *Norman* and *Grecian*. This chapter sets the foundation of this comparison and answers the secondary research questions that were outlined in the introductory chapter: what are the primary environmental processes (*n-transforms*) that have caused *Norman* and *Grecian* to transform from ship to shipwreck? And what are the primary anthropogenic processes (*c-transforms*) that have caused *Norman* and *Grecian* to transform from ship to shipwreck?

To answer the above questions, Chapter Two's explanation of archaeological site formation theory will be applied to the 3D models built by the author (see Chapter Three) and the results of historical and archaeological research on *Norman* and *Grecian* (see Chapter Four). This chapter will analyze the models of *Norman* and *Grecian* within the context of *c-transforms* and *n-transforms* and the historical records of these ships on a site-by-site level (a comparative analysis will follow in Chapter Six).

This chapter begins by looking at the joint historical model of *Norman* and *Grecian* constructed using the builders' plans obtained from the BGSU Library. The shared historical model can illustrate the *c-transforms* that took place in the construction of these ships and is used as a baseline for each subsequent model. This chapter will analyze *Norman* and *Grecian* individually to understand the specifics of their site formation. In the individual examination of these ships, the pre-depositional model will be first examined to discuss the *c-transforms* and *n-transforms* that would have affected these ships during their lives working on the Great Lakes.

Specific cultural transformations that are discussed are collisions with objects and repairs. Non-cultural transformations include grounding damage and general wear and tear caused by sailing on the Great Lakes. Then the wrecking models of *Norman* and *Grecian* will be shown, illustrating the wrecking event. This illuminates the *c-transforms* and *n-transforms* that affected these ships during their depositional stage. During this stage, possible *c-transforms* include collisions, towing methodologies, or reactions to the wrecking event. Possible *n-transforms* include any damage sustained through the wrecking event such as: water damage, air bubble release, and differential buoyancy. The last set of models that will be presented in this chapter are those of the wrecks themselves (i.e., the post-depositional stage). *C-transforms* during the post-depositional stage deal mainly with salvage. Non-cultural transformations include water currents, corrosion, mussel colonization, and biological degradation. Although there is the potential for quantitative measurements regarding corrosion of these wrecks, this study was unable to collect such data so will rely on qualitative modeling through the theories discussed in Chapter Two.

Joint Historical Model

To understand how *Norman* and *Grecian* transformed from ship to shipwreck, the author began by reconstructing the systemic context of both vessels. Since these vessels were constructed nearly identically, a *joint historical model* was created to understand how their construction affected the general site formation trends (Figure 26).

As mentioned in Chapter Three, this project was unable to obtain the actual builders' plans for *Norman* and *Grecian*. Alternatively, the schematics of the vessels constructed immediately before the Menominee Transit Company ships were used. Those ships were supposed to be identical according to contemporary newspapers at the time and Mansfield (1899) and others who gave measurements of these vessels. Despite the evidence pointing towards them being identical, a slight difference between the builders' plans and the archaeological sites was noted. When looking at the archaeological site plan of *Grecian* (Figure 20), it was discovered that the aft most cargo hatch was not where the builders' plans show it being. This means that the plans used were not identical to the plans of the Menominee Transit Line vessels. In the late stages of this thesis, a video was uploaded onto YouTube by W. Wes Oleszewski (Oleszewski 2022). The video features an image of builders' plans that are labeled as *Grecian*, which shows the layout of the aft cabin as it appears on the wreck and should appear on the builders' plans (Figure 34). Upon inquiring about the image, it was discovered that an anonymous individual owns the plans to *Norman* and *Grecian,* but they were unwilling to share these plans for this research (Oleszewski 2022; W. Oleszewski 2022, elec. comm.).

The difference manifested itself in a cargo hatch being between the boiler house and the aft cabin on the builders' plans while this cargo hatch is found before the first coal hatch on the wrecks of *Norman* and *Grecian.* The reason for the placement of this cargo hatch could be that these vessels are not identical as reported. It is also possible that this difference is the result of a cultural transform during the building phase. As shown by the outboard profile plan, the model's steam pipes are running between the boiler house and the aft cabin, over the cargo hatch (Figures 35 and 36). This construction would have limited the accessibility of this cargo hatch, and thus may have led to the vessel being altered during the construction stage to allow the cargo hatch to be more accessible. It is, therefore, not inconceivable for the aft cabin and cargo hatch to be moved during construction when this issue manifested. To mitigate the issue highlighted, this extra cargo hatch along with the hull underneath was removed and the two sections of the vessel were pushed together to better represent the ships as they looked during their working lives (Figure 37).

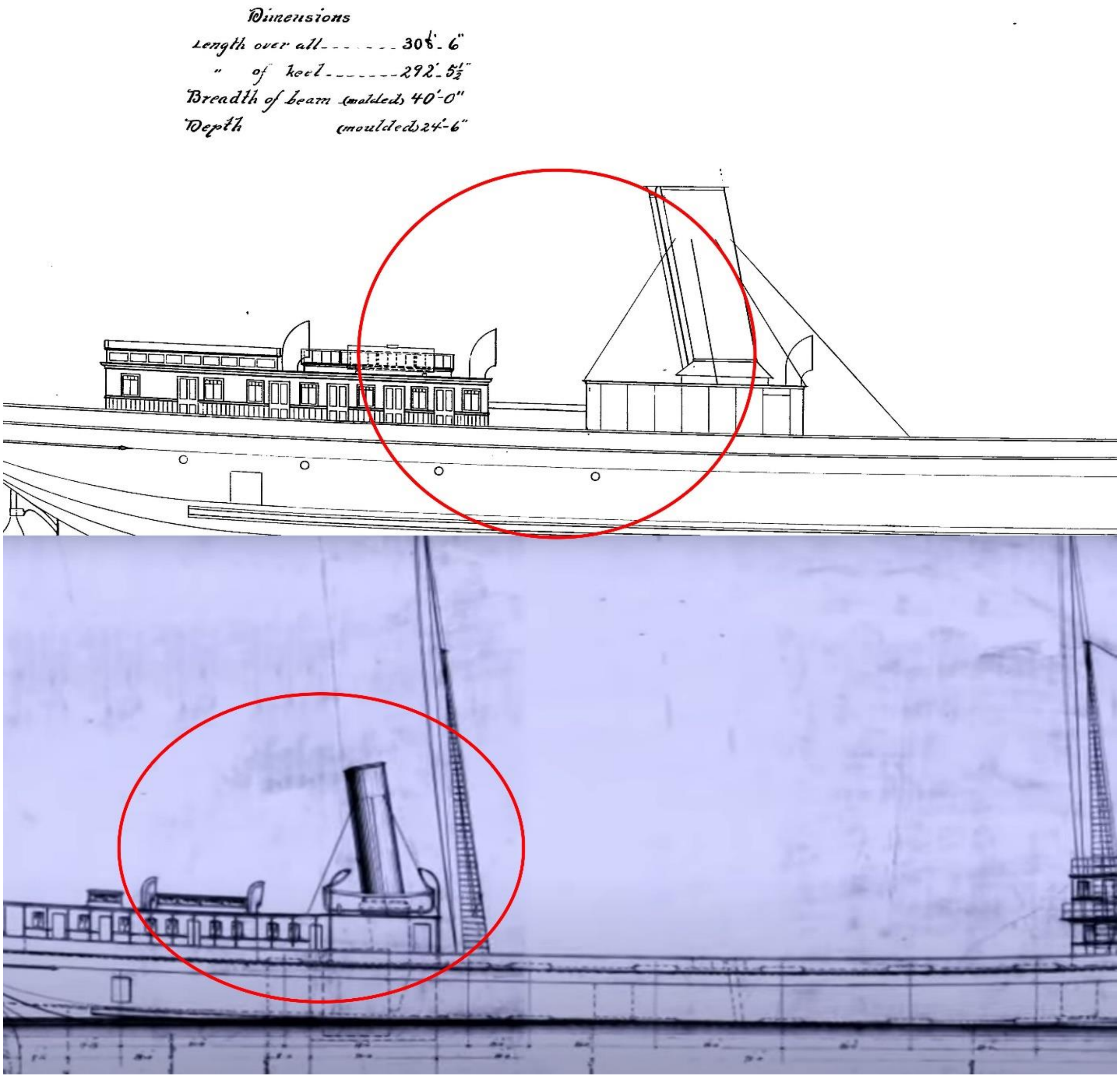

Figure 34: Comparison between the builders' plans used (top) and the plans depicted in W. Oleszewski's YouTube video (bottom) (Image by Caleb O'Brien).

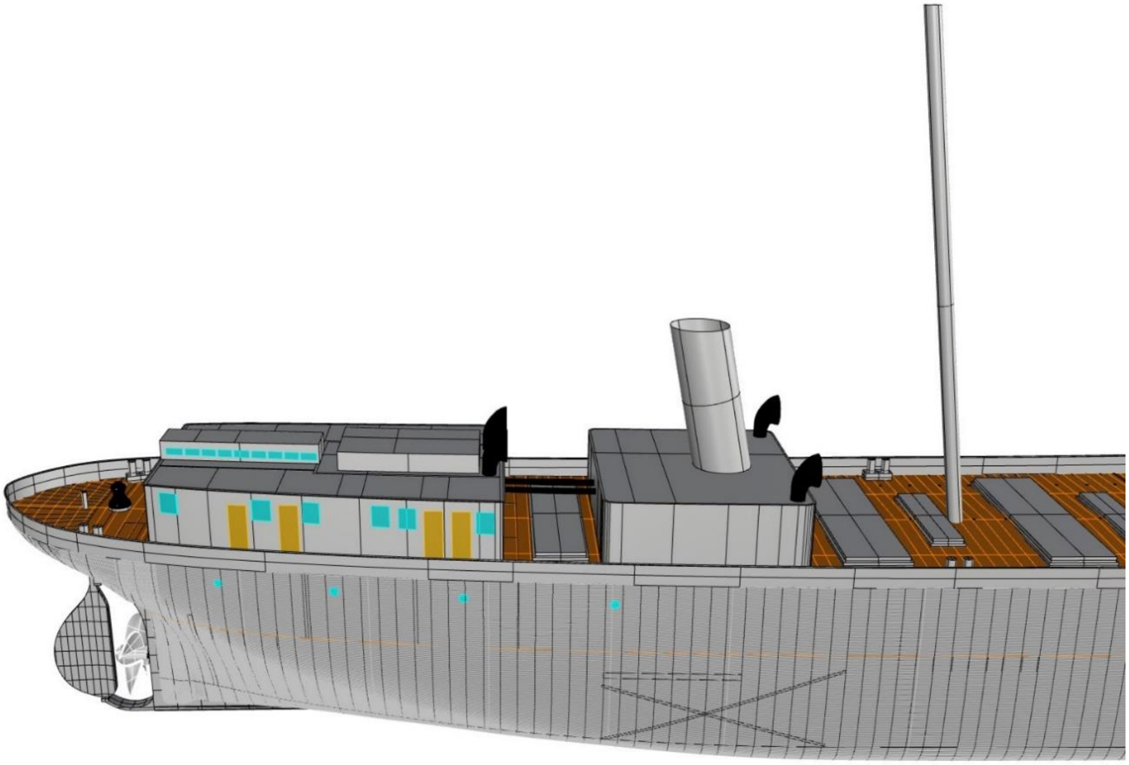

Figure 35: Stern of the vessel as depicted by the builders' plans (Image by Caleb O'Brien).

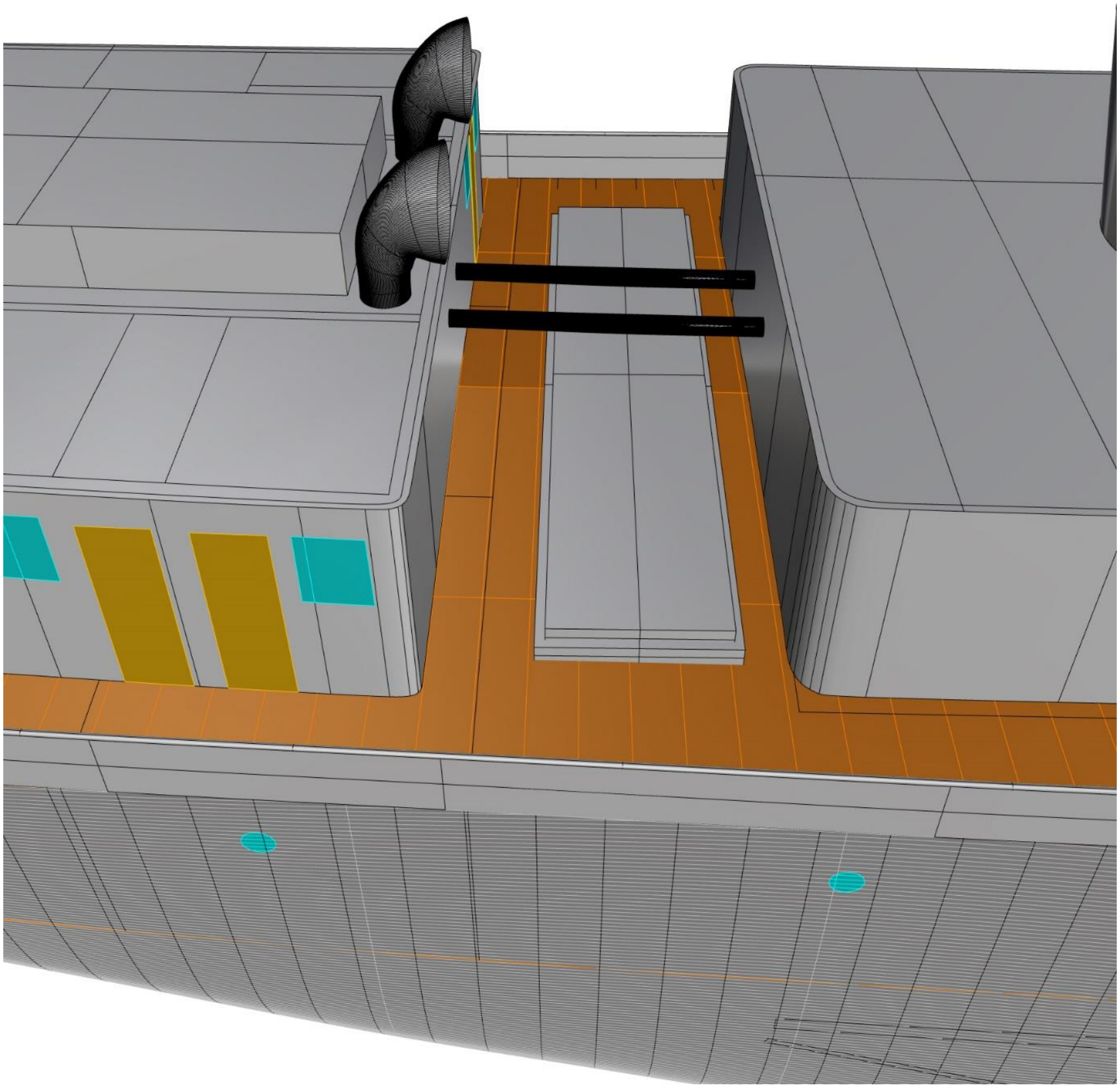

Figure 36: Boiler pipes that run over the cargo hatch on the builders' plans (Image by Caleb O'Brien).

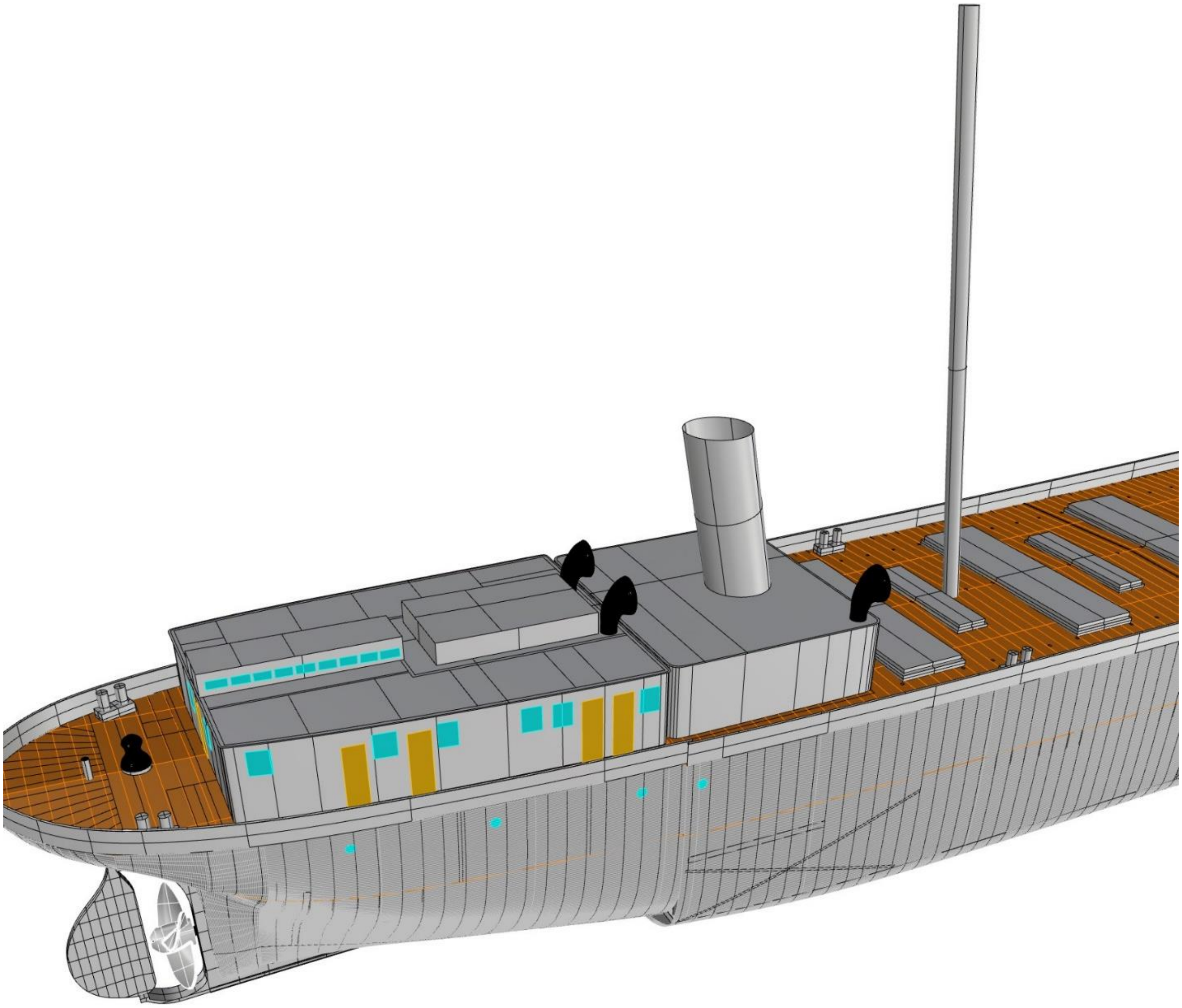

Figure 37: Model depicting the cargo hatch moved to better represent Norman *and* Grecian *(Image by Caleb O'Brien).*

Cultural transformations occurred to these vessels before they were even constructed. In building these ships, decisions were made to construct them in a certain way, out of certain materials, and for certain purposes which reverberates throughout the site formation processes of *Norman* and *Grecian*. The biggest of these decisions was that these vessels would be constructed out of steel. Although steel is a stronger material than wood and these ships followed the best construction practices at the time, a steel-constructed vessel is prone to specific site formation processes, namely physical and chemical processes (as discussed in Chapter Two). This has been noted by other authors:

> Iron wrecks are more likely to deteriorate as a result of physical and chemical processes, whereas wooden wrecks are more influenced by physical and biological processes. In-situ corrosion studies of iron and composite wrecks indicate a clear correlation of the extent of degradation (measured from corrosion potential) with the oxygen flux (associated with the amount of water movement) at the wreck site (Ward et al. 1999:564).

Although steel wrecks are prone to these types of transformations, the fact that these vessels were in active use means that these transformations would be mitigated through processes such as cleaning and painting. After sinking these ships no longer underwent these mitigation processes and began to deteriorate. Alongside these vessels being constructed out of steel, their construction also plays a large role in their transformation from ship to shipwreck. As shown by the insurance records, *Norman* and *Grecian* were rated the highest a vessel in *Inland Lloyd's* could obtain (Class A) which meant that they were constructed to the best standards in the United States in the early 1890s. Furthermore, this rating was maintained for both of their entire working lives, showing that they were constructed to be rated at the highest level for as long as possible. Arguably, because of this, these vessels were able to survive several incidents that caused damage but did not sink them. This then led to multiple repairs over the pre-depositional stage that were done sufficiently to maintain a Class A rating (See Chapter Four).

The construction needed for the high rating also could have led to the wrecks being structurally sound and thus be the reason that they remain mostly intact today.

Despite these vessels being nearly identically constructed, they each followed a different trajectory in their working life. This led *Norman* and *Grecian* to transform from nearly identical to the vastly different wrecks that exist today. The following sections will analyze *Norman* and *Grecian* individually to show how the joint historical model changed into the pre-depositional, depositional, and post-depositional models.

Pre-Depositional *Norman*

Between *Norman*'s construction in 1890 and its sinking in 1895, it would have been subjected to cultural and non-cultural transformations from shipping iron ore and coal between Escanaba, MI, and Cleveland, OH. Although the historical record illuminates the *c-transforms* that occurred during the working life of *Norman*, there is little information about the effects of *n-transforms* acting upon the vessel during this time.

C-transforms

Although *Norman* only was in service for five years, the vessel had one major cultural transformation that occurred. In 1892, *Norman* was involved in a collision with *Republic,* another Great Lakes bulk freighter. During this collision, it was reported that *Norman* was "cut down to the water's edge ten feet back from the stem" (*Buffalo Enquirer* 1892). Although later reporting suggests that the damage was not as extensive as originally suggested, the vessel certainly took damage and was repaired (*Marine Review* 1892d). The potential extent of this damage is modeled below (Figure 38).

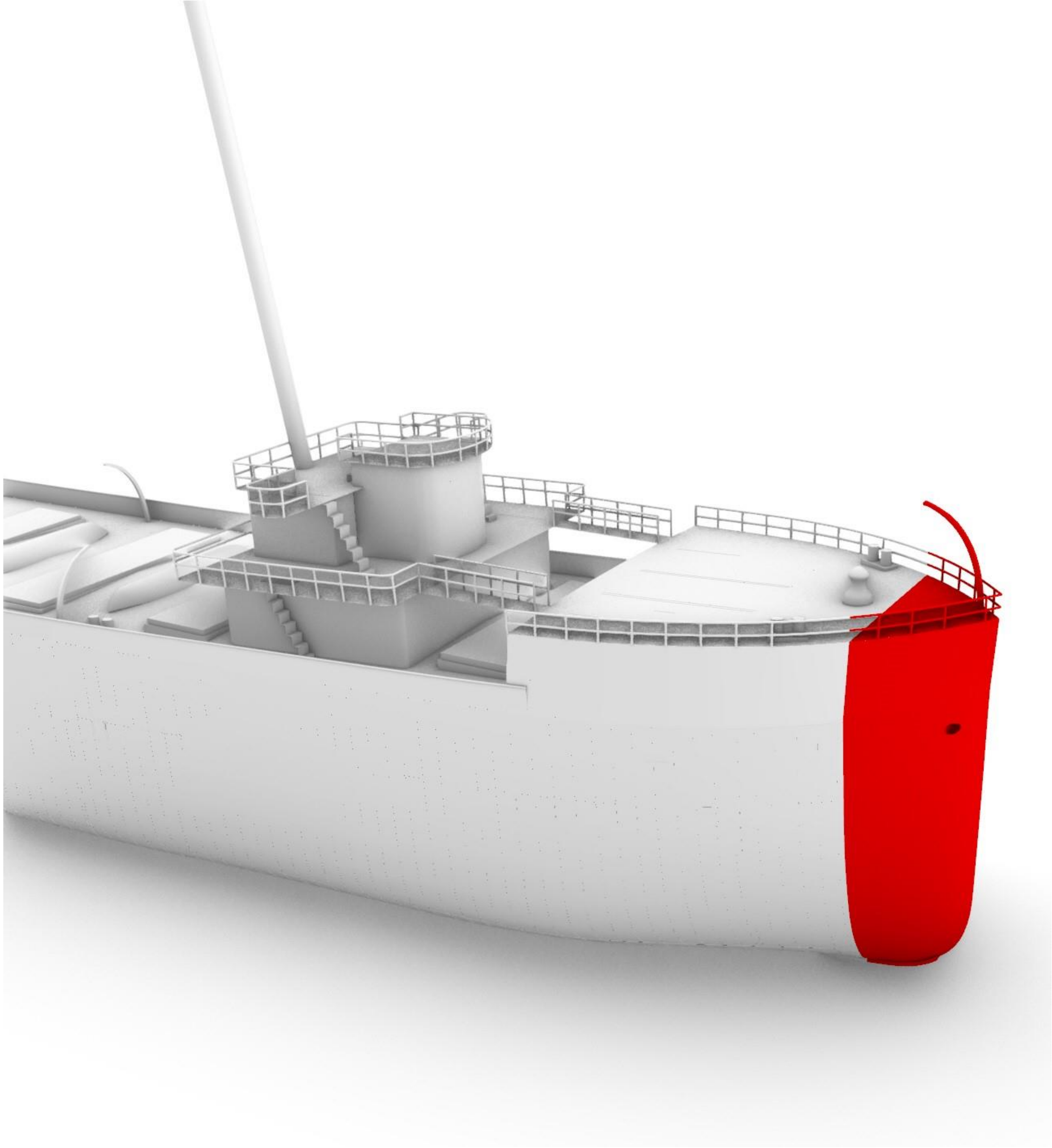

Figure 38: Model depicting damage to Norman*'s bow sustained as a result of the collision with* Republic *(Image by Caleb O'Brien).*

Despite such a large section of the vessel being damaged and repaired as a result of the collision, it is unlikely to be manifested on the site as any repairs to the vessel were made to the best standards since *Norman* was able to maintain a 'Class A' rating for insurance (*Inland Lloyds Register* 1894:52).

Alongside this major cultural transformation, an additional minor transformation also likely occurred in 1892. As part of the electrification modification, the 'lamp room' located on the spar deck was possibly altered as the storage of lamp oil was no longer needed. As a result of this electrification, this room is almost certainly improperly depicted on the models (Figure 39). For this room to be accurately depicted on the model, further archaeological study must be done at the wreck site as that room is still intact.

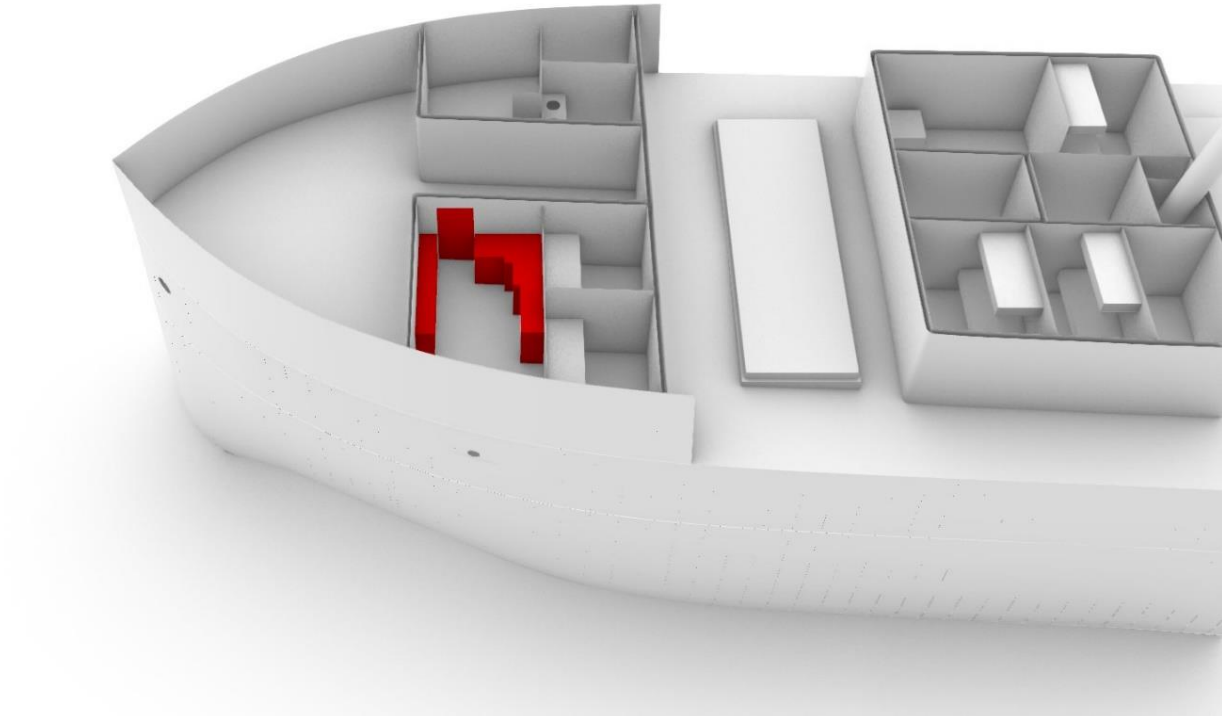

Figure 39: Cut away model of Norman*'s bow showing the lamp room which is likely incorrectly modeled (Image by Caleb O'Brien).*

N-transforms

Compared to *Grecian* and the other vessels of the Menominee Transit Line, *Norman* was not subjected to long pre-depositional *n-transforms* as it sank only five years after construction. This short lifespan would have resulted in significantly fewer pre-depositional *n-transforms* than the other vessels of this line since they served longer. Regardless, *n-transforms* constantly affect a working vessel since the environment constantly alters it (Richards 2008:52). Although these transformations are constant, they are generally not the focus of maritime archaeological research, and thus were not modeled or researched for this project (Gibbs 2006:8). Furthermore, since *Norman* was in use, any *n-transforms* would have been mitigated through maintenance.

Depositional *Norman*

The next stage of *Norman*'s transformation to the present-day shipwreck was the wrecking event itself, or the depositional stage. *Norman*'s wrecking event played a major role in its archaeological site formation. Due to the nature of the wrecking event being a collision, the transforms seen in this stage of *Norman*'s site formation are mainly cultural.

In this section, models will be used to show *Norman* both during and immediately after its wrecking event. To create these models, the historical record was used to put *Norman* and *Jack* in their positions as reported by the conflicting accounts of both captains. Alongside the historical record, the modern photogrammetric model of the wreck was used to show where the break occurred and what the wreck likely would have looked like immediately on the bottom of Lake Huron.

C-transforms

On 30 May 1895, *Norman* was sailing from Cleveland, OH. to Escanaba, MI carrying a small cargo of coal. While steaming upbound, a severe fog set in, increasing the chances of collision with another vessel. As noted in Chapter Two, Gibbs (2006) considers this fog the 'pre-impact threat phase' and would see the vessel's crew attempting to minimize the chances of collision. The history of *Norman* sees this stage being reflected in the captain of the vessel slowing down and giving the required whistles to alert other vessels of their presence (*Detroit Free Press* 1895a). This stage could either prevent the wreck entirely or continue the wrecking process to the next stage: the 'pre-impact warning phase' (Gibbs 2006:10).

Chapter Two describes the 'pre-impact warning phase' as occurring immediately before the wrecking event and characterized by drastic actions. For *Norman*, this stage occurred when the captain saw *Jack* and gave more signals to the other vessel. These immediate actions did not alleviate the issue and more drastic measures were taken. When the captain of *Norman* saw *Jack* appear closer, he turned the vessel hard to port to avoid the collision. The captain assumed that *Jack* would pass *Norman*, however, even when *Jack* turned hard to starboard, *Norman* was hit by the other vessel. As reported by *Norman*'s captain, *Jack* hit amidships with a loud crash (*Detroit Free Press* 1895a). Using this narrative, the collision of these ships is shown below (Figure 40). Although the captain simply states that the collision occurred amidships, based on the photogrammetric model and the present wreck model, the collision likely occurred immediately forward of the boiler housing (Figure 41).

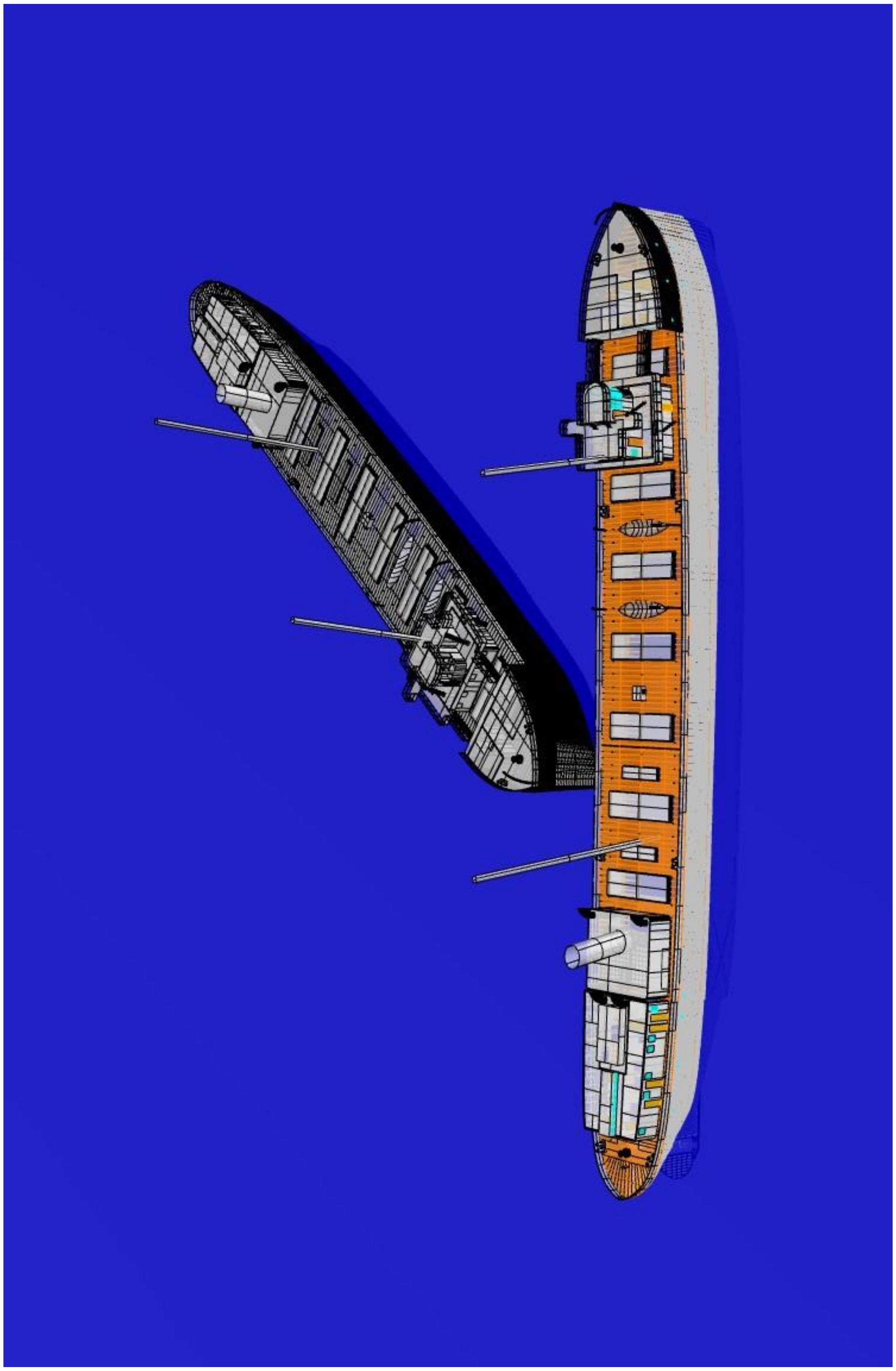

Figure 40: Collision of Norman *(colored) and* Jack *(gray) (Image by Caleb O'Brien).*

42).

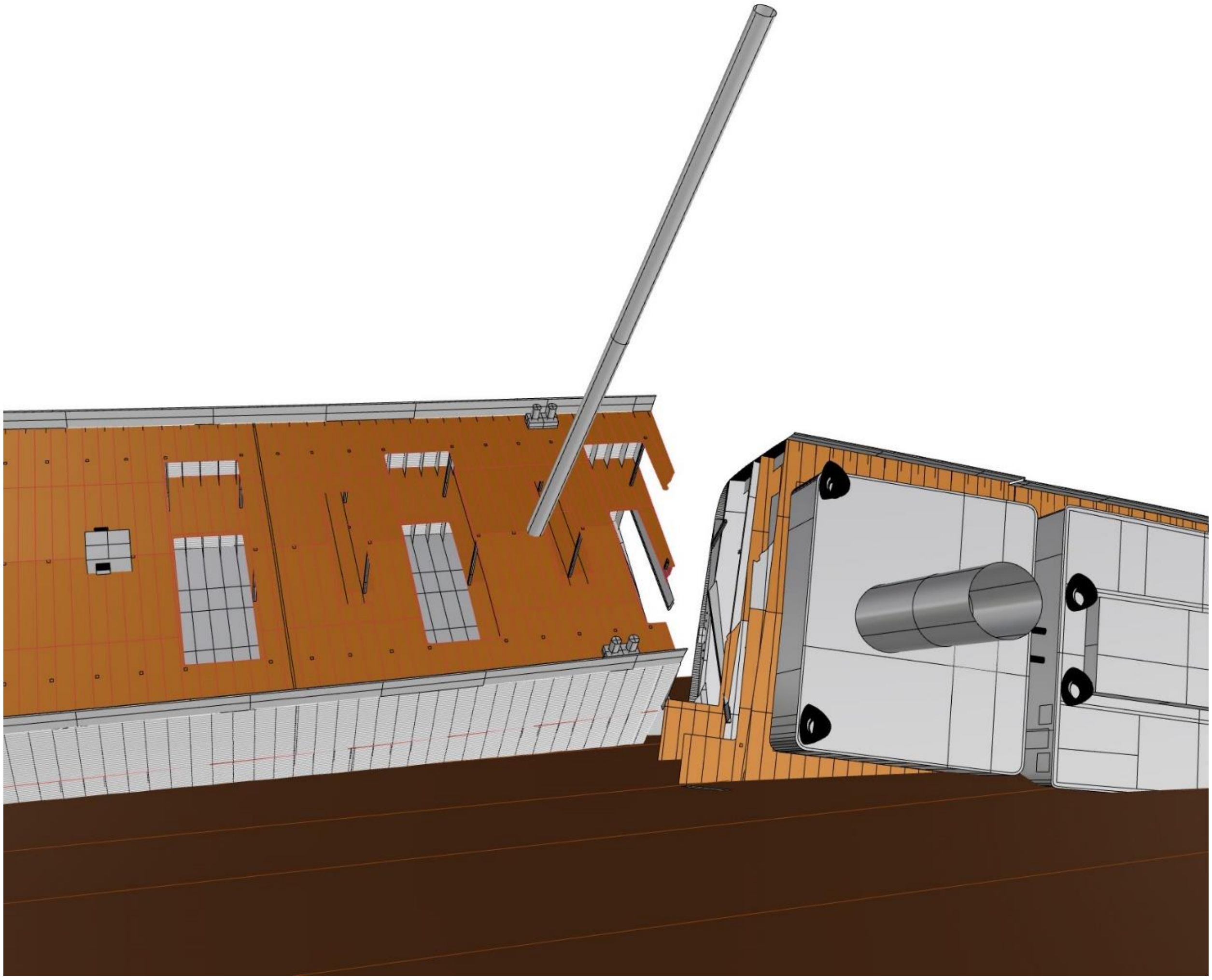

Figure 41: Area Jack *hit* Norman *(Image by Caleb O'Brien).*

Following the 'pre-impact warning phase' is the 'impact phase,' described as the period of collision. One part of this phase as described by Gibbs is the deployment of lifeboats (Gibbs 2006:11-12). As reported in the *Detroit Free Press*, following the collision the captain of *Norman* ordered that the ship be abandoned. The crew, minus three members who were never accounted for, launched two yawl boats, and lashed them together (*Detroit Free Press* 1895a). This is accounted for on the model as only one of the yawl boats appears on the wreck (Figure 42).

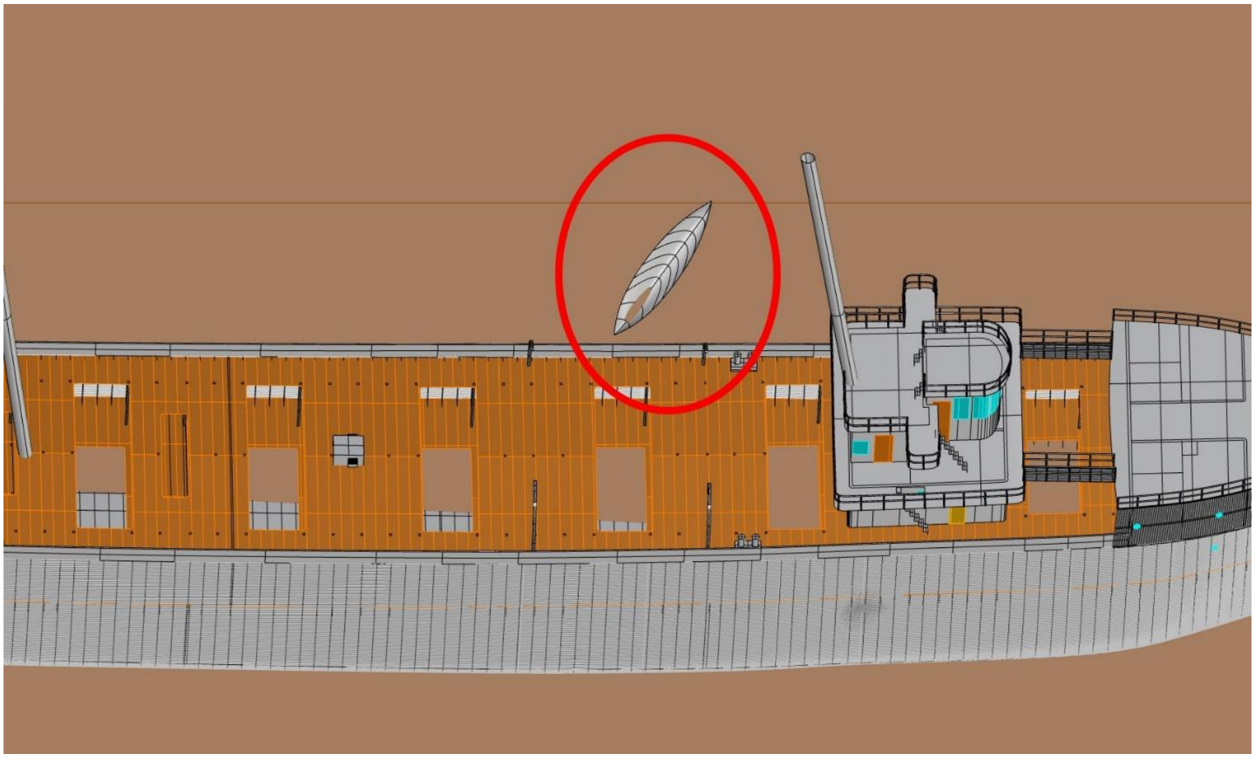

Figure 42: Single yawl boat that remains on the wreck (Image by Caleb O'Brien).

The above transformations led to the wreck to appear as shown below when it settled to its present location (Figure 43). As illustrated by the model, *Norman* most likely would have remained relatively intact, minus the break in the hull and the yawl boat falling off the wreck. Alongside the wrecking event causing many transformations, the circumstances around *Norman*'s sinking also protected the wreck from later cultural transformations. As noted in Chapter Four, *Norman* sank while only carrying a small cargo of coal. Due to the cargo only being coal, there would have been less interest in salvaging the wreck. The sinking event also positioned the wreck in deeper water making it much harder for potential salvagers to locate. As a result, *Norman* was protected from salvage.

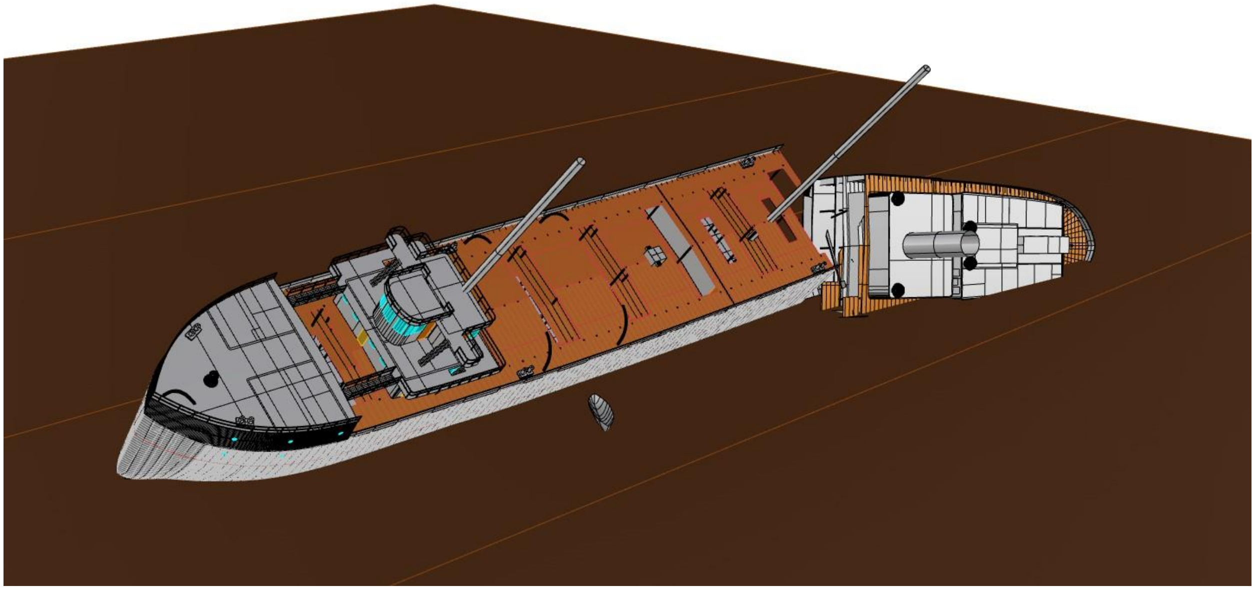

Figure 43: Depositional model of Norman *(Image by Caleb O'Brien).*

Post-Depositional *Norman*

The final model that shows the transformation of *Norman* from ship to shipwreck is the post-depositional model. Due to the depth of *Norman*, it was saved from salvage and more destructive *n-transforms* such as ice or waves. Using archaeological site formation theory, this model will help describe the various transformations seen on the wreck. As discussed in Chapter Three, this model was created by taking the pre-depositional model and breaking it down to fit within the photogrammetric model of the wreck. This process has some limitations as both models likely have inaccuracies. First, the pre-depositional model has imprecisions pertaining to the accuracy of the builders' plans. The photogrammetric model can have problems due to incorrect scaling. Despite these issues, the model depicted in this section accurately depicts the transformations that occurred to *Norman* between its sinking and today.

C-transforms

As has already been mentioned, the depth and limited cargo of *Norman* led to the wreck being protected from salvagers. Eventually, these factors led to *Norman* being forgotten until being rediscovered by recreational divers. Even since *Norman*'s rediscovery, the wreck has not been a popular dive site due to its depth being outside the recreational limits of SCUBA. However, it has become a more visited diver site with the prevalence of technical diving. *Norman* did not have a mooring buoy in place until 2022 and beforehand had several 'unpermitted moorings' tied to its spars (Wayne Lusardi pers. comms. 2022). Other than tackle that remains on the spars, it is difficult to quantify *c-transforms* that have affected this site.

N-transforms

Since *Norman* is a steel-hulled bulk freighter it is prone to chemical and physical deterioration processes (Ward et al. 1999:564). As discussed in Chapter Two, chemical deterioration is caused by chemical reactions and is highly affected (in the case of shipwrecks) by temperature, salinity, and pH levels of the water (Schiffer 1987:148,196). Physical deterioration was described in Chapter Two as being caused by waves, storms, and other physical forces acting on the wreck (McCarthy 1996:219). Although steel is more prone to chemical and physical deteriorations it is possible for some biological deterioration, namely mussels and sulfate-reducing bacteria, to alter the wreck (Singley 1988:29; Watzin et. al. 2001:2).

When it comes to the chemical deterioration of *Norman*, it has been minimized due to the cold, freshwater environment of Lake Huron. Although this has generally been one of the primary forms of deterioration when it comes to ferrous hulled vessels, the archaeological site formation studies that were used for this project have mainly examined wrecks in marine environments (see McCarthy 1996; Fox 2015; Smith 2020). When it comes to the Great Lakes, many of the chemical deteriorations are minimized. As noted in Chapter Two chemical deteriorations occur twice as fast for every 10 degrees Celsius (Schiffer 1987:148). Luckily there is a NOAA/GLERL (Great Lakes Environmental Research Laboratory) ReCON buoy off the coast of Alpena, MI. This buoy is located at 44° 59.2746´N, 83° 16.1892´ W and sits in 66ft of water. Using the published data of this buoy, it is possible to see the temperature at 66ft underwater near Alpena for May through October (the buoy is removed during the winter). For the months that this buoy is in the water, the average water temperature at 66ft hovers between 10 to 15 degrees Celsius (GLERL 2021). Considering that *Norman* rests in 200ft of water it is most likely the case that the water temperature of this wreck remains closer to or below 10 degrees Celsius for most of the year, which would severely limit the rate of chemical deterioration. Because of the lack of salinity and the water temperature being relatively cold, it is unsurprising that considerable chemical deterioration has not occurred on the wreck.

When it comes to the deterioration of *Norman* the most prominent changes appear to be caused by physical transforms. The pilothouse and the aft cabin have been washed off the wreck and onto the lake floor adjacent to the wreck (Figure 44). The collapse of the pilothouse seems to have been the result of physical deterioration as the entire structure was flipped off the wreck and collapsed in on itself. This is evidenced by structures such as the wheelhouse being buried under the deck (Figure 45).

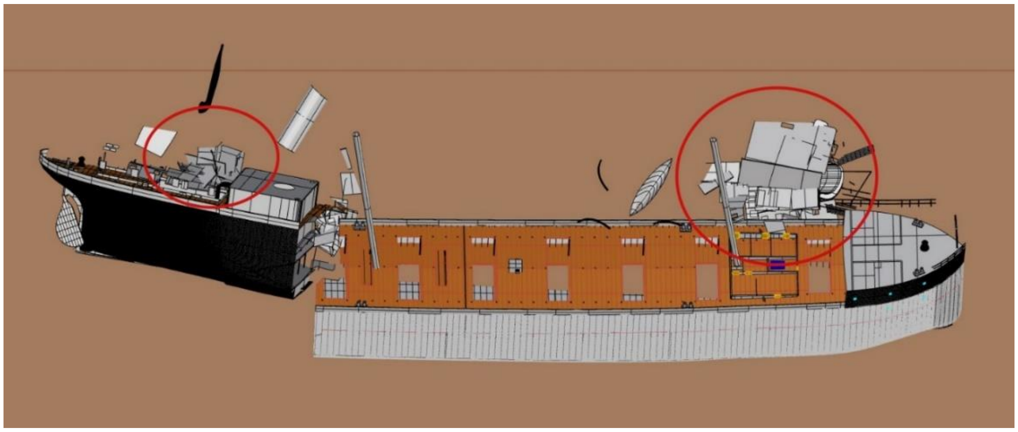

Figure 44: Wreck of Norman *from above that shows the remains of the pilothouse and aft cabins (Image by Caleb O'Brien).*

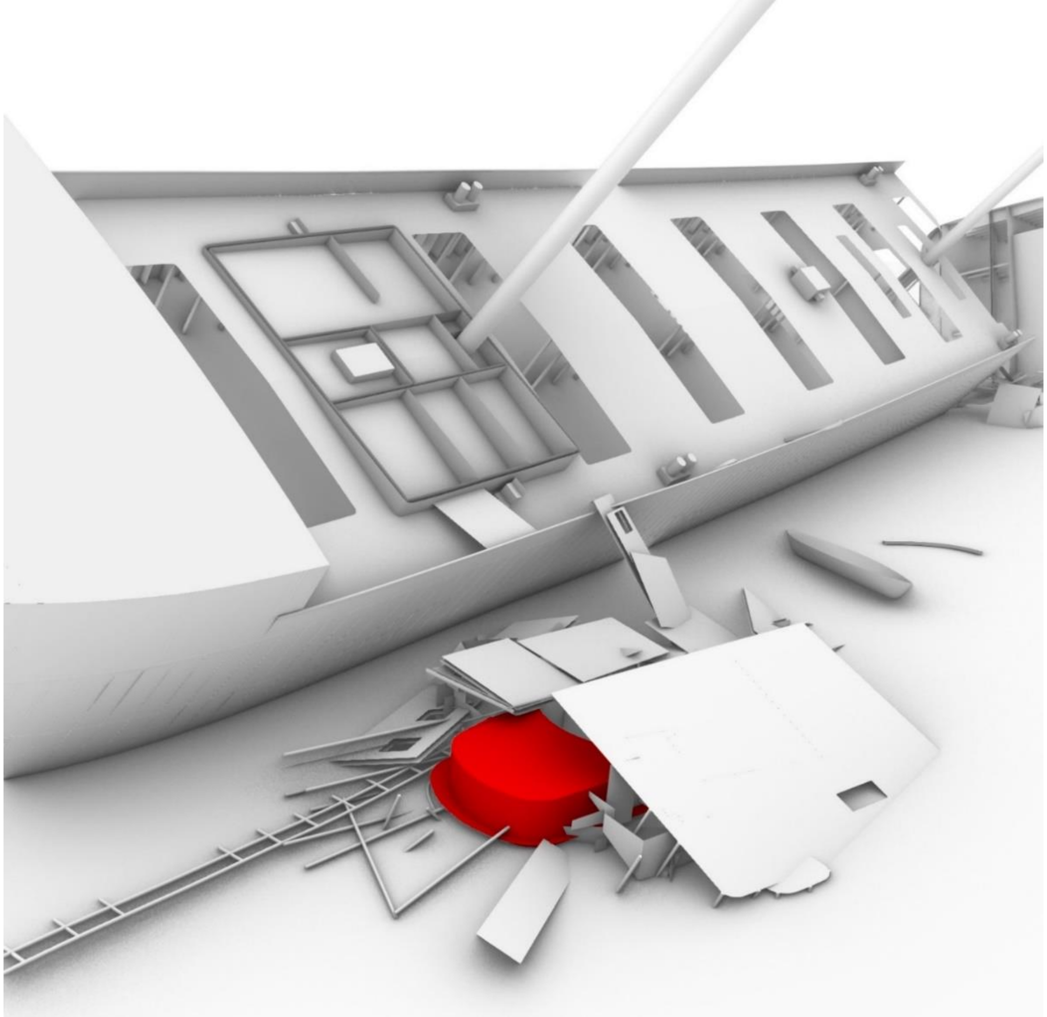

Figure 45: Collapsed pilothouse with the wheelhouse shown in red (Image by Caleb O'Brien).

The collapse of the aft cabin on the other hand seems to have been the result of the structure collapsing in on itself. This assumption is based on identifiable wreck pieces from the starboard side being located at the top of the debris pile (Figures 46 and 47).

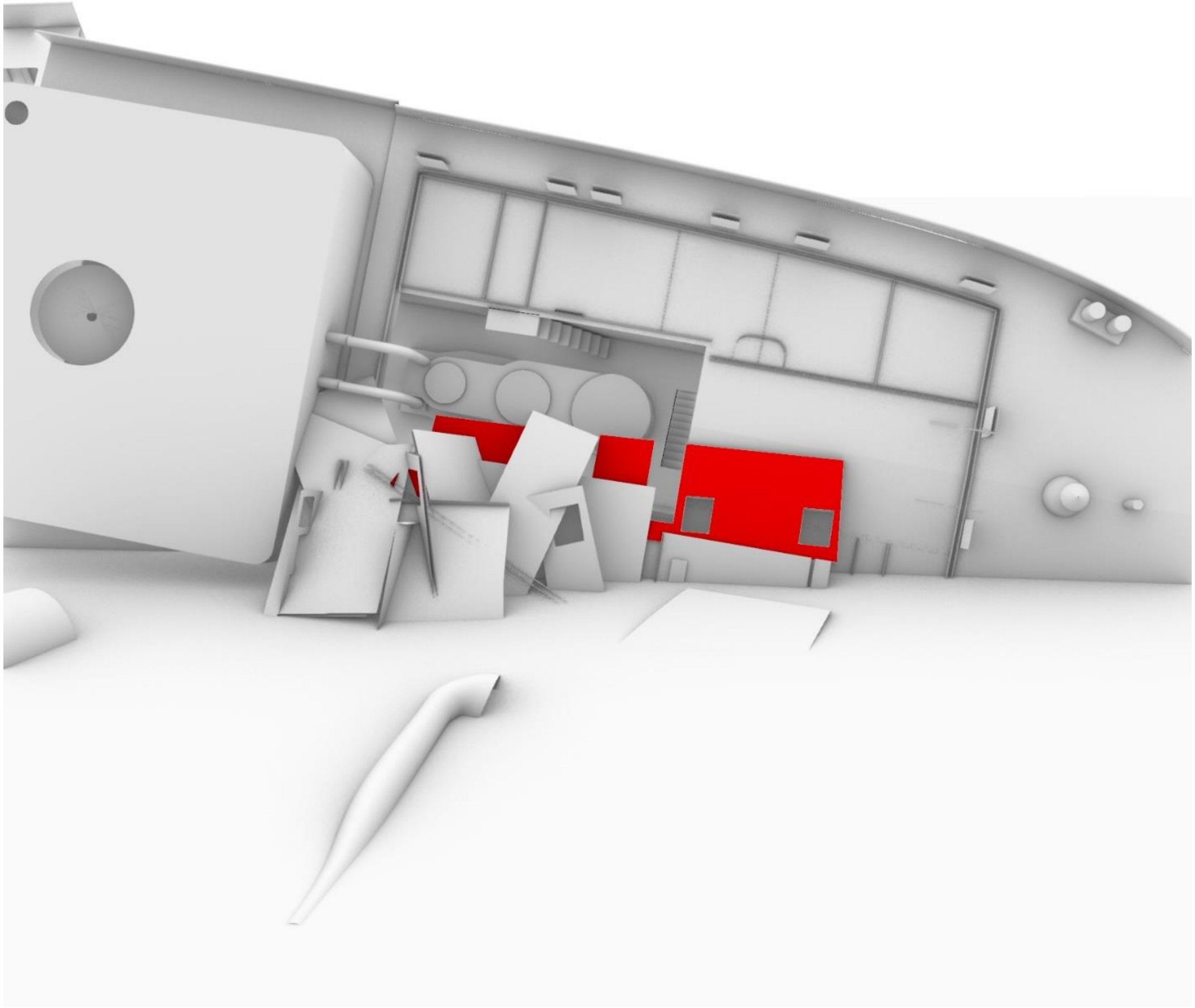

Figure 46: Debris pile from the aft cabin, with the starboard side wall highlighted (Image by Caleb O'Brien).

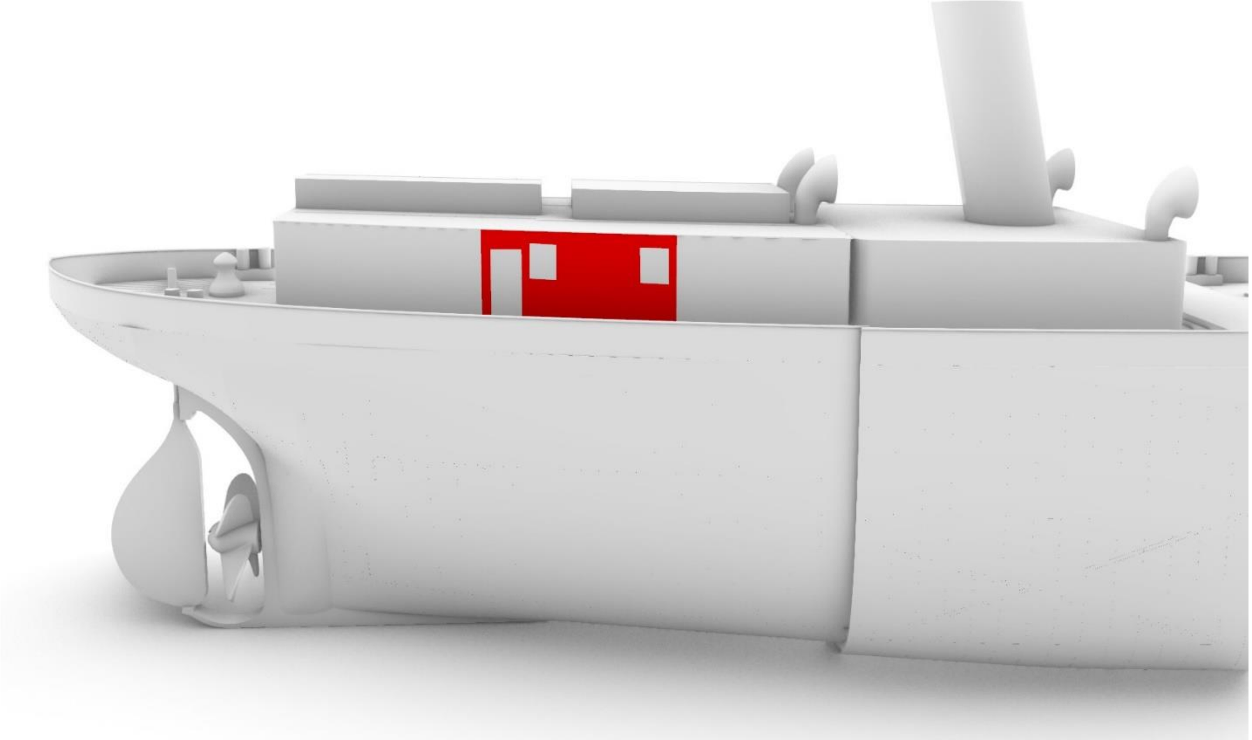

Figure 47: Same debris highlighted on the pre-depositional model of Norman *(Image by Caleb O'Brien).*

The funnel seems to have fallen off the wreck like the pilothouse as it became detached from the boiler housing which remains intact (Figures 48 and 49). The reason for the boiler house remaining intact is due to the construction of the Menominee Transit Line vessels since they had iron boiler houses.

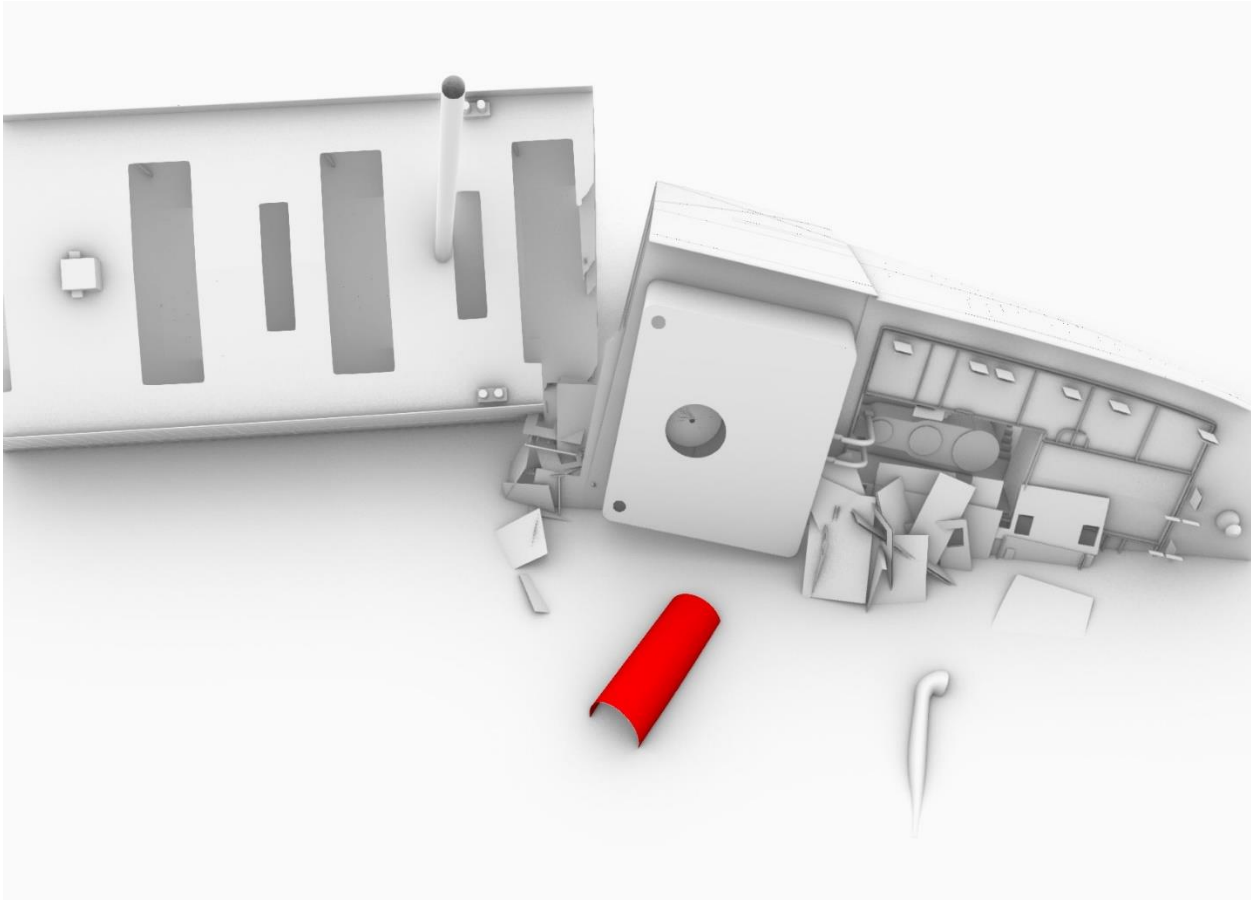

Figure 48: The present location of the funnel (Image by Caleb O'Brien).

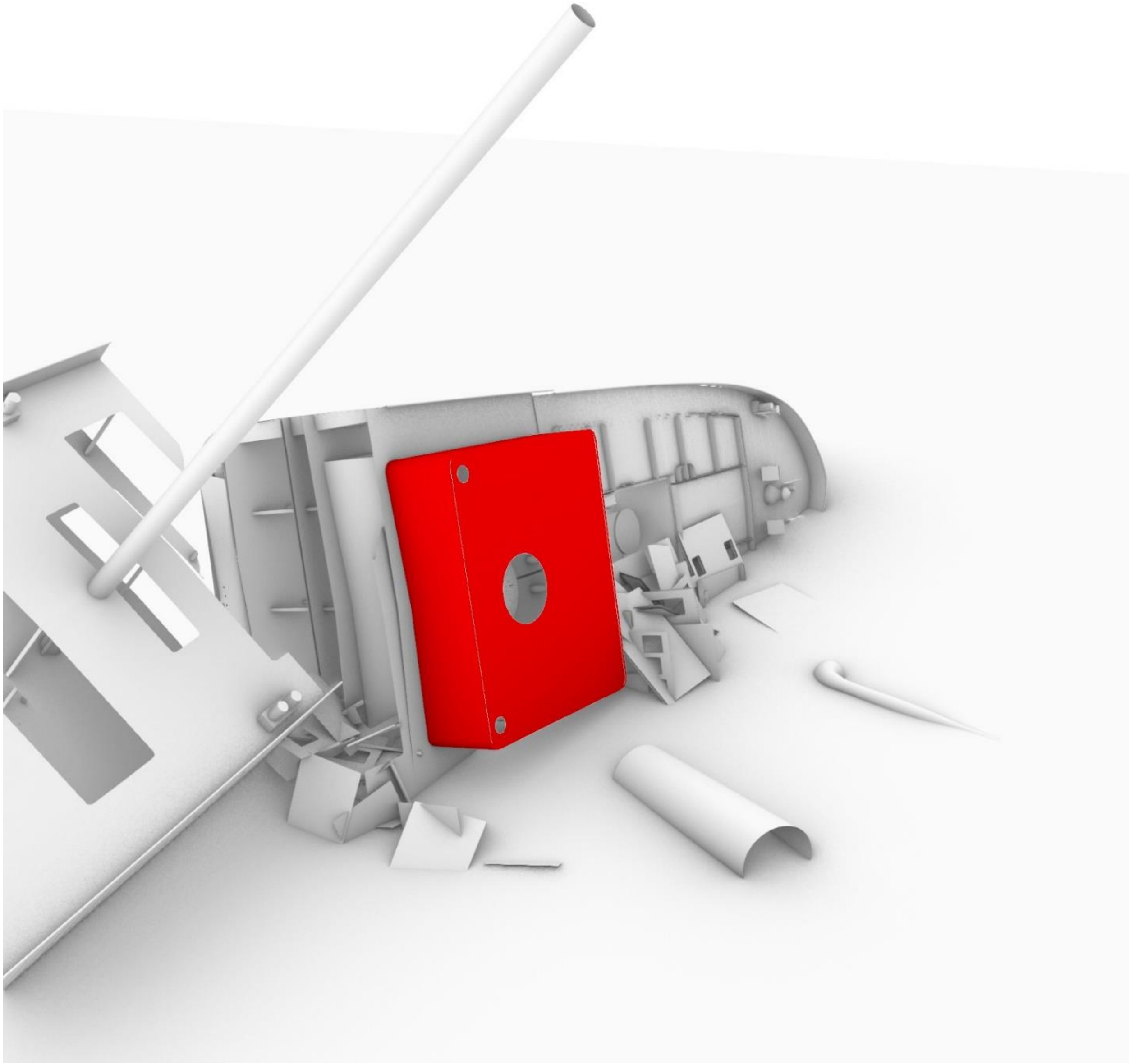

Figure 49: Present location of boiler house (Image by Caleb O'Brien).

Although the primary forms of deterioration for ferrous hulled vessels are chemical and physical, it is possible that biological deterioration is affecting *Norman* in the form of mussels and sulfate-reducing bacteria. Mussels, as discussed in Chapter Two, cause a variety of damage from pitting to increasing rates of corrosion (Watzin et al. 2001:33-36). Sulfate reducing bacteria is found in anaerobic environments such as under encrustations and buried in mud (Russell et al. 2004:42-43). Since some of *Norman* embedded itself under the lake floor, these buried areas may have been affected by sulfate-reducing bacteria (Figure 50).

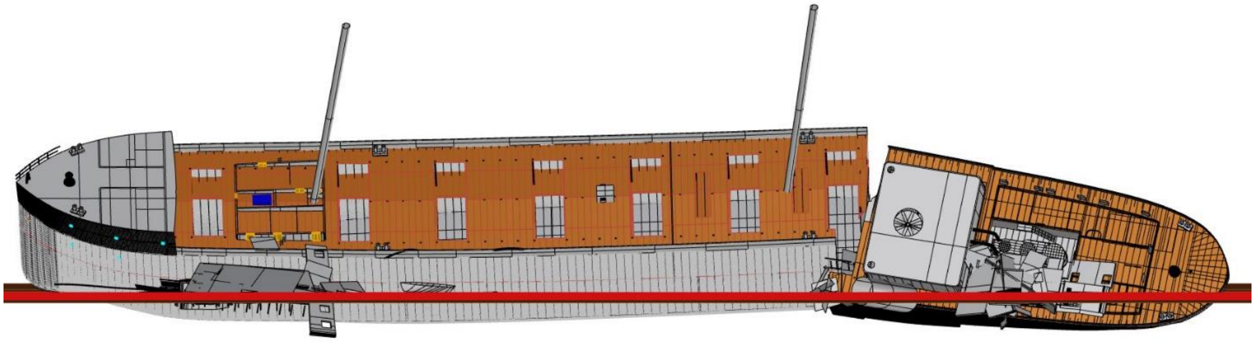

Figure 50: A red line showing the approximate lakebed with everything below being buried material (Image by Caleb O'Brien).

The transformation of *Norman* from its systemic context to its archaeological context has been shown using 3D models. The transformation of this vessel began with the cultural transformations involved in the construction. These transformations continued through the working life of the vessel (pre-deposition) determining how *Norman* changed from the joint historical model. During the depositional stage (wrecking event) how *Norman* would come to rest on the lakebed was determined along with the situation that allowed *Norman* to be spared from salvagers that impacted other wrecks in the area. Lastly, due to this vessel being made from steel, the site formation of the wreck was determined to be mostly caused by chemical and physical processes. Due to the environmental conditions of the Great Lakes, chemical deterioration has been limited. Physical deterioration meanwhile has been prominent on the site as it led to the collapse of the pilothouse and aft cabin. Although this study was unable to analyze quantitative data, based on the model of *Norman,* sections of the hull are buried under the bottom sediments and may be deteriorating due to sulfate-reducing bacteria. Using these transformations, it was possible to see the change of *Norman* from ship to shipwreck.

Pre-Depositional *Grecian*

While *Norman* had a short lifespan (1890-1895), *Grecian* worked for much longer on the Great Lakes. From 1891 to 1906, *Grecian* worked primarily shipping ore between the upper lakes and the lower lakes. The ship also was involved in the grain and package trade (see Chapter Four). This longer life, albeit still shorter than the estimated 20-year lifespan of historic commercial ships (see Culliton 1974:5), also saw the vessel undergo significantly more transformations than *Norman* as it was involved in several collisions and groundings before finally sinking in 1906. This section outlines a breakdown of the pre-depositional *Grecian* model that was created by altering the joint historical model with events from the historical record. Since these transformations were repaired in a way that allowed *Grecian* to maintain its Class A rating throughout its working life, these transformations are not likely detectable on the archaeological site.

C-transforms

During *Grecian*'s 15 years of service on the Great Lakes, the vessel was involved in at least 14 incidents involving *c-transforms* that altered the joint historical model into the pre-depositional model. These 14 events can be divided into two categories: accidental events and intentional events. Accidental events include collisions and groundings, while intentional events include refits or rebuilding.

In 1895, the year that *Norman* sank, *Grecian* almost met the same fate because of a fire. As reported by *The Inter Ocean Tribune*, a fire was discovered in the aft cabin of *Grecian* on Monday, 18 November. Before the fire could be put out, the galley, main dining room, deckhand's dining room, and "nearly all of the after cabin" were destroyed (*The Inter Ocean Tribune* 1895). Comparing the description of the damage to the layout of the aft cabin shows that this fire most likely started in the galley and spread to the port side of the aft cabin. To showcase the area that would have been damaged and repaired as a result of this fire, the area impacted has been highlighted in the image below (Figure 51).

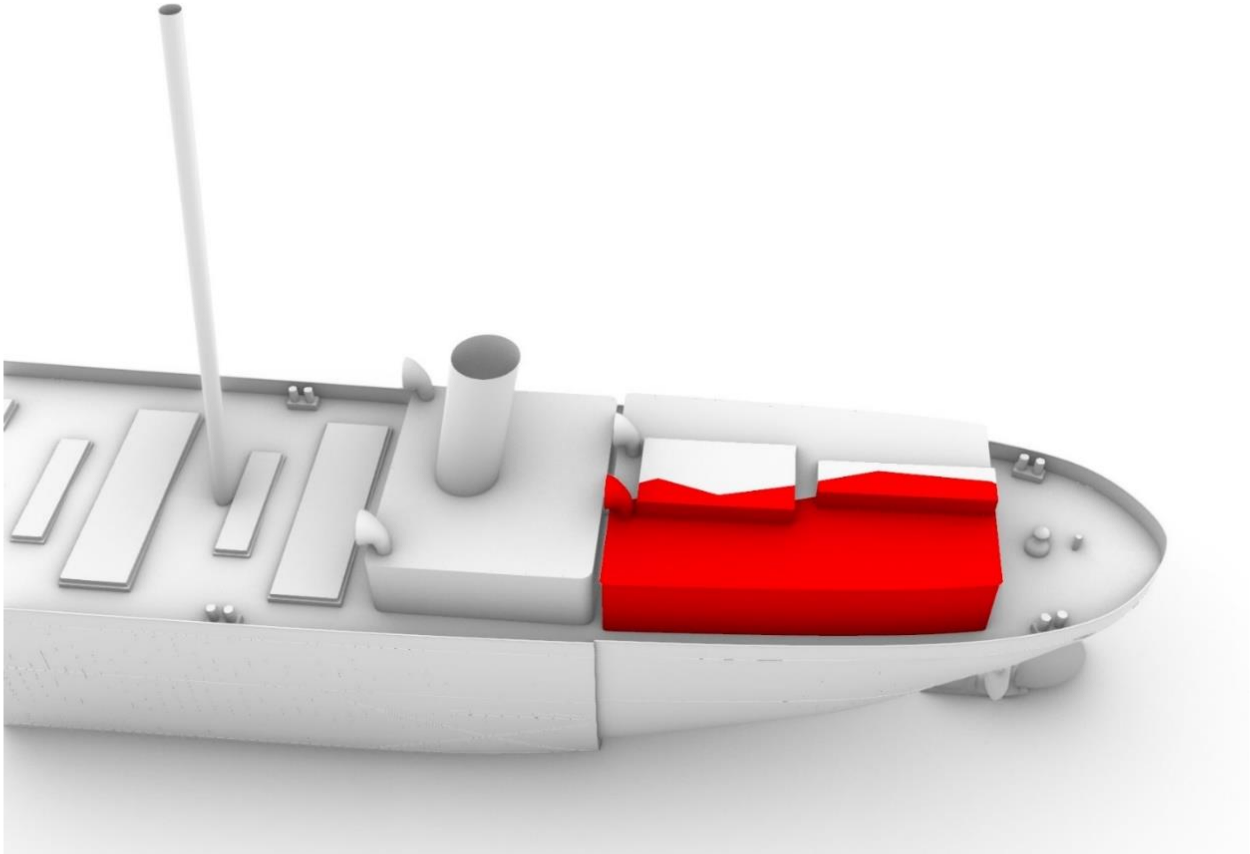

Figure 51: Potential damage to Grecian *following the 1895 fire, affected areas in red (Image by Caleb O'Brien).*

As noted in Chapter Four, *Grecian* along with the remaining four Menominee Transit vessels, was refit in 1898 as part of a two-year contract for package freight. As part of this contract, approximately $6,000 was spent on refitting each vessel to better accommodate package freight (*Marine Review* 1898). Despite the intent for the ship to be part of package freight shipping for two years, only a year later in 1899 the vessels were once again shipping ore between the iron mines and iron foundries. As a result, the vessels were altered back to the ore shipping industry (*Marine Review* 1899; *The Iron Wood Times* 1899; *The Representative* 1899). Although these alterations are recorded in the history of *Grecian*, they were not modeled as part of the pre-depositional model of the vessel. Since there was no discussion on the nature of these alterations, any attempt to replicate them in the model would have introduced unnecessary errors into the project. Furthermore, since these changes were so short-lived they must have been relatively minor and hard to detect on the shipwreck of *Grecian*.

Alongside the refit in 1898, *Grecian* also was involved in a very public incident. As discussed in Chapter Four, the vessel ran into a bridge in Chicago, IL. Although the news report of this incident focused primarily on the damage to the bridge, it is possible to hypothesize how this damage may have manifested on *Grecian*. Since *Grecian* was under tow when it collided with the bridge and it hit the bridge somewhere near its midpoint, this was likely a simple collision with the bow of the vessel hitting the bridge (*Chicago Tribune* 1898). It is most likely the case that *Grecian* would have suffered damage to the bow of the ship along the collision bulkheads and would have been repaired. Although this damage or repairs were not recorded, below is a hypothetical extent of the vessel that was damaged and repaired as a result of this incident (Figure 52).

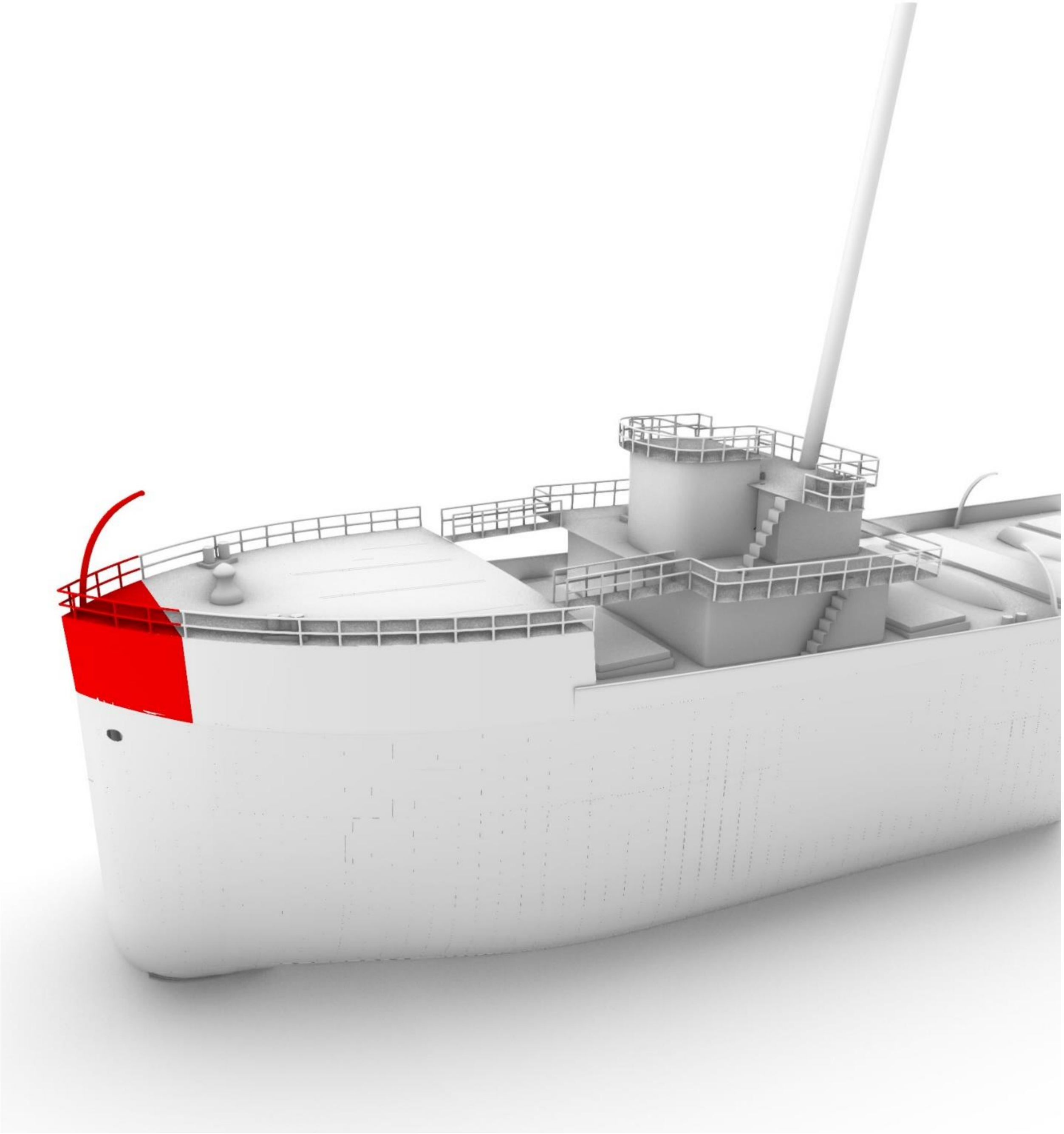

Figure 52: Area damaged on Grecian *after colliding with Lake Street Bridge (Image by Caleb O'Brien).*

The most extensive cultural transformation of *Grecian* was a result of the nine groundings that the vessel had during its 15 year working life (see Chapter Four). The first of these incidents occurred in 1891 and saw the vessel have wood debris between several damaged hull plates (*Detroit Free Press* 1891a). In 1894, while steaming through the canal at Sault Ste. Marie, *Grecian* struck a rock in the canal and punctured its aft watertight compartment and caused the vessel to take on water. This damage caused the vessel's crew to remove its cargo and seek repairs (*Chicago Tribune* 1894). The following year, and the same year of the fire that almost sank *Grecian*, the ship hit an obstruction damaging four hull plates (*Chicago Tribune* 1895; *Detroit Free Press* 1895c). In 1896 there is an undocumented event that caused *Grecian* to have 31 hull plates repaired or replaced (*Marine Record* 1897a). Although the cause for this damage is unknown, this may be the result of the vessel either running aground or hitting an obstruction. The following year, *Grecian* ran aground near Amherstburg, Ontario. *Grecian* was aground for less than a day and no reports of the vessel needing repairs were recorded (*Chicago Tribune* 1897). In 1900 *Grecian* ran aground in Cleveland, OH. Although no damages were reported, *Grecian* did have to lighten its load showing that the vessel did spend some time aground and could have sustained damages (*Detroit Free Press* 1900; *The Daily Herald* 1900). In 1901 *Grecian* went aground near Windsor, Ontario. In this highly detailed account, *Grecian* was aground for several days and was only freed with the assistance of two tugboats and was suspected of having sustained severe damage. Despite the assumption that *Grecian* would be damaged, during an inspection, it was discovered that the hull was not damaged from this event (*Chicago Tribune* 1901; *Detroit Free Press* 1901a, 1901b). The following year, 1902, saw *Grecian* run aground near Sault Ste. Marie. This was the most significant of *Grecian*'s groundings as the vessel punctured two of its watertight compartments (*The Benton Advocate* 1902). The final incident of *Grecian* running aground occurred in 1903 near Sandusky, OH. The vessel was quickly able to free itself, however, it is unknown if it suffered any damage (*The*

Sandusky Star-Journal 1903). The image below depicts what the hull would have looked like following the events listed above (Figure 53). Although there is no way to know exactly which plates were damaged in these events, the hull of *Grecian* before it sank in 1906 would have become a patchwork of repairs and replacements.

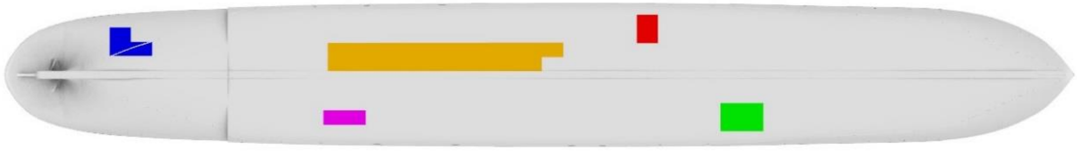

Figure 53: Patchwork of repairs on the bottom of Grecian*'s hull (Image by Caleb O'Brien).*

N-transforms

Grecian had a 15 year long working life and would have been exposed to environmental impacts for these years. As previously mentioned, *n-transforms* constantly affect a working vessel since the environment constantly alters it (Richards 2008:52). Furthermore, damage sustained while being aground, such as that caused by waves rocking the ship, would be *n-transforms*. It would be almost impossible, however, to categorize what damage was caused by the initial impact and what damage was caused by natural forces. As in the case of *Norman*, the *n-transforms* were not modeled.

Although the above transformations turned *Grecian* into a patchwork of repairs and replacements (as shown in Figure 53), these changes were not detected in the depositional and post-depositional models of *Grecian*. This is likely due to these repairs being to the best standards of the day, as shown by *Grecian* maintaining its Class A rating in *Inland Lloyds* until it sank in 1906.

Depositional *Grecian*

Following the pre-depositional stage is the depositional stage, or the wrecking event. The sinking of *Grecian* was not as dramatic as that of *Norman* but still played a major role in how the vessel turned into the modern shipwreck. Many of the transformations are cultural as the sinking was caused by a grounding.

This section contains models depicting *Grecian* during its sinking event and immediately after it hit the lakebed. The models depicted in this section were created by using the historical record to show the process of *Grecian* sinking, followed by using the site plan along with the historical record to show what the wreck would have looked like immediately following the wrecking event.

C-transforms

On 6 June 1906, *Grecian* was steaming upbound, or to the upper Great Lakes, with a load of coal. As mentioned in Chapter Two and earlier in this chapter, this period would be considered the 'pre-impact threat phase.' During this phase, the vessel would be trying to minimize the chance of disaster (Gibbs 2006:10). In the case of *Grecian,* this would be shown by the vessel following known shipping channels, although, this was unable to prevent disaster as *Grecian* struck a rock in the channel near DeTour, MI. Due to the nature of *Grecian'*s collision, there was no 'pre-impact warning phase' and *Grecian* immediately entered the 'impact phase.' This phase is characterized by the vessel hitting the obstruction and putting it in danger (Gibbs 2006:10-12).

This obstruction punctured *Grecian*'s double hull and caused the bow watertight compartment to fill with water (*Chicago Tribune* 1906; *Detroit Free Press* 1906a). In the model, this event is interpreted by showing the extent of the damage in a cutaway of the midships sections (Figure 54).

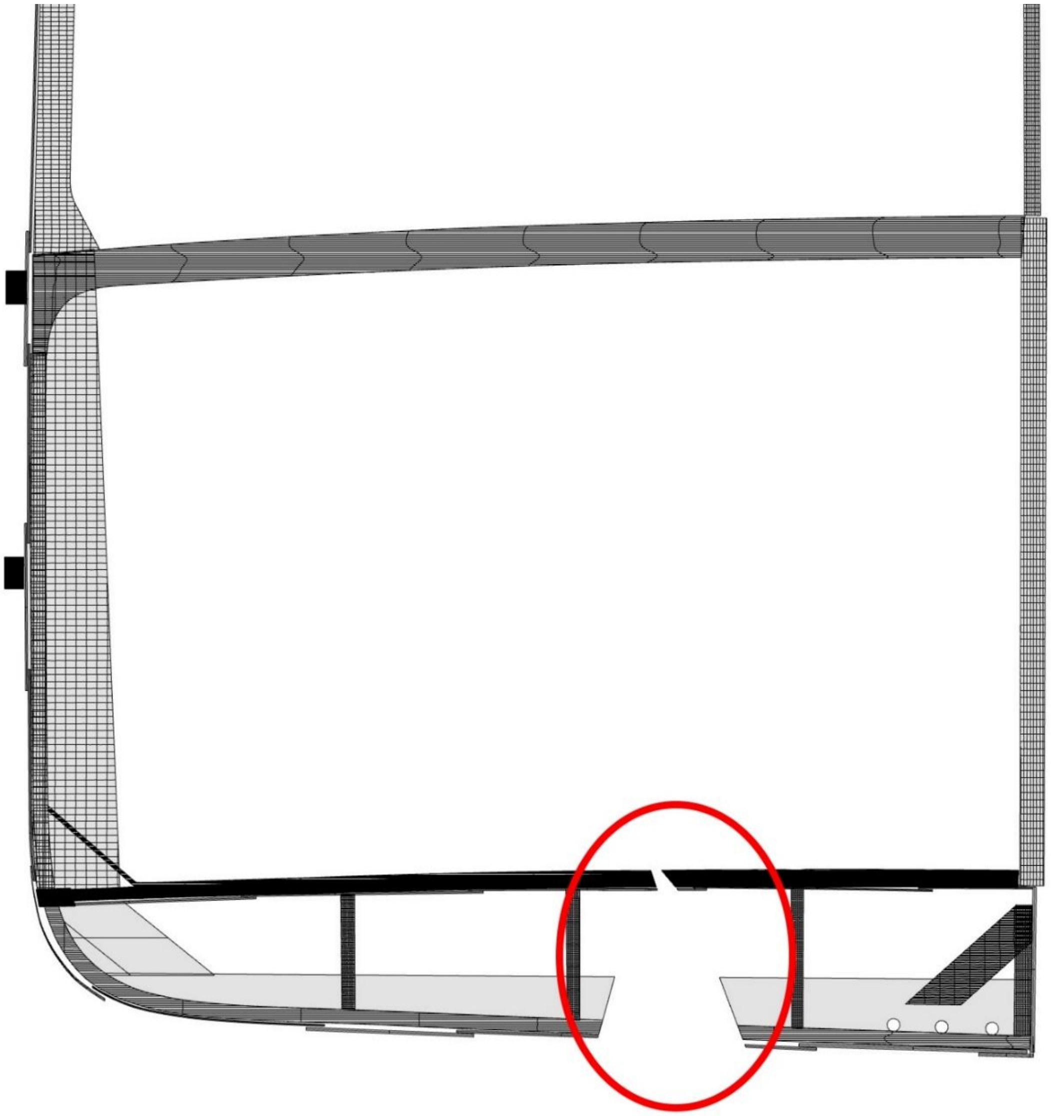

Figure 54: Midship section showing what the puncture might have looked like (Image by Caleb O'Brien).

Following the collision, the crew of *Grecian* decided to remain onboard the vessel and attempt to prevent it from sinking. Successfully, the crew was able to keep it afloat and get it to the harbor in DeTour, MI (*Chicago Tribune* 1906; *Detroit Free Press* 1906a). As stated in Chapter Two, the impact phase is followed by the recoil phase which can see the vessel being repaired and refloated (Gibbs 2006:13). Overnight *Grecian* sank in DeTour's harbor and over the next few days was patched, refloated, and had its cargo offloaded with the intent of moving the vessel to Detroit for repairs (*Detroit Free Press* 1906b). This is depicted in the model through another cutaway showing the potential placement of the patch before the vessel made way for repairs (Figure 55).

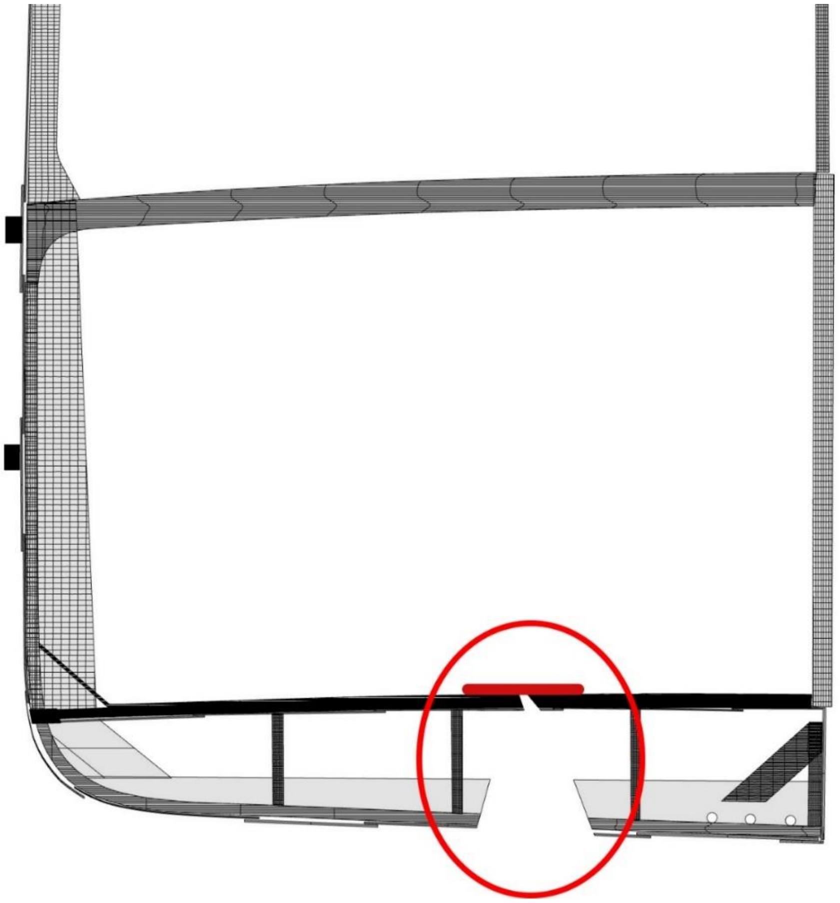

Figure 55: Area that the patch would have been placed in the hull (Image by Caleb O'Brien).

While sailing for Detroit, due to the repair not being suitable for the conditions, the patch failed. This led to the vessel entering another ‘impact phase.’ Like the previous ‘impact phase,’ the crew of *Grecian* remained onboard with the intent of keeping the vessel afloat. In a futile attempt, the crew attempted to pump the water out of the vessel, but soon the water ended up being too much for the pumps to handle and the vessel took on a port list and sank low in the water (Figure 56). Around 6:30 pm another vessel, *Bessemer*, spotted *Grecian* and attempted to tow the sinking vessel to Thunder Bay to beach the vessel (Figure 57). *Grecian* continued taking on water and soon the cables snapped causing the vessel to take its final plunge to the floor of Lake Huron (Figure 58). As shown in the model and recorded in contemporary newspapers, *Grecian* took on a starboard list and sank bow first (*Detroit Free Press* 1906b, *Detroit Free Press* 1906d).

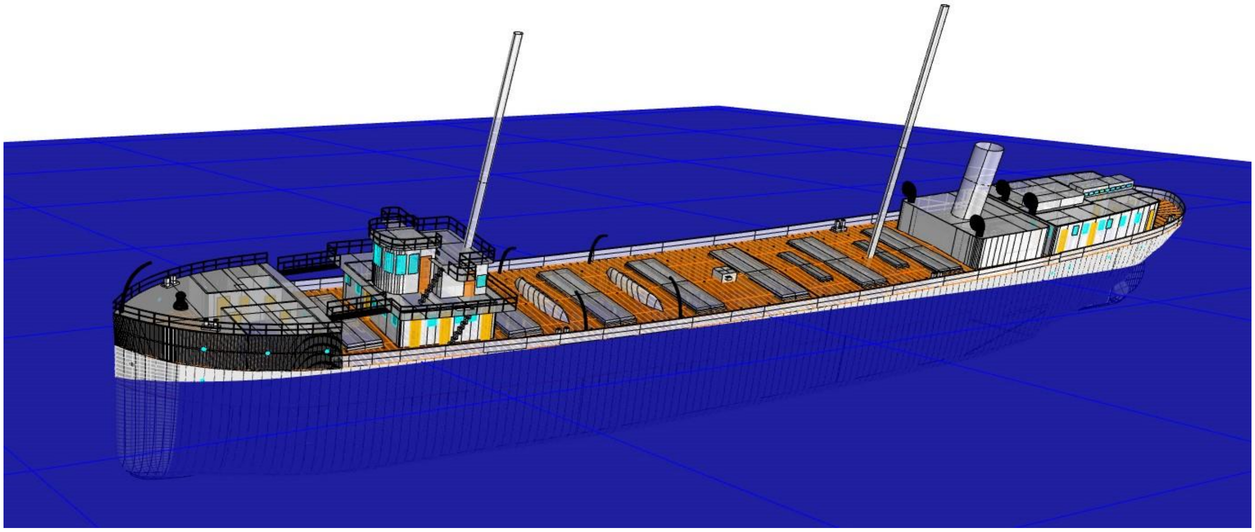

Figure 56: Grecian *after the patch failed (Image by Caleb O'Brien).*

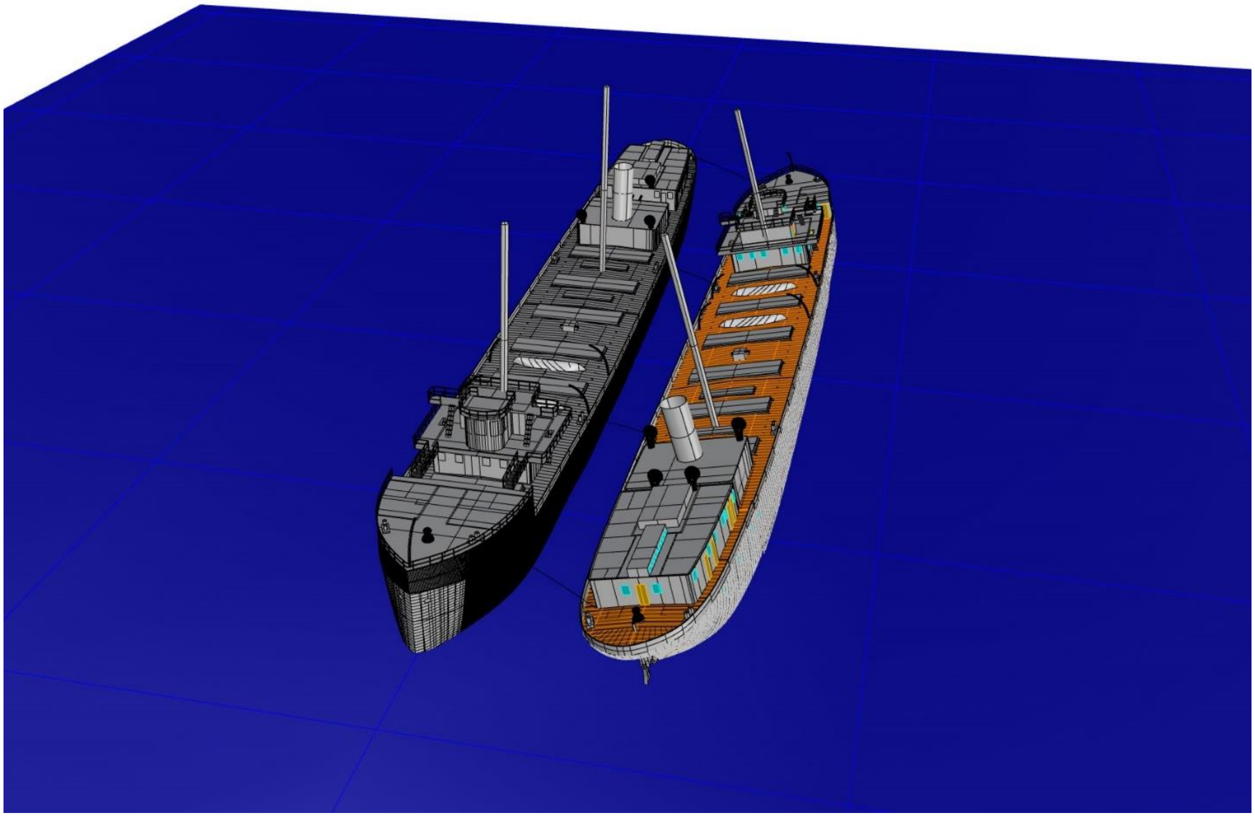

Figure 57: Grecian *(right) being towed by* Bessemer *(left) (Image by Caleb O'Brien).*

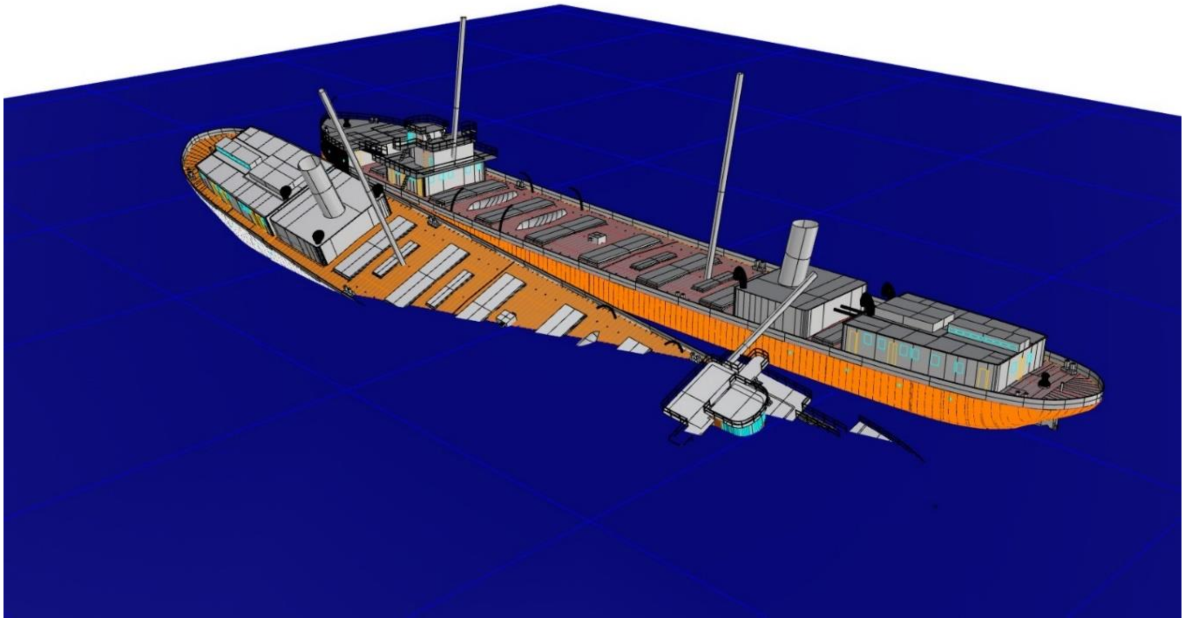

Figure 58: Final plunge of Grecian *(Image by Caleb O'Brien).*

N-transforms

During the process of *Grecian*'s sinking, it also became the subject of non-cultural transformations mainly in the form of physical deterioration. As stated earlier in this chapter and in Chapter Two, this form of deterioration is caused by waves, storms, and other physical forces (McCarthy 1996:219). The first physical transformation that occurred on the wreck was the breaking of a least one of the spar beams, and possibly both (Figure 59).

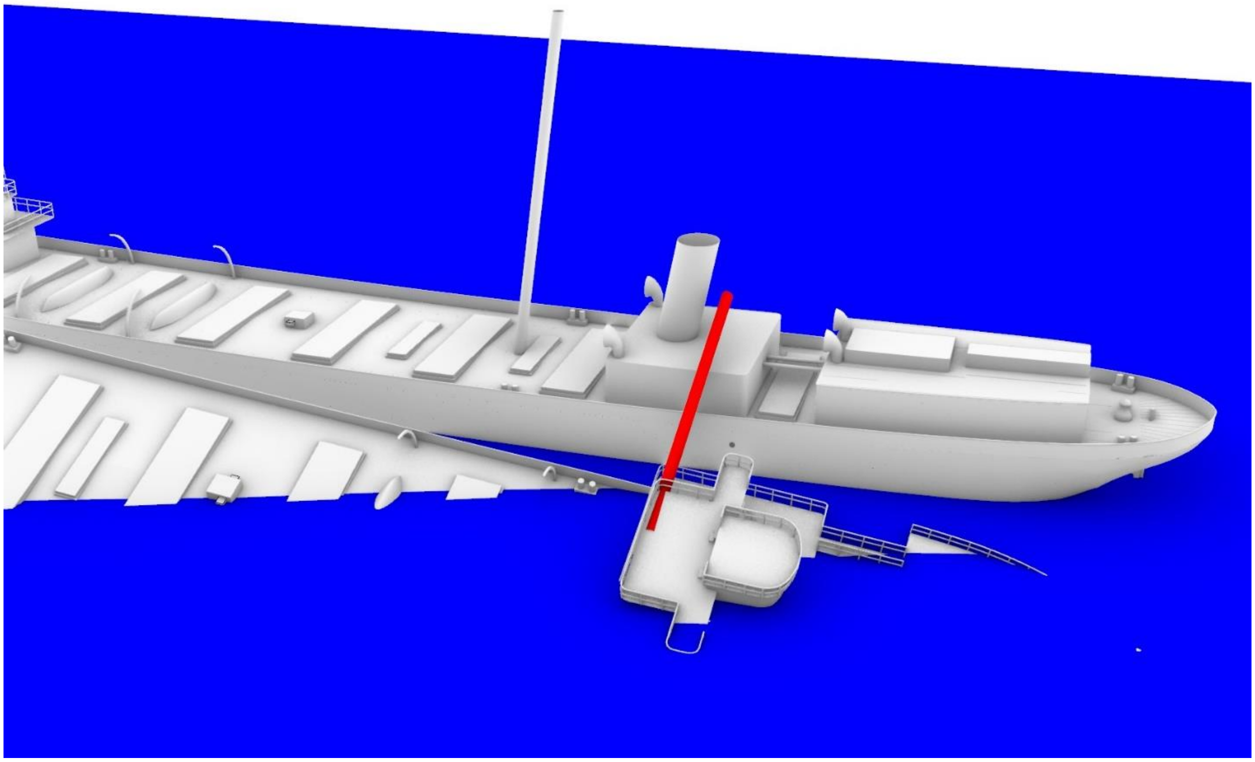

Figure 59: Spar beam breaking on Grecian *as it sinks (Image by Caleb O'Brien).*

As recorded in the historical record, one of the spar beams broke off and crashed onto the deck of *Bessemer* as *Grecian*'s hull made its final plunge (*Detroit Free Press* 1906d). Using the models, it seems that the spar broke because of *Grecian* having water wash over its deck or the spar hitting the rescue vessel during the sinking; it is possible that these factors also caused the other spar to break to its present location.

After becoming completely swamped, *Grecian* came to rest on the bottom of Lake Huron sitting upright without any major list to the waterline (Figure 60). This follows similar observations made by others who used the phrase 'waterline theory' to describe ferrous vessels coming to sink into the sediment up to the ship's waterline (Riley 1988:191-197; McCarthy 1996:216-217).

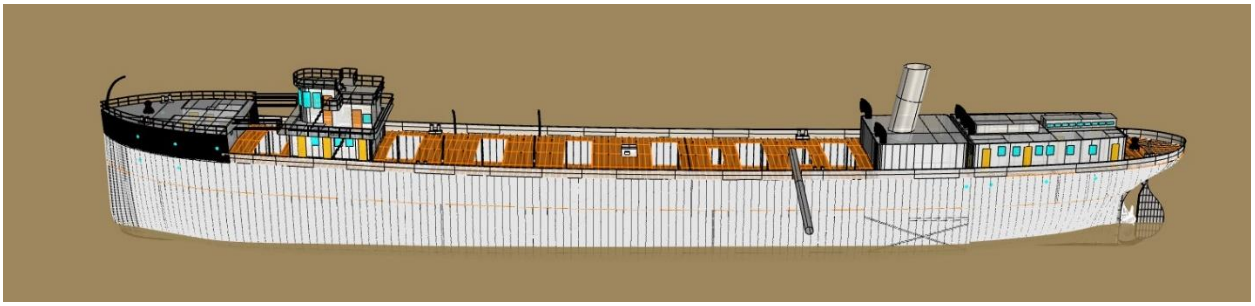

Figure 60: Grecian *as it would have been immediately after sinking (Image by Caleb O'Brien).*

Immediately following the sinking, *Grecian* was once again subjected to physical alteration in the form of objects floating away (also known as flotsam). As discussed in Chapter Two, the material floating off the wreck is described by Muckelroy as an extracting filter and part of the wrecking event (Muckelroy 1976:158). Per the United States Life-Saving Service, after *Grecian* sank, they found the wreck because the pilothouse and aft cabin were found floating above where the steamer had come to rest. Alongside the recovery of the pilothouse and the aft cabin, other objects were reportedly recovered near the wreck site by the steamers *Tempest* and *City of Alpena* (*Detroit Free Press* 1906c). From these records, it is possible to model what the wreck of *Grecian* would have looked like following the wrecking event (Figure 61).

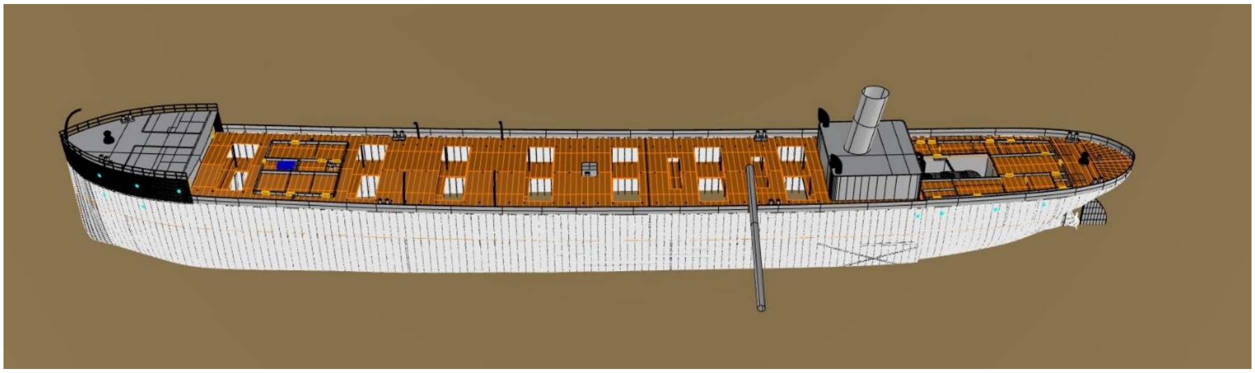

Figure 61: Grecian *after the deck structures floated to the surface (Image by Caleb O'Brien).*

Post-Depositional *Grecian*

Following the depositional models of *Grecian* are the models that depict the vessel after it sank to the lake floor, or post-depositional models. In these models, both cultural and non-cultural transformations are depicted showing the final transformation of *Grecian* from ship to shipwreck. As shown in Chapter Four, *Grecian* was subjected to salvage soon after its sinking and thus both c- and *n-transforms* are present on this wreck.

To create these models, the depositional model was broken down and added to according to the site map and side-scan sonar data. Like *Norman* there is the potential for inaccuracies with this model. Despite these inaccuracies, the models of this wreck accurately depict the transformations that have altered *Grecian*.

C-transforms

As discussed in Chapter Four, *Grecian* was the subject of two salvage attempts. During these attempts, material was deposited around the wreck in the form of burst canalons. There also appears to have been material removed from the wreck. In 1909 Dr. Staud began his first attempt to raise *Grecian*. During this attempt, one of the four canalons exploded during a storm and was deposited near the wreck (*The Daily Herald* 1909; *Detroit Free Press* 1909b). The following year, Dr. Staud once again attempted to raise *Grecian* and this time, two canalons burst on the wreck (*The Times Herald* 1910). As a result of these two salvage attempts, the remains of three canalons are located around the wreck of *Grecian* (Figures 62 and 63).

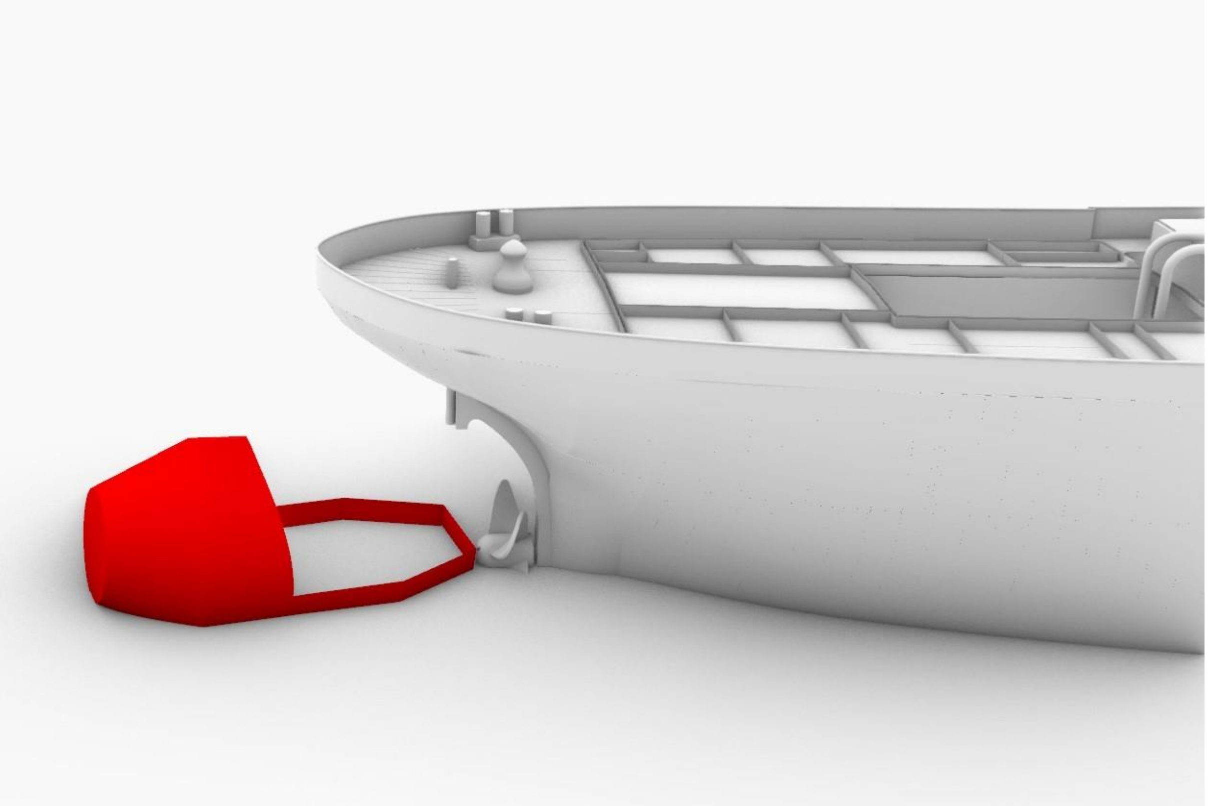

Figure 62: Canalon from salvage underneath stern of Grecian *(Image by Caleb O'Brien).*

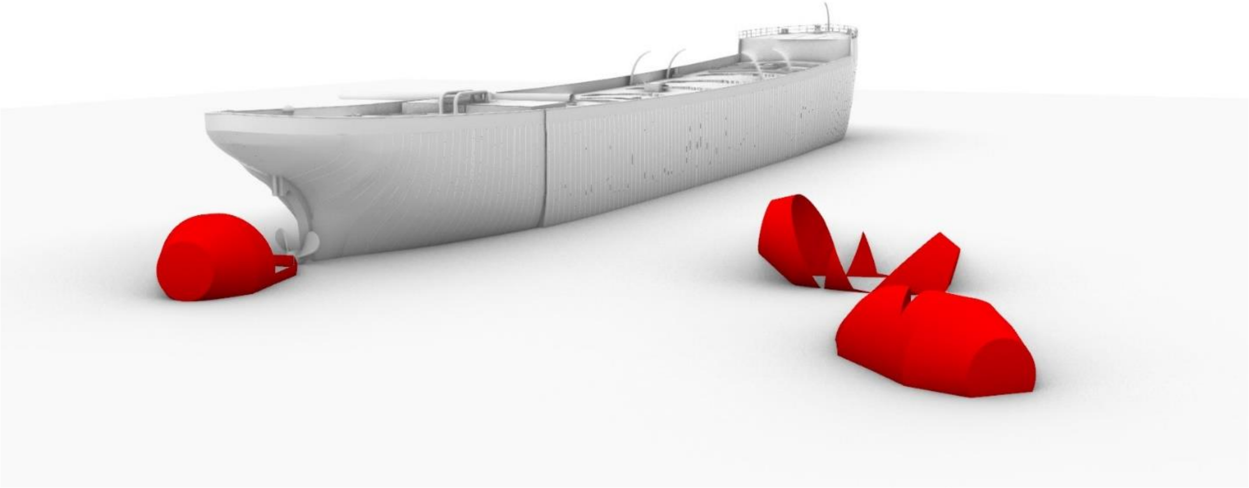

Figure 63: The three canalons located behind and to the port side of the wreck (Image by Caleb O'Brien).

In addition to depositing more material on the wreck, these salvage attempts also seem to have removed a section from the ship. As shown in the site map and the sonar scans, the boiler housing is no longer present on the site, nor are any disarticulated remnants of it. Since the housing was constructed entirely out of iron, per the insurance records, it could not have simply floated away after the wreck. Furthermore, any collapse of this structure would leave remains. Due to these facts, it seems likely that the salvage operations described in Chapter Four saw the boiler house removed from the wreck (Figure 64).

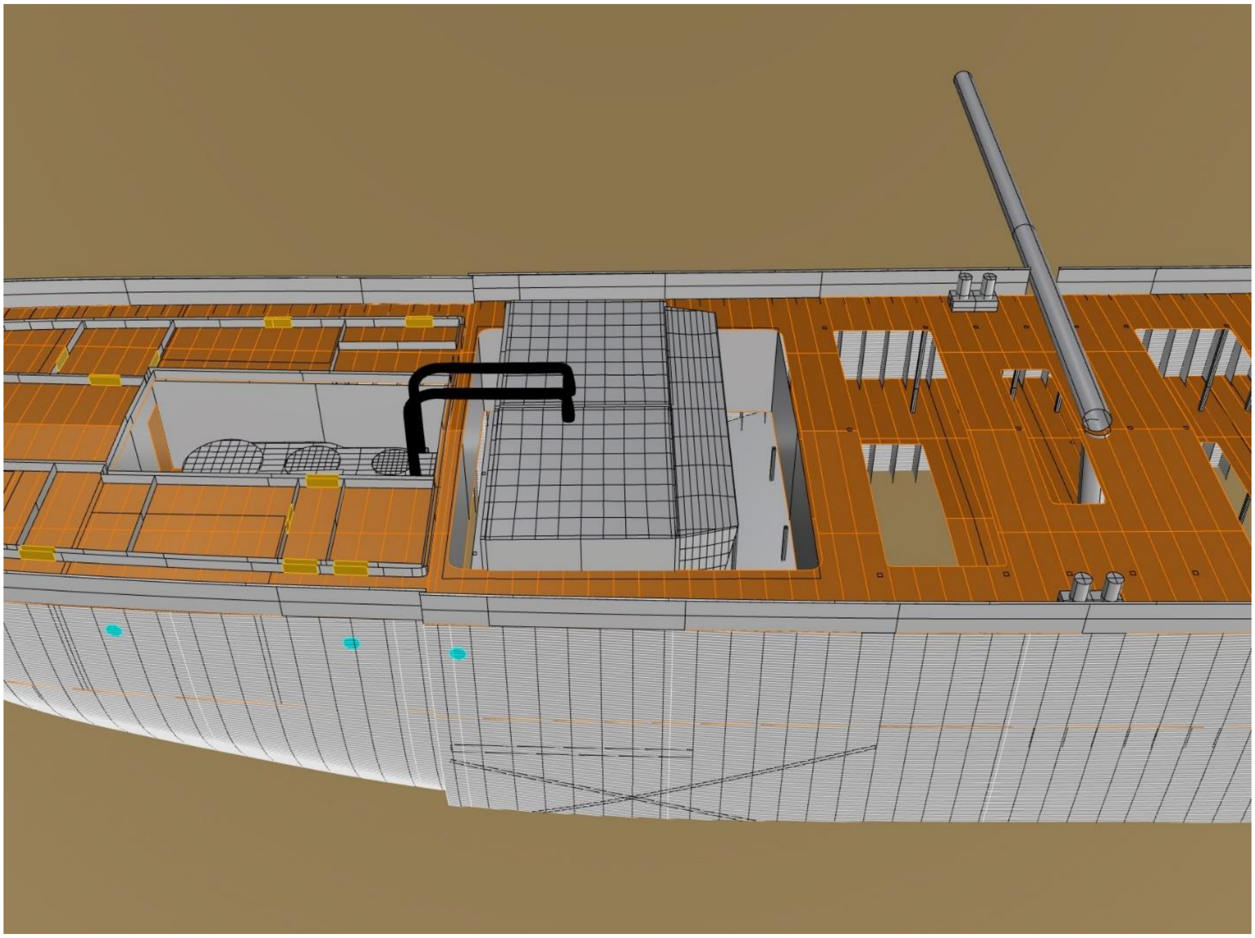

Figure 64: Grecian*'s missing boiler house.*

N-transforms

Alongside the cultural transformations that have affected *Grecian* since it sank in 1906, the wreck has also been subjected to *n-transforms*. The deterioration of *Grecian* is like *Norman* as discussed above, with a few differences.

Since *Grecian* is only 100 feet underwater it has been subjected to mussel-induced deterioration longer than *Norman*. Zebra mussels, which have been in the Great Lakes since the 1980s, prefer shallower waters and could have affected *Grecian* since their introduction (Benson et. al 2022a). This led to it being deteriorated by mussels for approximately 20 years longer than *Norman.*

The only difference between *Norman* and *Grecian* regarding corrosion is a slightly higher temperature due to the depth only being half as deep as *Norman* and its location within the mouth of Thunder Bay. Refer to *Norman*'s section above for a full analysis of the chemical deteriorations affecting these wrecks.

Compared to *Norman*, the most noticeable n-transform on *Grecian* are the physical transformations. The model of the modern wreck clearly shows that the mid-section of the ship has completely collapsed (Figure 65).

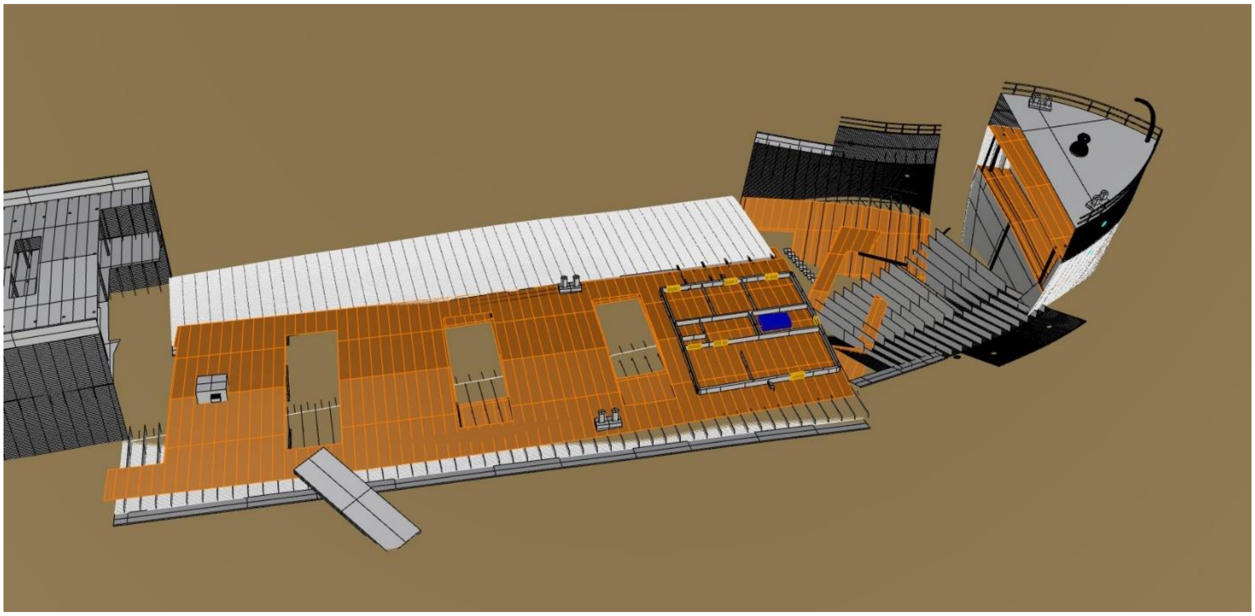

Figure 65: Collapsed midships of Grecian *(Image by Caleb O'Brien).*

The entire vessel, forward of the boilers and aft of the collision bulkheads, has collapsed to the starboard side of the wreck. As noted by McCarthy (1996), this is a common feature of iron and steel vessel disintegration. Due to the lack of support in the cargo holds they generally flatten out before areas with more structure such as the bow, stern, and engine compartments. The collapse then leads to what McCarthy calls the "bow and stern triangles" with collapsed ship between them (McCarthy 1996:219). As shown by the model of *Grecian*, the wreck follows this observation very closely. The model shows that the 'bow triangle' remains upright with a slight starboard list (Figure 66). The bow triangle that remains upright also seems to correspond with the collision bulkheads, where there would be extra hull support (Figure 67).

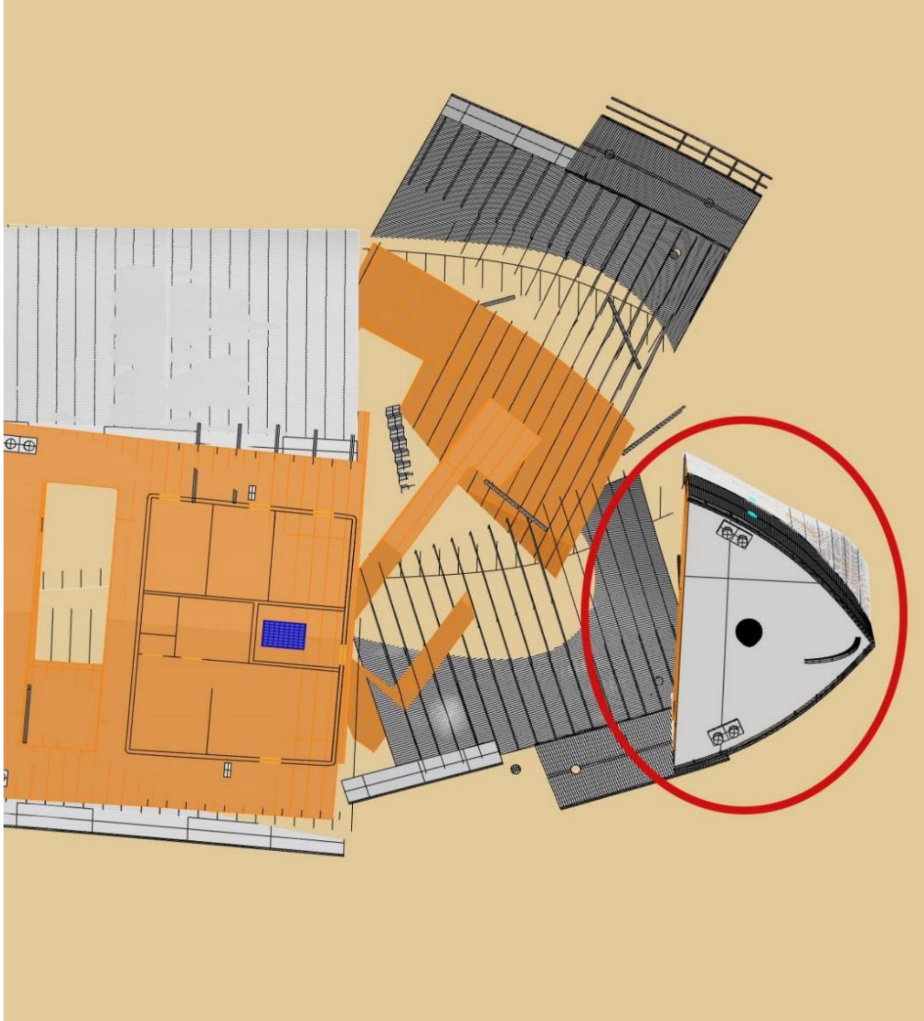

Figure 66: The bow triangle of Grecian *(Image by Caleb O'Brien).*

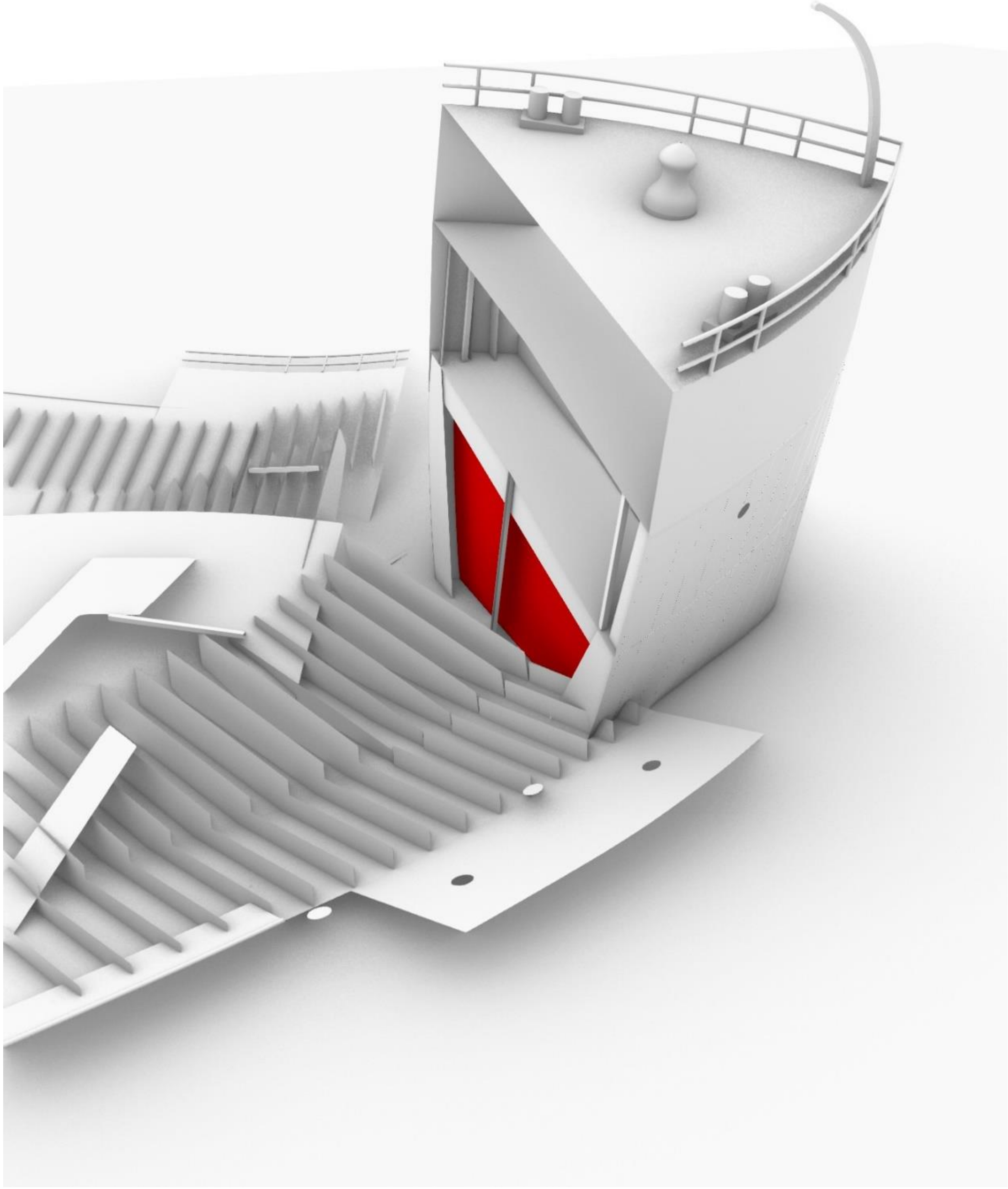

Figure 67: The collision bulkheads highlighted in red within the bow triangle (Image by Caleb O'Brien).

Along with the bow, the stern portion of the vessel also remains intact (Figure 68). The reason for this is that the area that remains is more reinforced due to the boilers and triple-expansion steam engine support structures (Figure 69).

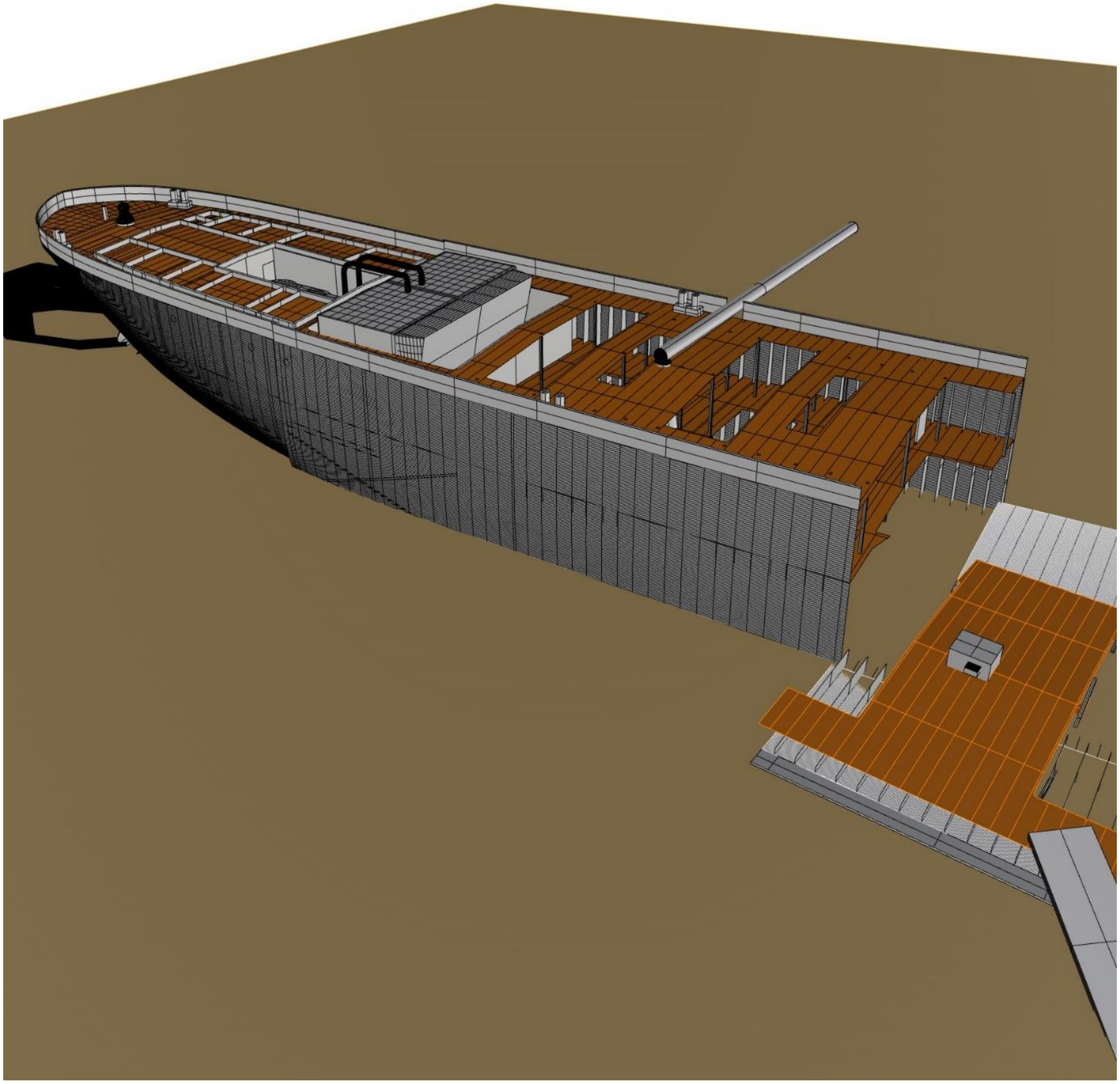

Figure 68: The remaining stern section of Grecian *(Image by Caleb O'Brien).*

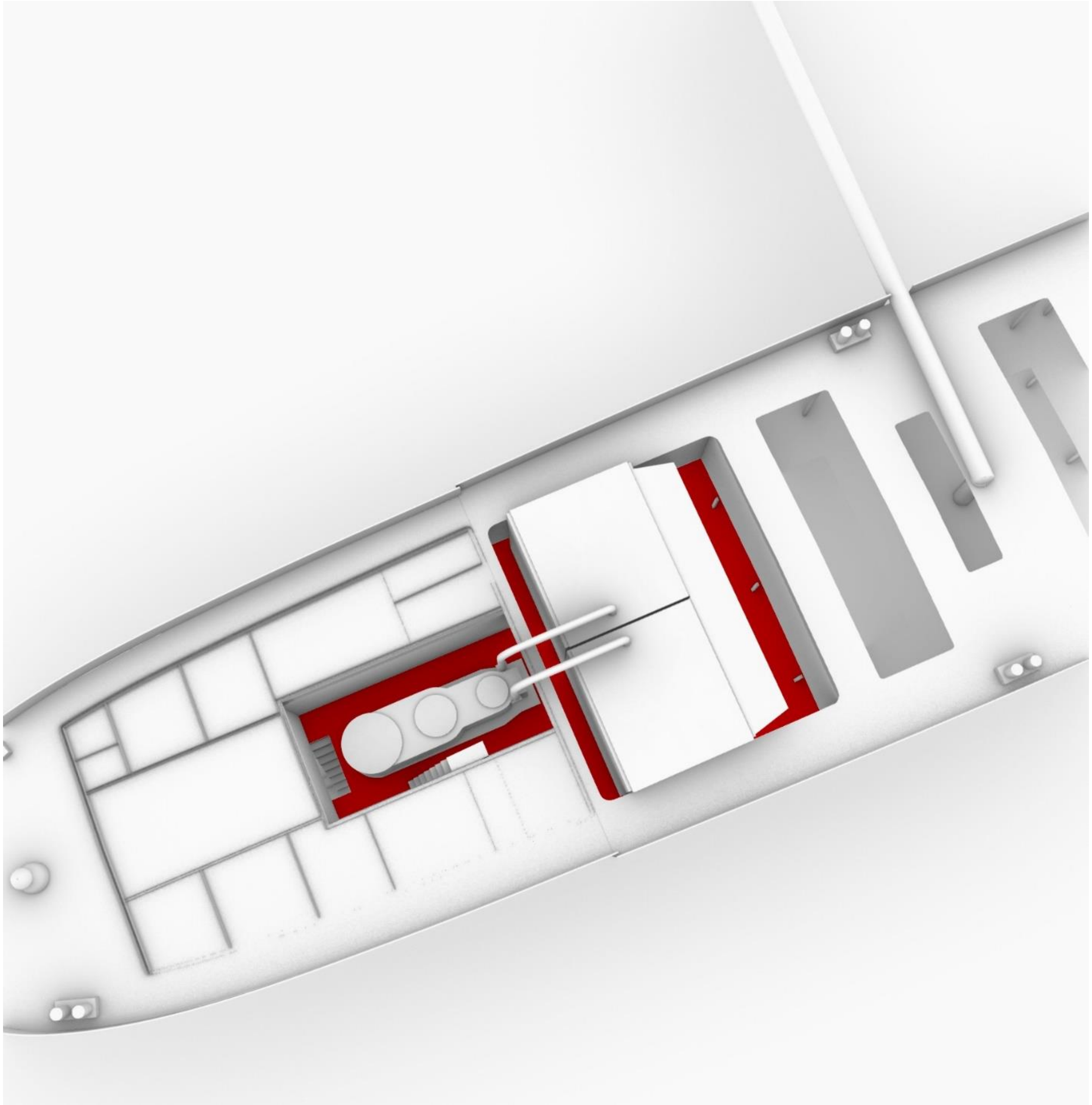

Figure 69: The extra support that holds up the boilers and engines (Image by Caleb O'Brien).

When it comes to the collapsed section of the wreck it can be noticed that the vessel collapsed toward the starboard side (Figure 70). This is evident by the port side hull having collapsed with the deck remaining mostly in line with it (Figure 71). The starboard side of the hull is mostly buried by the spar deck, but some of the frames remain exposed on the upper level of the hull (Figure 72). The only exception to the above description is the midships immediately behind the bow. Instead of having collapsed to one side, it fileted into both directions with the starboard hull falling to the right and the port hull collapsing to the left (Figure 73). In between these two sections of the hull are the remains of the spar deck and the forecastle (Figure 74).

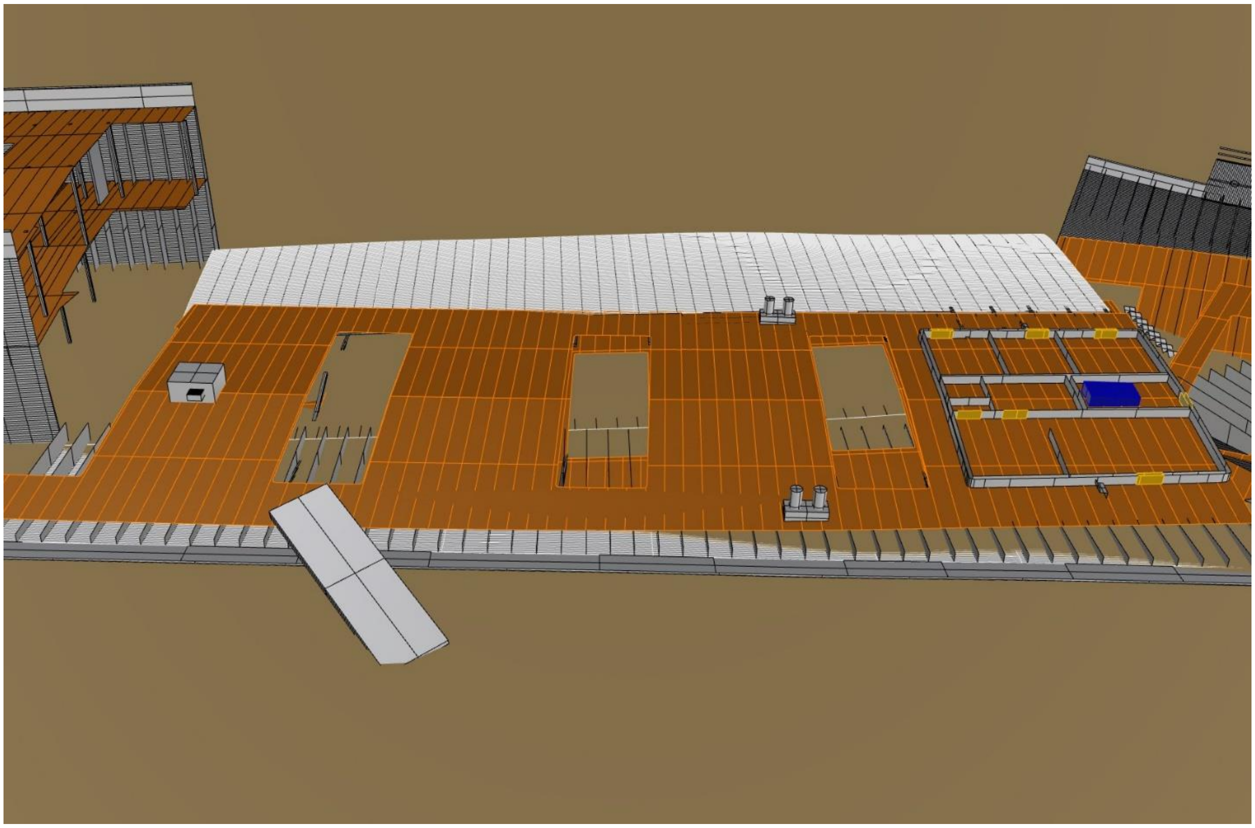

Figure 70: Grecian*'s collapsed midship section (Image by Caleb O'Brien).*

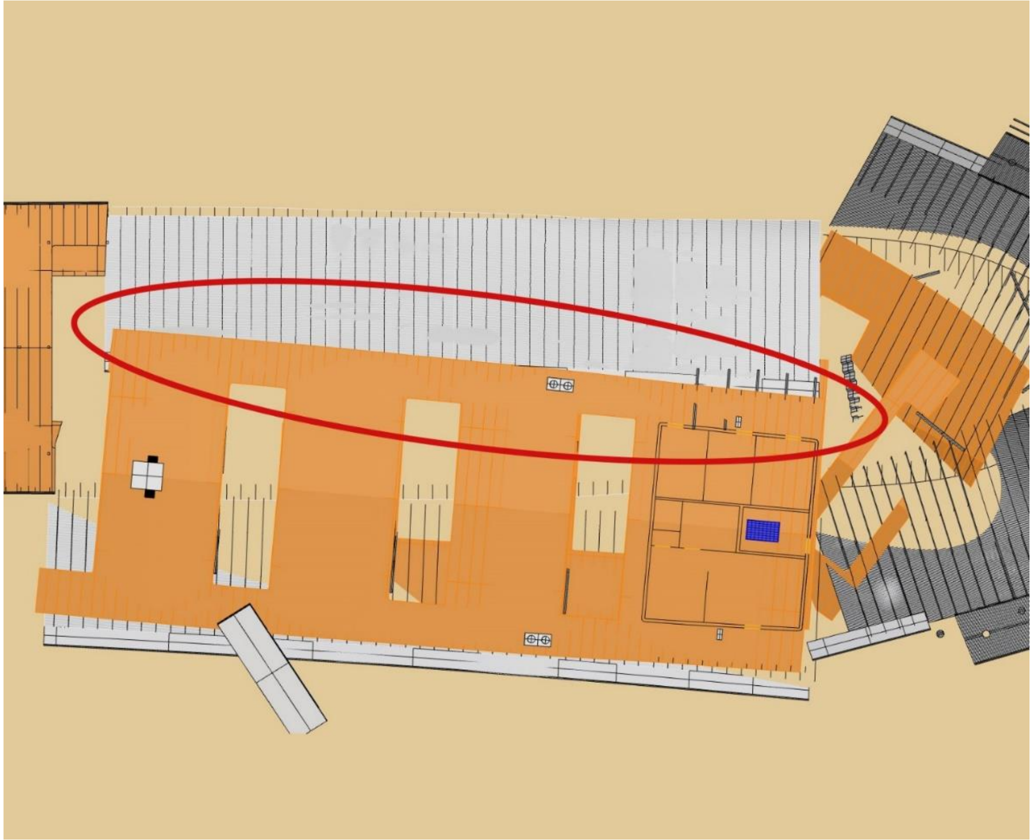

Figure 71: How the port side and the deck are almost still in-line (Image by Caleb O'Brien).

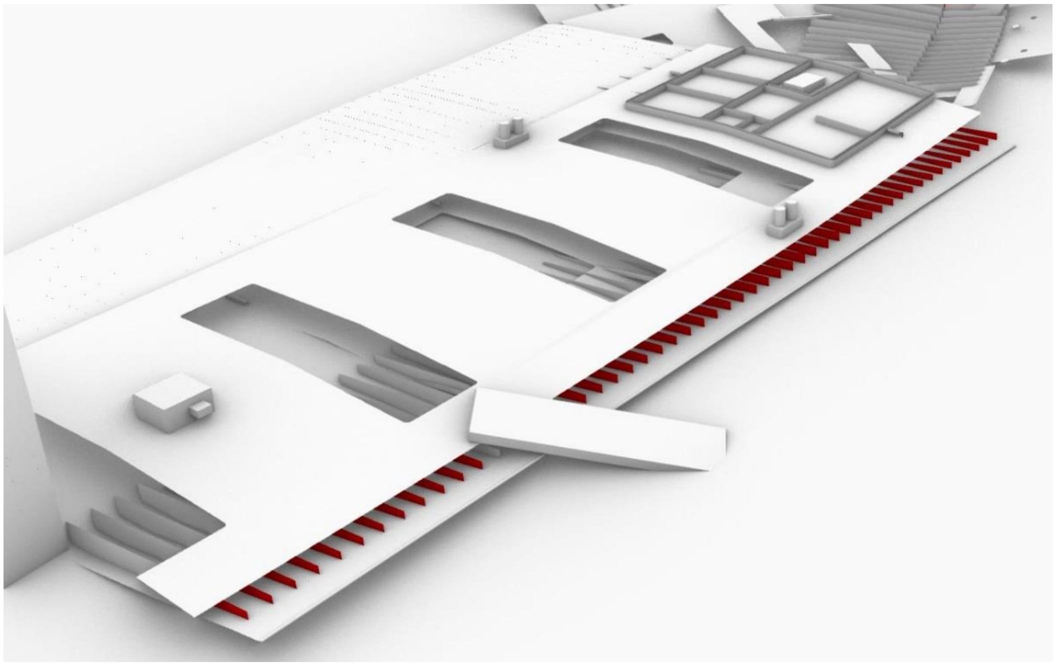

Figure 72: The exposed frames underneath the collapsed deck (Image by Caleb O'Brien).

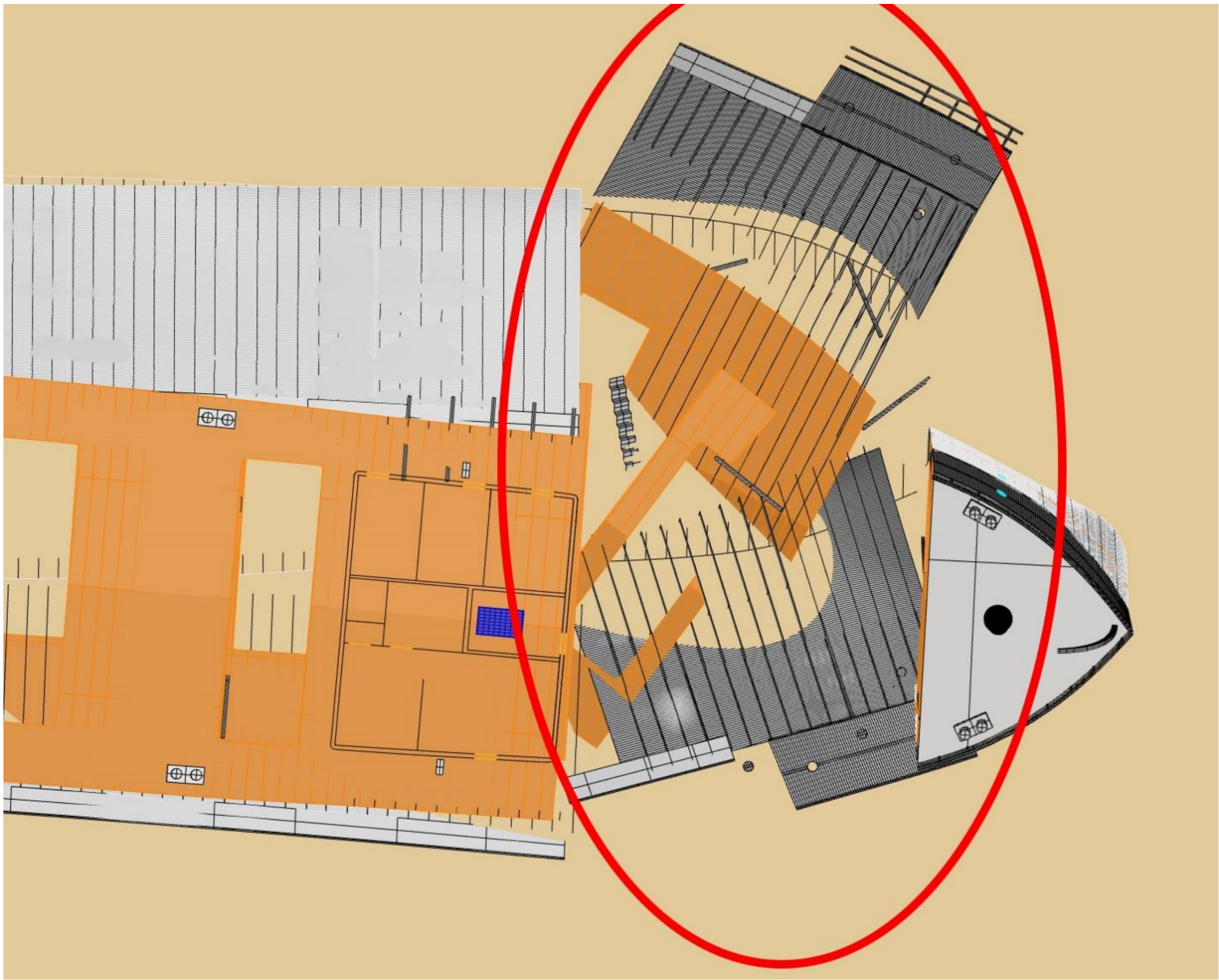

Figure 73: Fileted section of Grecian*'s hull (Image by Caleb O'Brien).*

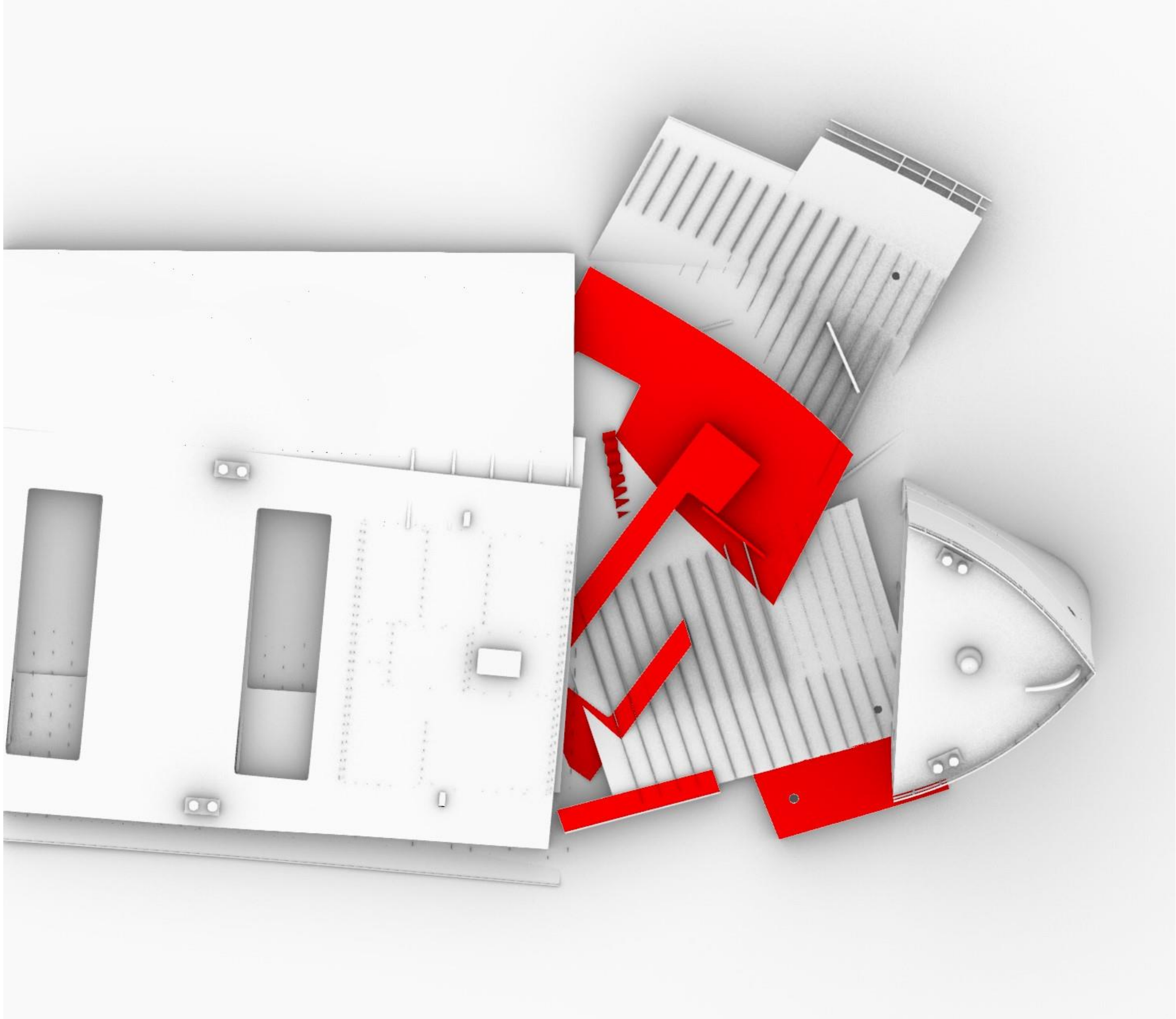

Figure 74: The spar deck and forecastle remains at the bow of the wreck (Image by Caleb O'Brien).

In addition to the chemical and physical deterioration that has been previously mentioned, there is the potential of sulfate-reducing bacteria, as in the case of *Norman* (Figure 75). Importantly the hull collapse seems to correspond to the sediment line which could indicate that this area is deteriorated (Figure 76). The reason for this deterioration could be biologically based, however, a biological analysis is needed to know for certain.

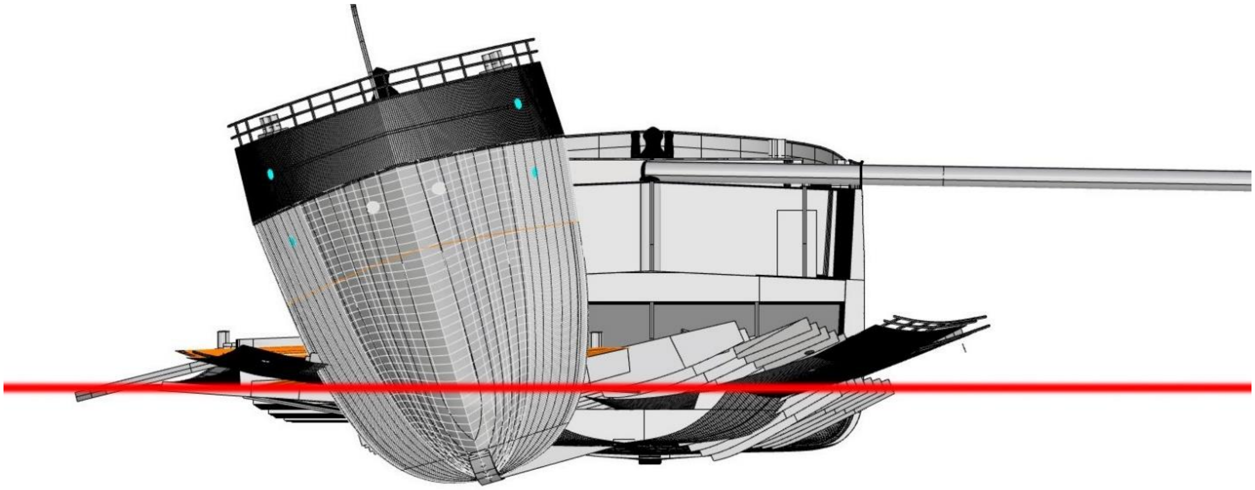

Figure 75: A red line showing the approximate lakebed with everything below being buried (Image by Caleb O'Brien).

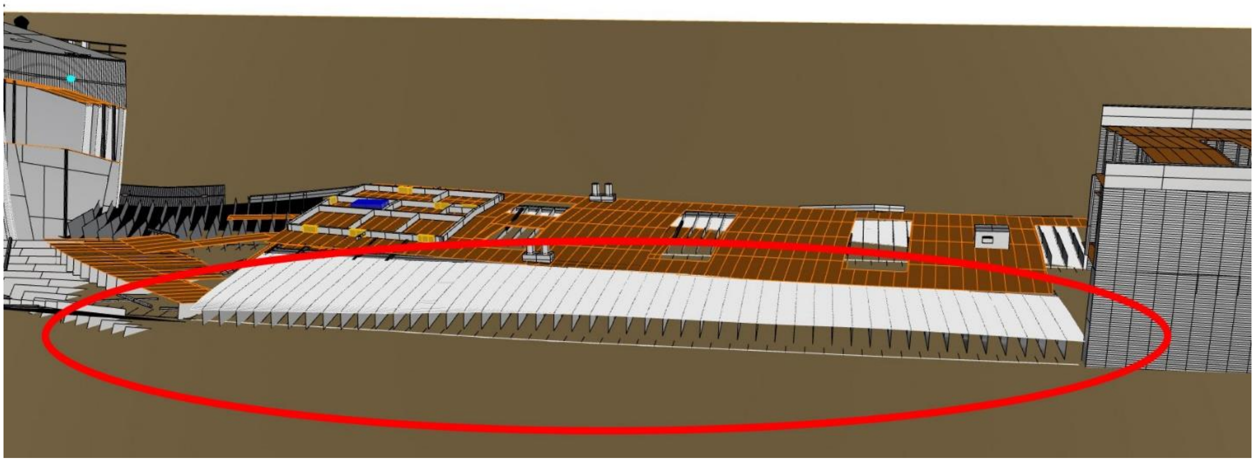

Figure 76: Break on the portside hull running along the lake floor (Image by Caleb O'Brien).

Through the models above, the transformation of *Grecian* from its working life to the wreck that exists today is shown. Specifically, the models show that the vessel had become a patchwork of damage and repairs in its pre-depositional stage. During the depositional stage, the c- and *n-transforms* lead to the wreck taking on its present state. As a result of the wrecking event and the location of the wreck, *Grecian* became the target of salvage a few years after, which drastically changed the wreck. After this salvage operation, *Grecian* was subjected to many natural transformations including chemical, physical, and biological processes that finalized the change of this wreck into what is on the bottom of Lake Huron today.

Conclusion

By combining the archaeological site formation theory described in Chapter Two, the history of these vessels as discussed in Chapter Four, and the 3D models, it is possible to recreate the archaeological site formation processes of *Norman* and *Grecian*. By starting with the joint historical model, it is possible to see how these two vessels were designed and created in a nearly identical template. The model transformations then continue by highlighting how these two similar vessels changed into those that would later sink. Although many of these pre-depositional transforms were not discernible in the later models, they highlight how these vessels became patchworks of damage and repairs during their working lives. These incidents also show that they underwent many transformations before finally sinking in their respective depositional stages. The depositional stage of *Norman* and *Grecian* positioned them to be subjected (or not subjected) to later transformations. In the post-depositional stages, the models complete their transformations from the joint historical model into the present-day archaeological models.

In this chapter, the cultural and non-cultural transformations that are affecting these wrecks are illustrated. This information is brought into the following chapter to determine the similarities and differences between these wrecks and their respective site formation processes. These wrecks will also be compared to other wrecks to see how their transformations are similar and different to *Norman* and *Grecian*. Finally, the next chapter will showcase a hypothetical future model of *Norman* and *Grecian* using the cultural and non-cultural transformations presented in this chapter.

Chapter Six: A Comparative Site Formation Analysis of *Norman* and *Grecian*

Introduction

This project seeks to understand the cultural and non-cultural archaeological site formation processes affecting *Norman* and *Grecian*. In Chapter Five this was done on a site-by-site basis. In this chapter the models will be compared to understand what shared and novel archaeological site formation processes affected each wreck and how these processes are similar and dissimilar to other wrecks in TBNMS. Upon completion of that analysis, predictive models for the wrecks of *Norman* and *Grecian* will be showcased.

The comparison of these two shipwrecks will begin by analyzing the pre-depositional models of *Norman* and *Grecian*. This comparison will show how the damage sustained by these vessels is similar to each other, as well as to other vessels sailing on the Great Lakes in the 1890s and 1900s. The depositional comparison will look at how *Norman*'s and *Grecian*'s sinking circumstances deviate, and how those differences caused different post-depositional transformations. The post-depositional comparison will discuss the similarities and differences between the post-depositional stages of *Norman* and *Grecian*. Furthermore, this section will review the ways in which *Norman* and *Grecian* compare to other wrecks within TBNMS. Comparisons will also be made to other vessels that have been studied in similar ways (*Xantho* and *Caribsea*), as well as a vessel similar to *Norman* and *Grecian*: *Northern Light*. *Northern Light* is another early steel-hulled freighter built at Globe Iron Works in 1888 and sank in 1930 off the coast of the Florida Keys in Florida Keys National Marine Sanctuary [FKNMS]).

During these comparisons, it will be possible to make interpretations according to the theoretical framework outlined in Chapter Two. Comparisons with similar wrecks may inform what the future holds for *Norman* and *Grecian*. Such changes may include corrosion, physical deterioration, and accelerating biologically induced change.

Analyzing the Pre-Depositional Site Formation Stage

The first deviations in the life trajectories of *Norman* and *Grecian* occurred during their pre-depositional stages. As discussed in the previous chapter, the pre-depositional models of these vessels were constructed to correspond to the damage they received during their working lives. And these vessels indeed had different lives: *Norman* was reportedly only involved in two discernable *c-transforms* during its five-year working life, while *Grecian* was involved in 14 eventful *c-transforms* during its 15-year working life. Although these vessels had drastically different working lives, they both received similar pre-depositional transformations. Furthermore, not only were the transformations between these two vessels similar, they seem to be common for Great Lakes ships located in TBNMS. It should be noted, however, that unlike the later depositional and post-depositional comparisons, this section is unable to rely on historical and photographic evidence as that would require additional site formation studies on other vessels in TBNMS. As a result, this information is gleaned through statistics generated by examining wrecks in TBNMS and sources already analyzed in previous chapters.

C-transforms

When it comes to the similarities and differences of the pre-depositional stages of *Norman* and *Grecian*, all recorded transforms are cultural. As discussed in Chapter Five, examples of these transformations include refits, collisions, and groundings.

For the refits that took place on these vessels, both underwent the same c-transform when it came to electrification. As discussed in Chapter Five, this would have rendered the ‘lamp room’ obsolete on both *Norman* and *Grecian*. Due to the obsolescence of the ‘lamp room,’ it is highly probable that this space would have been altered for another use. Sadly, the details of this refit, or even if there was a refit, were not located. Understanding what, if any, refit took place on both vessels, would require an examination of the wrecks. Luckily the forecastle remains on the wreck of *Norman* and this room could be explored for evidence of the room’s transformation (Figure 77).

Grecian, along with the other Menominee Transit Line vessels (minus *Norman* as it had already sunk) was part of a refit to handle package freight. Once again, this refit was not recorded in historical sources, so the changes that occurred are unknown. It would, however, have altered *Grecian* to appear slightly different than *Norman*. As mentioned in Chapter Four, these changes were not permanent and were removed the following year as *Grecian* and the other Menominee Transit line vessels were put back into the iron ore trade. It was outside the scope of this project to determine if these sorts of renovations were common among Great Lakes vessels during the 1890s and 1900s.

Pre-depositional *Grecian* was different from *Norman* since it had a deck structure rebuilt. As discussed in Chapters Four and Five, *Grecian* suffered from a fire that nearly destroyed the aft cabin in 1895 (*The Inter Ocean Tribune* 1895). This event would have resulted in *Grecian* having the aft cabin rebuilt (possibly different from the original), while *Norman* maintained its original cabins (Figures 78). Fires, like the one that almost sank *Grecian* in 1895, were a common cultural transformation that affected vessels on the Great Lakes. Using the database of wrecks from TBNMS, it was discovered that 11 of the 105 vessels, or 10.5%, were lost due to fires (Lusardi 2018). Assuming that the wrecks in TBNMS are a representation of Great Lakes wrecks, it indicates that slightly more than one in 10 wrecks were caused by a fire-related incident and that fires were a common occurrence on Great Lakes ships.

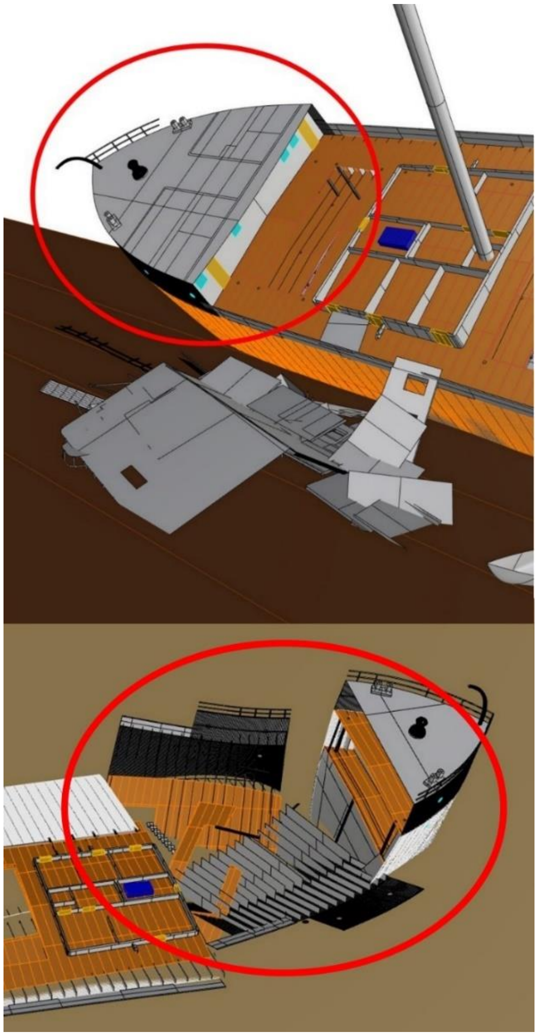

Figure 77: The forecastle on the wreck of Norman *(top) and* Grecian *(bottom) (Image by Caleb O'Brien).*

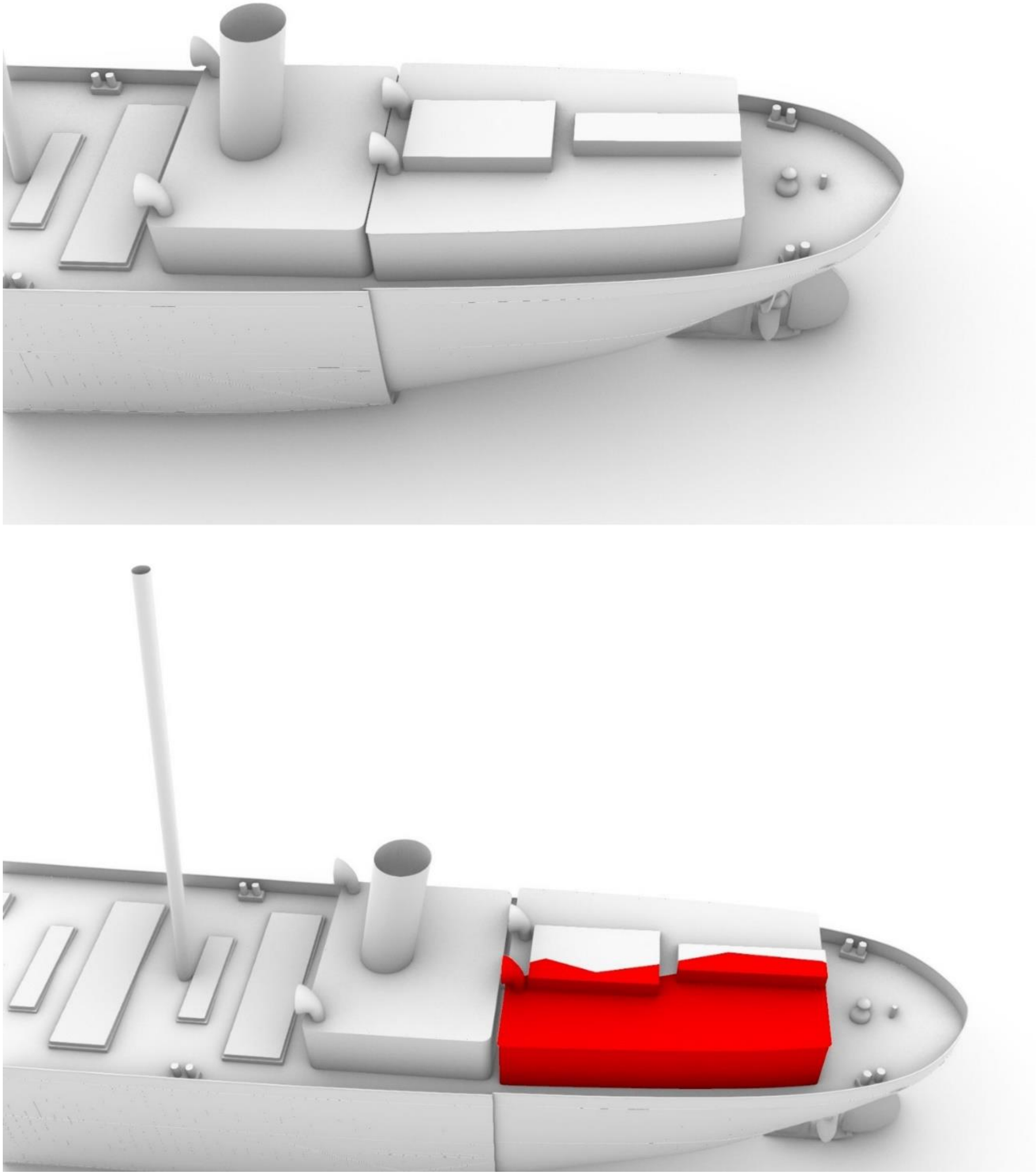

Figure 78: Norman*'s aft cabin with no sign of repair (top) and* Grecian*'s aft cabin showing repairs in red (bottom) (Image by Caleb O'Brien).*

The most noticeable cultural transformations of *Norman* and *Grecian* were the damages sustained during collisions while steaming on the Great Lakes. These transformations are discussed in Chapter Four and are the results of collisions with objects, as well as running aground.

When it comes to collisions, both *Norman* and *Grecian* suffered damage to their bow (Figure 79). Due to the nature of *Norman*'s collision with *Republic*, the entire bow down to the keel sustained significant damage, while *Grecian* only sustained this damage to the upper bow since it hit a suspended bridge. In this regard, *Norman* is a more typical 1890s/1900s Great Lakes vessel. When it comes to Great Lakes ships colliding with each other, three types of evidence show it was a common occurrence. The first two pieces of evidence are the design of lake freighters themselves. As shown by the models, the pilothouse was located at the bow of the vessel and had been since the construction of the first ship of this type, *R.J. Hackett* (1869). The reason that the pilothouse was located on the bow of the ship was to increase visibility. As Bruce Bowlus describes:

> Hidden shoals, narrow channels, and oncoming ship traffic in narrow confines made it crucial that ships' masters be able to react quickly. As ships grew in length, commanding from the stern became more difficult and dangerous. Peck, therefore, placed the pilothouse over a cabin at the bow, giving *Hackett's* captain better vision and the opportunity to respond to sudden crises quickly (Bowlus 2010:109).

The other evidence suggesting that vessels were designed with collisions in mind is the reinforcement of the bow with collision bulkheads. As shown by the present-day model of *Grecian* in the previous chapter, the forward most point of the ship was highly reinforced leading this section of the ship to remain more intact (Figure 66). This reinforcement led the bow of both vessels to be intact, despite the collapse of other structures on the wrecks.

Alongside the design of the vessels, the frequency of collisions on the Great Lakes is shown by the number of vessels in TBNMS sinking due to collisions. Per the TBNMS database, 29 of the 105 known wrecks resulted from collisions, corresponding to 27.6% (Lusardi 2018) This, however, represents only vessels that were fatally lost. The true number of Great Lakes vessels that collided is most likely even higher as both *Norman* and *Grecian* did so but did not sink (*Buffalo Enquirer* 1892; *Chicago Tribune* 1898). Furthermore, the collision that sank *Norman* saw the other vessel return to service after repairs, showing that collisions were not always fatal to both ships (*The Chicago Chronicle* 1895). It, therefore, seems that many vessels of the Great Lakes were involved in collisions but did not sink as a result. This fact should make this type of transform common among the wrecks at TBNMS and the Great Lakes as a whole, if they had similar studies completed.

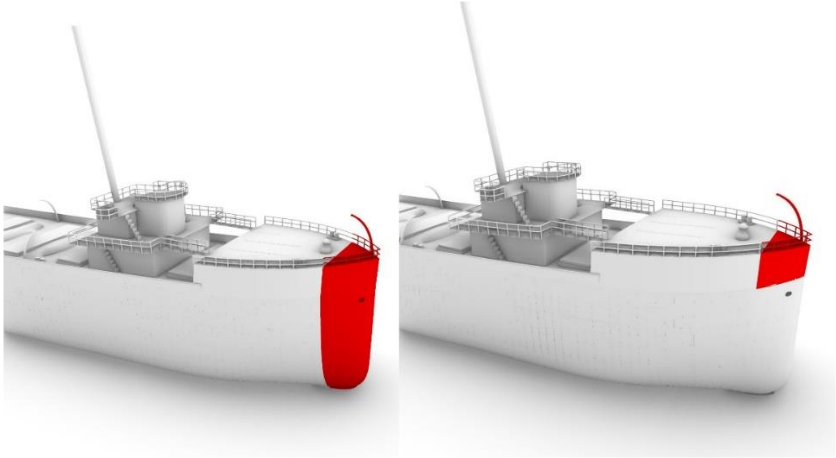

Figure 79: Norman *(left) showing the damage sustained colliding with* Republic *and* Grecian *(right) showing the damage sustained from colliding with the Chicago bridge (Image by Caleb O'Brien).*

Grecian sustained significantly more hull damage than *Norman* during its working life (Figure 80). This is due to the many incidents of *Grecian* running aground, while *Norman* was spared of this fate. This makes *Grecian* more typical of other Great Lakes vessels as running aground was a common occurrence. As shown by many of the articles discussing *Grecian* running aground, other vessels commonly hit the same obstructions. In the historical record, the following incidents of *Grecian* running aground also mentioned other vessels that had shared this fate on the same obstacle: 1891 Colchester Reef, 1894 Sault Ste. Marie, and 1901 Windsor (*Detroit Free Press* 1891c; *Marine Review* 1894b; *The Sandusky Star-Journal* 1901a). The frequency of vessels running aground is further highlighted by the wrecks in TBNMS. Using the information provided online, it was discovered that 33 of the 105 vessels in the sanctuary were lost due to running aground (listed as 'stranding') (Lusardi 2018). This represents 31.4% of wrecks at TBNMS, once again showing that running aground was a common incident that occurred to vessels not only in TBNMS, but also the Great Lakes region.

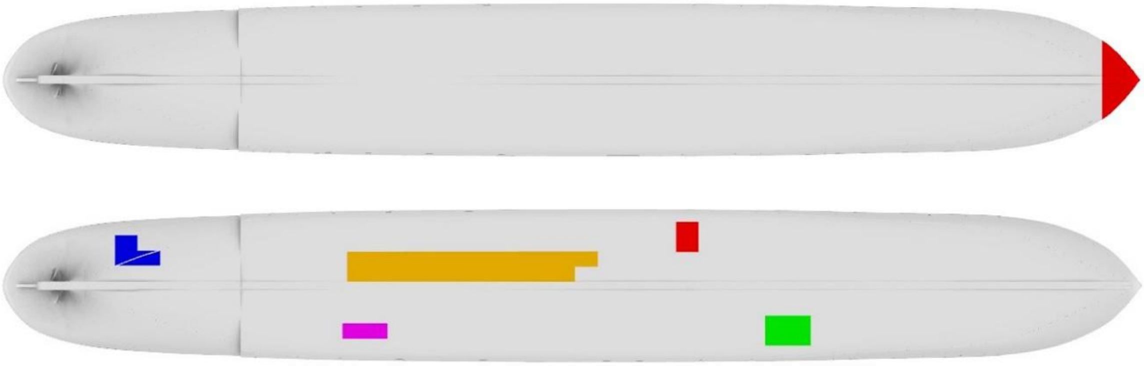

Figure 80: The repair that would have taken place on Norman*'s hull (top) and the repairs that would have taken place on* Grecian*'s hull (bottom) (Image by Caleb O'Brien).*

N-transforms

Alongside the above *c-transforms, Norman* and *Grecian* would have sustained similar *n-transforms* during their working lives, such as general wear and tear. Since these transformations were not modeled, there is no way to compare the extent of *n-transforms* on *Norman* and *Grecian*. Despite this, it would be the case that *Grecian* would have had more noncultural transformations since it was in service three times longer than *Norman*. Although these transformations were not modeled in this project, it is still possible to hypothesize that these would be like other ships in the Great Lakes. Since many of the Great Lakes ships were used in the same or similar industries (carrying cargo), they would have shared similar enough working conditions and environments that their deteriorations should be similar.

Overall, the cultural transformations of *Norman* and *Grecian* were similar since they both suffered from collisions with objects. Due to the longevity and traveling to more locations, *Grecian* had significantly more damage resulting from running aground. Furthermore, using the history of the region and the frequency of different types of incidents within TBNMS, one can see that the pre-depositional transforms of *Norman* and *Grecian* were quite common to other Great Lakes ships.

Analyzing the Depositional Site Formation Stage

The period with the fewest common transformations between *Norman* and *Grecian* is the wrecking event or the depositional stage. Although it was shown that the pre-depositional models of *Norman* and *Grecian* diverge, the differences may not be noticed on the wreck sites today. This leaves the depositional stage as having the first discernible differences between these two wrecks. As noted previously, *Norman* sank as the result of a collision, while *Grecian* sank due to a failed hull patch. These sinking events then led to drastically different transformations, both immediately following the wreck and into the post-depositional stage.

C-transforms

The depositional stages of both *Norman* and *Grecian* were centered on cultural transformations. The first difference between these two vessels is the lead-up to the sinking. As noted in Chapters Four and Five, *Norman* was sailing upbound with a light load of coal when it collided with *Jack* on 30 May 1895. Due to the violence of the sinking, the vessel very rapidly went through the pre-impact threat phase, pre-impact warning phase, and impact phase. Due to this rapid transition, the only two cultural transformations that were found in the historical record (other than the collision) were the position of *Norman* as it tried to avoid *Jack* and the single remaining lifeboat on the wreck (Figures 42 and 43). *Grecian* meanwhile had a lengthy sinking event. As noted in Chapter Five, *Grecian* had two pre-impact threat phases, two pre-impact warning phases, two impact phases, and finally one recoil phase. Due to this extended sinking event, multiple cultural transformations were able to be modeled such as the original hole caused by the obstruction and the patch that was installed in DeTour, MI.

The most obvious c-transform divergence occurring during the deposition of these two vessels was the sinking event itself. Collisions, like the one that sank *Norman*, caused approximately 30% of wrecks in TBNMS, as stated above. Vessels that had similar fates are *Defiance* (1854), *E.B. Allen* (1871), *F.T. Barney* (1868), *John J. Audobon* (1854), *Florida* (1897), *Kyle Spangler* (1860), *M.F. Merrick* (1889), *Monrovia* (1959), *New Orleans* (1906), *Persian* (1868), *Typo* (1899), and *W.C. Franz* (1934) (TBNMS 2022c, 2022e, 2022f, 2022g, 2022i, 2022j, 2022k, 2022l, 2022n, 2022o, 2022q, 2022r). This shows that the method of sinking for *Norman* was relatively common for wrecks located in TBNMS. This also shows that the transformations discovered during *Norman*'s depositional stage can be applied to many other vessels in TBNMS (Figure 81).

While collisions commonly occurred to Great Lakes vessels, the nature of the collision event itself, as well as the consequences, vary. For example, *Kyle Spangler* and *John J. Audubon* were both sail-powered wooden vessels that collided with other vessels and sank in TBNMS. *Kyle Spangler*'s damage is mostly centered on the bow, which corresponds to it running into another vessel. *John J. Audubon*, meanwhile, sustained damage along the midships. This damage is minor compared to the damage caused by collisions by other vessels. Both *New Orleans* and *Florida* were steam-powered, wooden freighters that sank due to collisions. In both cases significant damage occurred, and large parts of the ships were destroyed on impact. In the case of *New Orleans,* the entire midship section was destroyed during the collision and the ship was nearly sheered in two. *Florida* meanwhile was significantly less damaged than *New Orleans* and instead only has collision damage to the hull on its starboard side. *Norman* which was a steam-powered, steel-hulled freighter suffered from damage somewhere in between *Florida/John J. Audubon* and *New Orleans*. This comparison suggests that the method of propulsion (speed), material of the ship, and vessel masses have a significant role in determining damage sustained from collisions. On wooden, sail-powered vessels the damage seems minor compared to later steel, steam-powered ships, which can be explained by their lower speeds and mass. For this to be confirmed, however, further archaeological site formation studies need to be undertaken to determine if this trend is widespread.

Grecian on the other hand foundered and would have been very intact when it landed on the lakebed. The reason *Grecian* was more intact is that it was structurally sound and slowly filled with water while *Norman* suffered structural damage from the collision and rapidly filled with water. Foundering was a less common sinking event and only accounts for 16 of the 105, or 15.2%, of TBNMS wrecks (Lusardi 2018). Although less common than collisions, the processes identified in this stage of *Grecian*'s archaeological site formation can be applied to these other vessels such as: *Cornelia B. Windiate* (1875), *Corsair* (1872), *D.M. Wilson* (1894), *Isaac M. Scott* (1913), and *Newell A. Eddy* (1893) (Figure 82).

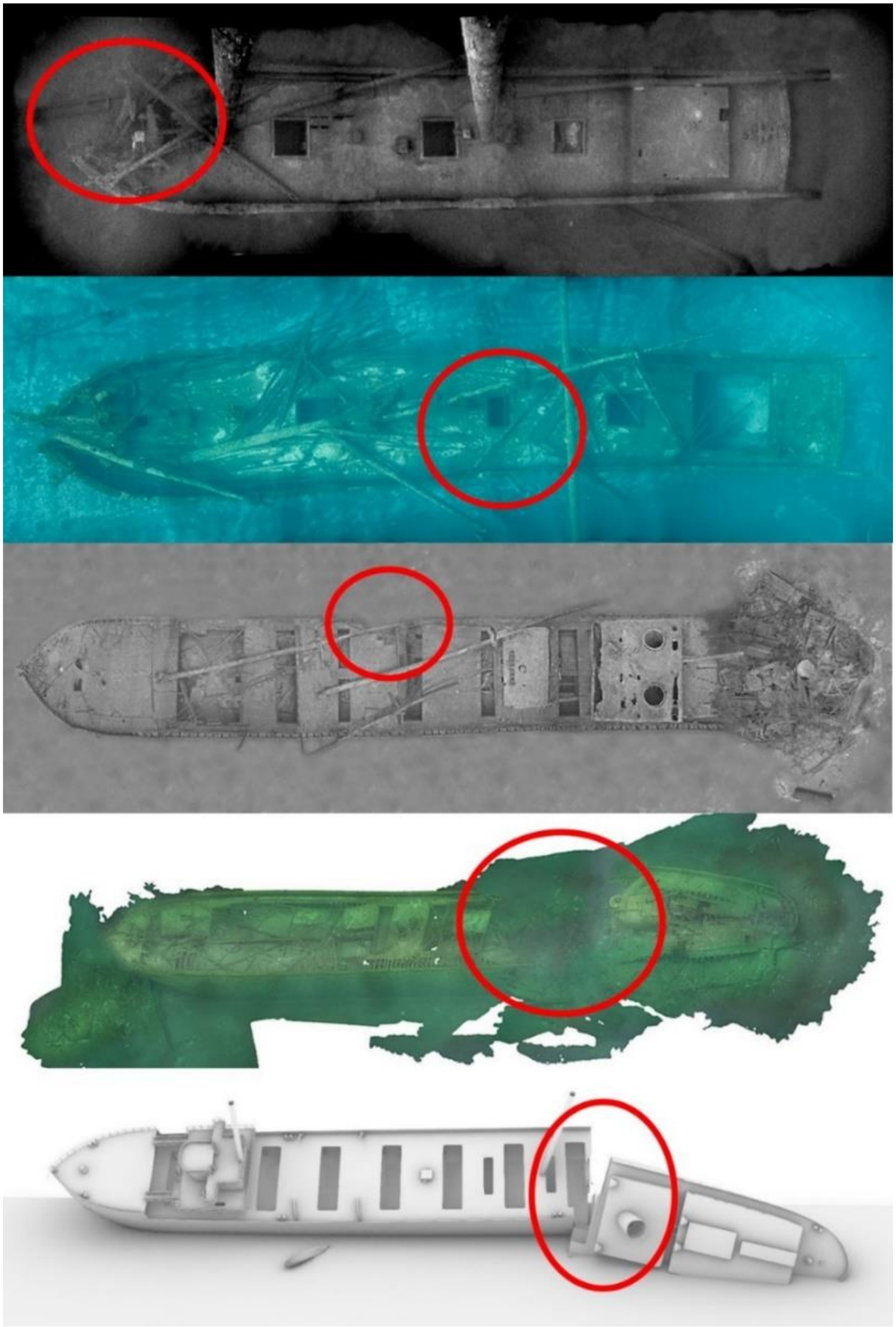

Figure 81: Comparison of collision damage on wrecks in TBNMS (from top to bottom: Kyle Spangler *(TBNMS)*, John J. Audubon *(TBNMS)*, Florida *(TBNMS)*, New Orleans *(TBNMS), and* Norman *(Caleb O'Brien).*

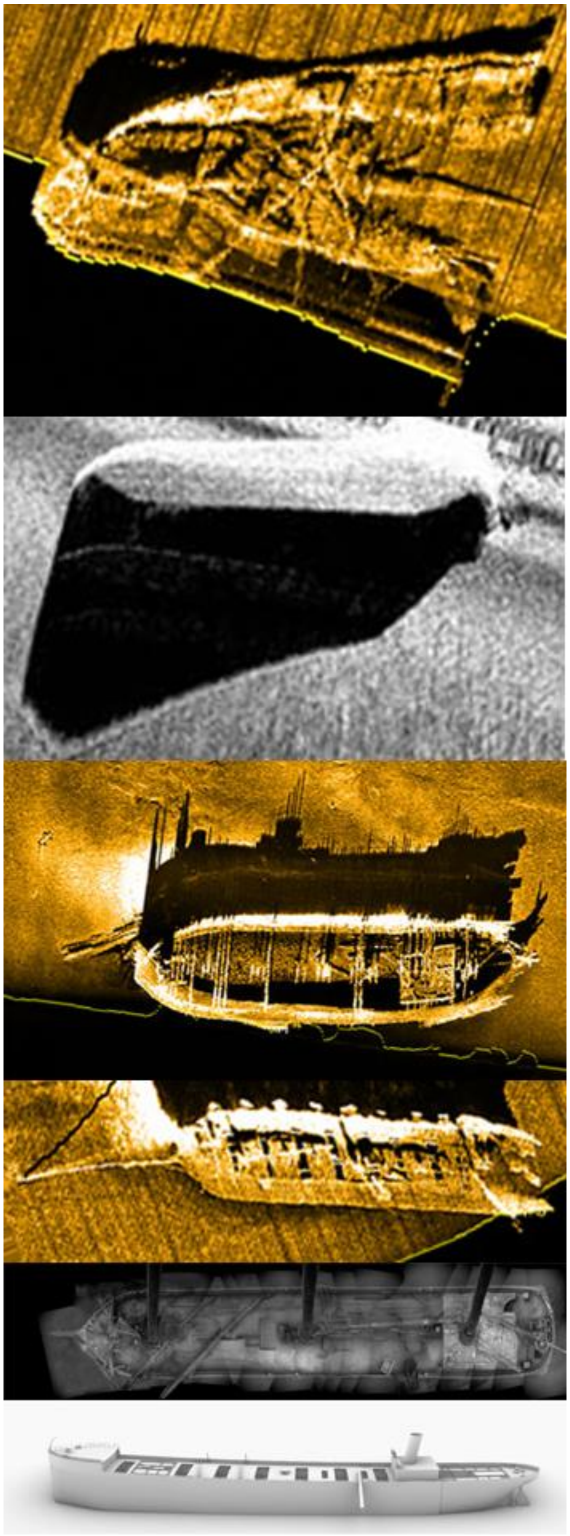

Figure 82: Comparison of foundering wrecks in TBNMS (from top to bottom Corsair *(TBNMS),* Isaac M. Scott *(TBNMS),* D.M. Wilson *(TBNMS),* Newell A. Eddy *(TBNMS),* Cornelia B. Windiate *(TBNMS), and* Grecian *(Caleb O'Brien).*

As shown above, the foundered wrecks also share the resemblance of being in one piece because of their similar sinking sequence. The only exception to that is *Corsair* which has fileted into two sections down the keel. *Corsair*'s deterioration is most likely due to post-depositional transformations (discussed later). The only ship that stands out from the rest is *Isaac M. Scott.* Unlike the others, which are laying right side up, it rests upside down and has the bottom of the hull exposed. This indicates that this vessel rolled sometime during its depositional stage. Despite this, it seems to be the case that vessels that founder should be in one piece and, minus a few exceptions, right side up like *Grecian*.

Along with the above differences, there is an additional cultural transformation that is different between *Norman* and *Grecian*. *Grecian*, due to it having the time to unload its cargo at harbor before finally sinking near Alpena, would have no cargo at the wreck site. The above differences manifest themselves in the depositional wrecks looking different as shown (Figure 83).

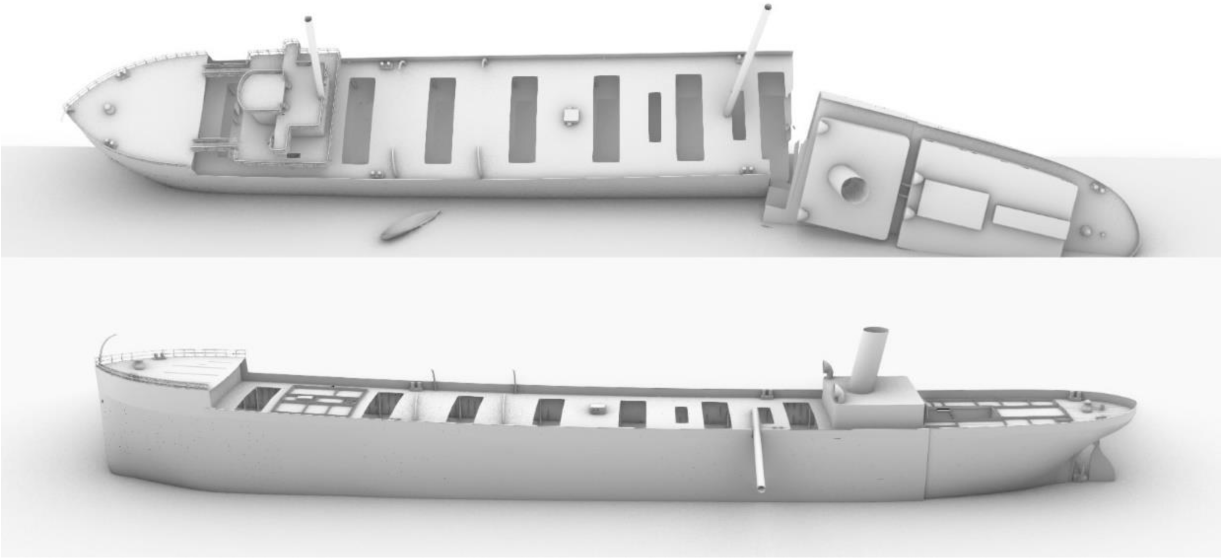

Figure 83: The depositional models of Norman *(top) and* Grecian *(bottom) showcasing the differences in wrecks as soon as they sank (Image by Caleb O'Brien).*

Due to the differences in the wrecking event, it is possible that later site formation was altered. Specifically, a vessel that is more intact should remain complete longer as its structural support is more intact and less surfaces are exposed to things such as currents. Vessels that are not intact, such as *Norman,* could experience a faster deterioration as more surfaces are exposed and the damage caused by a breakup could have significantly weakened the structure of the vessel. These differences may also be observable in other wrecks within TBNMS.

N-transforms

Although both vessels sank due to cultural transformations, they also experienced *n-transforms* during the depositional stage. These mainly seem to be physical transformations and were very dissimilar between the two wrecks.

The first of these changes occurred as the vessels were sinking. As shown by models, plans, and images, both *Norman* and *Grecian* possessed two spar beams (Figure 7). The wreck of *Norman* still has two upright spar beams, while *Grecian* retains only one broken spar beam (Figure 84). The reason for this difference was found in interviews following the sinking of *Grecian* as it was stated that one of the spar beams broke off and fell onto the rescue vessel (*Detroit Free Press* 1906d). Due to this single spar breaking off, it seems possible that both of *Grecian's* spar beams broke during the sinking event itself. Despite being such a visible difference between the two wrecks, no further deterioration arises from having broken spar beams.

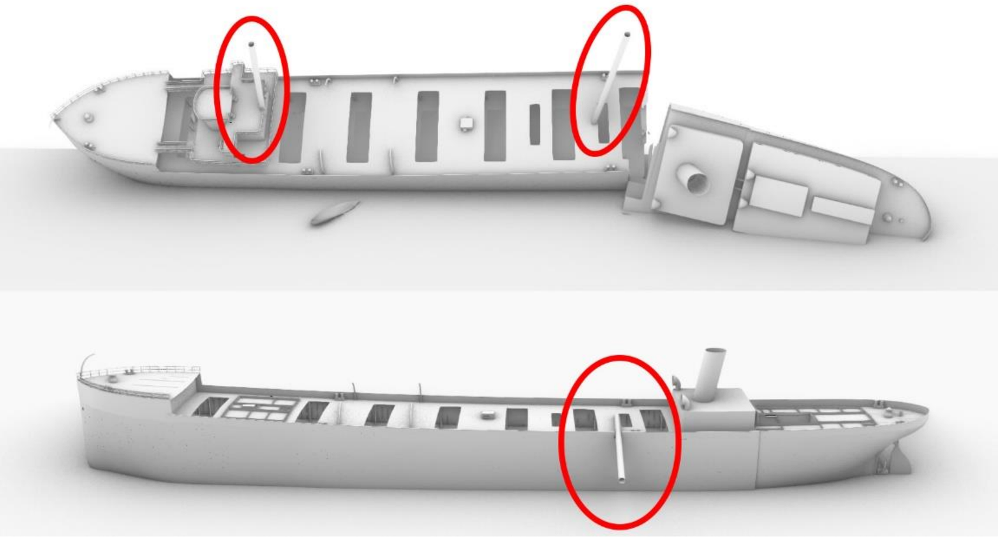

Figure 84: The depositional models of Norman *(top) and* Grecian *(bottom) showing the differences in spar beams (Image by Caleb O'Brien).*

When it comes to the presence of intact spars/masts on other wrecks, it was found that roughly half of the intact wrecks with evidence of spars/masts had them intact while half had them broken (TBNMS 2022a, 2022c, 2022d, 2022e, 2022f, 2022g, 2022i, 2022j, 2022k, 2022l, 2022n, 2022q, 2022r). This observation spans all construction periods and as a result, *Norman* and *Grecian* follow the general trend observed since one has intact spars while the other has broken spars (Figure 85). In the image below, two of the vessels, *Cornelia B. Windiate* and *Kyle Spangler*, retained all masts are upright. All the spars are broken on *E.B. Allen*, *John J. Audubon*, and *Florida*. This suggests that *Norman* and *Grecian* follow general trends and further studies should see this trend continue. The reason for spars breaking on *Grecian* and not *Norman* could result from several factors including it being slightly more worn due to its longevity, rougher water conditions during the sinking, or the position of another vessel being nearby when it sank.

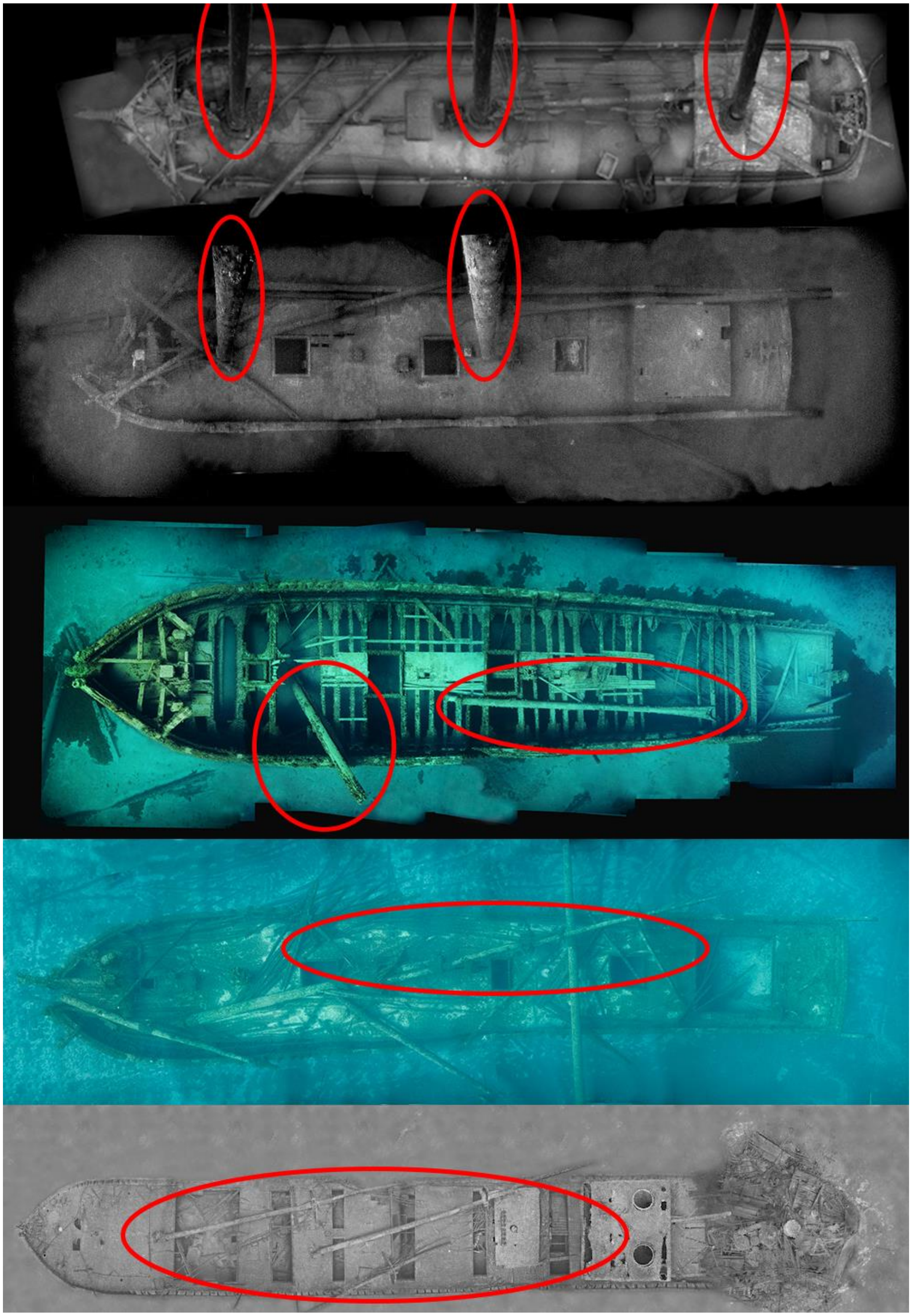

Figure 85: Image showcasing the differences in spar beams on wrecks within TBNMS (from top to bottom: Cornelia B. Windiate, Kyle Spangler, E.B Allen, John J. Audubon, *and* Florida*) (Images by TBNMS; Compiled by Caleb O'Brien).*

When *Norman* and *Grecian* hit the lake floor, each saw some buoyant materials become flotsam. On both, flotsam would have come in many forms from personal items, unsecured materials, and the cargo hatches that covered the cargo holds. The only deviation is the single cargo hatch that remains on *Grecian* (Figure 86).

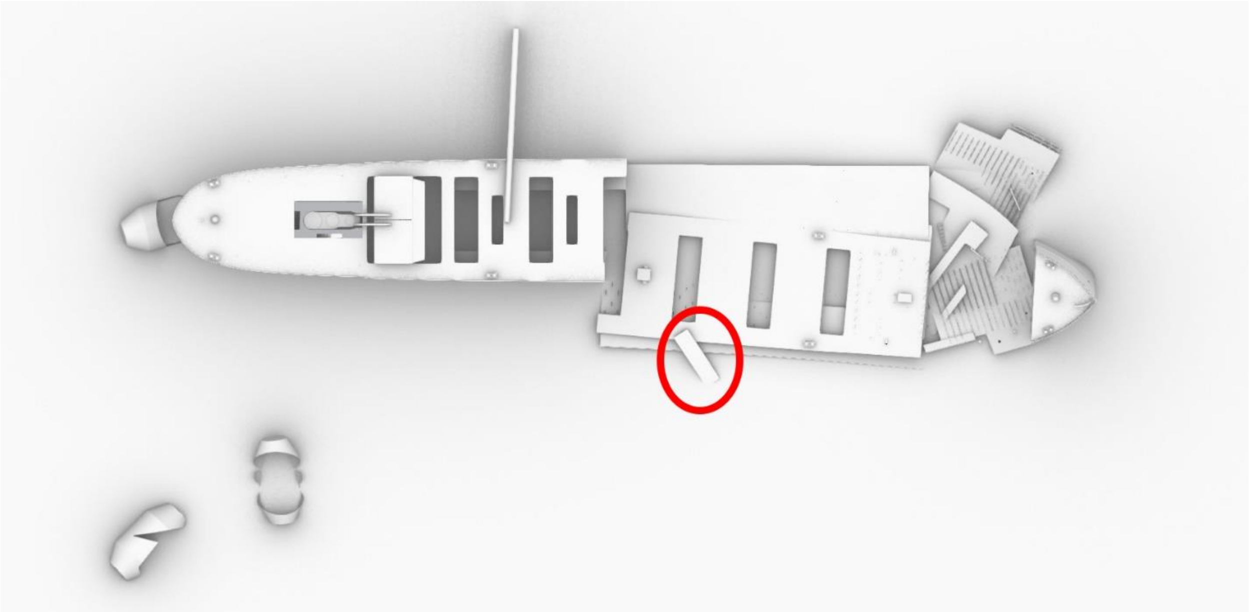

Figure 86: Post-depositional model of Grecian *with the remaining cargo hatch cover (Image by Caleb O'Brien).*

Of the other wrecks analyzed for missing cargo hatch coverings, eight were confirmed to have missing hatches, while only one was confirmed to have them. Below, an example of several of these vessels are shown, which suggest that cargo hatches are not that common on wrecks in TBNMS (Figure 87).

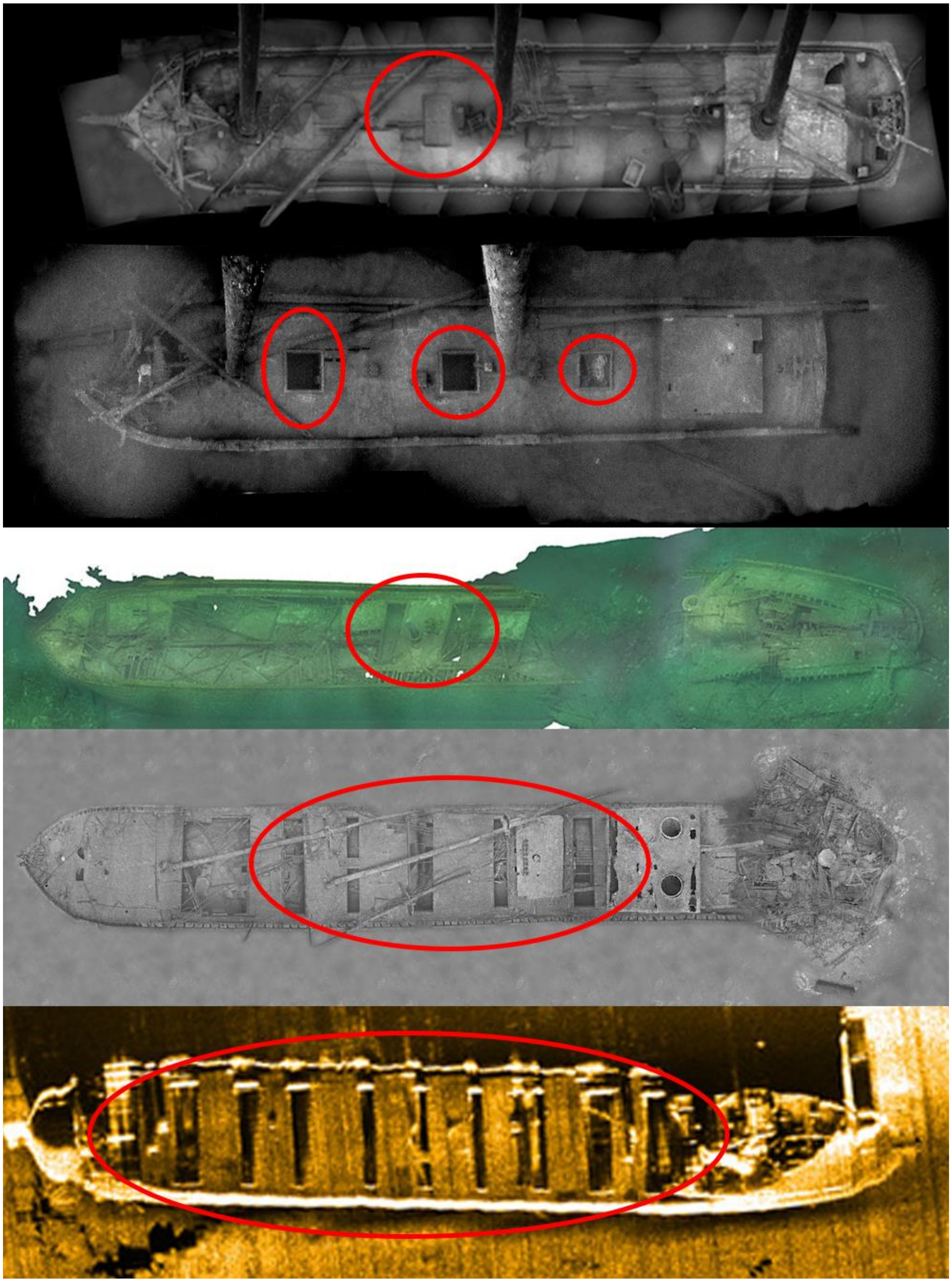

Figure 87: Missing cargo hatches seems to be the norm for intact wrecks in TBNMS (from top to bottom: Cornelia B. Windiate, Kyle Spangler, New Orleans, Florida, *and* W.C. Franz*) (Images by TBNMS; Compiled by Caleb O’Brien).*

When analyzing the wrecks similar in preservation to *Norman* and *Grecian*, nine vessels were discovered that could still have identifiable cargo hatches: *Cornelia B. Windiate, Defiance, D.M Wilson*, *E.B. Allen*, *Florida*, *John J. Audobon*, *Kyle Spangler, New Orleans*, and *W.C. Franz* (TBNMS 2022a, 2022c, 2022d, 2022e, 2022f, 2022i, 2022j, 2022n, 2022r). Of these nine (11 total including *Norman* and *Grecian*), only one has cargo hatches on the wreck. This shows that cargo hatches are rare among wrecks in TBNMS. The reason for the missing cargo hatches is because they were constructed out of buoyant material (wood) and lightly attached to the vessel as they needed to be removable. Due to the hatch covers being made of white pine (*Pinus strobus)* on *Norman* and *Grecian* (See Figure 11), they were buoyant enough to float off the wreck (Wood Database 2022). The missing cargo hatches on *Norman* and *Grecian* suggests that future archaeological site formation studies in TBNMS should look for this trend continuing.

Along with the cargo hatches, the other flotsam that occurred on these wrecks was the pilothouse and aft cabins on *Grecian*. When comparing the presence of intact deck structures to other wrecks in TBNMS, deck structures were found on comparatively few wrecks in TBNMS (Figure 88). Of the wrecks that possessed intact deck structures, four were wooden-hulled ships (*Cornelia B. Windiate*, *F.T. Barney*, *Kyle Spangler,* and *Ohio*), but two were fully constructed of steel and were built much later than *Norman* and *Grecian* (*Monrovia* and *W.C. Franz*). The vessels closest in age and design to *Norman* and *Grecian* (*Florida* and *New Orleans)* had evidence of missing deck houses, but both also still have intact boiler houses. It also should be noted that it is difficult to know whether the missing deckhouses results from immediately becoming flotsam, as is the case with *Grecian*, or the result of long-term physical deterioration as with the case of *Norman*. This suggests that the presence of deck houses on wrecks in TBNMS is at least partially dependent on the period and materials at which the vessel was constructed. The builders' plans used for the models of *Norman* and *Grecian* (Figures 7-13) show that the main deck was steel, and the deck structures were only lightly attached to it. Assuming that this was standard building practice during the 1890s, it could be the reason the deck structures do not remain intact on *Norman*, *Grecian*, *Florida*, and *New Orleans*. In the case of *Norman* and *Grecian* the following image shows the differences between these two wrecks (Figure 89).

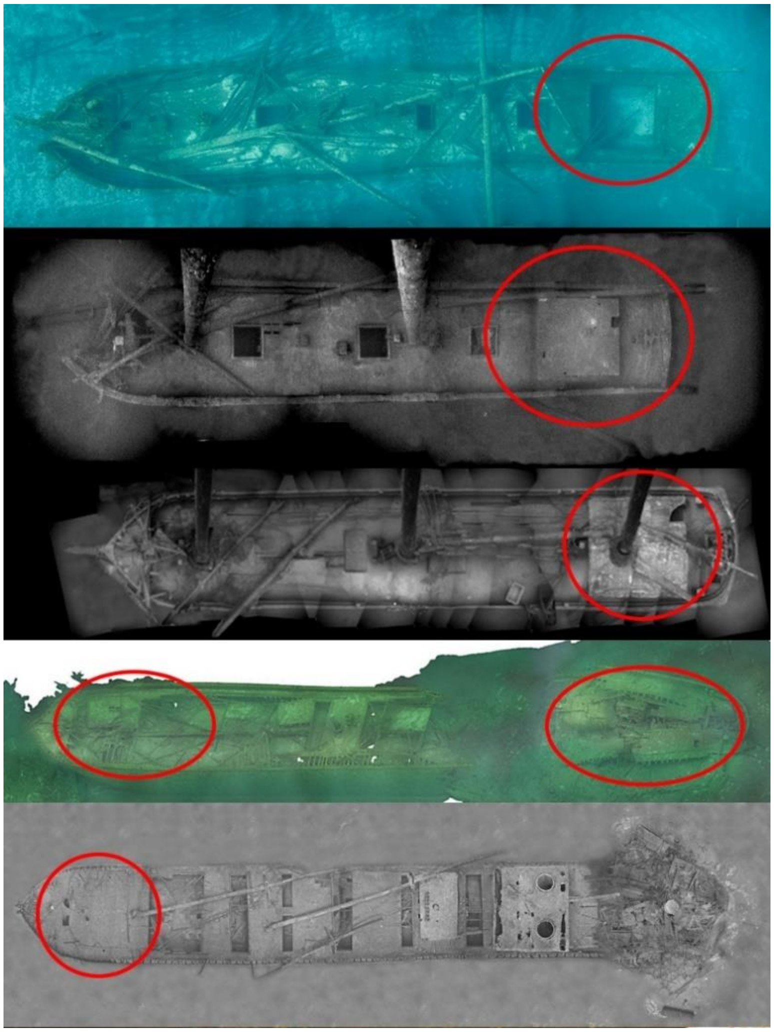

Figure 88: Image showing the three early wooden wrecks and two wrecks contemporary to Norman and Grecian and their present or missing deck structures (from top to bottom: John J. Audubon, Kyle Spangler, Cornelia B. Windiate, New Orleans, *and* Florida*) (Images by TBNMS; Compiled by Caleb O'Brien).*

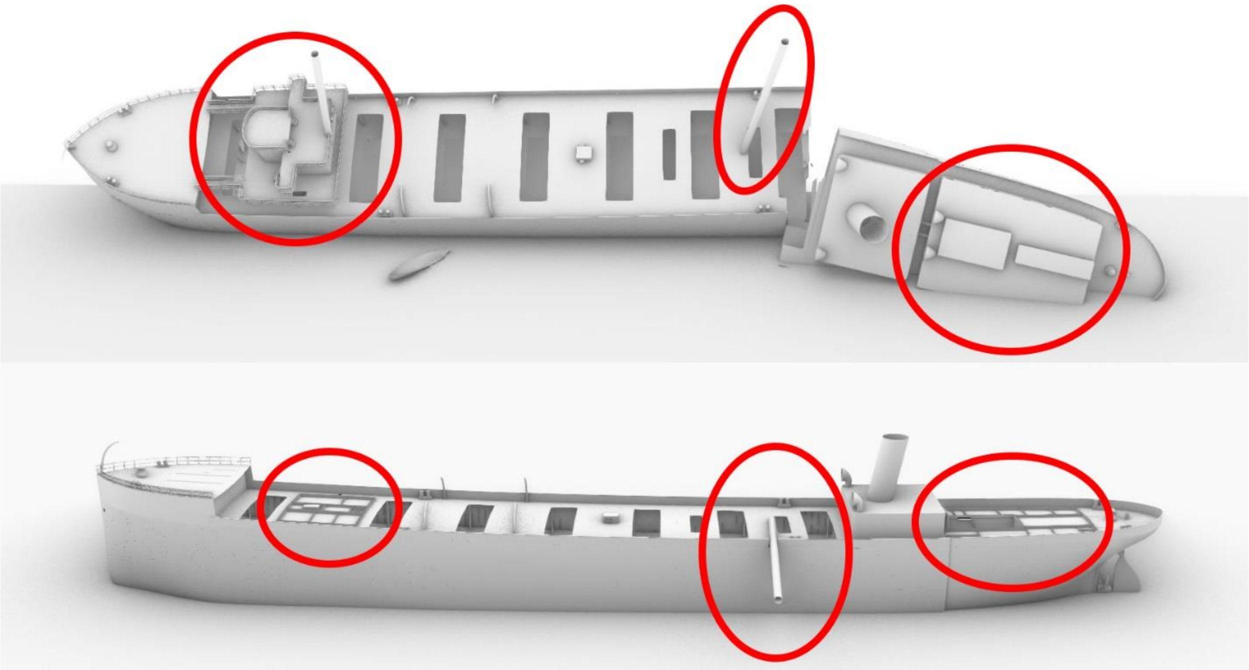

Figure 89: Depositional model showing Norman *and* Grecian *with the difference in spar beams and deck structures shown (Image by Caleb O'Brien).*

Analyzing the Post-Depositional Site Formation Stage

After wrecking in Lake Huron, *Norman* and *Grecian* were subjected to post-depositional transformations. It is during this stage that the vessels had the most similar transformations as they are subjected to approximately the same *n-transforms*. The main differences between these two vessels are the attempted salvage on *Grecian* and changes that can be attributed to the difference in depth of the wrecks.

C-transforms

When it comes to cultural transformations in the post-depositional stage the only transformation analyzed for this project was salvage. *Norman*, due to its deeper location and lack of valuable cargo, was saved from salvage and only altered by noncultural transformations. *Grecian* on the other hand was the target of a major salvage operation a few years after it sank. Presumably, the reason it was the target of this salvage is the shallower location and little damage sustained during the wreck. During the salvage operation, three canalons were deposited on the wreck site. Also during this stage, it seems that the iron boiler housing was removed from the wreck. Due to these activities, *Grecian* would have been altered more significantly than *Norman* in the locations shown below (Figure 90).

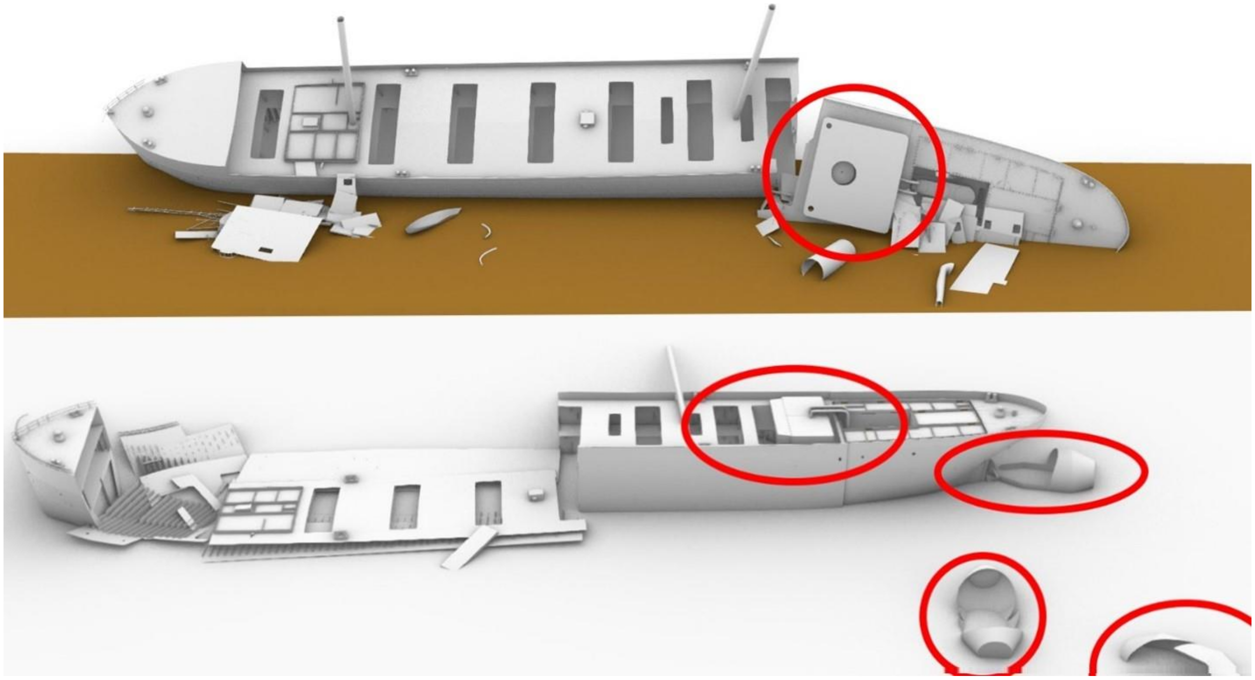

Figure 90: Post depositional model of Grecian *highlighting the addition of the canalons and the removal of the boiler house (Image by Caleb O'Brien).*

Salvage was routinely carried out on Thunder Bay shipwrecks. As found when looking at the wrecks in TBNMS, it was discovered that 22.78% of the vessels in the sanctuary sustained some level of salvage, however, this is heavily skewed towards shallow wrecks (Lusardi 2018).

Using this information, it was possible to create another collage of wrecks showing the various types of salvage at TBNMS (Figure 91). When looking at these representative site maps, two levels of salvage appear. The first type of salvage is significant and involved the removal of most of the vessel and its engines/boilers. Systematic and large-scale salvage only occurred in shallow, more accessible wrecks. The other type of salvage seems to be the removal of parts of the wreck without removal of large machinery components. This type of salvage includes both *Pewabic* (1895) and *Grecian*, from which, deck structures and other impediments were removed. Despite salvage being quite common among the vessels at TBNMS, *Grecian* appears to be one of only a few wrecks within the sanctuary to include the remains of salvage equipment. Salvage should therefore be studied closely for future research in TBNMS. Furthermore, the attempted salvage of *Grecian* provides an excellent insight into salvage operations during the early 1900s, as remnants of salvage equipment remain near the wreck.

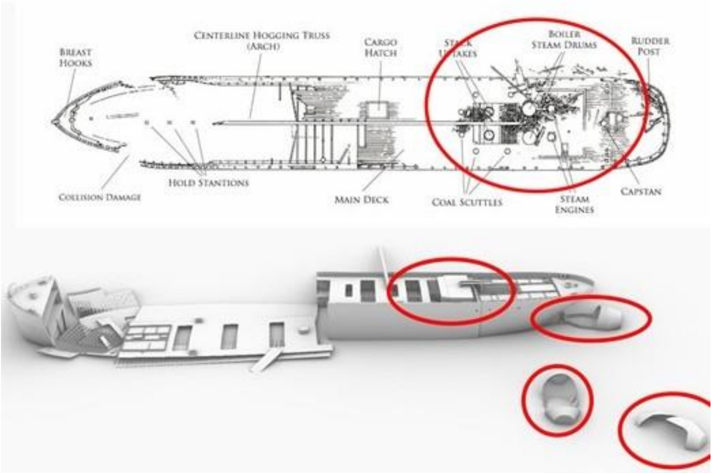

Figure 91: Collage showing different vessels that were salvaged, showing the salvage of deck structures (from top to bottom: Pewabic *(TBNMS) and* Grecian (*Caleb O'Brien*) *(Compiled by Caleb O'Brien).*

N-transforms

Following the wrecking events, *Norman* and *Grecian* would have been subjected to similar physical, chemical, and biological processes due to their locations within Lake Huron. *Grecian*, however, has been affected more due to its shallower depth.

Both *Norman* and *Grecian* saw significant structural collapse, however, the processes for the collapses are different. Since noncultural transformations are constantly affecting *Norman* and *Grecian*, it seemed most appropriate to locate vessels in TBNMS that sank around the time of *Norman* and *Grecian* and were similarly constructed and had similar sinking events, and in similar water depths to *Norman* and *Grecian* (Figure 92). When looking through the vessels at TBNMS, two were most similar to *Norman* and *Grecian*: *Florida* and *New Orleans. Florida* was a wooden package freighter built in 1889 and sunk in a collision in 1897 (TBNMS 2022f). *New Orleans* was a wooden bulk freighter built in 1885 and sunk only two weeks after *Grecian* in June 1906 (TBNMS 2022n). Since *Florida* and *New Orleans* both were similarly constructed, had similar sinking events, and had similar sinking dates, it is possible to look at these wrecks to see how the physical transformations compare to *Norman* and *Grecian*.

Using *Florida* and *New Orleans* for comparisons shows that deteriorations are seemingly dependent on depth, with shallower wrecks exposed to less preservative environments than deeper ones (Figure 93). *Grecian* saw its midsection collapse and is the shallowest of the four wrecks at only 100 feet. There seems to have been two stages of collapse as the area immediately behind the ‘bow triangle’ fileted onto both sides of the wreck, while the area aft of that saw the port side collapse onto the starboard side of the wreck. Meanwhile, *New Orleans*, which rests at 145 feet, seems to have sustained physical transformations as shown by the collapse of the stern. This collapse seems to have occurred from the starboard side of the wreck and onto the port side, pancaking the wreck in a similar fashion to the midships of *Grecian* (TBNMS 2022n). These two wrecks show that even up to 150 feet below Lake Huron there are physical processes acting upon the wrecks causing them to break apart. Finally, both *Florida* and *Norman* rest at 200 feet and suffered limited physical deterioration. *Florida* seems to have avoided much deterioration other than the damage caused by the collision and the stern breaking apart. The reason for the stern's destruction per TBNMS is that "the steamer sank so quickly that its stern was crushed when it hit the bottom" (TBNMS 2022f). Other than the collapse of the deck structures, *Norman* has stayed relatively intact. As shown below, the deeper wrecks like *Norman* and *Florida* seem to have less major structural collapse, due to a more preservative and stable environment.

When it comes to the corrosion of *Norman* and *Grecian* the changes were minimal and there was no attempt at modeling them. The environment of Lake Huron, with its cold and fresh water, is highly preservative and slows corrosion. Thus, it seems inappropriate to compare *Norman* and *Grecian* to other Great Lakes wrecks since they all have similar levels of chemical deterioration. As such, it seems imperative to compare *Norman* and *Grecian* to other steel vessels in more typical, oceanic environments. The best example to see these deteriorations is *Caribsea*, which was studied in a previous archaeological site formation project (Fox 2015). Another example is the wreck of the steel Great Lakes freighter, *Northern Light*, also built by Globe Iron Works and wrecked in FKNMS. By looking at these two wrecks, the more preservative cold, fresh water of Lake Huron can be contrasted to the warmer and saline environment of the ocean.

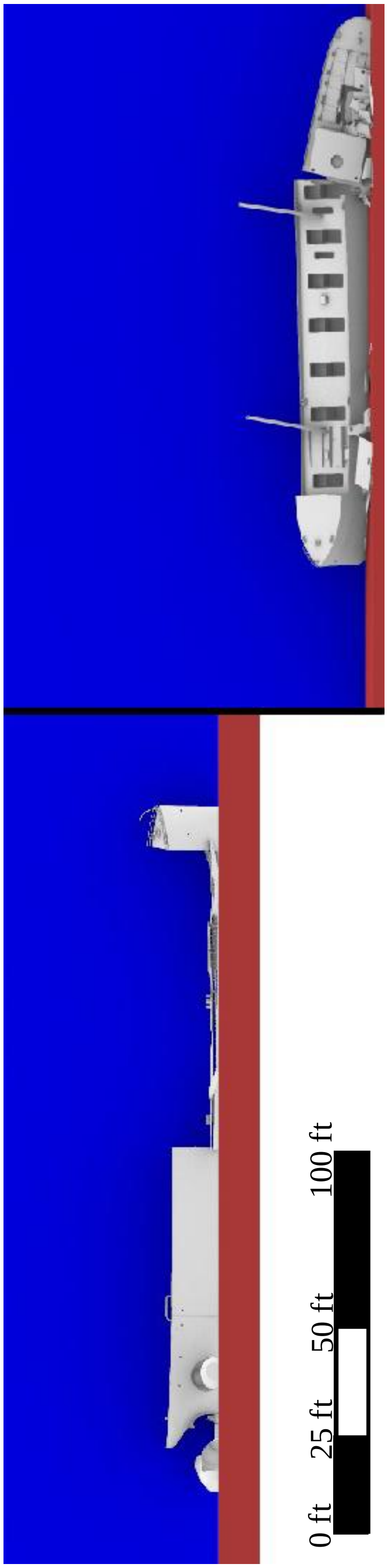

Figure 92: Comparison of depth between Norman *(right) and* Grecian *(left) (Image by Caleb O'Brien).*

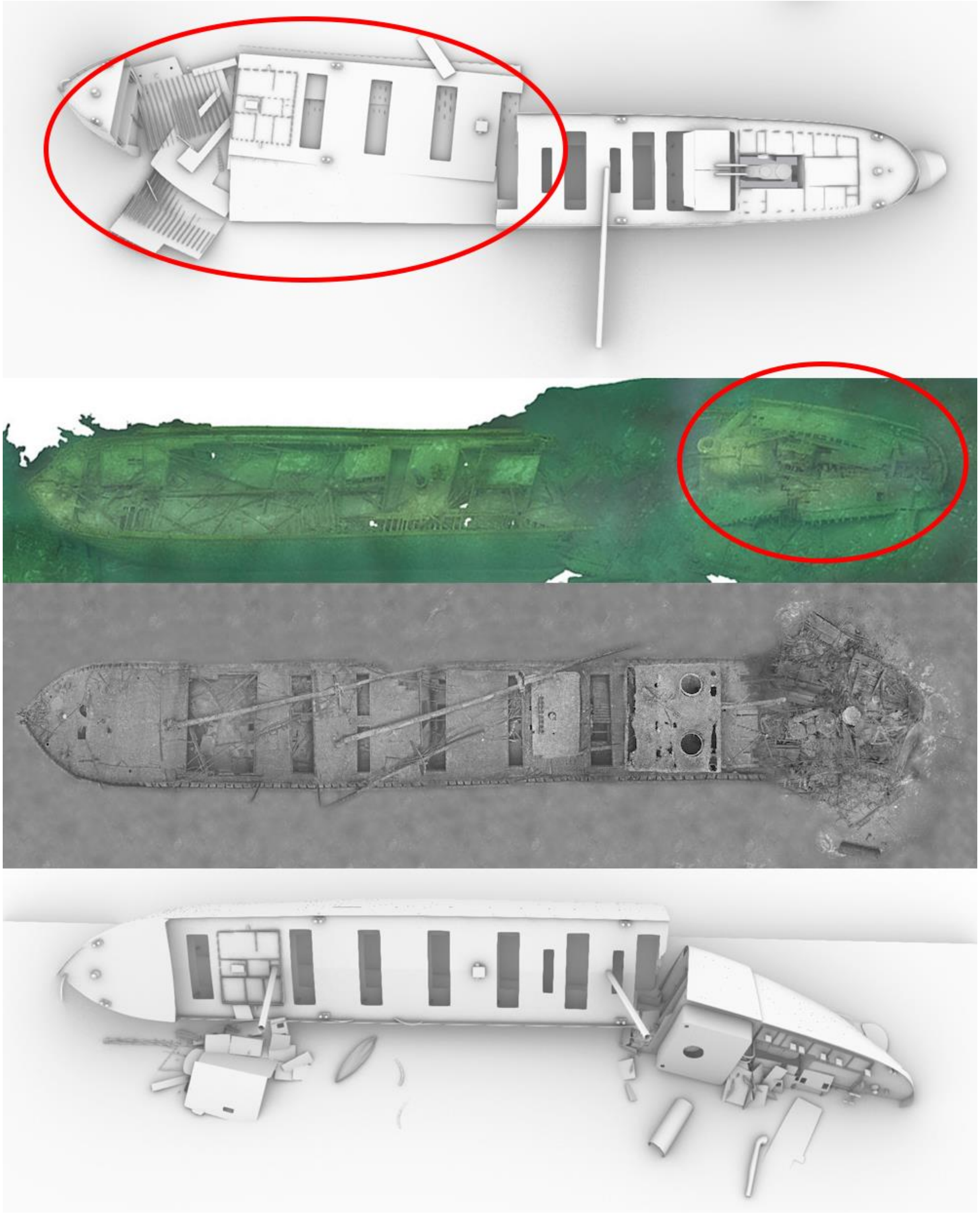

Figure 93: Collage showing the decrease physical deterioration at depth of (from top to bottom: Grecian *(Caleb O'Brien),* New Orleans *(TBNMS),* Florida *(TBNMS), and* Norman *(Caleb O'Brien)*) *(Compiled by Caleb O'Brien).*

In Kara Fox's study of *Caribsea*, the effects of corrosion were shown on the post-depositional model of the wreck. As she states:

> The effects of corrosion, however, were observed in the remaining hull structure, deck plating, and debris fields of the shipwreck site. The remaining hull structure and decking components of the shipwreck site appeared to exhibit active signs of corrosion which appeared in the form of various sized holes and structural decay (Fox 2015:145-146)

As she noted, this leads to holes appearing on the deck which she modeled as shown below (Figure 94).

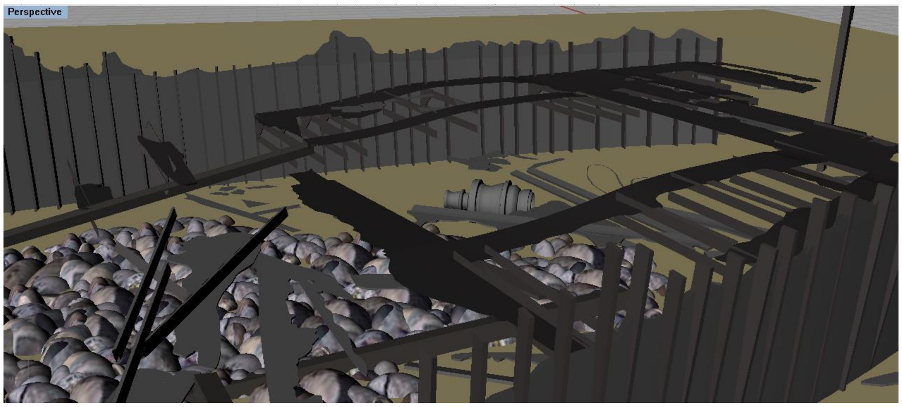

Figure 94: Model of Caribsea *showing the corrosion of the deck (Fox 2015:146).*

Corrosion is also present on the wreck of *Northern Light* in FKNMS. This vessel was built in 1888 at Globe Iron Works in Cleveland, OH, but ended up leaving the Great Lakes and sinking off the Florida Keys in 1930. In 2008, *Northern Light* was investigated by NOAA researchers, and images were taken for comparison with *Grecian* (Brenda Altmeier 2022, elec.

comm.). The images highlight corrosion on this wreck, especially on the bow. When comparing the images of *Northern Light*'s bow to the bow of *Grecian*, the differences of levels of corrosion becomes apparent (Figures 95 and 96). As shown below, *Northern Light* has lost all its railing and the top of the forecastle, leaving the chain locker underneath entirely exposed. *Grecian* meanwhile still has parts of the deck railing and maintains the integrity of its outer hull. Furthermore, only a bit of *Northern Light*'s spar deck is intact, while *Grecian* still has its windless and other deck accessories still resting on its spar deck.

The corrosion highlighted by *Caribsea* and *Northern Light* shows how wrecks generally deteriorate when in the world's oceans. It also contrasts the effects of corrosion, which has been drastically slowed on *Norman* and *Grecian* due to the cold, freshwater environment of Lake Huron. These wrecks also show what the future may hold for *Norman* and *Grecian*, and the other wrecks in TBNMS.

Biologically induced change is likely now similar between *Norman* and *Grecian*. The biggest biological threats to these wrecks are the invasive zebra and quagga mussels that now live on the sites. As previously discussed, the mussels cause a variety of deteriorations to shipwrecks (Watzin et al. 2001:33-36). Although these wrecks are both affected by the mussels now, *Grecian*, due to its shallower depths has been affected by mussels for 20 years longer than *Norman* (Benson et al. 2022a; 2022b). As mentioned before, sulfate reducing bacteria could also affect *Norman* and *Grecian*. Since these vessels both are partially buried in the lakebed, it is possible that these buried sections are being deteriorated by such bacteria (Figures 50 and 75). The other wrecks in TBNMS are also undergoing the same deterioration as they all are being affected by the invasive mussels and possibly sulfate-reducing bacteria.

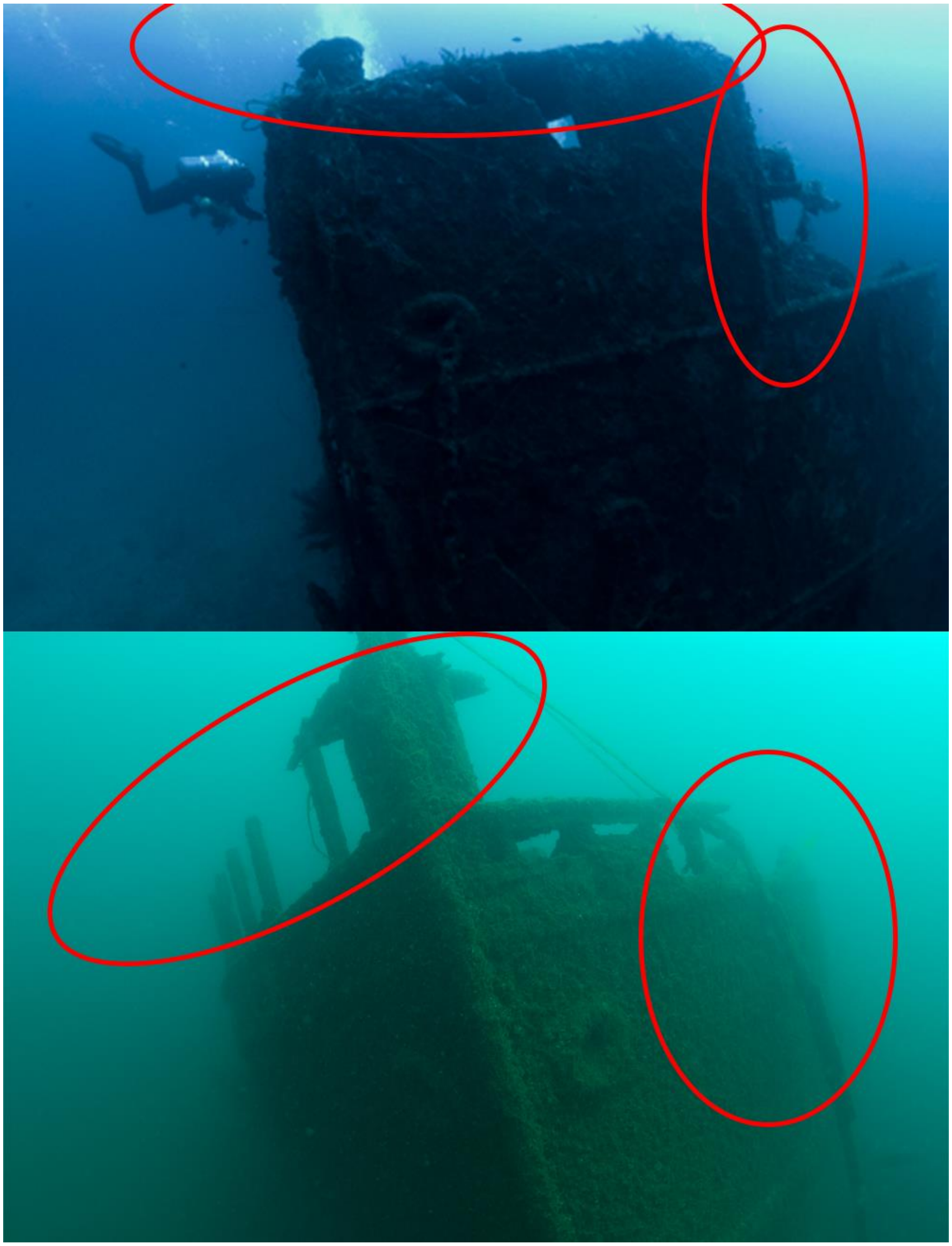

Figure 95: Comparison between Northern Light *(top) and* Grecian *(bottom) highlighting the difference in railing and hull integrity (Images by TBNMS; Compiled by Caleb O'Brien).*

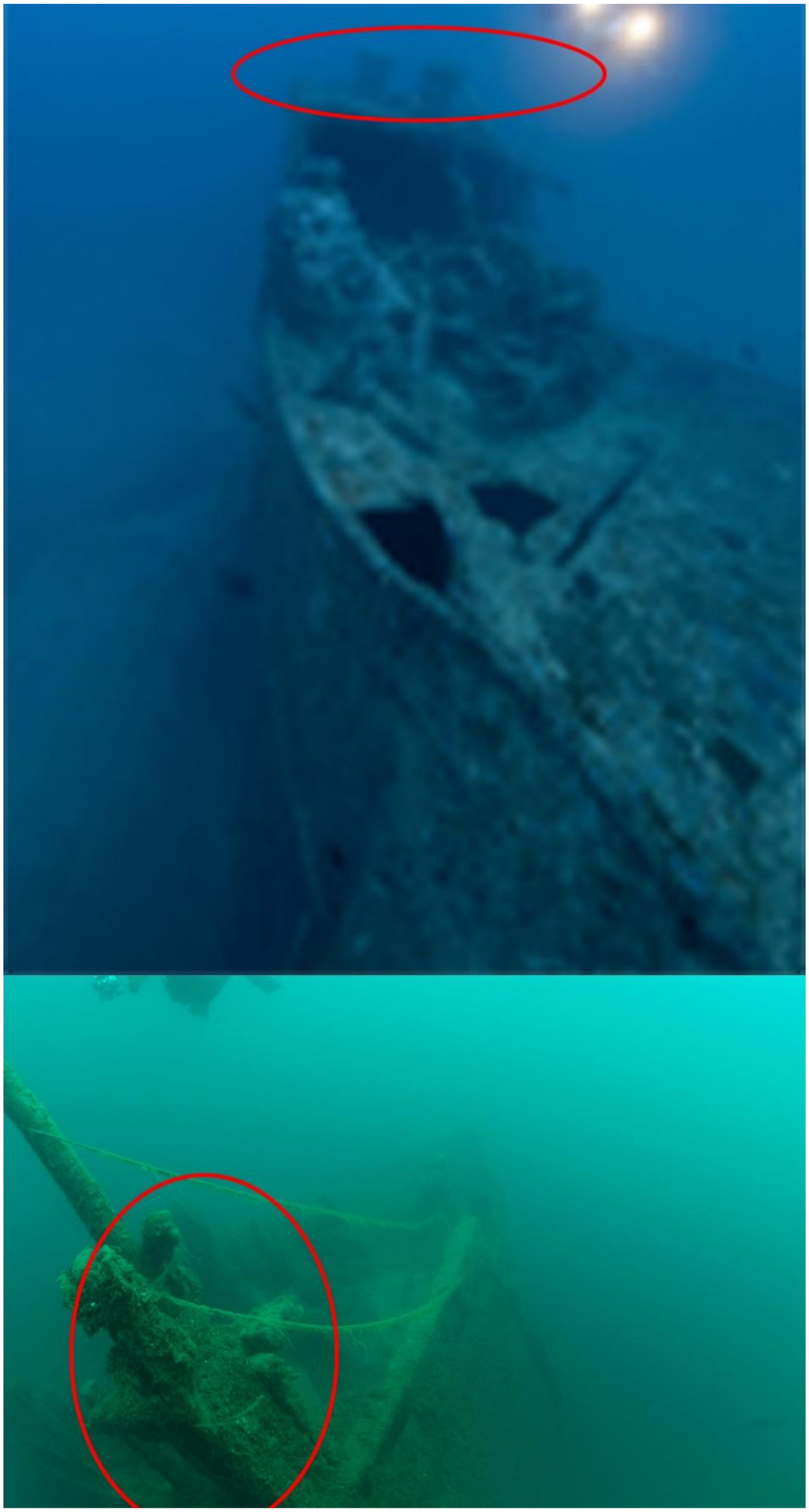

Figure 96: Comparison between Northern Light *(top) and* Grecian *(bottom) showing the deterioration of the deck accessories (Images by TBNMS*; *Compiled by Caleb O'Brien*)..

Predictive Deterioration Model of *Norman* and *Grecian*

Using the information gained by comparing *Norman* and *Grecian* to other wrecks in different environments and modern research, it is possible to determine what the future holds for them. Due to these wrecks now being located within TBNMS, cultural transformations should remain minimized or eliminated due to the current management plans which include prohibition on anchoring and removal of artifacts (State of Michigan/NOAA 2009:3). Since the cultural transformations are minimized, this section will consider the *n-transforms*, whether they be physical, chemical, or biological, and how they will continue to affect these wrecks.

The physical processes that are affecting these wrecks, such as currents, are unlikely to disappear and should remain relatively constant. This will lead to the continued collapse of the hull and structures on *Norman* and *Grecian*. Chemical transformations on these wrecks also should remain relatively constant. Although chemical reactions are constant, yet slow due to the cold, freshwater environment of Lake Huron, they may eventually become more apparent as time goes on. This, however, is dependent on the environment of the lakes remaining constant. Climate change, acidification, and pollution could change the water chemistry and characteristics which affect corrosion rates.

The biggest change to these wrecks is a relatively new threat: invasive species in the Great Lakes. The introduction of zebra and quagga mussels has increased biological deterioration and corrosion on most archaeological sites. As stated in Chapter Two, research on zebra mussels which has shown that they prefer ferrous objects, which means they pose a significant threat to *Norman* and *Grecian*, which are constructed out of steel (Watzin et al. 2001:2). This research showed that these mussels cause pitting on the wrecks before leading to a more general deterioration through a more acidic environment (Watzin et al. 2001:41-44).

Alongside the direct effects of mussels, they also appear to have an effect due to their weight. As noticed by staff at the Lake Champlain Maritime Museum, surfaces on some wrecks have begun to collapse, which they believe is due to the weight of the mussels (Chris Sabick 2022, elec. comm.). Using the above information, it seems possible to create individual models of *Norman* and *Grecian* showing potential future deterioration.

Predictive Deterioration Model of Norman

The future deterioration of *Norman* is contingent upon the rates of biological processes and corrosion. The introduction of mussels will accelerate deterioration and lead to a structural weakness in the wreck. This structural weakness will eventually lead to the point where physical processes affecting the wreck will be strong enough to alter it.

It is possible that the structural integrity eventually gets to the point that the midship section of *Norman* will begin to collapse (Figure 97). If corrosion and the invasive mussels begin to compromise the stability of the wreck, it is possible that the supporting features (i.e., the frames and deck beams) are no longer strong enough to support the weight of the hull. This would result in the hull collapsing into the wreck in the midships section but not the bow or stern due to the wreck having less support in those areas.

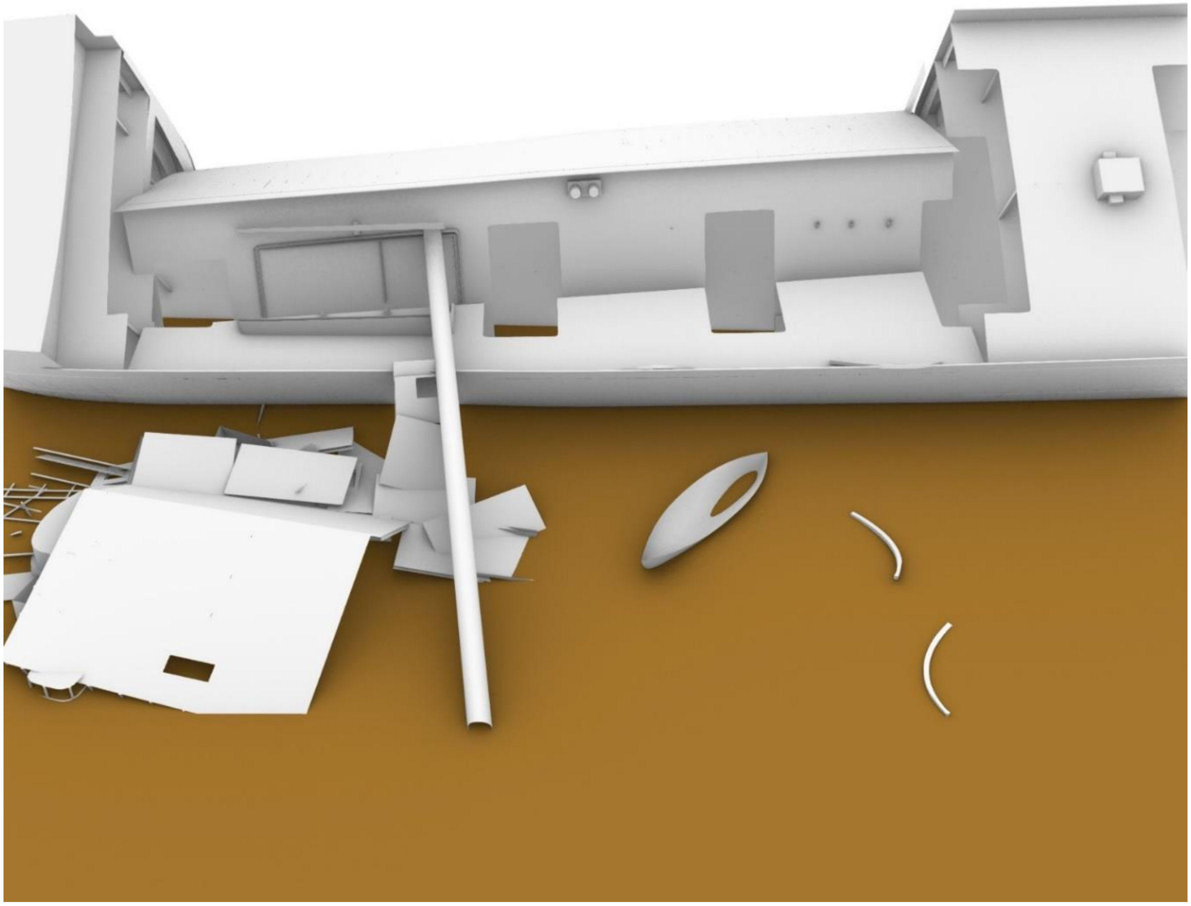

Figure 97: Hypothetical collapse of Norman*'s midships (Image by Caleb O'Brien).*

Aside from the possible collapse in the midship section, it is also probable that corrosion starts to affect the continuity of surfaces such as the hull plates. As shown above with *Northern Light*, over time corrosion holes will likely form on the hull (Figures 95 and 96). Using this information, the predictive model shows corrosion becoming more noticeable on the wreck (Figure 98). Corrosion could also lead to the disappearance of the railings, as occurred at

Northern Light. Collapse of the hull, corrosion holes, and disappearing features would persist past this model as the deteriorations will continue into the future.

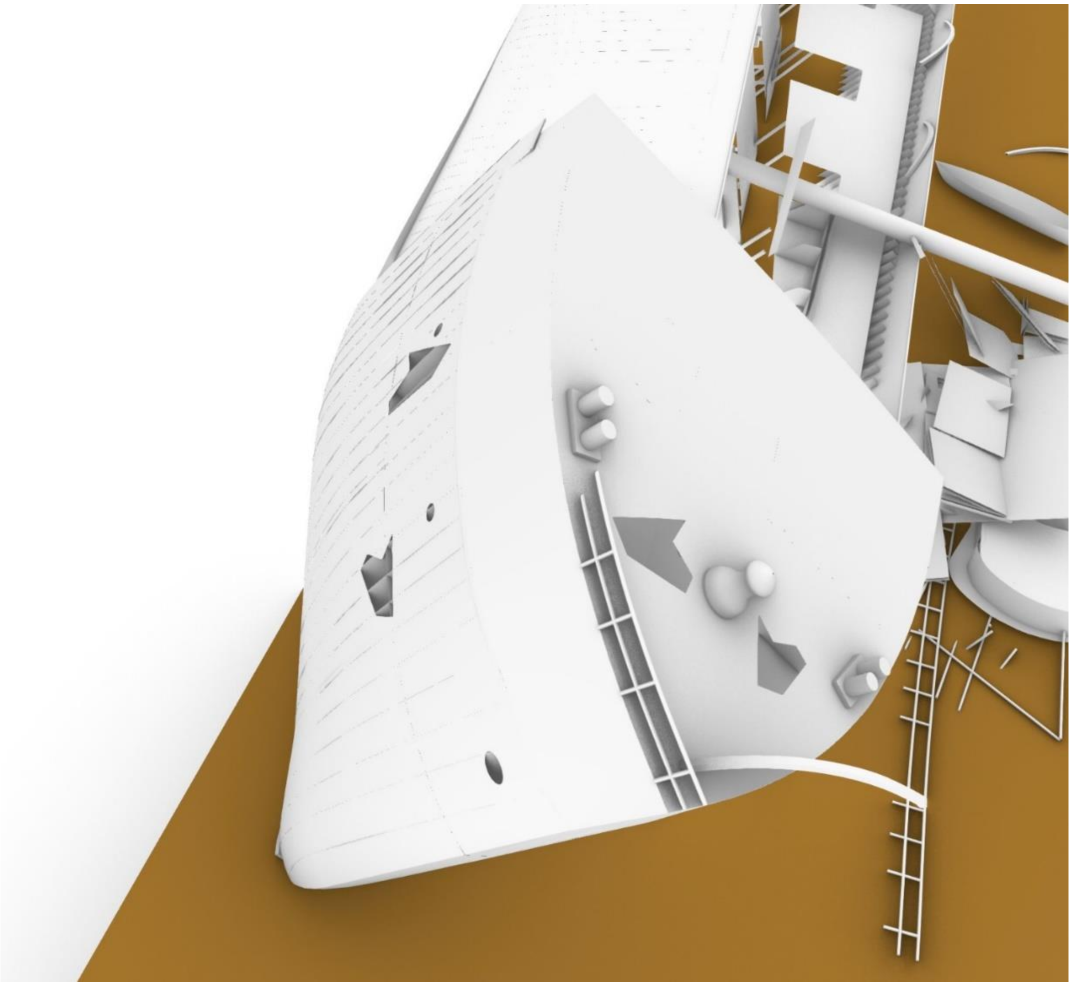

Figure 98: Hypothetical holes forming on Norman*'s bow due to chemical corrosion (Image by Caleb O'Brien).*

It was possible to create a predictive model for *Norman* using the above information on deteriorations (Figure 99). In the model, the major difference is the collapse of the cargo holds in the midships immediately aft of the bow. If this area were to collapse it could fall in a manner similar to that depicted in the model and would cause the spar to collapse as well. This model also shows corrosion occurring on the bow, cargo deck, and the boiler house, which currently are intact surfaces. These specific areas were chosen due to them being more expose, deteriorated on similar vessels such as *Northern Light*, and are easily noticeable on the model.

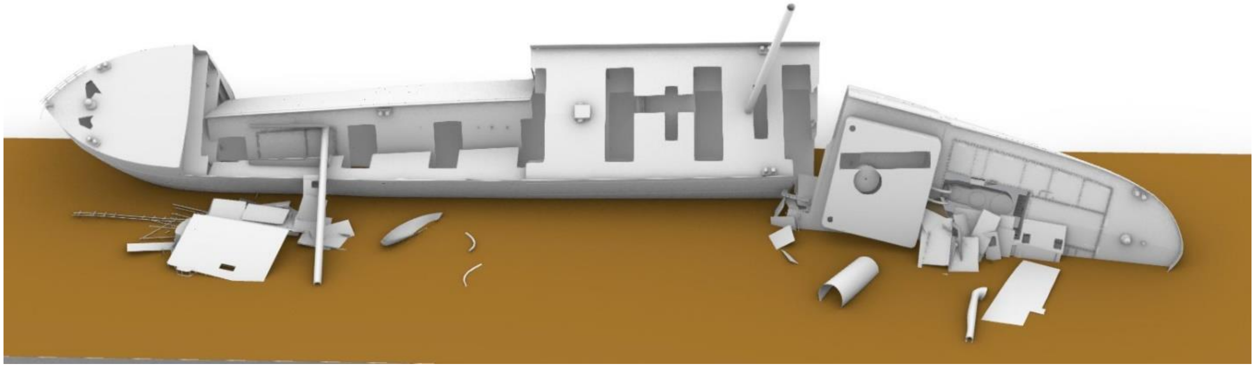

Figure 99: Predictive model of Norman *with collapsed structure and corrosion holes (Image by Caleb O'Brien).*

Predictive Deterioration Model of Grecian

As with *Norman*, the future deterioration of *Grecian* is dependent on the rates of corrosion and biological changes, which have increased with the introduction of invasive mussels. Since *Grecian* has been affected by mussels longer than *Norman* deterioration should be noticeable sooner. *Grecian* is also exposed to a more turbid environment due to its shallower depth, which may also speed up the breakdown of the wreck. One change that may occur in the future is the continued collapse of the midship cargo holds (Figure 100). Although the wreck has already collapsed onto the starboard side, future alterations can occur in either side of the wreck. This could result in the remains of the hull laying on both the port and starboard side of the wreck. If the deck beams and frames that support the hull are weakened to the point of being unable to hold its weight (as has already happened), further structural collapse is inevitable.

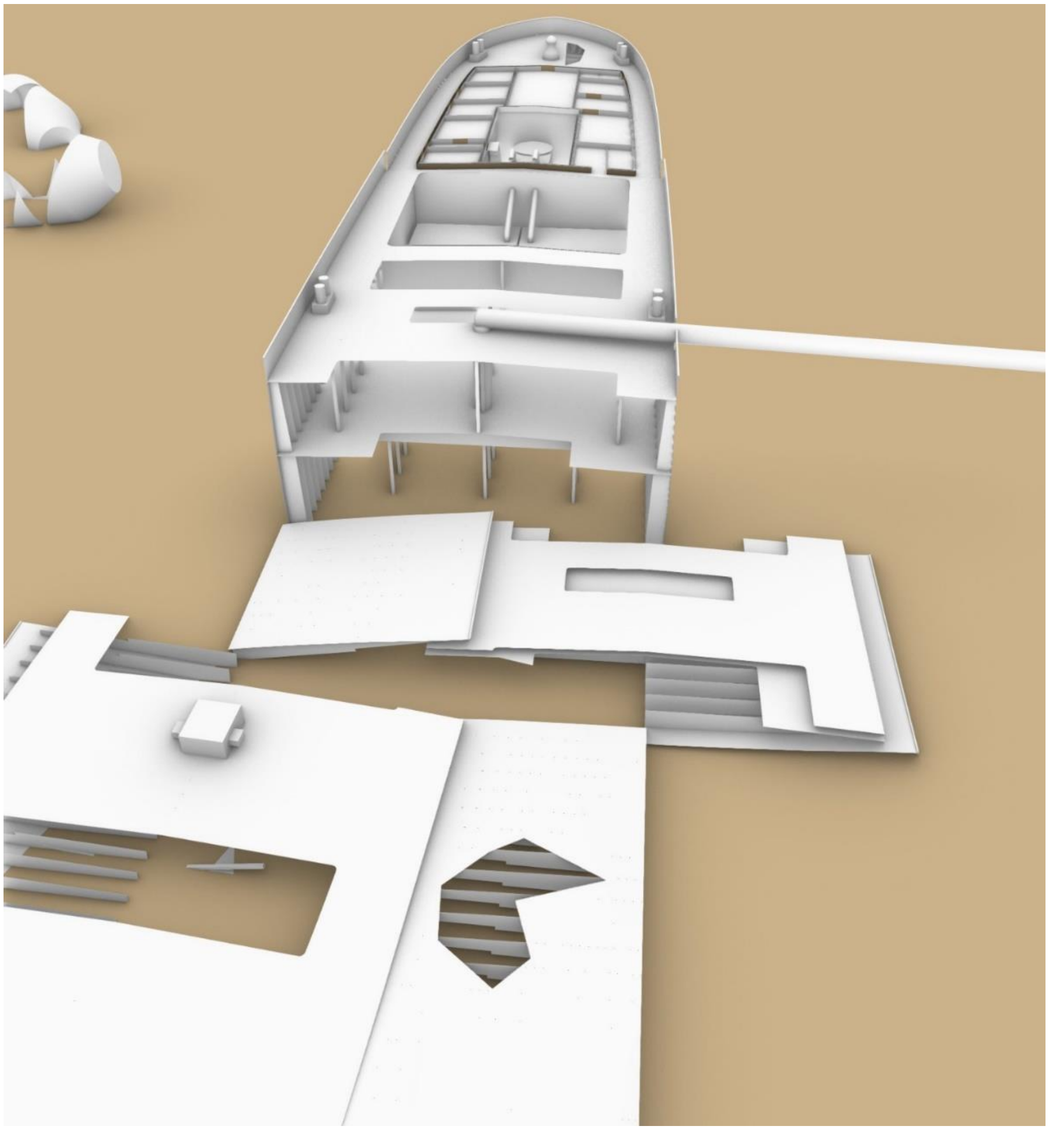

Figure 100: Hypothetical extended collapse of Grecian*'s cargo holds (Image by Caleb O'Brien).*

Due to the weight of the engine and the boilers the support structure around these areas may give out and cause the engines and boilers to collapse on to the lakebed. This deterioration will be compounded with the deterioration of the supporting structures holding up the engine and boilers (Figure 101).

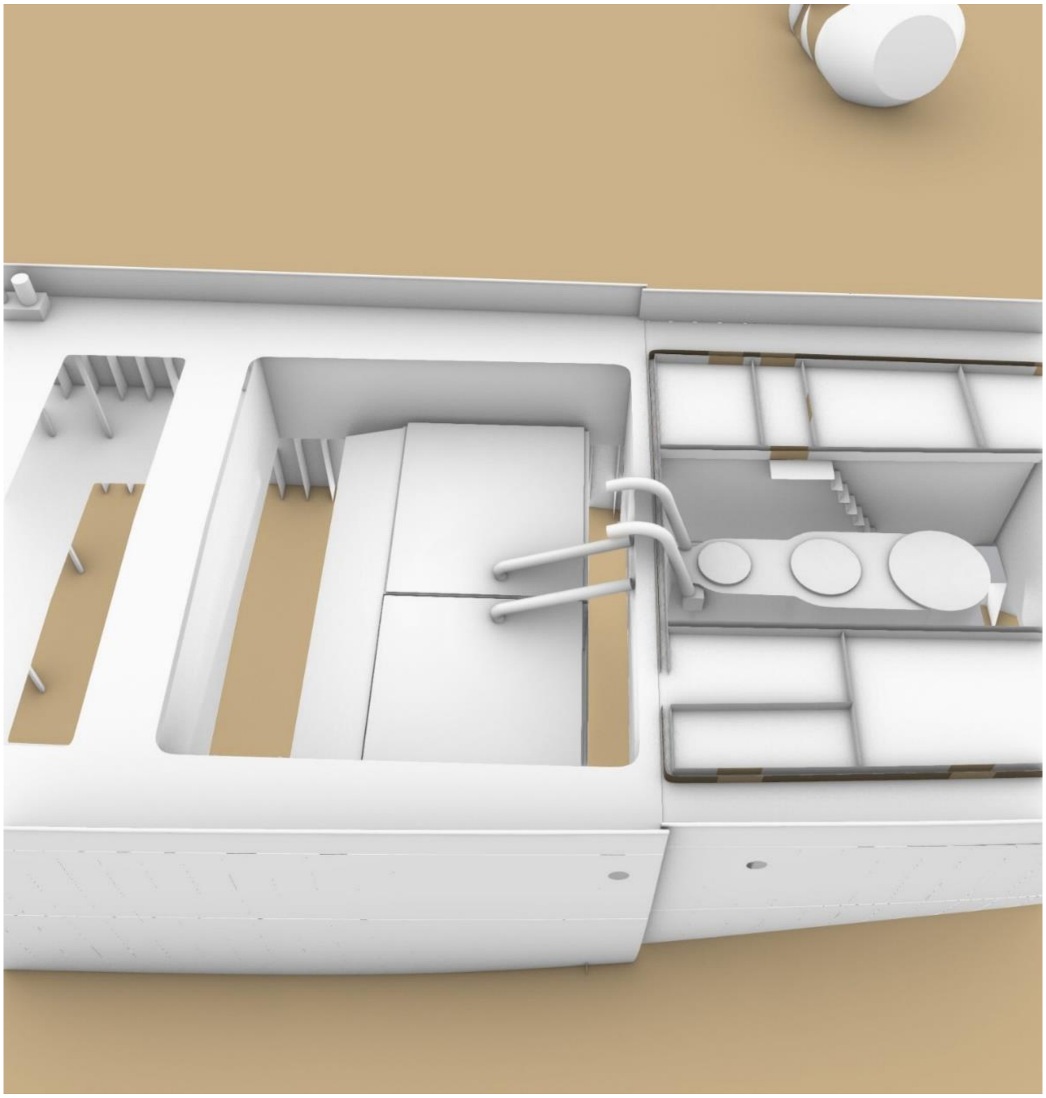

Figure 101: Hypothetical collapse of Grecian*'s boilers (Image by Caleb O'Brien).*

Alongside these structural collapses, *Grecian* also may begin to show signs of corrosion on currently intact surfaces. As the images of *Northern Light* illustrate, common areas of deterioration include sections of the hull and decks (Figures 95 and 96). Figure 102 shows a hypothetical hole on the forecastle resulting from advanced chemical deterioration.

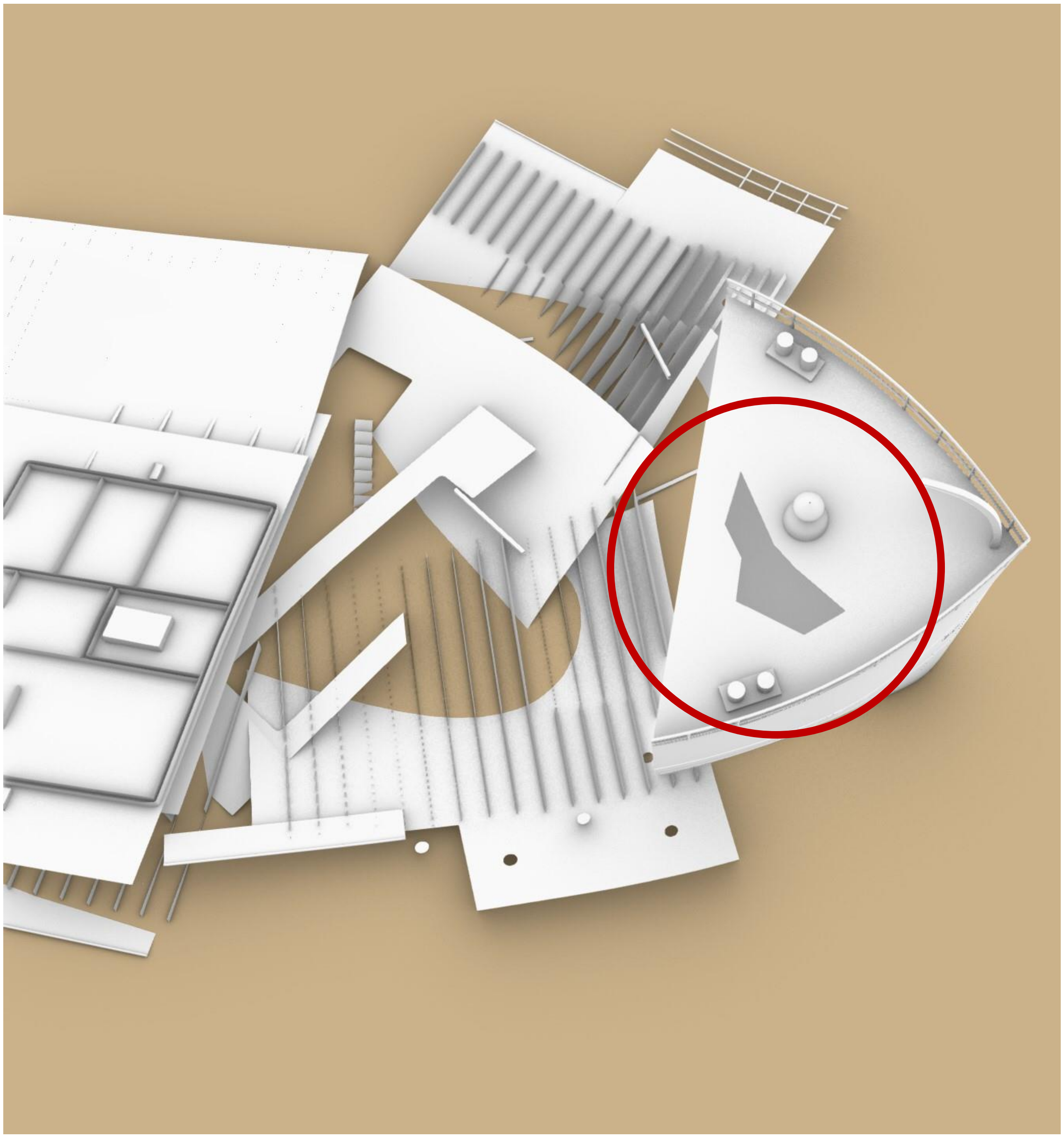

Figure 102: Hypothetical corrosion creating holes on the bow of Grecian *(Image by Caleb O'Brien).*

The above information allowed for the creation of a future wreck model of *Grecian* (Figure 103). In this image, corrosion holes are present on the hull and deck. In the future these holes will likely continue to become more numerous and larger as more corrosion becomes apparent on the vessel. This image also shows potential future structural collapse due to weakening of the hull. Specifically, this collapse could occur immediately behind the present collapsed section as it still falls within the cargo holds, which is a less structurally supported area. The model also depicts the boilers sitting on the lake bottom as the structure they currently rest upon is also a potential point of failure as biological deterioration and corrosion become more prominent. This is only a predictive model, however, and only shows one potential future of this wreck site.

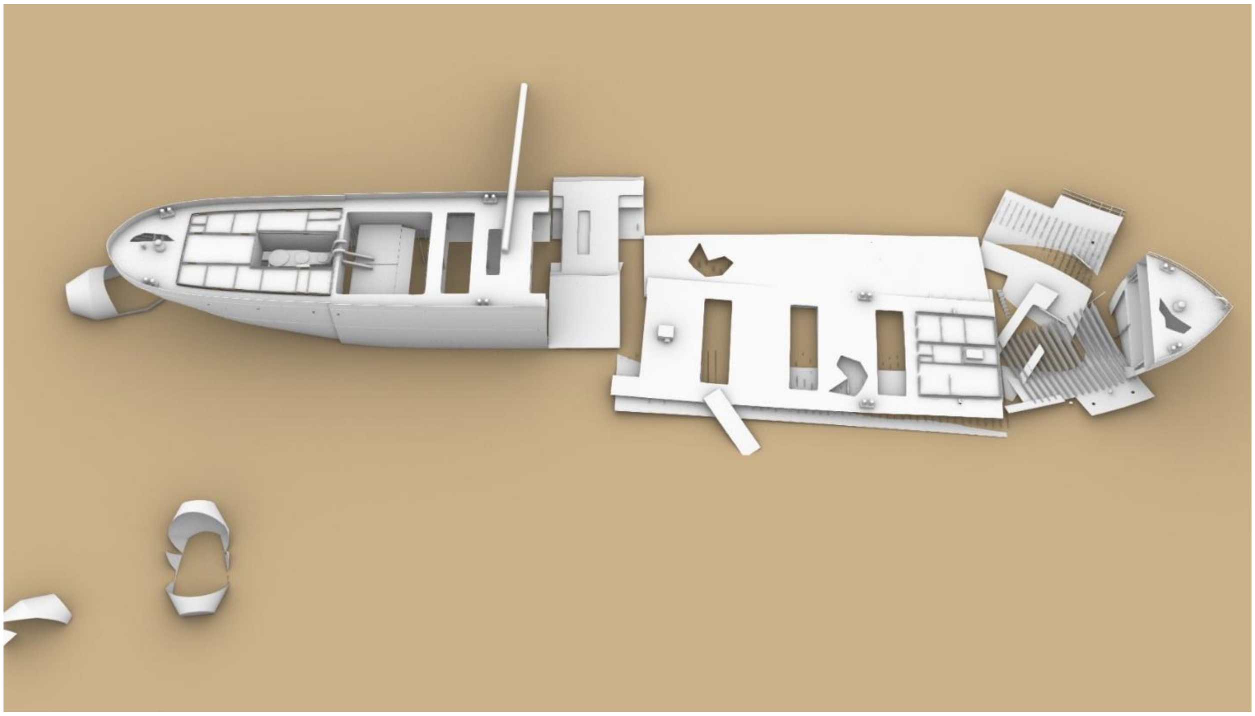

Figure 103: Predictive model of Grecian *with extended cargo hold collapse, boiler collapse, and corrosion holes forming (Image by Caleb O'Brien).*

Conclusion

This chapter shows how the transformations are similar and different on *Norman* and *Grecian*. It also shows how the pre-depositional and depositional transformations seen on *Norman* and *Grecian* are quite common to the other wrecks in TBNMS. The information gained proposes a list of areas to be examined during further research on wrecks within the Great Lakes. The post-depositional deteriorations on *Norman* and *Grecian* also are similar to those of other wrecks lost around the same time in TBNMS. Due to *Norman* and *Grecian* being early steel-hulled ships, it was impossible within the confines of this study to compare them to older wrecks to see how chemical and biological deterioration occurs in Lake Huron. To remedy this the pool of comparable vessels was expanded to wrecks in other environments which show how corrosion generally manifests on shipwrecks. Using information gleaned from *Caribsea* and *Northern Light*, it was possible to see how well-preserved *Norman* and *Grecian* are due to the cold, freshwater environment of Lake Huron.

Using the above information, it was also possible to create a predictive site model showing how *Norman* and *Grecian* may look in the future. Specifically, these models hypothesize future structural collapse due the weakening of the frames and deck beams which currently hold the hull together. Furthermore, corrosion will likely become more prominent on the wrecks over time which will result in a less articulated and more perforated wreck.

Chapter Seven: Conclusion

This project attempted to answer three questions pertaining to the archaeological site formation of the steel-hulled, Great Lakes bulk freighters *Norman* and *Grecian*. The questions were answered using through the application of archaeological site formation theory, historical and archaeological data of the ships, and through the creation of three-dimensional models. After understanding archaeological site formation theory, it was possible to create a historical context for *Norman* and *Grecian* with special attention paid to the transformations that affected these ships. These transformations were then depicted in a series of models that were compared to understand deterioration of shipwrecks in Lake Huron. Creating these models allowed the three research questions to be answered and may allow TBNMS to create better management plans for these two shipwrecks specifically.

To begin this project, Chapter Two detailed archaeological site formation theory as developed by Muckelroy (1978) and Schiffer (1987). This theoretical approach explored the ideas and terms of c- and *n-transforms*. For this project specific transforms include collisions, salvage, and corrosion. Chapter Two also points out specific transformations affecting wrecks in the Great Lakes, such as the effects of zebra and quagga mussels. Chapter Three discusses how the historical documents and archaeological data were combined to create the historical context and 3D models that were vital in this study. Integral to this were the builders' plans of similar Great Lakes bulk freighters and archaeological site maps of *Norman* and *Grecian*. This chapter also explained the methods used to create the 3D models using the builders' plans and archaeological data.

Chapter Four unveiled a new history of *Norman* and *Grecian* specifically focused on the c- and *n-transforms* that affected these ships in their working lives, wrecking events, and from the time of wrecking to today. This history begins with the context of these two ships from both the Chapin Iron Mine, who operated these vessels, and Globe Iron Works, who constructed them. An individual history for *Norman* and *Grecian* was then highlighted the transformations that affected the ships in their pre-depositional, depositional, and post-depositional stages.

Chapter Five combined the archaeological site formation theory, the history of *Norman* and *Grecian*, and the 3D models. Within this chapter, images show how the joint historical model transformed into the individual pre-depositional, depositional, and post-depositional models. This chapter also answered the two secondary research questions as it was determined these wrecks were affected by both c- and *n-transforms* which caused them to change from ship to shipwreck. Chapter Six provides an analysis that compared the deteriorations of *Norman* and *Grecian* to each other. This analysis also compared *Norman* and *Grecian* to other wrecks within TBNMS, as well as two wrecks in the Atlantic Ocean. This analysis also illuminated the future potential deteriorations that may affect *Norman* and *Grecian*, answering the primary research question guiding this project.

The archaeological site formation of *Norman* began as a combination of c- and *n-transforms* resulting from general wear-and-tear and a collision that damaged the bow of the vessel. The vessel then wrecked as a result of a c-transform (collision) while steaming near Alpena, MI in a fog. After sinking in 1895, the vessel remained free of *c-transforms* as it remained lost until the late 20th century. Despite the lake being conducive to better preservation, significant *n-transforms* broke the wreck down to its present appearance.

Grecian was similarly affected by c- and *n-transforms* during its working life, however, to a much greater extent. The historical record showed that along with wear-and-tear, the ship was involved in multiple groundings and two collisions while sailing up and down the Great Lakes. During *Grecian*'s wrecking event, *c-transforms* led to its final grounding as it punctured its double bottom before foundering near Alpena, MI. This sinking, however, displayed significantly more *c-transforms* as the crew attempted to refloat and repair the vessel after unloading its cargo in DeTour, MI. After its sinking, *Grecian* was changed by both c- and *n-transforms* through attempted salvage soon after its sinking and major structural collapse due the environmental conditions.

Since both *Norman* and *Grecian* are within the present boundaries of TBNMS, future *c-transforms* should be eliminated on these wrecks. Despite these mitigations, it is highly likely that they will deteriorate faster due to the introduction of zebra and quagga mussels to the Great Lakes. Using the information on mussels and other forms of *n-transforms* it was possible to create predictive deterioration models of *Norman* and *Grecian.* These predictive models show how these wrecks may deteriorate in the future.

Although this study successfully answered the three research questions, there are several ways it could be improved and expanded upon. As noted in Chapter Three the builders' plans of *Norman* and *Grecian* were not located and similar vessel plans were used in their place. If the actual builders' plans were used the models would be more accurate and may provide details that are currently missing. This study could also be expanded upon by having a more detailed site map or photogrammetric models of each site. Since *Grecian* has been a popular dive site since the 1970s, it is possible that this wreck was affected by looting before the sanctuary was created.

Having more detailed archaeological information would allow the effects of looting to be determined and more accurate post-depositional models to be created.

Perhaps the biggest shortcoming of this project was the inability to do field research on these sites. If field research was able to be completed, the models could be quantitative as opposed to qualitative. Having quantifiable information could create a better understanding of the *n-transforms* affecting these sites and lead to a more accurate predictive model.

Lastly this project could be expanded upon by studying more wrecks for comparison or conducting a deeper analysis of other wrecks. An example of another wreck is that of *Northern Light,* since it is a similar steel freighter wreck, though in the Florida Keys. Having a better understanding of that site could lead to new insights for *Norman* and *Grecian* and in turn to a better predictive model and comparative study.

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