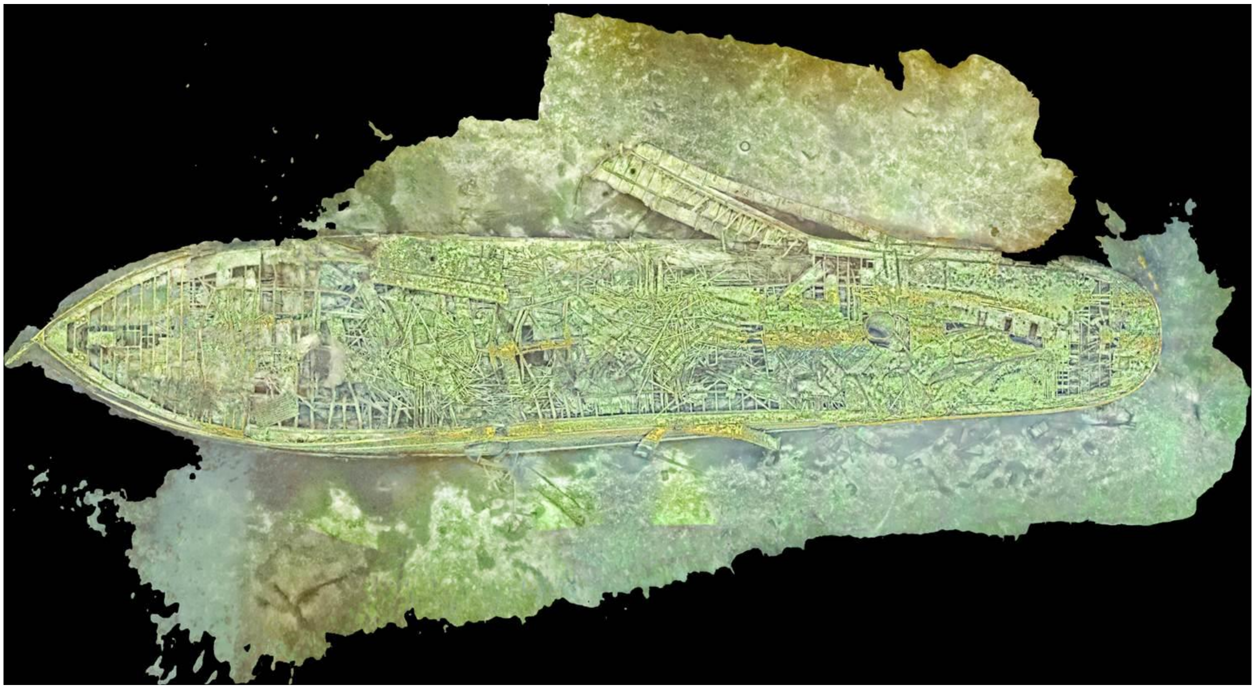
Preliminary Report on the SS *Wisconsin* Archaeological Field Project, Summer 2015



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Acknowledgements

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Likewise, the data collection and analysis could not have been completed without the work of our collaborators, Jordan Mertes and Dr. Jason Gulley of Michigan Technological University, who completed all of the renderings and models for the project, and our stedfast group of volunteer divers, videographers, and crew: John Scoles, John Janzen, Carolyn Rock, and Gayle Orner.

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Introduction

The remains of the iron package steamer *Wisconsin* rests in 38 m of water, 9.66 km southeast of Kenosha Wisconsin. Built in 1881 at the Detroit Dry Dock Company in Wyandotte, Michigan, the *Wisconsin* was originally part of the break bulk cargo trade, ferrying goods across Lake Michigan for the Goodrich Transportation Company. During its 48 years of service, the *Wisconsin* served Lake Michigan's cross lake freight trade under many different names and owners, before returning to the name *Wisconsin*. The *Wisconsin* was lost 29 October 1929 due to an unknown leak during a violent storm while in route from Chicago to Milwaukee. Today the Wisconsin lies upright and mostly intact on the lakebed. The lower portion of the wreck exhibits excellent preservation, while its upper decks have long since collapsed. The contents of the *Wisconsin*'s final cargo remain intact within the vessel's hull. Although the site retains extensive archaeological integrity, diver reports have indicated that the site has degraded rapidly in recent years.

The *Wisconsin* is a rare example of a vessel type that was vital to Great Lake's economy. Year round steamers like the *Wisconsin* were an important link for railroad freight traffic connecting Wisconsin's communities economically with wider regional and national markets. As one of the few iron package steamers in Wisconsin waters, the site is an archaeological rarity, and still has the potential to yield further archaeological information. The *Wisconsin* was listed on the National Register of Historic Places on 7 October 2009 (Thomsen and Meverden 2009).

Figure 1: Image of the SS *Wisconsin* as it looked after its remodel in 1909 (Bowling Green State University)

Archaeological Information

Purpose of Project

Anecdotally, divers have noted a significant collapse of metal shipwrecks in Lake Michigan since the 1970's and 1980's, with visible acceleration within the last ten years. Many divers now associate the collapse of metal wrecks with the growth of invasive muscle populations on the wreck sites. This collapse has been most often attributed to a buildup of carbonic acid on the surface of wrecks created from the interaction of carbon dioxide and water as a result of the respiration of muscles and associated microbial communities. Current scientific research has proven layers of carbonic acid are forming beneath invasive muscles, greatly lowering pH levels, but this process' effect on cultural resources has not yet been fully investigated, a factor important to cultural resource managers as a strategy to predict change (Tyner 2013).

The preservation and management of submerged cultural resources (SCRs), such as shipwrecks, is a difficult task that has been compounded in the Great Lakes region by the introduction of invasive species. Traditionally, cultural resource managers have had difficulty systematically monitoring and managing SCRs with limited time and funds. Structure from Motion (SfM) technology can be a viable way to study long-term change in shipwreck sites, and as a way of systematically quantifying shipwreck degradation over time. The capability to quantify changes in shipwreck sites allows for the ability to determine if freshwater metal shipwrecks are indeed collapsing at a measurable rate, and remains a critical first step in understanding how invasive muscle populations are affecting SCRs.

In 2005, archaeologists from Wisconsin Historical Society visited the Wisconsin to collect extensive video data of the site in order to create a photomosaic. The following year, in 2006, archaeologists and volunteers from the Wisconsin Historical Society returned to the site to get extensive measurements and photographs of the site as it rested on the bottom of Lake Michigan.

Figure 2: Photomosaic of the Wisconsin using photographs taken in 2005 (Wisconsin Historical Society)

In 2015 Wisconsin Historical Society archaeologists returned to the site, thanks to grant funded by Wisconsin Coastal Management, the David and Julia Uihlein Charitable Trust, and

George Beyer, to collect new video data of the site for monitoring purposes. Upon the start of the 2015 survey, there were already major changes to the site that could be seen with the naked eye. A 65-foot long section of the side of the ship had fallen outward, where in the initial surveys of 2005/2006; it was attached, and seemed to be caving inward.

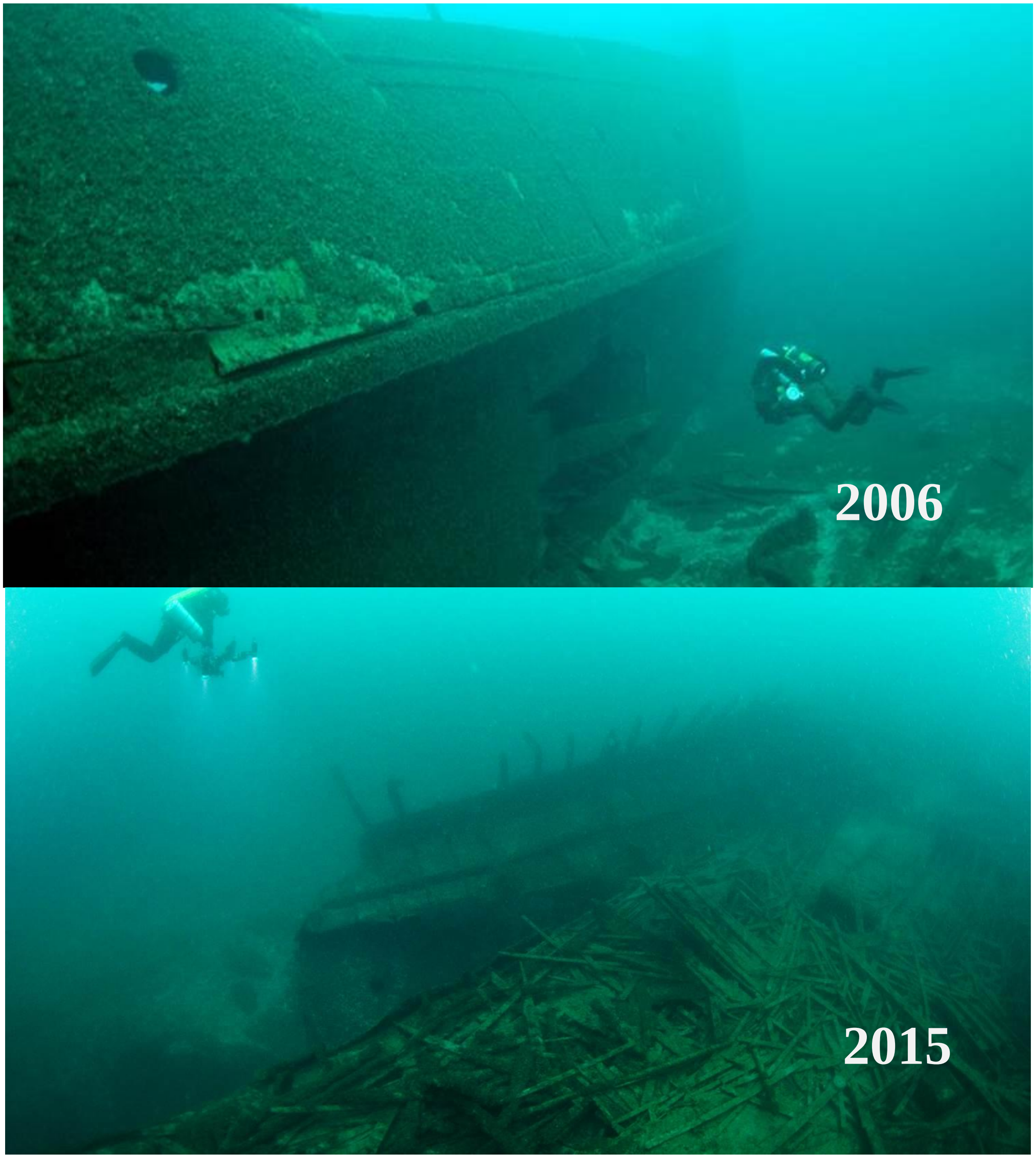

Figure 3: Photos of the Wisconsin’s side intact in 2006 and broken in 2015 (Tamara Thomsen, Wisconsin Historical Society)

Once video data was collected, the projects focused turned to attempting to quantify site degradation using archived video collected 10 years ago and comparing it to video data collected in 2015. The initial results produced two individual 3D models of the Wisconsin, one from 2005 and one from 2015, from a downward looking view. Because video for the sides of the ship was not collected in 2005, a fully rendered 3D model was not possible.

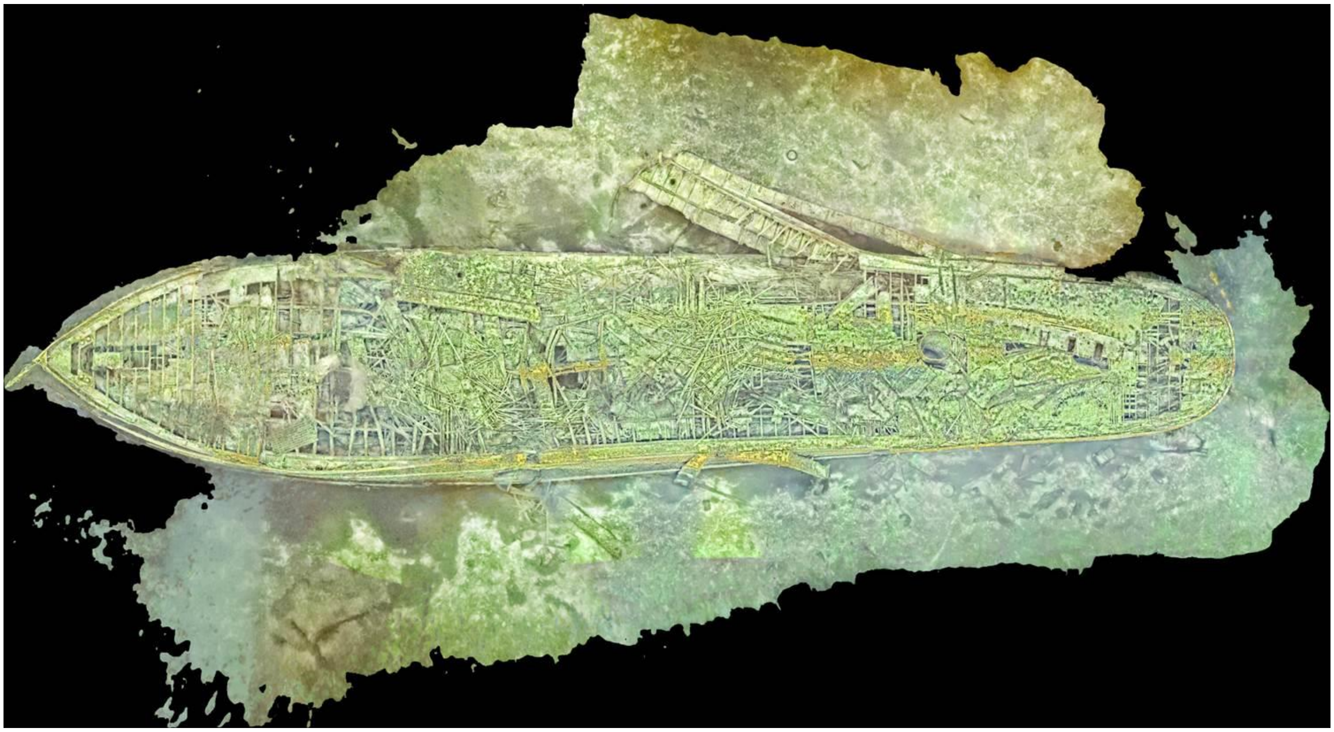

Figure 4: Downward looking 3D model of the *Wisconsin* as it appeared in 2015 (Jordan Mertes, Jason Gulley, Michigan Technological University)

Beyond just creating two downward looking 3D models of *Wisconsin* in 2005 and 2015, an elevation map was created to show areas of change/twisting/collapse in the hull side by side. The project has also allowed us to create a change map that allows researchers to determine where the shipwreck has changed the most in the last 10 years. By taking the two 3D models, and essentially subtracting one image from another, we were able to determine areas that had large changes, versus areas that had little change. Through this project, we showed that the invasive zebra and quagga mussel colonization has created an acidic microenvironment around our metal shipwrecks that is causing them to degrade at an accelerated rate.

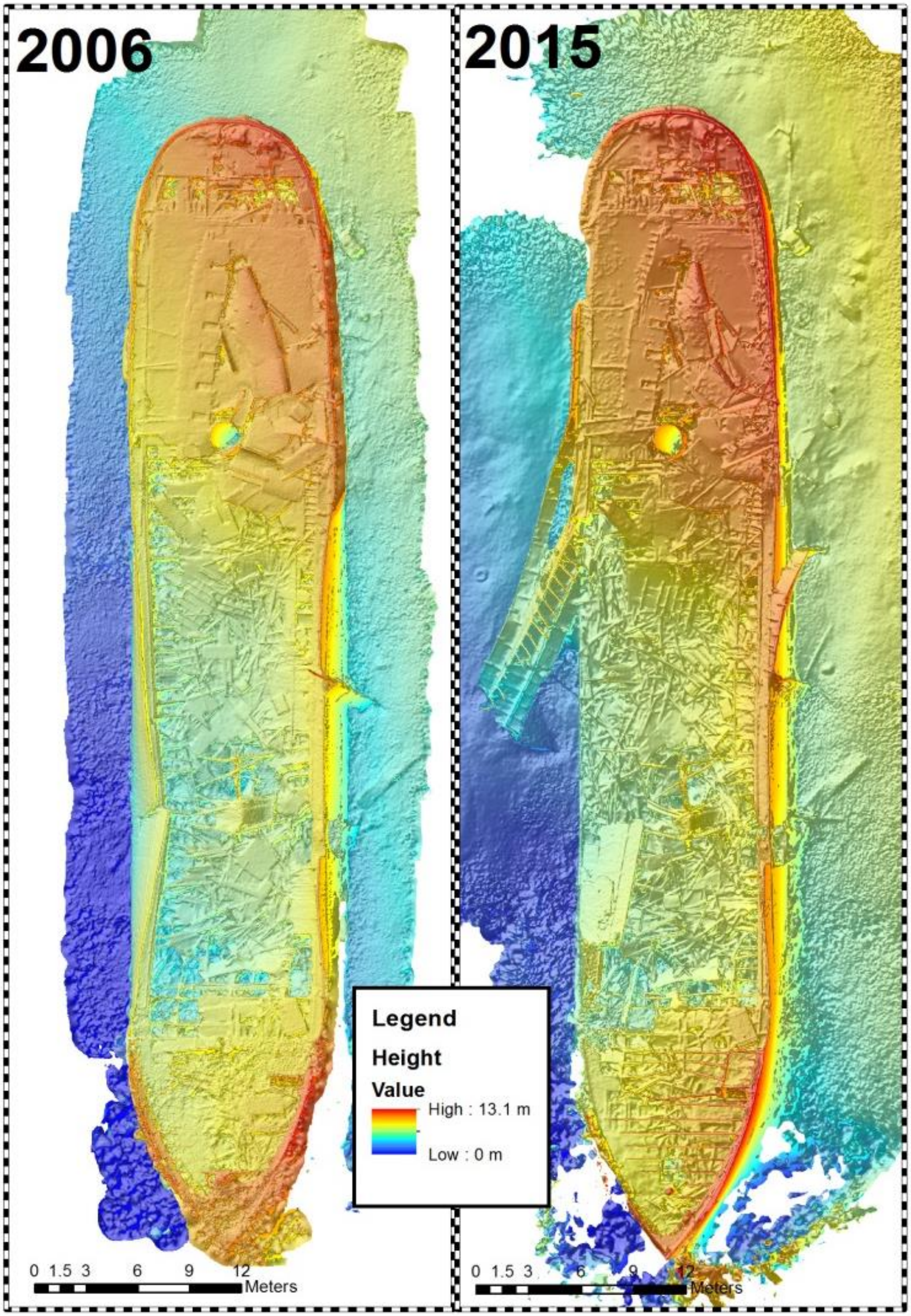

Figure 5: Side by side comparison of *Wisconsin*, 2005 & 2015 (Jordan Mertes, Jason Gulley, Michigan Technological University)

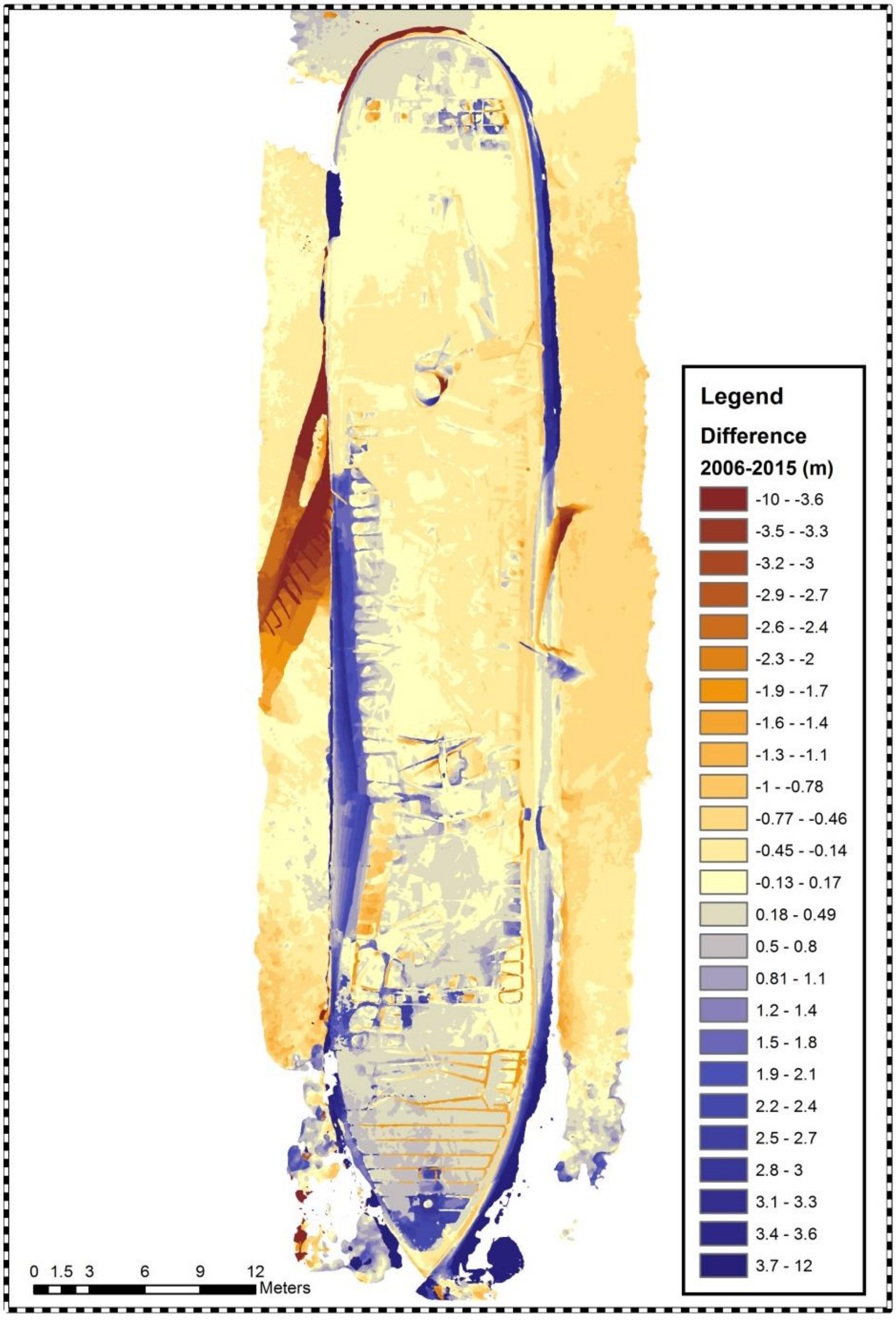

Figure 6: Change map of the Wisconsin, with amounts of change indicated: blue are areas of loss or collapse, and red are areas of gain (Jordan Mertes, Jason Gulley, Michigan Technological University)

Archaeological Analysis of Results

The results of the comparative analysis of the two models indicate that the vessel is collapsing, but not in the pattern that was previously speculated. Because of their superior material strength, iron and steel vessels were built much lighter than traditional wooden steamers and cargo vessels. Ships could be built much longer, with a much narrower beam, and with much thinner hull structures. With this thin hull structure, vessels could be built much larger, but lighter, and were able to carry higher tonnages of cargo. Narrow steel or iron I-beams, usually measuring 0.3 m square, were used as stanchions along the centerline of vessels. These I-beams have been found to be a notorious weak point in metal shipwrecks located in Lake Michigan. Despite their excellent preservation, after years of submersion, most of these metal wrecks have begun to collapse inward, as opposed to outward (Thomsen, Reckner and Stout 2014, Zant, Thomsen, et all 2015, Meverden, Thomsen and Zant 2016).

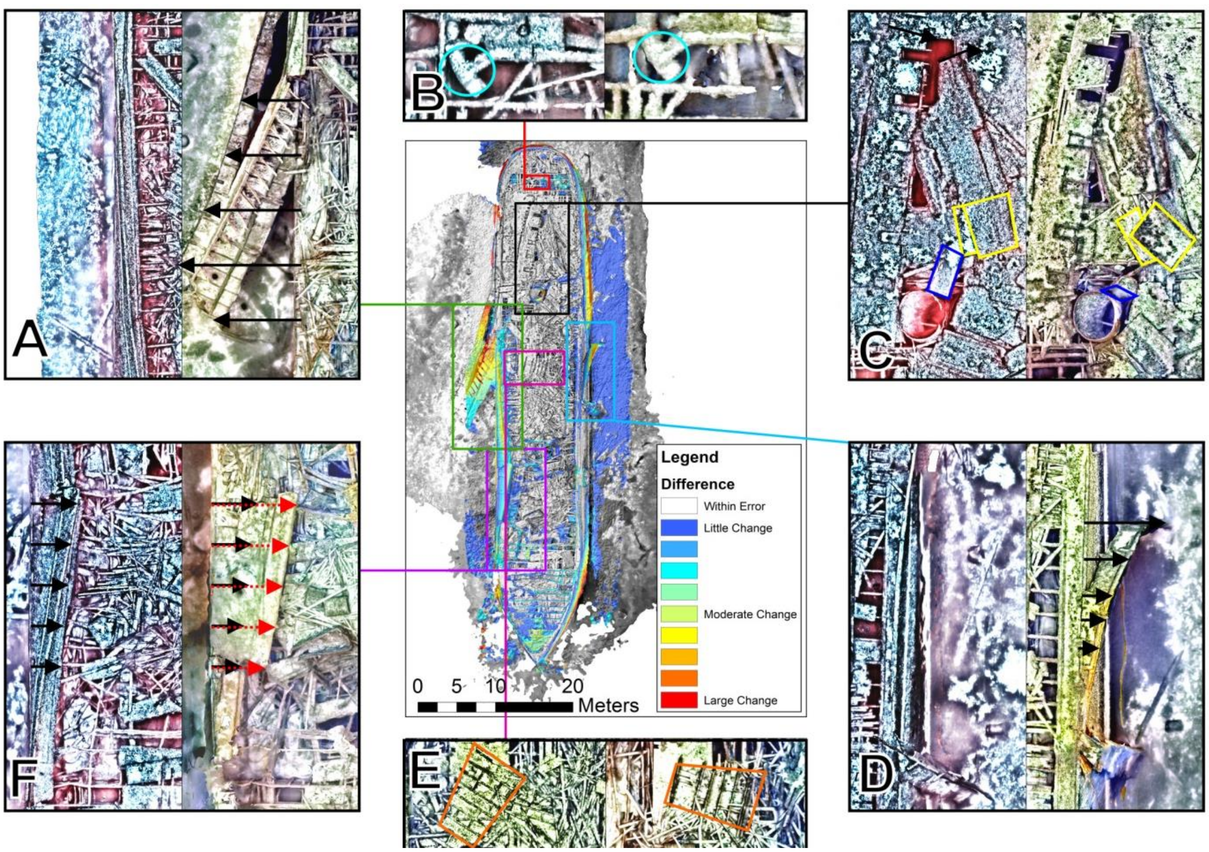

Figure 7: Map of the *Wisconsin* with large changes highlighted (Jordan Mertes, Jason Gulley, Michigan Technological University)

Initial archaeological investigations of the *Wisconsin* in 2006, seemed to indicate a similar trend. The upper sections of the *Wisconsin*'s outer hull had begun to lean inward as the central deck beams collapsed (Thomsen and Meverden 2010). Data reports from investigations in 2015 indicate that this pattern, however, is no longer evident. A 19.8 m section of the *Wisconsin*'s starboard hull, which had been leaning inward significantly in 2006, has fallen away from the main body of the wreck, hinged at the aft end (sub figure A). A 7.0 m long section of the hull, located just forward of this large section, has continued its collapse inward, creating a vertical crack along its forward edge, at the aft edge of the forecastle deck, and causing the collapse of previously intact forecastle deck beams (sub figure F). Additionally, a section of the vessel's main railing, which had remained intact in 2006, now hangs off the port side of the hull (sub figure D). The fantail stern of the *Wisconsin* has also shifted significantly further aft (comparison MapDif). This indicates that the *Wisconsin* is actively collapsing outward, not inward.

Although there is no direct indication as to why this is occurring at this site and not others, one possible explanation is that the buildup of a carbonic acid layer beneath the quagga mussels now inhabiting the site have added to the site formation processes already at work on the vessel. During the sinking event, the *Wisconsin*'s upper deck cabins blew off due to a sudden release of air trapped within its enclosed spaces. When this occurred, the integrity of the iron deck beams was compromised, and upon the vessel's collision with the lakebed, these beams and their support stanchions, collapsed inward along the ship's centerline (Thomsen and Meverden 2010).

This trajectory of inward collapse should have continued as increasing weight from the buckled upper decks was placed on the remaining deck stanchions in the lower hold of the vessel. The addition of mussels, however, has sped this process. Through a combination of weakened metal from carbonic acid buildup, increased water turbulence over the uneven surface of the mussels, and the sheer weight of mussel accumulation (in many places reaching 0.08 m in thickness) the thin iron covering the vessel's upper decks is cracking above the vessel's bustle, allowing the forces of wave, current (storm damage), and human (anchor damage) action to affect the vessel's typical degradation. The bustle refers to the 0.9 m sections on either side of the ship where it was widened in 1909. Historically, this was an area noted for leaking and weaknesses in the hull, and may be further indication of why the vessel is degrading more rapidly here than in other sections. Except for the small section of the vessel's fantail stern, the bow and the stern of the vessel have experienced very little overall change between 2005 and 2015. This is likely because these two sections retain their integrity from the original build of the vessel in 1881.

Although marked as areas of little change, the remaining intact sections of the upper decks, in the bow and the stern, are seeing signs of degradation as well. The most notable of which is located near the remains of the *Wisconsin*'s smokestack. The 2015 data notes a significant shift in the angle of the smokestack (which is still attached to the boilers below decks) from a slight list to starboard to a significant list forward (sub figure C). This change is indicative of the collapse of the deck beams holding the smokestack in place. Though most of the upper deck beams were damaged during the original sinking, the visible continuation of this collapse progressively aft reveals a continued rapid degradation of the site. Similar deterioration has been noted in the vessel's bow, with the forecastle deck beams beginning to collapse progressively forward.

During the 2015 archaeological investigations, divers did qualitatively note that the bulkheads and stanchions in the lowest deck of the cargo hold are significantly buckled as well, indicating further collapse from the 2006 survey. Despite this, most of the measured change in the vessel between 2006 and 2015 has occurred to the vessel's upper decks, or what would have existed above the waterline when the vessel was afloat. This is likely occurring because these early iron and steel vessels were made with two different thicknesses of metal and using different sizes of plating. Built to break through thick Lake Michigan ice to operate in year round service, the *Wisconsin*'s lower hull plates were significantly stronger than those used on the upper decks. Below the bustle, the hull plating consists of a series of iron plates measuring significantly smaller in size than the hull plates used for the upper decks. These plates were also 0.03 to 0.06 m thicker than the upper deck hull plates as well (Thomsen and Meverden 2010, Zant, Thomsen, et all 2015).

Conclusions and Future Work

Moving forward, this methodology can then be applied to a broader range of shipwrecks, both wood and metal, to compare the amount of deterioration in each vessel type, therefore determining which resources are at a higher risk of damage than others.

Beyond archaeology, this project can serve as a model for a new methodology in sustained monitoring strategies for preservation of other resources. Not only is this be an effective tool for cultural resource managers it can also be applied to a wide variety of fields conducting monitoring and research both above and below the water. From marine biologists studying changes in coral reefs, to researchers studying the shifting nature of the nation's coastlines, SfM technology serves as a pioneering tool in understanding the processes of change. The methods of survey demonstrated by the results of this research pave the way for new technique in documenting, quantifying, and understanding change in order to develop pertinent strategies for managing resources nationwide.