Case Study of the Admiral: An Example of Monitoring a 20th-Century Steel Tugboat and the Involvement of Citizen Science in Maritime Archaeology.

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Dedicated to My Parents Jon Fisher and Kyle Fisher

My Two Pillars in This World Without Whom I Could Not Stand

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Abstract

Shipwrecks and other underwater cultural heritage sites need to be monitored appropriately to be protected and preserved for future generations. There are many methods to preserve underwater sites properly; however, most of the methods do not focus on low visibility, cold temperature sites with specific time constraints, and budget. The goal of this study was to compare the results from two possible methods, photogrammetry and citizen science, and establish if either method could be used to monitor the *Admiral* adequately. The *Admiral* is a significant site within Lake Erie due to its devastating story and unique ship design. The photogrammetry method was inspired by the work done on the *Oostvoornse Meer 8,* while the citizen science data was acquired from The Maritime Archaeological Survey Team (MAST). MAST is an accomplished underwater archaeology citizen science group located in Lake Erie. Both methods were tested with a low budget and a limited time period. The results of each method yielded noteworthy results and concluded that both methods need to be further explored for more conclusive results.

Keywords: photogrammetry, maritime archaeology, underwater archaeology, Agisoft, Site Recorder, citizen science, community archaeology, public archaeology

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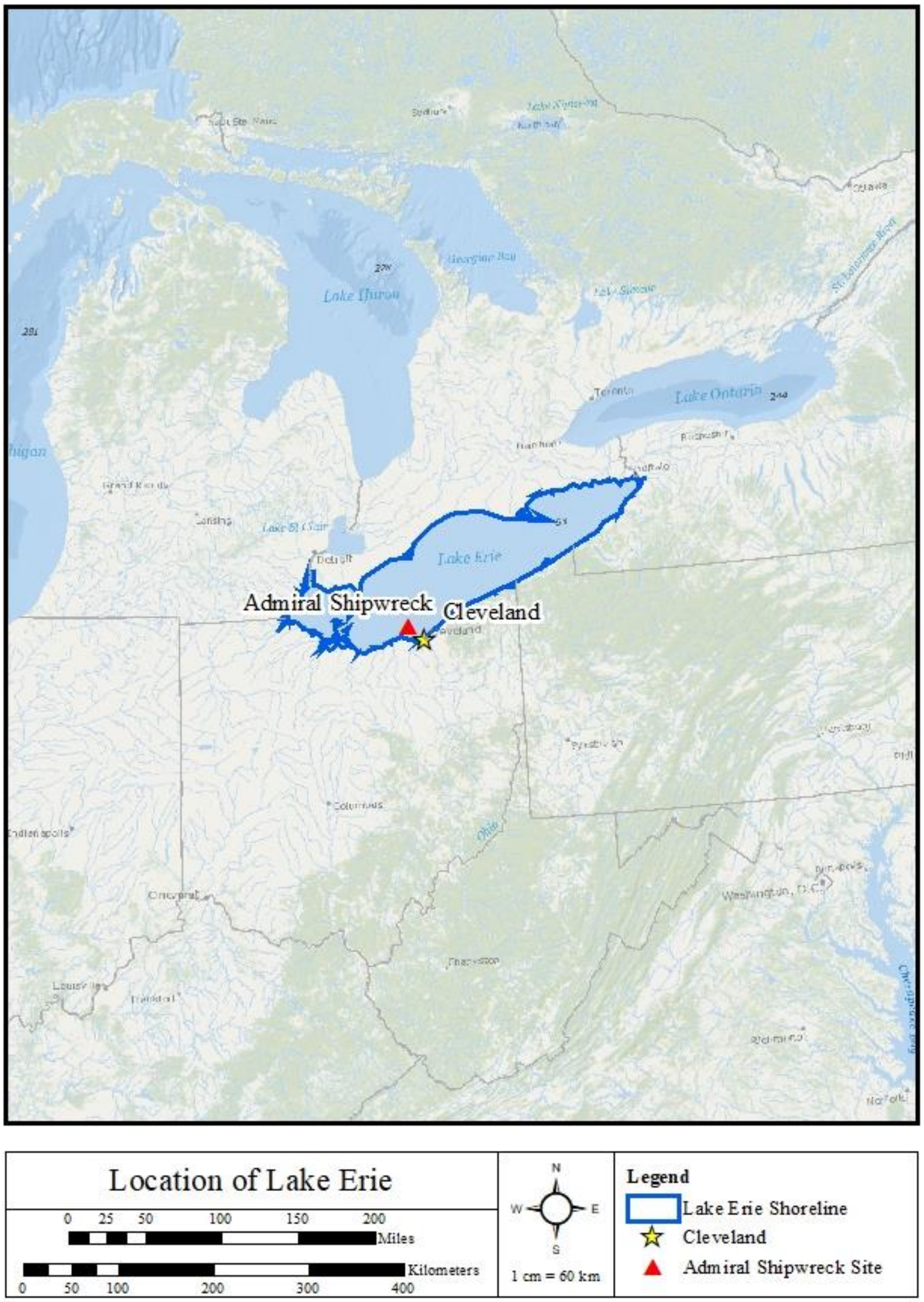
Site Map


Lake Huron
Lake Ontario
Lake Erie
Admiral Shipwreck
Cleveland
Location of Lake Erie
0 25 50 100 150 200
Miles
Kilometers
0 50 100 200 300 400
N
W
E
S
1 cm = 60 km
Legend
Lake Erie Shoreline
Cleveland
Admiral Shipwreck Site

Chapter 1 - Introduction

Shipwrecks are primarily considered as underwater cultural heritage in and out of the academic world. Many consider shipwrecks as underwater time capsules and believe they need to be preserved and protected (Lakeerieliving.com, 2019). Management systems and guides are required to monitor the stability of the site and properly preserve the site (Vrana and Halsey, 1992). Shipwrecks within the Great Lakes are no exception. The wrecks highlight the socioeconomic history and the growth in ship development and technology in the Great Lakes (and surrounding rivers) environment (Vrana and Halsey, 1992). Ships were utilized in battle, cargo, and passenger vessels and played a vital role in the allocation of natural resources and workforce for many American ancestors (Vrana and Halsey, 1992). Preserving the site can bring in many benefits for the local and surrounding communities.

However, the wreck sites are slowly deteriorating due to reasons like uncontrolled sports diving (i.e., touching or grabbing the wreck) and the invasion of zebra mussels (Johnston, 2017). Archaeologists have only begun to study and evaluate the shipwrecks and hope to gather as much information as they can before the sites are entirely gone (Johnston, 2017). Efforts to protect, study, and evaluate marine cultural heritage have been made by agencies and individuals outside the academic community to help fill in any gaps. In order to successfully manage a site, professionals need to collaborate with different agencies, interest groups, and citizens. A successful management plan needs to be multi-facet (Murdock and Stewart, 1995). Successful management plans include but are not limited to: (1) assessment of the known resources, (2) citizen and community education, development, and participation, and (3) plans for tourism, recreation, and possible marine parks (Murdock and Stewart, 1995).

A large portion of the management plans is to promptly assess and monitor sunken cultural resources before the information is lost and can no longer be adequately preserved (Murdock and Stewart, 1995). Many parks and agencies utilize proper monitoring programs to determine the state of preservation and any possible threats (Murdock and Stewart, 1995). Common threats to submerged cultural resources within the Great Lakes are zebra mussels, local fishing, anchoring, storms, illegal salvaging, and unintentional damage done by recreation divers (Murdock and Stewart, 1995). Most of the programs focus on monitoring the wreck's physical integrity, the leading causes deteriorating the wreck, and the environment around the wreck (Vrana and Halsey, 1992). The aim or goal for most of the programs is to preserve the wreck for future generations to study. As technology advances and more wrecks are discovered, only the sites that are deemed the most important will receive the most focus on management and preservation (Murdock and Stewart, 1995. Both land and underwater archaeologists agree that the process of recording the shipwreck is one of the main aspects of our discipline. Archaeologists must attempt to document each site to the best of their abilities. They should strive to be as accurate and objective as they can be within the time, budget, and environmental constraints they are exposed to (Vrana and Halsey, 1992).

In order to accurately record a site to the best of their abilities, archaeologists need to make the most of established recording methods, reassess these methods, and explore innovative ways of documenting our heritage (Murdock and Stewart, 1995). Today, most underwater archaeological site recording is accomplished through simple recording techniques such as scale drawings, offset measurements, trilateration, and photography (Vrana and Halsey, 1992). These methods are easy enough to use in an underwater environment and are both affordable and reliable. However, they are not always very accurate. One of the most accurate methods in photography combined with photogrammetry, which is the process of developing 3D models through still images (Van Damme, 2015). The other methods are very time-consuming and susceptible to human errors (Van Damme, 2015). Furthermore, the recording techniques generally only produce either 2D or simplified 3D illustrations of the site and shipwreck (Van Damme, 2015). They fail to capture all of the intricate three-dimensional details of each site and highlight the yearly changes happening to the wreck.

The question arises about which methodology should be preferred amongst the community of scientists. In clear water, the choice is rather simple, photogrammetry. The method is simple, cost-effective, and can be useful in public education (Van Damme, 2015). However, what technique would be best for us in a low-visibility and relatively cold environment like Lake Erie were many of the shipwrecks are vast in size.

Lake Erie has a rich history in provident entertainment, employment, food, and recreation to Great Lakes residents. The lake has played a strategic role in many wars like the War of 1812, World I, and World War II. Lake Erie shares a border with both Canada and the United States (Sly, 1976). The written record of the maritime history of Lake Erie dates back to the late 1660s after first being documented by European Louis Jolliet (Sly, 1976). However, Lake Erie was utilized by the Native Americans residing by Lake Erie beforehand. The lake was heavily traveled in early history because it connected the east to the Midwest when short roads and railroads did not exist (Sly, 1976). Lake Erie was and still can be regarded as a lifeline for cities like Buffalo, Cleveland, and Detroit.

Today, Lake Erie is suspected of having over 2,000 shipwrecks, which is among one of the highest concentrations in the world (Johnston, 2017). However, only about 400 to 600 wrecks have been discovered today (Johnston, 2017). Researchers have discovered schooners, freighters, steamships, tugs, and fishing boats (Johnston, 2017). Since the lake is cold and freshwater, many of the wrecks are nearly perfectly preserved along with their stories and histories.

Lake Erie's environmental health has been a significant concern over the past view decades. The lakes have had issues with overfishing, algae blooms, and eutrophication. Lake Erie also suffers from a zebra mussel species invasion (MacDonald, 2009; USA Today, 2007). These disturbances make it hard to monitor and preserve the sites, as well as other surrounding environmental factors. The waters cold temperatures require at least a 7mm wetsuit or a dry suit to stay warm. The visibility can vary on location and is nearly impossible to predict (MacDonald, 2009). Visibility can get as low as a few inches or centimeters with the visibility dropping to practically nothing during the dive due to algae and silt. These conditions make it challenging to monitor the ship's degradation and adequately record the site through human resources or photogrammetry.

As previously mentioned, zebra mussels pose a threat to the recording of the shipwrecks and cause ecological harm. Zebra mussels were introduced to the Great Lakes in the late 1980s and became a new source of biofouling (Binnie *et al*., 2019). Zebra mussels can cover the ships up to 100%, and adequately cover any visual archaeological observations and recordings (Gannon, 2013). The layers of the mussels can be several inches thick. They can make it difficult for archaeologists and other divers to gain exact measurements and an overall concept of the ship's actual overall shape (Gannon, 2013). Zebra mussels cover both metal and wooden shipwrecks (Gannon, 2013). The long-term effects of zebra mussels are unknown, and any modern removal techniques risk the potential damage of the cultural resource (Binnie *et al*., 2019; Gannon, 2013). Archaeologists and divers are hopeful for a less harmful removal process, because the mussels may cause damage to the ships through their build-up, creating heaviness

(Binnie *et al*., 2019; Gannon, 2013). With the mussels and the poor visibility, how can shipwrecks be appropriately recorded and documented?

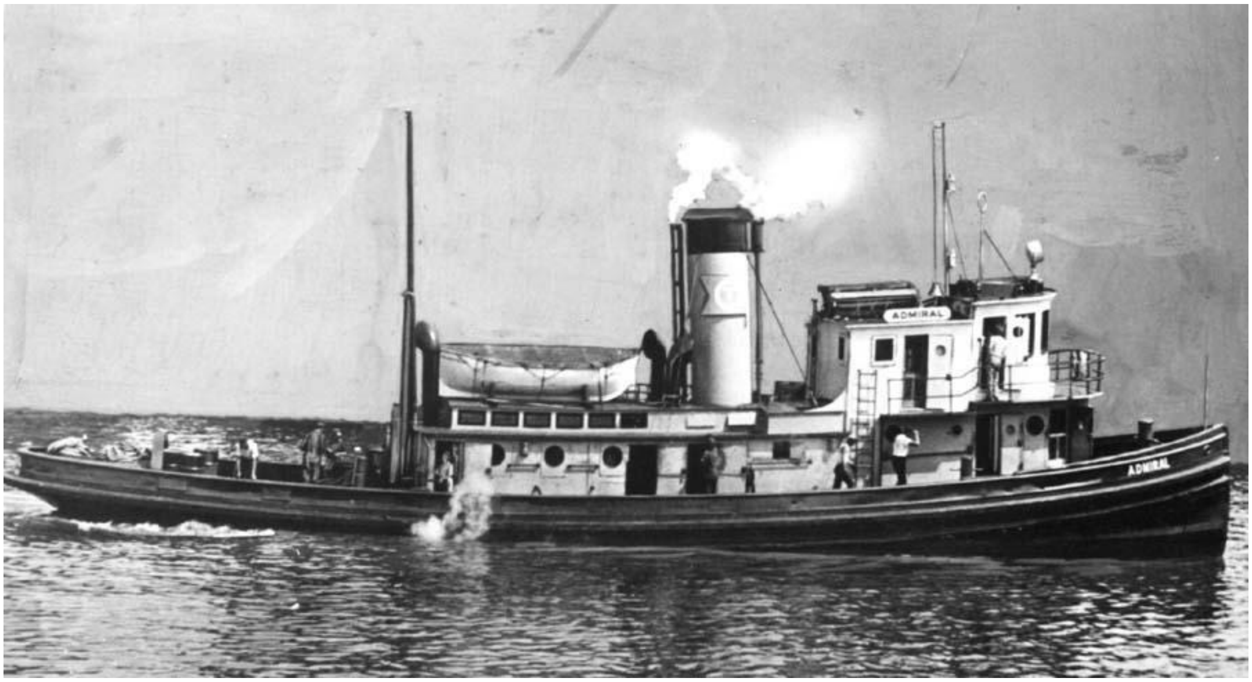


Figure 1. Photograph of the Admiral [Source: (Miller, 2017)]

The shipwreck the *Admiral* (Figure 1) is located 14 miles (22 km) off the coast of Cleveland and provides the conditions to be a suitable case study to answer the research questions posed in this dissertation (Wolf, 1993b; Inland Seas, 1961; Bowen, 1952). The *Admiral* sank in 1942 with the *Cleveco* due to a harsh snowstorm (Wachter and Wachter, 2001; Wolf, 1993b; Parker, 1981b; The Great Lakes News, 1942; Inland Seas, 1961; Bowen, 1952). The *Admiral* is a major wreck to Cleveland and Lake Erie. The wreck is a burial site for at least fifteen men and provides information to one of the most devastating moments in Lake Erie history (Wachter and Wachter, 2001; Wolf, 1993b; Parker, 1981b; The Great Lakes News, 1942; Inland Seas, 1961; Bowen, 1952). Further information and background on the wreck and the current site of the *Admiral* is further discussed in Chapter 2.

The *Admiral* is located in harsh conditions to record in. The visibility and temperature make it difficult to follow a proper path for photogrammetry (Van Damme, 2015). The sinking silt and zebra mussels also make it essential to survey the wreck accurately. The silt also makes it challenging to conduct a proper survey due to the control points sinking and moving and disappearing.

A possible solution to poor visibility and cold conditions that make it difficult for two dive buddies or a small crew to survey a shipwreck in a reasonable time could be citizen science. Citizen scientists can be defined as members of the public who volunteer their time to help collect or process data as part of ongoing scientific research (Silvertown, 2009). They allow projects to collect intricate or vast amounts of data over a large geographical scale and within a short time and budget constraints (Silvertown, 2009). Chapter 3 will provide a more in-depth look into citizen science and provide the benefits and the concerns the field can bring to the scientific community and, more specifically, the archaeology community.

The Maritime Archaeological Survey Team (MAST) from Ohio attempts to record as many wrecks in Lake Erie as possible under small budgets and short periods. MAST collects measurement data on several wrecks in order to accurately report and survey wrecks. This study aims to determine whether the measurements from MAST can be used to not only survey the wreck but also be used toward monitoring the *Admiral*. The method will be compared to a photogrammetry survey performed on the site to determine if either method is useful towards monitoring the site and, if so, which method is more worth it based on the method's time, budget, and effectiveness.

The methodology and results for both the MAST and photogrammetry survey will be discussed in Chapter 4. To examine the application of MAST, Chapter 5 will present the results of a questionnaire distributed to the members that had the opportunity to help record the *Admiral* in 2016 and 2017. The questionnaire covered topics ranging from the motivations for joining, the value of the courses, the educational material, and the leaving impact of MAST on its members. The final chapter will review the utility of citizen science in site monitoring based on the findings from Chapters 4, 5, and 6. This chapter will also provide information on possible future studies and discuss the limitations of the study.

Chapter 2 – The *Admiral*

2.1 Background on the Admiral

The *Admiral* was built in 1907 by the Manitowoc Ship Building Company in Manitowoc, Wisconsin (Herman 2012). She was initially named the *W.H. Meyer* (Figure 2) before being redesigned and repurposed as the *Admiral* in 1942 (Herman, 2012). She was a steel propeller tugboat that was utilized as a tugboat and a periodic harbor icebreaker (Herman, 2012). Manitowoc Shipbuilding Company was a major shipbuilder in the heart of the Great Lakes (Herman, 2012). The company was started in 1902 by Elias Gunnell, Charles C West, and Lynford E. Geer, who bought the shipyard from H.B. and G.B. Burger (Herman, 2012; MarineLink, 2019). They mainly built steel ferries, icebreaking machines, dredges, lighters, self-loading cargo ships, ore haulers, tugs, tank land crafts, and self-propelled fuel tankers (Herman,

Figure 2. Photograph of the Admiral as the W.H. Meyer before she was sold and altered [Source: (Ohioshipwrecks.org, 2019)].

2012; Morison, 1962; International Directory of Company Histories, 2004). During World War II, the company was commissioned also to build submarines, which allowed them to grow tremendously in numbers during the war and grew to about 7,000 employees (Herman, 2012)

The submarines building program commissioned by the Navy saved the company after the Great Depression (Herman, 2012). A contract was put into action for ten submarines to be made on September 9, 1940. Each submarine was 15 ft. (4.57 m) in height below the waterline (Herman, 2012). The location and size of their shipping yard and their shipping dock made for an ideal site (Figure 3) (MarineLink, 2019). The location was comprised of 35 acres (141,640 m2) and was connected to the mainland by an 800 ft. (243.84 m). They also utilized the 4,800 feet (1463.04 m) of river frontage for rays, shops, and fitting purposes (International Directory of Company Histories, 2004). In the end, a total of about 28 submarines were commissioned by the Navy (Herman, 2012). The company officially closed the shipyard in 1968 and was bought out by the Bay Shipbuilding Company located in Sturgeon Bay (Herman, 2012).

Figure 3. Aerial photograph of the Manitowoc Shipbuilding Company illustrating the size and location of their shipping dock and yard [Source: (Wisconsin Historical Society, 2019)]

Before Manitowoc Shipbuilding Company closed, the tug the *W.H. Meyer* was sold to the Cleveland Tankers, Inc., which was owned by Allied Oil Co. of Cleveland, Ohio. The tug was renamed and remodeled as the *Admiral* only 89 days before she sank (Inland Seas, 1962; Bowen, 1952). The renovations included enlarging the crew quarters and the forward cabins, cutting away and raising the wheelhouse, raising the pilothouse and the smokestack, and adding a more extensive galley and mess room (Parker, 1981; Boyer 1968). The company also added additional quarters, a shower, a washroom, new refrigerating equipment, and new life rafts (In the Matter of the Petition of Cleveland Tankers, Inc., as owner of the Tug *Admiral,* for Exoneration from and

Limitation of its Liability., [1943]) The renovations in total added about 19,000 pounds, raised her center gravity, and raised her superstructure (In the Matter of the Petition of Cleveland Tankers, Inc., as Owner of the Tug *Admira*l, for Exoneration from and Limitation of its Liability., [1943]). The Steamboat Inspection Service gave the tugboat a few restrictions after the modifications: (1) vessel shall not be operated at a mean keel draft above 11 feet (3.35 m), (2) bilges shall be well pumped out, and (3) tow line shall be maintained in a fore and aft line (In the Matter of the Petition of Cleveland Tankers, Inc., as Owner of the Tug *Admiral,* for Exoneration from and Limitation of its Liability., [1943]).

According to a stability test done by the United States Coast Guard, the main dimensions of the steel tugboat were 99 feet (30.18 m) long and 22 feet (6.71 m) in breadth (the maximum width between the outer hull of the starboard side to the outer hull on the port side)(United States Coast Guard, 1940). The depth of the hull is 11.7 feet (3.57 m), and weight is about 130 tons (Inland, 1961; Markey; 1944; Bowen, 1952).

The crew of the *Admiral* was at capacity, and most of the men were local and originated from Cleveland, Ohio. The men varied in age. Some of the men were married while others were married with a few children. Men of the *Admiral*, regardless of their age or way of life, tragically passed away too young and left many mourners. For respect, each man of the crew will be highlighted later on in this chapter.

2.2 Background on the *Cleveco*

The *Admiral* was pulling the tanker the *Cleveco* before it sank. The *Cleveco* was built in 1913 by McDougall in Superior, Wisconsin, by the Standard Oil Company (Van der Linden and Bascom, 1986). The tanker was called *S.O. CO. NO. 85* initially. The following companies owned the tanker (in order): Standard Oil Company, Standard Transportation Company, and

Gotham Marine Corporation (Van der Linden and Bascom, 1986; Schneider, 1942). Cleveland Tankers, Inc. bought the tanker and renamed the *Cleveco* in 1940; Van der Linden and Bascom, 1986). The *Cleveco* was a 2,440-ton tanker (Cleveland Plain Dealer, 1949; Wolf, 1993b). After the sinking, the tanker was owned by the government (Cleveland Plain Dealer, 1949). The tanker was about 260 feet (79.25 m) long (Cleveland Plain Dealer, 1961).

The *Cleveco* was easy to locate. It lied on the bottom exactly where it sank (Inland Seas, 1961, which is about 4 ½ miles (1.6 km) off of the shore of Euclid Beach in Cleveland, Ohio (Cleveland Plain Dealer, 1949; Inland Seas, 1961). The vessel was about 65 feet (20 m) below the water (Cleveland Plain Dealer, 1949; Inland Seas, 1961). The vessel was upside down on the bottom of the lake sunken within the silt (Cleveland Plain Dealer, 1949).

After the *Cleveco* sank in 1942, discussion began about raising the tanker to avoid any potential environmental hazards. The tanker was holding between 880,000 to 1,000,000 gallons of oil (reports vary) in twelve different tanks (Garling, 1961; Schneider, 1942; Lawless, 1994). The plan (Figure 4) to recover the vessel was submitted in 1949. The army engineers were planning to spend upwards of $100,000 (about $1,076, 231 today with inflation) to recover the tanker (Cleveland Plain Dealer, 1949). The plan was heavily debated because if any mistakes were to occur, the crude oil could have heavily polluted Lake Erie (Cleveland Plain Dealer, 1949).

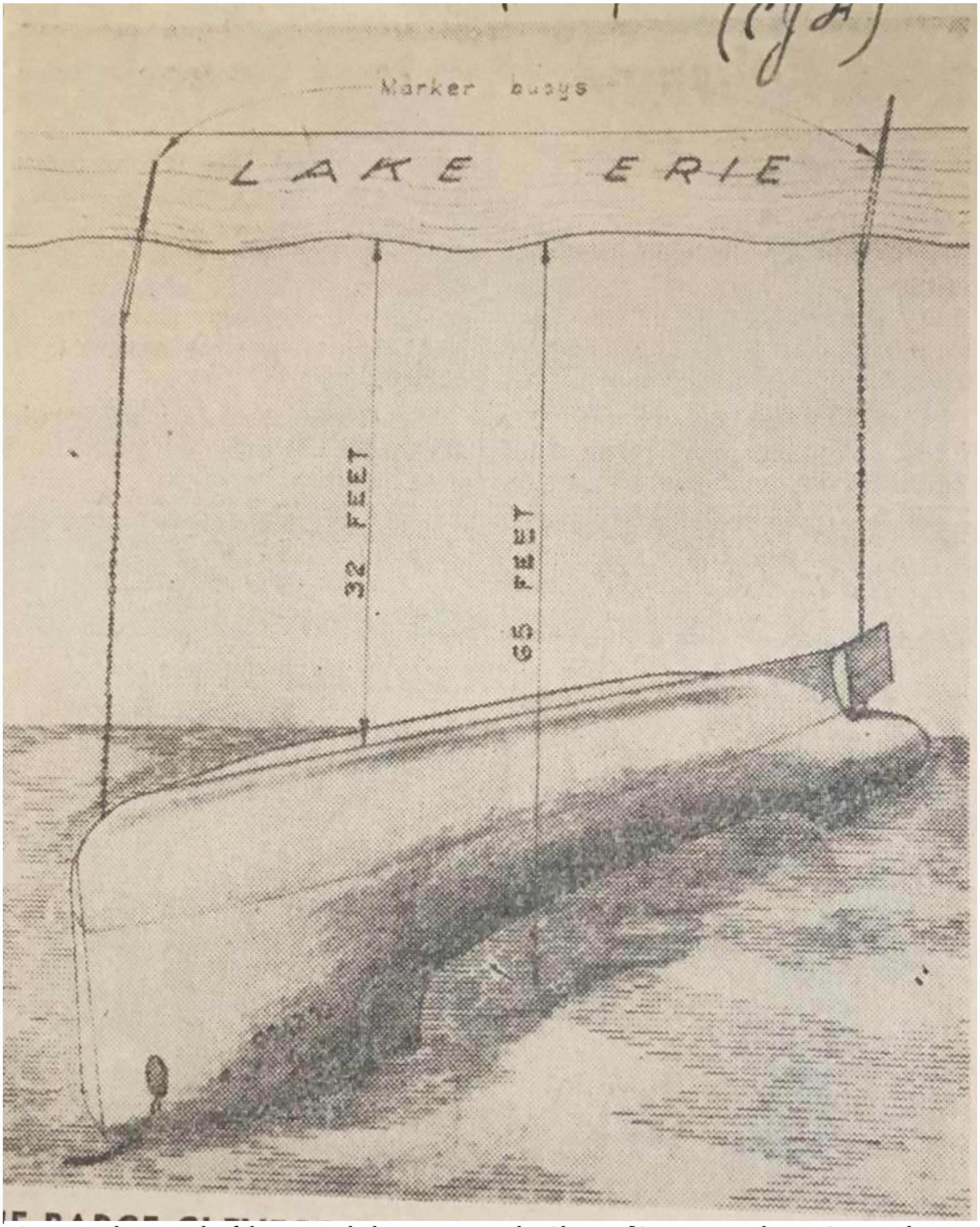


Figure 4. Photograph of the original plan to recover the Cleveco [Source: Peachman Great Lakes Shipwreck Research Center Files of the Great Lakes Historical Society]

The original plan was first to pipe out all of the oil from the tanker to avoid having to lift and recover the hull completely (Cleveland Plain Dealer, 1949). However, the original plan was impossible to complete because the tanker sank 3 feet (0.91 m) into the muck of Lake Erie (Cleveland Plain Dealer, 1949). The upside-down position made it hard for the divers enough room between the overturned deck and the oil storage tank to be able to attach any hose (Cleveland Plain Dealer, 1949). The only option left was to raise the tanker, which seemed possible after a salvage diver from D. A. Dysche reported the tanker was intact with no reported breaks (Cleveland Plain Dealer, 1949).

The tanker recovery was attempted in July 1961 (Cleveland Plain Dealer, 1961; Griffin, 1964). Commercial diving services raised the *Cleveco* under the supervisory of J. Rodney King and Bill Virgin (Cleveland Plain Dealer, 1961; Garling, 1961). The tanker was bought up (Figure 5) by the salvage boat *Rebel* through the use of many air hoses, slowly replacing the water with buoyant air (Cleveland Plain Dealer, 1961). No bodies were discovered at the wreck site; however, the original site will be known as the final resting place for Captain William H. Smith (Cleveland Plain Dealer, 1961; Griffin, 1964).

Figure 5. Photograph taken of the Cleveco being brought up the first time [Source: (Ohioshipwrecks.org, 2019) – Cleveco]

After the vessel was brought up, the salvagers had difficulty bringing the tanker to shore due to the broken rudder (Kuehner, 1994). The salvagers had to abandon and re-sink the vessel about 10 miles (16.09 km) off the shore of Euclid, Ohio, when a strong storm began to approach them (Kuehner, 1994). The *Cleveco* was moved about 19.5 miles (31.38 km) northwest from its original position (Figure 6) (Wolf, 1993). What the salvagers did with the oil remained a mystery until 1994 when the Coast Guard officials went to the tanker to test whether or not the *Cleveco* was clear of any hazardous materials (Kuehner, 1994). A diver from the salvage team in 1961

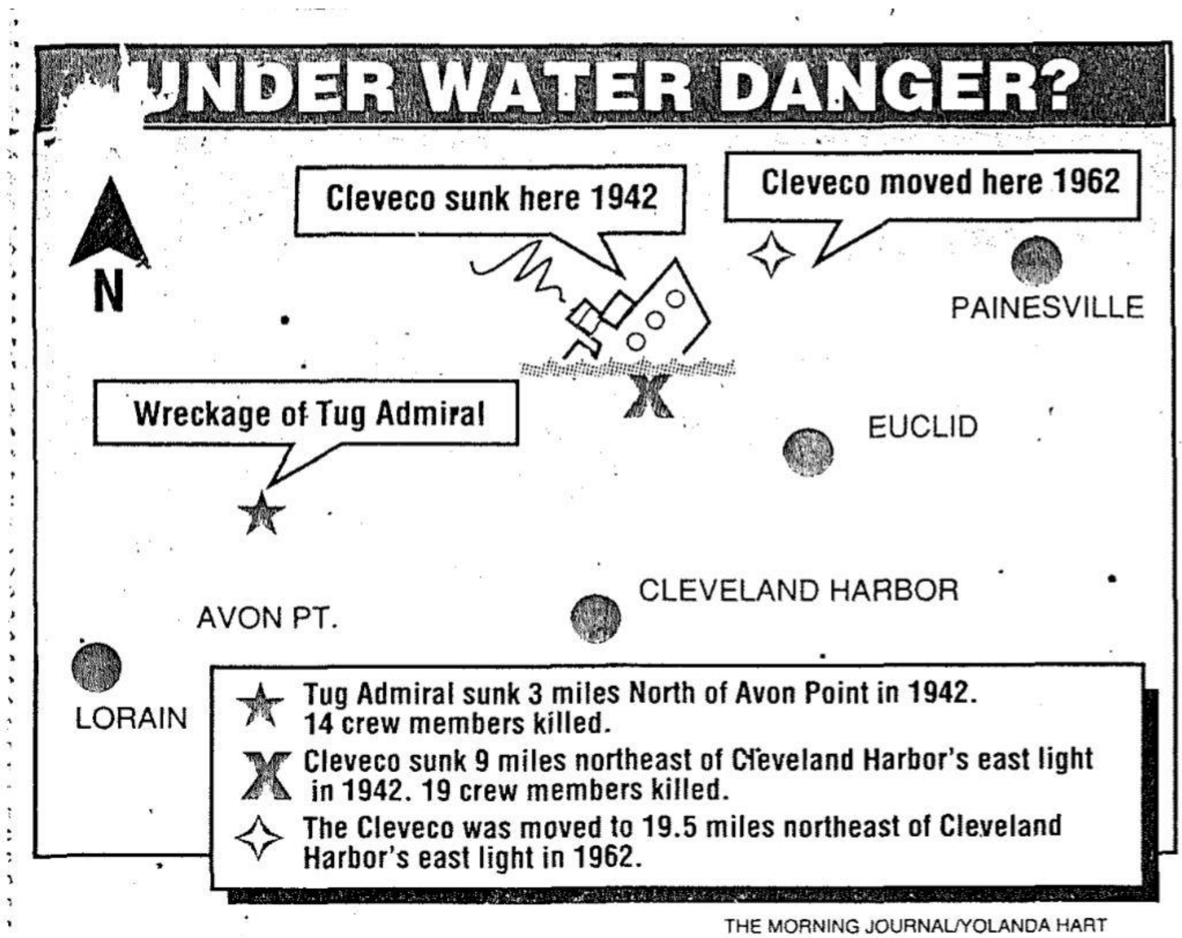


Figure 6. Photograph of the Cleveco's new location after it was moved in 1962 [Source: Wolf, 1993; Graphic completed by Yolanda Hart from the Morning Journal].

made a statement that the oil from the *Cleveco* was never emptied back in the 1960s (Kuehner, 1994). The original position of the tanker also was a threat to any incoming deeper-draft ships heading into the Cleveland Fairport Harbor (Kuehner, 1994). The keel was only at 25.6 feet (7.80 m) and Lake Erie required at any sunken vessel to be at 45 feet (13.72 m) deep for proper clearance (Kuehner, 1994). It was later discovered that the oil tanker was indeed still leaking oil into Lake Erie (Kuehner, 1994).

In 1994, the United States Navy hired Donjon Marine Co., a private salvage firm from New Jersey, to determine how much oil remains in the *Cleveco* (Kuehner, n.d.). Figure 7, a photo from the U.S. Coast Guard Marine Safety Office, describes the process and the equipment used throughout the test (Kuehner, n.d.). Essentially, the hired divers probed the hull with a select detecting oil paste to determine how much oil was still contained within the hull (Kuehner, n.d.).

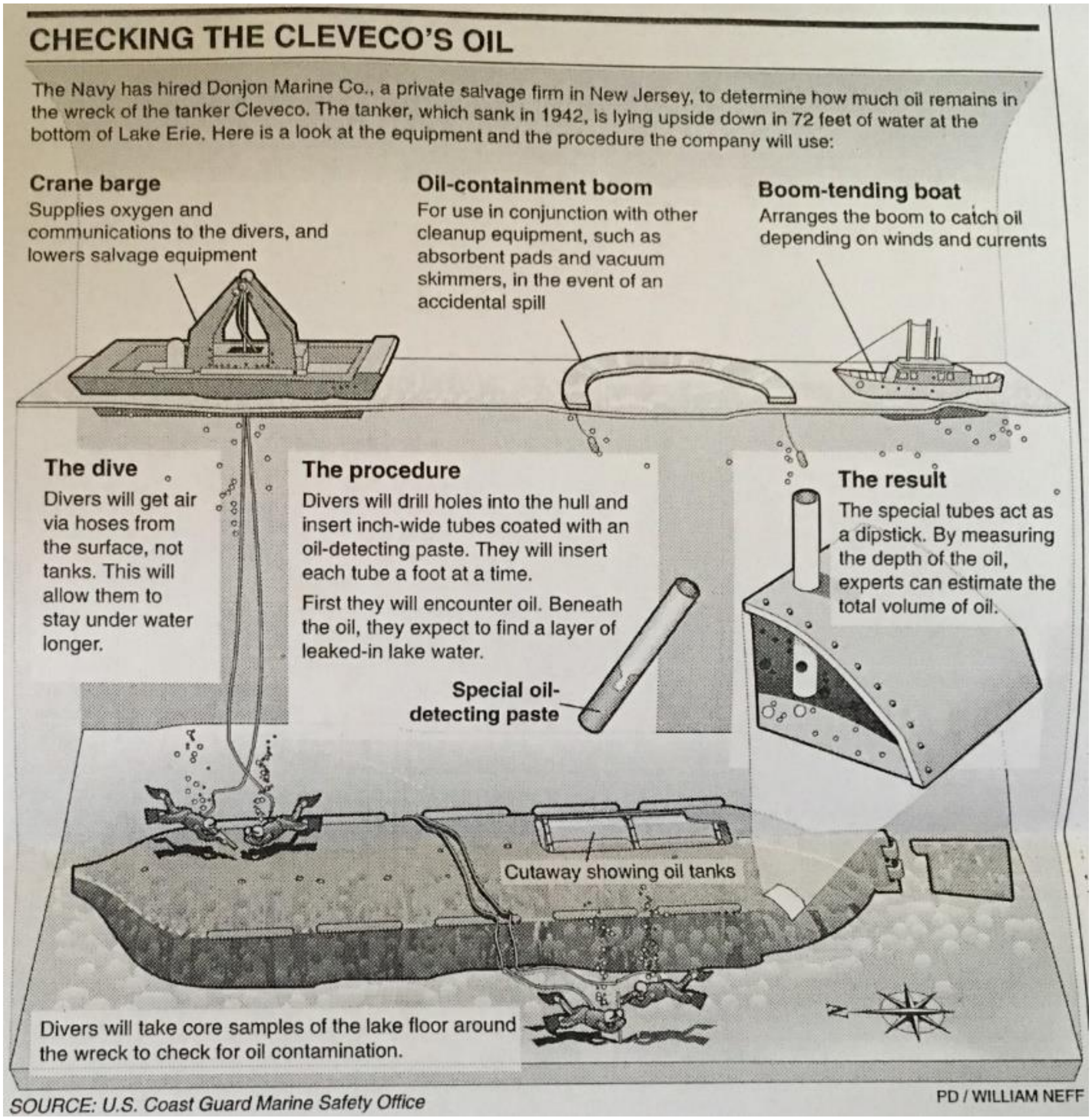


Figure 7. Photograph from the U.S. Coast Guard Marine Safety Office illustrating the procedure to test the amount of oil that remained in the Cleveco [Source: Peachman Great Lakes Shipwreck Research Center Files of the Great Lakes Historical Society]

The samples were tested during the summer of 1994 at Louisiana State University and determined that the *Cleveco* still contained approximately 165,000 gallons of oil (Kuehner 1994b; Lawless, 1994). The United States Coast Guard removed the oil from the tanker in August 1995 (The Plain Dealer, 1995). Donjon Marine Co. of New Jersey was hired to do the work, and the team recovered 185,000 gallons of oil and about 145,000 gallons of an oil and water mixture (The Plain Dealer, 1995). The old oil was sold for recycling (The Plain Dealer, 1995). Throughout the rest of the chapter, the background will focus more on the *Admiral*.

2.3 Story of the Shipwreck

On the afternoon of December 1, 1942, the crew of the *Admiral* connected a towline with the tanker, the *Cleveco* (Figure 8) in the Toledo Harbor in Ohio (Wolf, 1993b; Inland Seas, 1961; Bowen, 1952). The *Admiral* pulled the *Cleveco* down the Maumee River toward Lake Erie. The length of the journey was to be about 96 miles (154 km) (Wolf, 1993b; Inland Seas, 1961; Bowen, 1952). The weather was typical for December in Lake Erie, with relatively cold temperatures and cloudy skies, and the forecast was not predicting any storms (Inland Seas, 1961; Bowen, 1952). However, the wind began to pick up around midnight, leaving both ships to deal with breakers and cold temperatures (Inland Seas, 1961; Bowen, 1952).

At about 4 o'clock the next morning, the crew members from the lookout of the *Cleveco* reported the towline was at the wrong angle and appressed to be coming from the bottom of the lake (Wolf, 1993b; Inland Seas, 1961; Bowen, 1952). The *Cleveco* came to a slow stop as the lights of the *Admiral* disappeared into the lake (Wachter and Wachter, 2001; Wolf, 1993b; Parker, 1981b; The Great Lakes News, 1942; Inland Seas, 1961; Bowen, 1952). Captain, William H. Smith, and his first mate and brother Edwin S. Smith theorized the *Admiral* capsized and was lying at the bottom of Lake Erie (Wachter and Wachter, 2001; Wolf, 1993b; Parker, 1981b; The Great Lakes News, 1942; Inland Seas, 1961; Bowen, 1952). The fifteen crewmen of

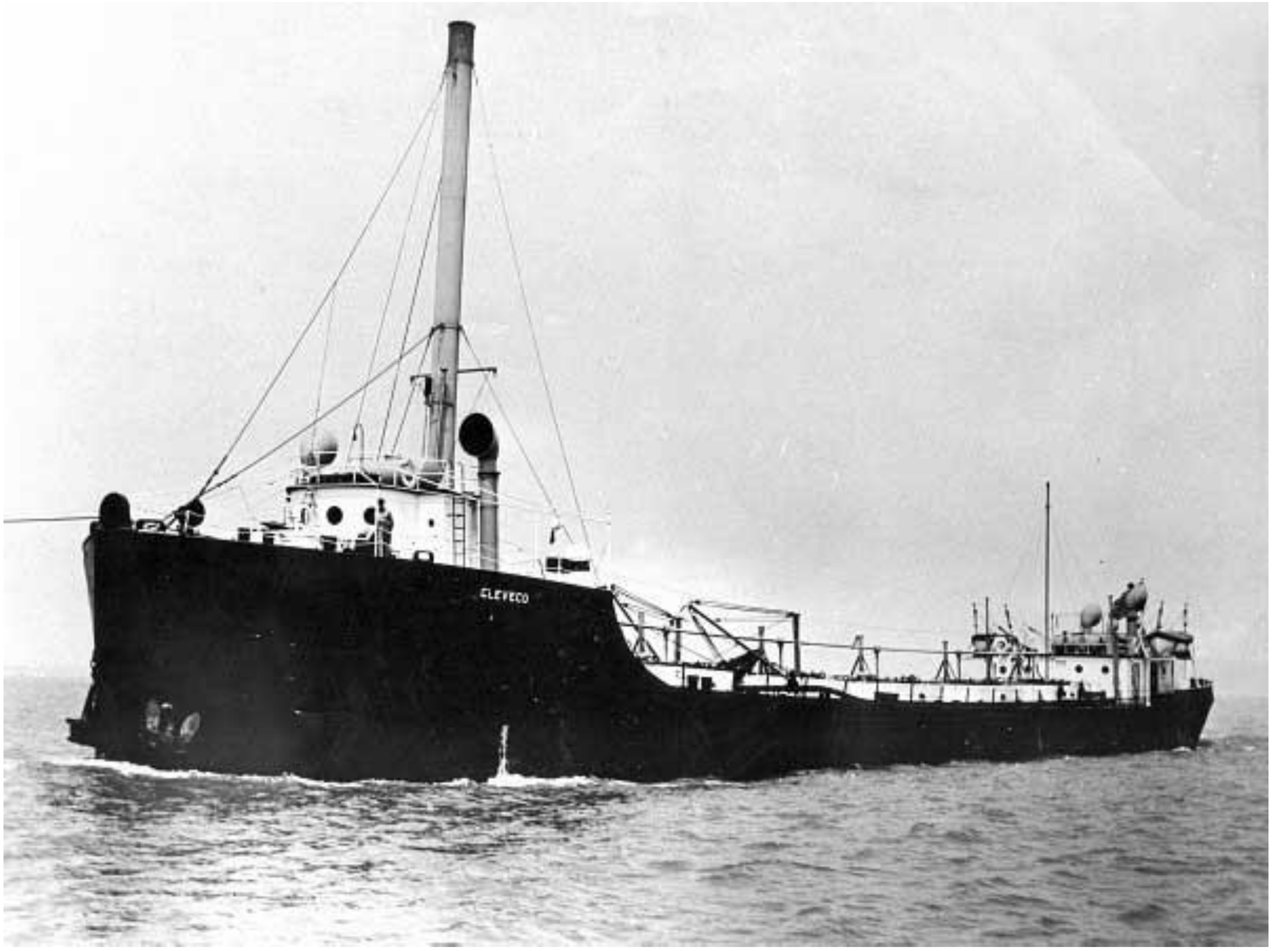


Figure 8. Photograph of the tanker the Cleveco [Source: (Gothro, 2012)]

the *Admiral* tragically passed away during the early morning of December 2, 1942 (Wachter and Wachter, 2001; Wolf, 1993b; Parker, 1981b; The Great Lakes News, 1942; Inland Seas, 1961; Bowen, 1952). The wreck occurred about six miles (9.7km) off of Avon Point in Cleveland, Ohio (The Great Lakes News, 1942).

Part of the truth behind what happened to the *Admiral* remains a mystery today. Several smaller mysteries still need to be solved today. Many believe the crew of the *Cleveco* released the two-line to avoid sinking because the *Cleveco* drifted powerless toward the Cleveland harbor (Inland Seas, 1961; Bowen, 1952). Another theory is about the men aboard the *Admiral.* Some people believe that many of the *Admiral* crew were asleep in the cabin at the time of their passing (The Great Lakes News, 1942).

2.4 Men Loss

A total of fifteen men died on the *Admiral* on December 2, 1942 (Parker, 1981b; Wachter and Wachter, 2001; The Great Lakes News, 1942; Inland Seas, 1961). The brave men that passed away on the *Admiral* are listed in Table 1 below. The men are listed in no approximate order. (The Great Lakes News, 1942; Schneider 1942). The information about each man was gathered from legal court rulings and documents (The Cleveland Tankers, Inc., v. Frank Szwed Administer of the Estate of John James Szwed, Deceased, *et al*., and Adelaide Rocks, as Administratrix of the Estate of William D. Rocks, Deceased, *et al*., [1943]). Special thank you for the research conducted by Jim Paskert and Kevin McGee to gather the exact number and names of the men that passed away on the *Admiral*. Please note that the men from the *Cleveco* who lost their lives will not be mentioned explicitly because the focus will remain on the men who lost their lives on the *Admiral.*

Table 1. Men Who Lost Their Lives on the *Admiral*

Name	**Occupation**	**Age**	**Location**
William R. Cowan	First Mate	31	Cleveland, Ohio
Harold V. Hanninen	Second Mate	36	Cleveland, Ohio
Francis S. Shannon	First Assistant Engineer	36	Ashtabula, Ohio
William D. Rocks	Chief Engineer	56	Cleveland, Ohio
John Tierney	Wheelsman	21	Cleveland, Ohio
John M. O' Connor	Wheelsman	34	Cleveland, Ohio
Niel Chambers	Fireman	23	Cleveland, Ohio
Jerry Girard	Utility Man	41	Chicago, Illinois
Michael J. Joyce	Fireman	46	Cleveland, Ohio
George L. Chambers	Fireman	25	Cleveland, Ohio
Alexander Baldwin	Fireman	54	Port Huron, Michigan
Robert J. Dundon	Steward	55	Cleveland, Ohio
John Swanson	Master, Captain	42	River Rouge, Michigan
Bertel Haahr	2nd Assistant Engineer	36	Detroit, Michigan
John E. Cahill	Wheelsman	37	Cleveland, Ohio

2.5 Overview of the Crew

William R. Cowan was the first mate and was survived by wife Grace O. Cowan and son Lorne Cowan. Cowan graduated from Lincoln Electric Company from a welding course and was able to quickly advance himself through the ranks from an ordinary seaman to first mate.

Harold V. Hannien was a second mate and was survived by his wife Mary E. Hanninen and his three daughters Audrey, Jacqueline, and Elisa. Hannien worked for the Allied Oil Company for approximately seven years. He worked his way up from a seaman to a licensed officer. He acquired an unlimited pilot's license. He was a competitive sailor since he was about 14 years old.

Francis S. Shannon was a first assistant engineer on the *Admiral*. He was succeeded by his wife Edna M. Shannon and his two daughters Mary Kathryn and Rita Irene. Shannon worked up from a seaman to the engineering department within two years. He first worked as a fireman and oiler before qualifying as a licensed officer. He graduated with high school education.

William D. Rocks was the chief engineer on board of the *Admiral* and was survived by his wife, Adelaide Rocks. He was described as industrious and energetic by his loved ones. He previously worked at the Great Lakes Dredge and Dock Company for 35 years before working for Cleveland Tankers, Inc. He worked hard to receive a stationary's engineer license to become appropriately qualified for his position. He first worked as a fireman before being promoted.

John Tierney was a wheelsman and was single at the time of his passing. He was survived by his father, Thomas Tierney, his mother Ellen Tierney, his sister Mary Ellen, and his brother James Tierney. Tierney worked to support both of his parents. He graduated with high school education and used to work in gardening. He also worked for the Great Lakes Dredge and Dock Company before his passing.

John M. O' Connor was a wheelsman at the time of his passing. O'Connor was not married and was survived by his father James O' Connor, his mother Ellen O'Connor, his two brothers, Pat and Neal, and his sister, Mary. He was previously a mail carrier and also worked for the following companies: American Steel & Wire Company, Otis Steel Company, Great Lakes Towing Company, Great Lakes Dredge and Dock Company, and an electrical appliance company. He was also a boilerman. He contributed a large portion of his salary to support his parents due to his mother's blindness. He helped his mother undergo surgery to restore sight in one eye before his time of death.

Niel Chambers was a fireman aboard the *Admiral* and did not get married before the time of his passing. He was survived by his father Connor Chambers and four brothers and three sisters, none of whom were named. He began working on tugboats and went to John Carroll University immediately after graduating from high school. He previously worked for the following two companies: L. A. Wells Construction Company and Great Lakes Towing Company. Right before his passing, he obtained a license to operate passenger boats for hire and a license to be a first-class pilot on steam and motor vessels.

Jerry Girard was working as a utility man at the time of his death on the *Admiral*. He was not married at the time of death; however, he was survived by his three siblings: his brother Peter Girard, his sister May Menn, and his other sister Clara Boucher. His sister Clara raised him while he worked to help contribute to his three siblings. He use to work for a telephone company. His co-workers described him as an able-bodied seaman. Girard also enjoyed sailing.

Michael J. Joyce was a fireman working on the *Admiral* before his passing. He did not get married before his passing. He was survived by his sister Margaret Maher and his half-brother Pat O'Donnell. Before his time of death, he resided with his sister and her six children.

He held a stationary fireman's license. Joyce lost some of his hearing during World War II. He enjoyed sailing. Joyce missed the boat leaving from the Cleveland harbor, but was able to catch up with the *Admiral* in Toledo because he was driven to the docks by a relative.

George L. Chambers was one of the firemen that passed away on the *Admiral*. He was not married by his time of death, but he was survived his mother Bridget McIver and his brother James Chambers and ten other brothers whose names are not listed. He worked hard to provide support for both his mother and his brother. He previously worked at the following companies: Great Lakes Dredge & Dock Company, L.A. Wells Construction Company, and the Great Lakes Towing Company.

Alexander Baldwin was working as a fireman on the *Admiral* before passing away aboard the vessel. He was not married at the time of his death. He was survived by his two siblings, his brother, Arthur A. Baldwin, and his sister, Charlotte B. Montrose. He supported his brother after his brother was disabled in World War I.

Bjorn Alvier worked as one of the Chief Engineers on the *Admiral* before the sinking of the tug. There is no additional information about Alvier and his next of kin.

John Swanson was working as the Captain (or Master) on the *Admiral* before his death. He was survived by his wife and two sons, none of which were named. He was promoted to Captain about six months before the *Admiral* sank. He was born in Sweden.

John E. Cahill was working as a wheelsman before the time of his death. There is no additional information about Cahill and his next of kin.

Bertel Haahr worked as a second assistant engineer before passing away alongside the *Admiral.* He was born in Denmark. He was survived by his mother Henrietta Haahr, his sister Charlotte Jensen, his other sister Bertha Jensen, and his brother Einar Haahr.

Men of the *Admiral* hailed from all over the mid-western states, but mainly Ohio. All of them came from humble beginnings. Only a few were able to pursue higher education. A large portion of the men worked hard to work up in the ranks. Others were using this job as a means of money to help support ill loved-ones. All of the men are described as hard-working. All were greatly missed (The Cleveland Tankers, Inc., v. Frank Szwed Administer of the Estate of John James Szwed, Deceased, *et al*., and Adelaide Rocks, as Administratrix of the Estate of William D. Rocks, Deceased, *et al*., [1943]).

2.6 Attempts to Rescue the *Admiral* and the *Cleveco*

Once the *Admiral* sank, the *Cleveco* was left without any form of propulsion (Wolf, 1993b; Inland Seas, 1961; Bowen, 1952). The crewmen on the tanker signaled for emergency help as soon as possible because the storm began to get worse throughout the morning (Inland Seas, 1961). Captain Smith, who was 62 years old, used the tanker's radiotelephone (technology that the *Admiral* and many other vessels at the time did not have) to report his position and ask for other tugs to be sent out toward his positioning (The Great Lakes News, 1942; Inland Seas, 1961; Bowen, 1952). The Captain reported his initial position about 14 miles (22 km) off of Avon Point, which is 15 miles (24 km) west of Cleveland, Ohio (Wolf, 1993b; Inland Seas, 1961; Bowen, 1952). Captain Smith reported that he and his crew were not in any immediate danger (Wolf, 1993b). However, the Captain requested a tug to be sent as soon as possible because the storm winds and the cold temperatures were eventually going to get worse (Inland Seas, 1961; Bowen, 1952).

Two tugs from the Great Lakes Towing Fleet, the *California* and the *Pennsylvania*, left from the Cleveland Harbor to help bring the *Cleveco* back to the harbor (Schneider, 1942; Inland Seas, 1961). The tugs headed toward the initially reported location (Inland Seas, 1961; Bowen, 1952). Both tugs could not find the *Cleveco* once they reached the reported site (Inland Seas, 1961; Bowen, 1952). It was difficult for the tugs to spot anything on Lake Erie due to the severe snowstorm (Inland Seas, 1961; Bowen, 1952).

The *Cleveco* began to move eastward and further away from the shoreline and the first reported site (Inland Seas, 1961; Bowen, 1952). More vessels and two airplanes began to search for the *Cleveco*. It difficult for any ship or airplane to keep a constant eye on the tanker because of the storm (Inland Seas, 1961; Bowen, 1952). However, Captain Smith remained in contact with help through telephone communication from the morning into the afternoon (Inland Seas, 1961; Bowen, 1952). The ships and airplanes began to gather ice and damage from the storm forcing many of them to turn back to shore (Inland Seas, 1961; Bowen, 1952).

The Coast Guard assisted by sending out any available boats, specifically the cutter the *Ossipee* (Figure 9) (Schneider, 1942; Inland Seas, 1961). She was the largest vessel in the rescue fleet. Captain of the *Ossipe*e decided to contact Captain Smith and request a new location from the *Cleveco* (Inland Seas, 1961; Bowen, 1952). The *Cleveco* reported their updated position about 10 miles (16 km) north of the west Cleveland lighthouse (Inland Seas, 1961; Bowen, 1952). The storm forced the smaller vessels to head back to shore, leaving only the *Ossipee* to continue the search (Inland Seas, 1961; Bowen, 1952). By noon, the temperature dropped to about 14 F (-10 C) (Inland Seas, 1961; Bowen, 1952).

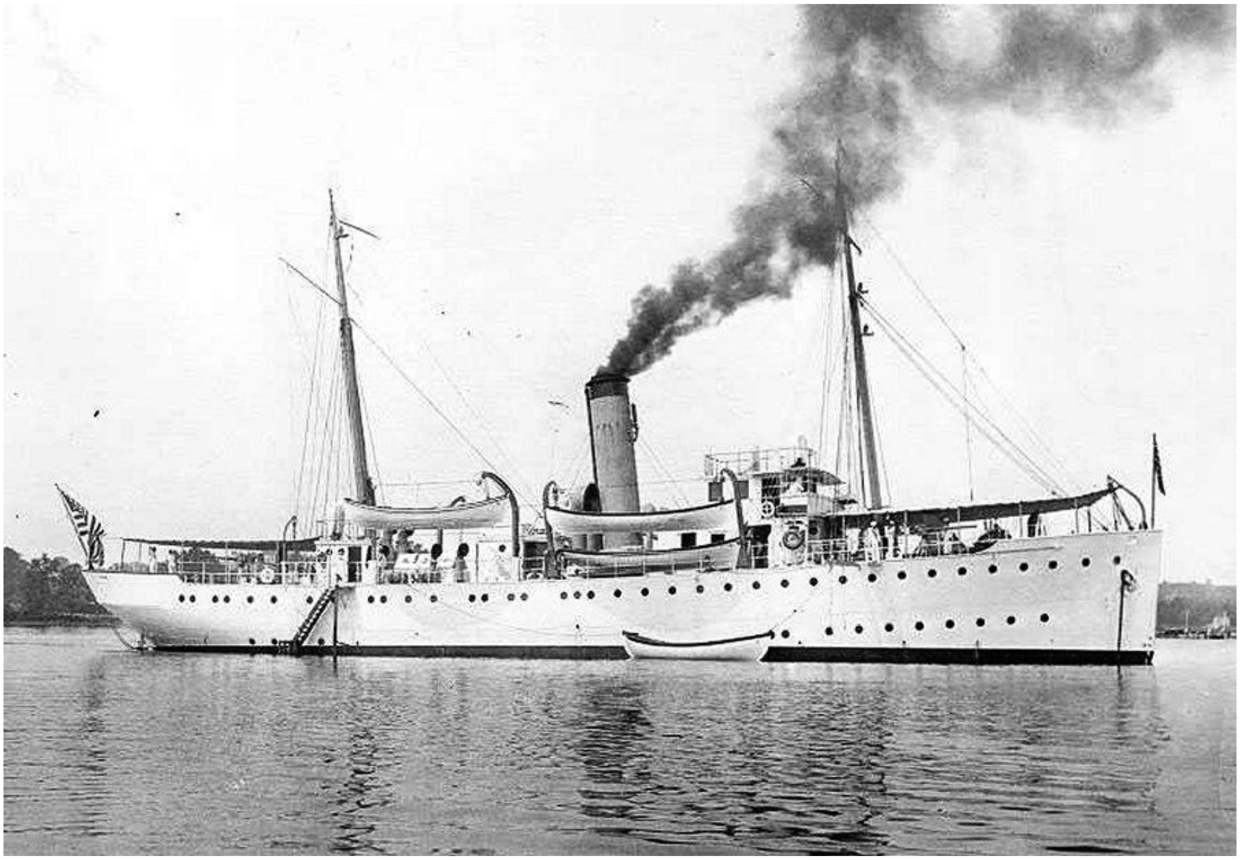


Figure 9. Photograph of the Ossipee, the cutter used by the United States Coast Guard [Source: (Navsource.org, 2019)]

While the *Ossipee* was searching the waters from below, more planes from the Cleveland Air Patrol began searching from the skies (Griffin, 1964; The Cleveland Plain Dealer, 1942). The three pilots were Clara E. Livingston, Donald W. Patrick, and Donald Page (Figure 10) (The Cleveland Plain Dealer, 1942; Griffin, 1964). They reportedly saw the vessel blanketed in ice (Griffin, 1964). The *Ossippee* reported the last two sightings of the day at 2:30 and 3:00 pm (Inland Seas, 1961; Bowen, 1952). The *Ossipee* received a call at 4:30 pm from the *Cleveco*. Captain Smith reported that the tanker was slowly taking in water, and the entire electrical system, including the radiotelephone, would be ruined (Inland Seas, 1961; Bowen, 1952).

Figure 10. Photograph of two of the pilots that helped search for the Cleveco (names of which two pilots are unknown. [Source: (Ohioshipwrecks.org, 2019) – Cleveco].

The wind increased to a velocity of 60 miles (96 km) per hour, with some gusts reaching 70 miles (112 km) per hour (Inland Seas, 1961). The Captain of the *Ossipee* attempted to reply to the crew and asked them to pump oil into the lake to create a slick trail for them to follow; however, they did not receive any reply (Inland Seas, 1961 Bowen, 1952). The *Ossipee* stayed out all night looking for the *Cleveco* despite their radio silence (Inland Seas, 1961 Bowen, 1952).

By night, the visibility for the *Ossipee* dropped to zero while the winds reached full gale, and the high waves began to affect the cutter (Inland Seas, 1961). The *Ossipee* was getting covered with heavy ice, and the crew was sentenced to a lockdown (Inland Seas, 1961). On the morning of December 3, the *Ossipee* crew spotted two bodies covered in oil and wearing safety belts from the *Cleveco* with the help of the two spotter planes (The Cleveland Plain Dealer, 1942; Inland Seas, 1961). The *Ossipee* gave up on the search for the rest of the day because the cutter was densely covered in ice (Inland Seas, 1961; Bowen, 1952). However, after clearing the ice, the *Ossipee* went out again to search for more bodies the following day, December 4 (Inland Seas, 1961; Bowen, 1952).

The nineteen crewmen from the *Cleveco* all lost their lives on December 3, 1942 (Wachter and Wachter, 2001; Schneider, 1942; Inland Seas, 1961; Bowen, 1952). The vessel sank near the coast of Gordon Park (about 5 miles or 8 km east from downtown Cleveland) in Cleveland, Ohio. For several days, lifeboats, the *Ossipee*, Coast Guard auxiliary vessels, and private vessels searched for the bodies from the *Admiral* and the *Cleveco* (Inland Seas, 1961; The Cleveland Plain Dealer, 1942). A total of eight bodies were found in Fairpoint Harbor about 50 miles from where the *Cleveco* sent out its first distress signal (The Cleveland Plain Dealer, 1942). A few days later, two more bodies were discovered again near Fairpoint (Inland Seas, 1961). Many believe that some of the men passed away within the cabin of the tanker (Inland Seas, 1961). The men had enough food and water for survival; however, the donkey engines were most likely flooded and would have caused the men to freeze to death due to the loss of heat (Schneider, 1942).

The double sinking of the *Admiral* and the *Cleveco* is still one of the worst disasters to ever occur on Lake Erie and the Great Lakes (Inland Seas, 1961). It is important to remember the shipwrecks' past to understand their relevance and importance today. The information is not only important to help preserve the wreck for future generations, but information brings light to how the wreck site was eventually discovered.

2.7 Court Case Regarding the Wreck

The company Allied Oil Co. and Cleveland Tankers, Inc. petitioned the courts in 1944 to receive limited liability in connection with the sinking of the *Admiral* and the *Cleveco* (Figure 11) (Cleveland Plain Dealer, 1944b). The case was in front of Federal Judge Emerich B. Freed (Cleveland Plain Dealer, 1944; Markey, 1944). The company's legal representative, Lee C. Hinslea argued that the *Admiral* was inspected and deemed seaworthy by the United States Steamboat Inspection Bureau after an inspection in March 1942 (Markey, 1944; Cleveland Plain Dealer, 1944b; The Cleveland Plain Dealer, n.d.). The counsel for both companies argued that the sinking was caused by an "act of god" due to the "60-mile gale with 20-foot waves" (Cleveland Plain Dealer, 1944b).

Audience at the Cleveco disaster hearing.

Com. Rasmussen. Com. Hull. Lieut. Binder.

Figure 11. Photographs from the court hearing [Source: (the Cleveland Plainer, 1944)

The representatives for the descendants (also referred to as the heirs), attorneys Edward Lamb and Harry A. Gordon, argued that the *Admiral* was not seaworthy, and the winds were only blowing at a "28-mile gale" (Cleveland Plain Dealer, 1944b; Markey 1944). The representative also included in their argument that the additional 10 tons added to the *Admiral* caused the tugboat to be unstable (The Cleveland Plain Dealer, 1944). The tugboat was consistently described as "top-heavy" (Markey, n.d.).

They also argued that the Captain was not fit to pilot the *Admira*l in December because he did not have a license to be a captain or a mate at the time of the sinking (Cleveland Plain

Dealer, 1944b). The widow of the Captain argued that he stated that he was not comfortable piloting the Admiral and had no previous experience before the incident (The Cleveland Plain Dealer, 1943). However, a second assistant engineer named Gordon Foucher, who previously worked abroad the *Admiral*, testified that the ship was in excellent condition, and Captain John O. Swanson was capable of piloting the tugboat (The Cleveland Plain Dealer, 1943d). H

The ruling of the court cased concluded that the two companies that owned the *Admiral* and the *Cleveco* were at fault (The Cleveland Plain Dealer, 1943c). The tugboat was only deemed stable when the hawser between the tug and the tanker was straight (The Cleveland Plain Dealer, 1943c). The heirs' representatives were able to prove that the hawser was at a 60-degree angle at the time of the incident (The Cleveland Plain Dealer, 1943c).

Despite the court's ruling, today, it is believed that the vessel did not sink from being unstable. The *Admira*l likely sank because of an inexperienced captain, the instability of the vessel, and the weight of the ice (Parker, 1981). The main reason was most likely the weight of the ice on the vessel because the tugboat lies flat on the bottom of Lake Erie and not on its side as if it would have tipped over due to instability (Parker, 1981).

2.8 Discovery of the *Admiral*

The first attempt to locate the *Admiral* was conducted in the spring of 1943 (The Cleveland Plain Dealer, 1942). Three planes from the Civil Air Patrol searched for the men that passed away on the vessel (The Cleveland Plain Dealer, 1942). The pilots were hoping that the decent weather would allow them to spot the tug through clear, calm water (The Cleveland Plain Dealer, 1942). The search was unsuccessful due to the cloudiness of the lake (The Cleveland Plain Dealer, 1942).

Commercial diver George Walton later discovered the *Admiral* in the fall of 1969 with the help of Dwight P. Joyce, the former head of the Glidden Co. (Figure 12) (Griffin, 1969). Walton used a magnetometer to locate the vessel off of Avon Point (Griffin, 1969). The magnetometer is an electronic device that measures variation in the magnetic fields (Griffin, 1969). Walton discovered the wreck as an amateur archaeologist during his own personal time (Griffin, 1969).

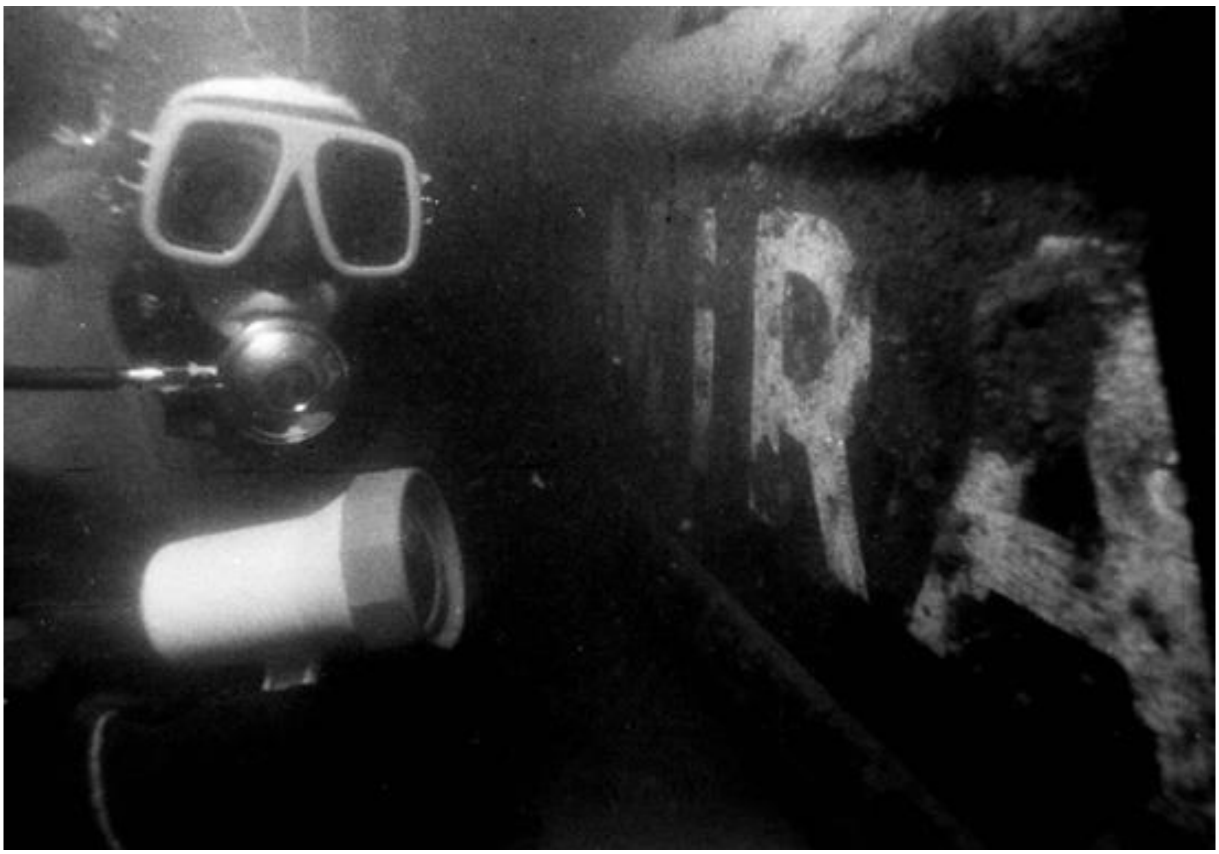


Figure 12. Photograph of George Walton diving on the Admiral before it was damaged by zebra mussels.

Bones of the some of the crew were discovered on the vessel (O'Donnell, n.d.; Melvin, 1985). Scuba diver Joe Suchy reported that he and his team found the bones of several crew members, including a skull (Melvin, 1985). Suchy and his team stated that they buried the bones of the men by the hull of the vessel (Melvin, 1985).

Soon after the site was discovered, a memorial for the fifteen men who lost their lives took place in 1981 (Parker, 1981b). The memorial (Figure 13) occurred off of a coastguard icebreaker (Parker, 1981b). Service was performed by Father Francis X. Klamet of St. Raphael's Catholic Church located in Bay Village, Ohio (Parker, 1981b) (Figure 13). The kin families of the victims attended the service to pay their respects. A total of 25 mourners attended the ceremony (Parker, 1981b).

Figure 13. Photograph of the memorial service was performed by Father Francis X. Klamet of St. Raphael's Catholic Church located in Bay Village, Ohio in honor of the Admiral [Source: Peachman Great Lakes Shipwreck Research Center Files of the Great Lakes Historic

2.9 Artifacts and Salvaged Items

Many items from the *Admiral* have been salvaged or found around the shores of the Great Lakes. The items salvaged directly from the wreck were either donated to museums and other historical societies or seized for personal collections or to be sold. In 1946, a man named James

Coursey discovered the life ring (Figure 14) from the *Admiral* and donated it to the Pennsylvania Sea Grant (Griffin, 1969). He found the ring along the shore of Lake Erie in Pennsylvania within the Presque Isle State Park (Sea Grant Pennsylvania, 2017). After the discovery of the vessel, George Walton brought up a bronze bell that stated *W.H. Meyer*, two lights, and some tools from the *Admiral* (Figure 15)(Griffin, 1969).

Figure 14. Photograph of the life ring from the Admiral found by James Coursey along the shore of Lake Erie in Pennsylvania within the Presque Isle State Park [Source: Sea Grant Pennsylvania, 2017).

Figure 15. Photograph of George Walton from a newspaper with the bell from the Admiral (kept the original W.H. Meyer) bell that is currently on display at the National Museum of the Great Lakes in Toledo, Ohio. [Source: Ohioshipwrecks.org, 2019)]

Scuba divers Bill Tuck, Mike Schaffer, Jack Ott, Jim Paskert, and Al Bailey relocated the wreck in 1981 (Parker, 1981). The scuba divers gathered the following items: Joe Suchy and his dive crew salvaged a lamp, a fire ax, a coffee mug, and a couple of portholes (Melvin, 1985). Suchy took the grease pump and the Captain's binoculars and eyeglasses (which he gave to the Captain's widow who still resided in Cleveland, Ohio, at the time) (Melvin, 1985).

A few of the salvaged items were donated to the National Museum of the Great Lakes and are currently on display today. The following items are on display or in storage: the *W.H. Meyer* bell, a gas can, a light fount, a fountain pen, a rod, a lamp holder, a porthole, an oil can, an inkwell, a deck light with the light bulb, and a toolbox recovered from the engine room (Figure 16).

Figure 16. Photograph of the Gas Can, Running Light Fount, and Oil Can from the Admiral on display at the National Museum of the Great Lakes in Toledo, Ohio. [Source: Photograph taken by Nancy Fisher).

2.10 Dive Site Today

The *Admiral* is still located in the same position where it sunk on December 2, 1942. The wreck is currently at the following approximate coordinates: Latitude: 41° 38’ 14.5788” N Longitude: -81° 54’ 11.88” W (Figure 17) (Shipwrecks and Maritime Tales of Lake Erie Shipwrecks, 2019). The wreck is about 10 miles (16.09 km) northwest of Cleveland, Ohio (Shipwrecks and Maritime Tales of Lake Erie Shipwrecks, 2019). The vessel likes upright on the bottom of the lake and is covered in the invasive zebra mussels (scientific name: *Dreissena polymorpha*) (Figure 18). The following drawing (Figure 19) from Georgann Watcher gives an adequate depiction of how the vessel lies in the silt on the bottom of Lake Erie.

The hull is buried approximately 10 feet (3.05 m) in the silt (Shipwrecks and Maritime Tales of Lake Erie Shipwrecks, 2019). There is a smokestack that lies to the side of the wreck. The water around the wreck varies from below 35F (1.67C) to about 70F (21.11C) (Shipwrecks and Maritime Tales of Lake Erie Shipwrecks, 2019). Visibility on the wreck can vary from 0 feet (0 m) to more than 30 feet (9.14 m) (Shipwrecks and Maritime Tales of Lake Erie Shipwrecks, 2019). Average visibility is probably between 2 feet (0.61 m) and 5 feet (1.52 m) (Shipwrecks and Maritime Tales of Lake Erie Shipwrecks, 2019).

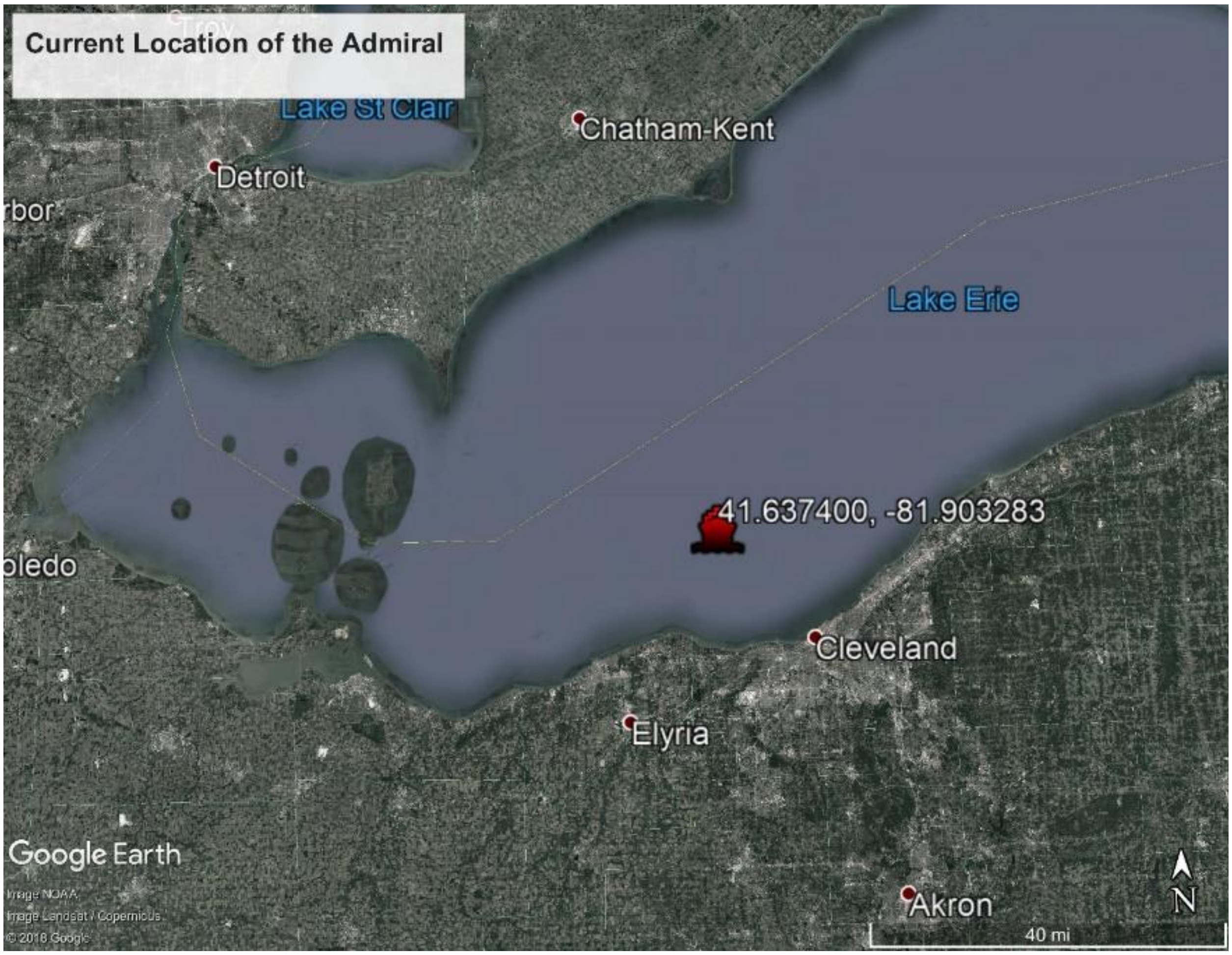


Figure 17 Map of the current location of the Admiral. [Source: Google Earth Pro]

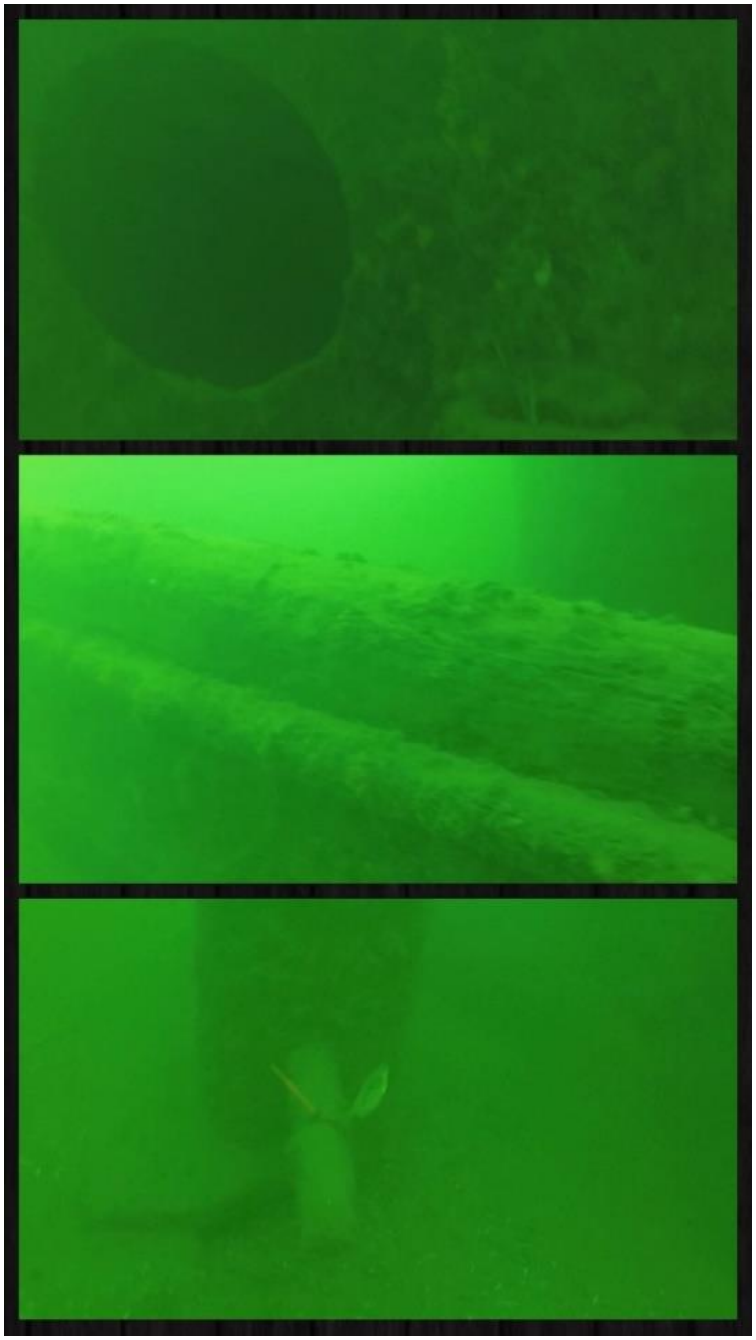


Figure 18. Photos of the Admiral covered in zebra mussels [Source: Photographs taken by Nancy Fisher]

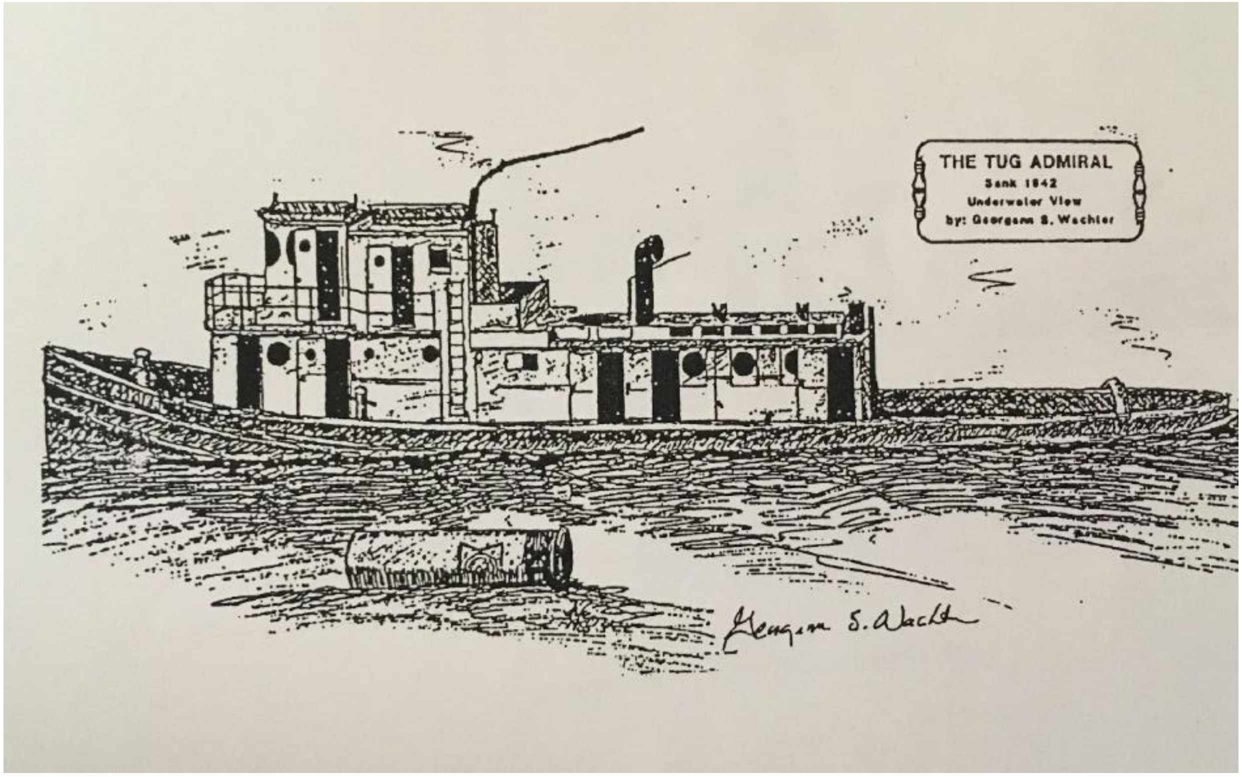


Figure 19. Artist rendition of the shipwreck the Admiral done by George Watcher. Note the wreck site may look different today. [Source: Peachman Great Lakes Shipwreck Research Center Files of the Great Lakes Historical Society]

2.11 Significance of the Site

Cultural heritage on land and underwater are both frequently assessed for their significance (Staniforth, 2002). Their significance can help determine their support from the government, assist in making decisions about the site's future, assist with gaining public or private funding (Staniforth, 2012; Forest 2002b). Many underwater cultural heritage sites are assessed on a case by case basis (Staniforth, 2012). Overall, the broad significance criteria can be defined as "the preservation of which help to trace the history of mankind and its relation with the natural environment" (Forrest, 2002b). Many sites can be determined as having an archaeological, historical, or cultural significance (Forrest, 2002).

Ships have not only helped distribute food, fuel, and other needs, but they also helped people discover new places and help shape and provide useful information about our ancestors (Forrest, 2002). Ships are as much as part of human evolution, as is fire. They represent the people and technology of their time and are commonly referred to as time capsules. Shipwrecks provide archaeologists and citizen scientists with a variety of evidence: (1) the naval architecture of the vessel and her equipment, (2) their mode of propulsion, (3) the vessels main and original purpose, (4) the lives of the men on board (Strati, 1995). The Australian government provides specific criteria to measure a wreck's and its evidence significant. The criteria are listed as the following (not all are listed):

a) Significance of the article in the course, evolution, or pattern of history
b) Significance of the article in relation to its potential to yield information contributing to the understanding of history, technological accomplishments, or social developments
c) The significance of the article in its potential to yield information about the composition and history of cultural remains and associated natural phenomena through an examination of physical, chemical or biological processes;
d) Significance of the article in representing or contributing to technical or creative accomplishments during a particular period
e) Significance of the article for its potential to contribute to public education
f) Significance of the article in possessing rare, endangered, or uncommon aspects of history (Federal Register of Legislation, 2018).

Based on several criteria, the *Admiral* wreck should be considered as a significant site. First and foremost, the site should be regarded as a resting place for 15 men (names listed above). The manual from UNESCO (United Nations Educational, Scientific and Cultural Organization) states that human remains and final resting places should be treated with respect, considered as scientific, and not be disturbed (Maarleveld, Guerin and Egger, 2013). The wreck is also a prime example of a 20th-century steel tugboat since the vessel's shape is considerably intact, which highlights technological accomplishments and history from the 20th century. The modifications completed on the wreck makes the ship distinctive. Some of the artifacts that have been recovered and preserve also demonstrate social developments from the 20th century. The shipwreck demonstrates the unique use of tugs in distribution within the Great Lakes. The wreck also tells an extraordinary story that involves 33 men, a story that involves living ancestors and a story that can educate the masses.

Chapter 3 – Citizen Science

3.1 Background

Before the 19th-century, science was conducted by citizens and not by paid professionals (Silvertown, 2009; Sbrocci, 2014). The growth of the profession in the early 20th-century led to a decrease in collaboration with the general public (Sbrocci, 2014). The public's involvement increased after the term "citizen science" was coined in the early 1990s (Sbrocci, 2014). Citizen science is utilized by many fields to educate and involve the public (Riesch and Potter, 2014; Scott-Ireton, 2014; Poliakoff and Webb, 2007). Participants provide needed assistance while gaining unique life experience and newfound knowledge and skills (Cohn, 2008; Sbrocci, 2014; Jordan *et al.*, 2011). Citizens' participation in research can change their attitude and behavior toward science, which can lead to positive growth within many fields of science with the right design (Sbrocci, 2014; Jordan *et al.*, 2011; Arcanjo *et al.*, 2016; Poliakoff and Webb, 2007). Citizen science is seen either as a "win-win situation" or as an ethical concern by professional scientists (Risech and Potter, 2014). Despite some concerns, many citizen science projects have successfully advanced scientific knowledge and have allowed science to become more attainable to the general masses (Risech and Potter, 2014).

The term 'citizen science' was coined by Alan Irwin in 1994 in the U.K. However, others argue Rick Bonney coined the term in the U.S. in the mid-1990s (exact date not found) (Risech and Potter, 2014; Silvertown, 2009; Caitlin-Groves, 2012; Follet and Strezov, 2015). Bonney's definition focuses on public engagement, while Irwin's definition focuses on a methodology that allows the science and research to become more available to the public (Risech and Potter, 2014; Jordan *et al.*, 2011). Initially, citizen science was applied to data collection. However, it was later expanded and allowed citizens to participate within the scientific process once citizen science became more defined and viewed as a field of study (Mankowski *et al.,* 2011; Dickinson *et al.,* 2010).

The Cornell Lab of Ornithology provides a more current definition of citizen science, "projects in which volunteers partner with scientists to answer real-world questions and help conduct research (Citizen Science Central, 2013; Riesch and Potter, 2014; Cohn, 2008; Sbrocci, 2014; Morais and Santos, 2015)." However, Jordan (*et al.* 2012) offers a broader definition, "partnerships between scientists and non-scientists in which authentic data are collected, shared, and analyzed." Despite which definition may be preferred, citizen science is utilized to increase research efforts, broaden educational impacts, help fields stay relevant to the public, and modernize certain studies (Jordan *et al*., 2012; Morais and Santos, 2015). Overall, the public has been a part of the observation, measurement, classification, annotation, or computation with little to no scientific training for a variety of different project (Danielsen *et al.,* 2009; Conrad and Hilchey, 2011; Arcanjo *et al.,* 2016; Morais and Santos, 2015). Today, the term citizen science can vary based on its application within the different scientific fields such as zoology, biology, astronomy, or archaeology (Sbrocci, 2014; Jameson, 1997; Staniforth, 1994)

Citizen science has been consistently useful toward projects collecting large volumes of data over a large geographical range or collecting data within various time intervals such as long-term monitoring (Follet and Strezov, 2015; Silvertown, 2009; Cohn, 2008, Dickenson *et al*., 2010). Citizen science also helps projects with constraints in funding; many of the original citizen scientist projects were for long term ornithology projects with unpaid field assistants (Cohn, 2008; Caitlin-Groves, 2012).

Projects in the past helped follow the spread of invasive species, detail the impact of land use or climate change, and help understand species distribution ranges (Caitlin-Groves, 2012;

Follet and Strezov, 2015). Project objectives ranged from scientific investigations to public action campaigns (Follet and Strezov, 2015). The USA, Australia, India, Canada, UK, and Russia are some of the most common countries utilizing citizen science (Conrad and Hilchey 2011; Danielsen *et al*., 2009). Citizen science can also be used in developing countries to help make up for a (1) lack in management, (2) lack in awareness, (3) lack in technology, and (4) a lack in policing (Ridwan, 2011).

Citizen science projects build a partnership between the participants and the scientists (Cohn, 2008). The most current citizen science projects are (1) education outreach, (2) natural resource monitoring, (3) social activism, and (4) information and communication technology (ICT) mediated (Caitlin-Groves, 2012, Scott-Ireton and McKinnon, 2015). ICT is any information communications technology that provides a platform where the correspondence of different knowledge can be delivered in a teaching and learning environment (Caitlin-Groves, 2012). Projects typically are run through either one-on-one communication or a standalone website (Caitlin-Groves, 2012).

An increase in studies utilizing citizen science can be observed through the growth and diversity of scientific publications citing the use of citizen science (Sbrocci, 2014; Follet and Strezov, 2015). This highlights the importance of the field. Past publications have focused on the history, framework, issues, best practice for engaging citizen scientists, social outcomes, needs of management, methodology, outcomes, and validation techniques of citizen science (Sbrocci, 2014; Follet and Strezov, 2015). Researchers have also focused on how the public integrates into the different steps of the scientific process (Wiggins and Crowston, 2011). The public will stay active as long as their personal development and well-being is a focus on citizen science projects (Sbrocci, 2014). Citizen science can be a powerful tool for scientists and the well-being of its participants (Sbrocci, 2014). Defining a project's goals, objectives, and degree of participation before execution will allow the project a higher chance to be successful.

3.2 Two Classifications for Citizen Science

There are two classifications to help define projects within the field of citizen science. The two different classifications come from Sbrocci (2014) and Wiggins and Crowston (2011). This section will review both classifications and use one to help define the citizen science group MAST.

The first classification is based on the interaction between the public and the professionals and the nature of the public involvement (Jordan *et al.*, 2011; Follet and Strezov, 2015). The classification consists of three models. The models allow scientists to define their relationship and the amount of involvement with the citizens from the beginning. The three models are (1) Contributory, (2) Collaborative, and (3) Co-Create (Sbrocci, 2014; Wiggins and Crowston, 2011).

The Contributory model is when scientists work with the public to collect the data and the public occasionally analyzes the results (Sbrocci, 2014; Follet and Strezov, 2015). The research design follows a top-down method with the designs and questions coming from the scientists (Jordan *et al.*, 2011). Most peer-reviewed literature focuses on the Contributory model (Sbrocci, 2014). The Collaborative model is when the citizens help the scientists collect as well as analyze the data (Sbrocci, 2014). Citizens occasionally assist with the design, interpretations, and conclusions of the projects (Sbrocci, 2014). The Co-create model is when the citizens are a part of all of the stages in the research (Sbrocci, 2014; Wiggins and Crowston, 2011). Citizens help define the questions, form the hypothesis, and draw the conclusions (Sbrocci, 2014). Co-create offers the highest level of interaction between the scientists and the citizens, meaning that designs are from a bottom-up reflective approach (Opgenhaffen *et al.*, 2018; Sbrocci, 2014).

Shrik (*et al.*, 2012) added two additional models to the CCC classification: contractual and collegial (Shrik *et al.*, 2012). Contractual projects are when communities (local citizens) hire professionals to conduct and report specific research investigations (Shrik *et al.*, 2012). Collegial projects are when citizens conduct research independently with expected recognition by either an institution or professionals (Shrik *et al.*, 2012).

As previously mentioned, the second classification of citizen science models was designed by Wiggins and Crowton (2011). They assigned citizen science projects one of five typologies based on the goals and participation techniques of the study (Wiggins and Crowton, 2011). The five typologies are (1) Action, (2) Conservation, (3) Investigation, (4) Virtual, (5) Education (Cailtin-Groves, 2012; Follett and Strezov, 2015, Wiggins and Crowton 2011). Some projects would be defined with a primary and secondary typology because some projects cannot be defined by just one (Wiggins and Crowston, 2011). The typologies highlight a project's demographics, types of outcomes, affiliations, different technological features, project design, and funding sources (Wiggins and Crowston, 2011). Wiggins and Crowston (2011) developed the models to help future projects better identify their purpose and gather helpful inspiration from similar past projects.

Action projects employ participants in action-based research to encourage and empower the participants to join in local concerns (Caitlin-Groves, 2012; Scott-Ireton, 2014; Follett and Strezov 2015). Many of these projects are designed by the citizens and viewed as ‘bottom-up’ organizations (citizen built) (Wiggins and Crowston, 2011). Most action projects are published in societal publications like newspapers, television, presentations, websites, and social media

(Follet and Strezo, 2015). The results are meant to be shared with a wide range of audiences instead of scientific publications only (Follet and Strezov, 2015).

Conservation projects are designed to address natural resource management goals and are commonly used in outreach in ecology (Caitlin-Groves, 2012; Follett and Strezov 2015; Wiggins and Crowston, 2011). The participants assist with the outreach but are mainly involved with data collection (Caitlin-Groves, 2012; Wiggins and Crowston, 2011). Most conservation projects have specific educational goals and content. These types of projects are excellent for large geographical regions. Many projects are affiliated with state or federal agencies (Wiggins and Crowston, 2011).

Investigation projects focus on scientific research goals based on collecting data from a physical environment (Caitlin-Groves, 2012; Follett and Strezov, 2015). The projects start with a set hypothesis or research goal (Caitlin-Groves 2012). Over half the articles on citizen science highlight Investigation projects, making it one of the more popular typologies in the Wiggins & Crowston classification set (Follet and Strezov, 2015). Education goals are strongly valued but not always stated or measured (Wiggins and Crowston, 2011). Many provide educational materials and include ongoing learning opportunities (Wiggins and Crowtson, 2011). These projects range from regional to international and can have high participation levels (Wiggins and Crowston, 2011).

Virtual projects are similar and will share common goals with the Investigation typology (Caitlin-Groves, 2012). However, these projects are entirely based on information technology and have no physical element (Caitlin-Groves, 2012; Follett and Strezov, 2015). Virtual projects are the fastest-growing category (Follet and Strezov, 2015). Virtual projects can connect volunteers through smartphones, tablets, notebooks, and laptops (Arcanjo *et al.*, 2016). Many projects go virtual to lower long-term costs and gain a larger global audience (Morais *et al.*, 2015; Arcanjo *et al.*, 2016). Virtual projects can increase the efficiency of data collecting, find data outliers, and make it easier to motivate a broad audience (Arcanjo *et al.*, 2016). Social media, like a community Facebook page, have become a powerful tool for virtual projects (Opgenhaffen *et al.*, 2018). Many virtual projects compare the results done by scientists to the results from the citizen scientists to test for validation (Follet and Strezov, 2015).

Education projects focus on education and outreach and are often found in classroom-based settings (Caitlin-Groves, 2012; Follett and Strezov, 2015). The data collected can be meaningful to the researchers; however, it can also solely be collected for educational purposes (Caitlin-Groves, 2012). These projects often provide informal and formal learning resources (Caitlin-Groves, 2012). Each project is typically designed to an intended audience such as young children or collegiate level students (Wiggins and Crowston, 2011). Education projects are rarely published, and the aspects of the project normally stay within the boundaries of the teachings (Follet and Strezov, 2015).

As previously mentioned, the above models and typologies are meant to be used by both the citizens and the scientists to help them organized and form their projects. They help others outline their specific goals and intended benefits for their future projects. Predefining their project can also help them find similar projects to reference back to for inspiration and further help with the organization.

3.3 Design and Benefits of Citizen Science Projects

The design and methods behind every citizen science project center around the purpose of the data, the project goals, and the scientific question (Riesch and Potter, 2014; Bonney *et al.*, 2009). The desired learning outcome for the researcher and the citizens should be set and well outlined at the start of every project unless the intent of the project is to investigate a particular environment (Sbrocci, 2014; Risech and Potter, 2014; Morais and Santos, 2015; Jordan *et al*., 2012) The outcomes help direct the project to the correct citizen-scientist interaction for each project (Sbrocci, 2014). The goals of the communities can also influence the project design (Sbrocci, 2014). The public satisfaction of a project depends on the level of participation, the overall experience, and the amount of support they receive. Personal satisfaction among the citizens and enjoyment should be a goal for every project (Sbrocci, 2014; Poliakoff and Webb, 2007). A successful design will have a proper choice in methodology, training, support, and supervision (Sbrocci, 2014). The more successful designs have citizens and scientists interacting from the first development phase (Sbrocci, 2014).

Scientists need to be realistic in what their projects can achieve (Sbrocci, 2014; Arcanjo *et al*., 2016; Jordan *et al*., 2012). Setting impossible standards can be destructive and stressful for both the citizens and scientists (Bonney *et al*., 2009). It can take much effort to successfully design and manage a successful citizen science project (Bonney *et al*., 2009). Many researchers today study and focus on how to improve citizen science projects (Mankowski *et al*., 2011). Bonney (*et al*., 2009) developed a model to help project developers successfully recruit, research, and educate the citizens. The model contains nine separate steps: (1) have a specific scientific question, (2) form a proper team, (3) design, test, and polish protocols, education materials, and any other forms needed, (4) recruit the participants, (5) properly train the participants, (6) accept, edit, and display the data, (7) interpret the data, (8) yield the results, and (9) measure the outcomes of the project. A detailed description of each step can be found in the article "Citizen Science: A Developing Tool for Expanding Science Knowledge and Scientific Literacy" (Bonney *et al*., 2009). Other methodology research focused on an individual's ability to adapt, the incorporation of any artificial intelligence, management of extensive data, methods to combine a variety of datasets, and how to meet project aims (Follet and Strezov, 2015).

Citizens have proven that they can be competent and participate in the development of the research question, in designing studies, and analyzing and interpreting the data (Sbrocci, 2014; Jordan *et al.*, 2012). It is vital to explain the project's importance and significance and provide proper training to the citizens (Bonney *et al.*, 2009). The degree of training will vary per each citizen and every project. The scientist and the citizens should gain a similar vocabulary, and both be aware of the overall context behind the project (Jordan *et al.*, 2011).

Comprehensive and engaging materials and feedback should be administered to the citizens (Bonney *et al.*, 2009) (Jordan *et al.*, 2011). Citizens can't improve if they are unaware of any issues relating to their performance (Sbrocci, 2014). Support materials include identification guides, posters, manuals, videos, podcasts, newsletters, and FAQ pages (Bonney *et al.*, 2009; Cohn, 2008). Interval testing and questioning help the success of a project through background, quizzes, and refreshers (Bonney *et al.*, 2009; Sbrocci, 2014; Mankowski *et al.*, 2011). Clear protocols and proper support can lower the chance for bad data quality (Bonney *et al.*, 2009). Protocols should be tested with a small audience and be modified before being utilized (Arcanjo *et al.*, 2016; Bonney *et al.*, 2009; Sbrocci, 2014). Projects can have data be submitted by paper, online, on social networking sites, by a mobile phone, and through data mining (Caitlin-Groves, 2012).

A sense of community among the citizens is vital for projects as well (Mankowski *et al.*, 2011). The scientific and social aspects of a project should get equal focus in order to maximize the benefits of the citizens' participation (Sbrocci, 2014). It is key to be kind and friendly because the citizens will be motivated to join and return (Mankowski *et al.*, 2011; Lee *et al.*, 2017; West and Pateman, 2017). When people believe that their actions are being valued and respected by others, they tend to stay with the commitment and spread their work and message to others (Lee et al., 2017; West and Pateman, 2017) A positive environment also helps the citizens retain information (Mankowski *et al*., 2011). Public forums and open communication help create a positive environment (Mankowski *et al.*, 2011). Case studies found that participants are more willing to learn and gather when they trust scientists (Cronje *et al*., 2011). Proper communication like collaborative exchange can help build trust (Jordan *et al*., 2011).

Surveys, questionnaires, follow-up interviews, and collaborative meetings can help measure the citizens' trust, true motivation, and overall comfort level (Jordan *et al*., 2011; Morais and Santos, 2015). Open-ended questions and anonymous answers can increase the citizens' willingness to participate in surveys and questionnaires (Jordan *et al*., 2011). Online forums and in-person gatherings can help build teamwork and build bonds (Fortson *et al*., 2012). Citizens who genuinely understand the projects will realize their direct effect on the research (Cronje *et al*., 2011). The social aspect of the process has to be enjoyable as well. The richer the experience, the lower the turnover rate (Sbrocci, 2014).

Recruiting participants for citizen sciences projects can be daunting. Recruitment can happen through press releases, direct mailings, advertisements, magazine and newspaper articles, brochures, flyers, presentations, posters, and workshops (Bonney *et al*., 2009). Recruitment materials should be targeted toward their specific audience. Audiences can range from grade school students to grandparents (Cohn, 2008). Often, members of citizen science projects, like in nautical archaeology projects, have been students, landholders, activists, fishermen, and scuba divers (Sbrocci, 2014). Long-term projects have a better chance of recruiting people (Caitlin-

Groves, 2012). The web has become a useful tool in recruiting. Many projects use the web for marketing, advertising, retention, sharing, and data collecting (Caitlin-Groves, 2012).

Many studies focus on the reasons why participants are a part of specific studies and what benefits they have gained (Follet and Strezov, 2015). Many citizens join a project because they are passionate about the field of science (Cohn, 2008; Sbrocci, 2014), whether the field is astronomy, biology, ecology, or archaeology (Mankowski *et al*., 2011; Fortson *et al*., 2012; Morais and Santos, 2015). A survey from Galaxy Zoo demonstrated that citizen scientists were motivated to participate because they contributed to real astronomy research (Fortson *et al*., 2012). Learning about science is another crucial motive; the projects expose the citizens to the scientific process and to unique contents to a field they could not get elsewhere (Lee *et al*., 2017; West and Pateman, 2017). Through a study conducted by Lee (*et al*., 2017*)*, citizen scientists have also stated that contributing to the field is one of the most important motivations to participate. Citizen's data is used by scientists within the field and also have the possibility of becoming published (Cohn, 2008; Follet and Strezov, 2015). Another last motivation is altruism, which is a quality retained by some people whose focus on is something or someone other than themselves (Lee *et al*., 2017; Merrium-Webster, n.d.) A few studies have found that people have joined because they want to focus on doing something good for others within a certain community (Lee *et al*., 2017; West and Pateman, 2017). One of the last motivations for people to join a project is for career motivation (West and Pateman, 2017). The citizens hope to gain new skills and experience that could help benefit or advance them within their careers (West and Pateman, 2017).

After recruitment and at the end of data collection, all of the material can be edited and analyzed by both scientists and citizen scientists (Bonney at al., 2009). If the data is to be made available to the public, then the raw data should be available at any time. As previously mentioned, some models or classifications may not require the data to become available to the citizens. Scientists can present their data to the public through forums, blogs, and other open access platforms (Opgenhaffen *et al.*, 2018). The study and manipulation of the data is a tremendous educational opportunity for citizens. However, data sets should be 'cleaned' before being analyzed. Outliers should be removed by either the citizen scientists or the professionals (Caitlin-Groves, 2012).

Every project should measure their outcomes to be sure that both the scientific and educational goals are attained for the project, community, and individual citizens (Bonney *et al*., 2009; Sbrocci, 2014; Wiggins and Crowston 2011; Jordan *et al*., 2012; Jordan *et al*., 2011). Their outcomes can be reflected in the knowledge and improved scientific literacy among the citizens (Bonney *et al*., 2009). Evaluations should measure the strengths and weaknesses of every project (Jordan *et al*., 2012; Morais and Santos, 2015).

Some projects' overall impacts and outcomes can be measured by the: (1) number of papers published in peer-reviewed journals, (2) number of citation results, (3) number of grants, (4) quality of databases, (5) number of graduate theses, and (6) the amount of media exposure (Bonney *et al*., 2009). Citizens can also gain stewardship action, have a change in behavior, an increase in skills and/or knowledge, an appreciation for data collection, and learn how to properly use the scientific process (Sbrocci, 2014; Jordan *et al*., 2011; Trumball *et al*., 2000). The community or local society can gain political awareness for specific issues, gain more decision-making power in certain scientific fields, highlight local conservation needs, limit some stakeholder engagement, and help people from underrepresented communities bring up local concerns and needs to the scientists (Sbrocci, 2014). The scientific literacy outcomes are based on (1) the understanding, (2) the participant's attitudes, and (3) the interest toward the project and the scientific field (Bonney *et al.*, 2009). Surveys are commonly used to test and evaluate the participants' scientific literacy (Cronje *et al.*, 2011; Morais and Santos, 2015). It is important to evaluate an individual's learning outcome because (1) it can help managers improve the project's outcome, (2) help find new audiences, (3) promote the learning opportunities, and (4) increase the projects term length and overall impact (Jordan *et al.*, 2012).

Additional information for designing, implementing, and evaluating citizen science projects can be found on the website www.citizenscience.org (Bonney *et al*., 2009). The website can aid in project development and data management (Sbrocci, 2014).

3.4 Ethics and Concerns in Citizen Science

Citizen science projects need to center around the benefits of the local communities and the citizens. The projects tend to be is more detailed than most other public engagement projects (Risech and Portter, 2014). Many public engagement activities are considered to be an informal scientific activity to raise awareness and bring education to the masses (Risech and Potter, 2014). Public engagement is commonly defined as "the use of appropriate skills, media activities, activities and dialogue to produce one more of the following personal responses to science: awareness, enjoyment, interest, opinion-forming, and understanding (Poliakoff and Webb, 2007)." Citizen science is a type of public engagement that gives citizens the chance to gather real scientific data and help with research with a project using the scientific method (Risech and Potter, 2014; Caitlin-Groves, 2012). The citizens' active engagement in scientific work differentiates it from other public engagement volunteer projects (Wiggins and Crowston 2011).

Citizen projects should always give something back to the citizens and never use citizens for free labor (Risech and Potter 2014, Silvertown, 2009). The treatment of citizen scientists can affect many aspects of the project; for example, the recruitment process (Risch and Potter, 2014). The citizens' needs should be supported as they freely give the project their time, effort, and/or personal funds (Sbrocci, 2014). The barrier between the scientists and the citizens should be removed, and the citizens should become equal and valid contributors (Risch and Potter, 2014). There should never be a cast system; scientists should never look down on the citizens for being amateurs (Mankowski *et al*., 2011). Citizen scientists are more impactful when they are kept informed about the various aspects of the project and not kept in the dark (Fortoson *et al*., 2012). Citizens will stay on a project as long as they feel they are useful and helpful (Fortson *et al*., 2012). No question should be considered a stupid question; openness is all a part of the learning process (Mankowski *et al*., 2011)

For some scientists, citizen science can be seen as disruptive towards their research and studies (Risech and Potter, 2014). Many scientists believed the citizens' skills could not compare to the professionals (Dickenson *et al*., 2010). However, many research institutions require grant holders to participate in some form of public outreach (Silvertown, 2009). Now a large portion of scientists focuses their research on new ways to engage the public in their field of study (Poliakoff and Webb, 2007). Three factors can be used to predict a scientist's willingness to conduct and participate in a citizen science project: (1) positive point of view on public participation, (2) trust toward the participants, and (3) their colleague's willingness to respect the project (Poliakoff and Webb, 2007).

Career recognition and time management also use to be frequent reasons for scientists to defer from citizen science (Poliakoff and Webb, 2007). Professors who conduct research were more likely to participate in citizen science (Poliakoff and Webb, 2007). However, the overall reception of citizen science by the scientific community has been positive. Many understand how public participation and citizen science can benefit their career and their field (Poliakoff and Webb, 2007). Every success in the study of citizen science motivates other scientists to explore how citizens can contribute to their research and projects (Wiggins and Crowston, 2011).

Bias by publications against citizen science can be based around the quality of the data (Sbrocci 2014, Risech and Potter, 2014). In 2014, Risech and Potter found the number one problem scientists had with developing and designing citizen science projects was data quality. Many had concerns if the data would be valid and accepted by the scientific community and peer-reviewed journals (Risech and Potter, 2014). Follet and Strezov (2015) have found an increase in studies relying on the use of datasets from past citizen science studies. Many published articles may not state the use of citizen science data; however, they do acknowledge that the data could not have been collected without citizens (Follet and Strezov, 2015). Three main factors can influence the quality of the data from citizen scientists: (1) design and execution of sampling methods (2) training methods, and (3) the quality assurance methods (Sbrocci, 2014; Follet and Strezov, 2015). The design of the projects should always be clear and concise (Caitlin-Groves, 2012). However, any doubt in the data should become the responsibility of the designer of the study (Sbrocci, 2014). Sparse data comes from problems in methodology, design, and communication (Sbrocci, 2014). Data can also be checked by comparing the data collected from the citizens to data collected from the scientists and/or experts (Sbrocci, 2014). However, the expert's accuracy should also be evaluated to avoid any bias (Sbrocci, 2014). Accuracy should never be rely on assumptions (Sbrocci, 2014)

Another central question in citizen science is who should be able to view and use the data. Should the data be made available to the public? As previously mentioned, every citizen science project must touch base on this issue (Risech and Potter, 2014). Most supporters of citizen science believe that the data should be made public, and the scientist should keep the people updated on what the data is being used towards (Risech and Potter, 2014). Since the citizens are 'co-producers' of the data, then the data should partially be in their hands (Risech and Potter, 2014). The results and data should be available to the citizens for free as well (Bonney *et al*., 2009).

Science by the people will soon be trending with the increase of citizen science projects. Scientists will attempt to learn about the benefits of the growing field of citizen science (Silvertown, 2009). People learn and understand best by doing. Citizen science will continue to grow and expand into different scientific fields and eventually become a distinguishable field of science on its own (Follet and Strezov, 2015).

3.5 Citizen Science in Maritime Archaeology

Citizen science in maritime archaeology and archaeology, in general, is utilized to collect and monitor mass datasets (Smith, 2014). Most of the mass data sets are collected through citizen scientists or students but managed by professional archaeologists (Smith, 2014). Common examples of when students or the public can contribute to datasets are through field schools, public and community archaeology, museum events, volunteer surveys, and site-monitoring programs (Smith, 2014). Many of these projects are done in smaller groups and are monitored by professionals. The professionals also commonly control the outputs, the parameters, media, and lectures associated with the data (Smith, 2014). Citizen science can help solve any "professional labor bottleneck" while contributing to the need for more public engagement in archaeology (Smith, 2014). Citizen scientists can help with imagery, fieldwork, historical records, and data entry (Bonney *et al.,* 2009). They should be kept up to date with the goals, expectations, and outcomes of the project (Bonney *et al.,* 2009).

Citizen science has just recently been integrated into land and maritime archaeology within the last two decades (Sabloff, 2016). The field essentially combines public archaeology and community archaeology. Public archaeology is commonly defined as any aspect within archaeology that relates to the public interest, such as communication with certain public interest groups through cultural resource management (Sabloff, 2016). The aim is to connect archaeology to a broader audience. This is similar to community archaeology (Marshall, 2002). Community archaeology is planning and implementing projects that are of the direct interest of the local community (Marshall, 2002). The community should be involved with planning the research questions, formulating the project, fieldwork, data collection, analysis, storage and distribution, and public demonstration (Marshall, 2002).

The most traditional form of citizen science in archaeology is field schools. Field schools allow students to engage in the scientific experiment with the help of professionals and learn how to foster relationships with the local community (Smith, 2014). The experience is often costly and exclusive (Smith, 2014). Many historical societies are non-profit avocational groups that dedicate their time and funds to their data collections, field recordings, and publications. The groups should comply with the local laws and any federal requirements (Smith, 2014). They are generally self-funded, and much of their fieldwork is accomplished through donations. Their fieldwork responds to the local situations and can make it easier to accomplish year-round fieldwork (Smith, 2014). The Maritime Archaeological Survey Team of Ohio (MAST) (http://www.ohiomast.org/) records, advocates, monitors, and preserves the local shipwrecks of Lake Erie and is an excellent example of an avocational archaeology group. MAST is the focal point and will be discussed in further detail later on. Other community and avocational underwater archaeology groups and their Wiggins and Crowston (2011) typologies are listed in Table 2 below:

Table 2. Other Underwater Archaeology Citizen Science Groups

Organization	**Location**	**Typologies**	**Links**
Diving with a Purpose	Nashville, Tennessee	Education	https://divingwithapurpose.org/
SHIPS - Shoreline Heritage Identification Partnerships Strategy	Boston, Massachusetts	Action & Conservation	https://www.mass.gov/service-details/buar-shoreline-heritage-identification-partnerships-strategy-ships
SSEAS - Submerged Sites Education and Archaeological Stewardship	Pensacola, Florida	Education & Conservation	chrome-extension://oemmndcbldboiebfnladdacbdfmadadm/http://www.flpublicarchaeology.org/documents/SSEAS.pdf
ARMHT - Apalachicola River Maritime Heritage Trail	Pensacola, Florida	Investigation, Education, & Conservation	https://www.flpublicarchaeology.org/about/interns.php
BAREG - Battle of the Atlantic Shipwreck Study	Washington D.C.	Investigation, Education, & Conservation	https://www.citizenscience.gov/catalog/405/#
MARC - Marine Archaeological Research and Conservation, Inc.	Florida	Investigation & Education	https://www.nps.gov/articles/preservationpartners.htm
UASC - Underwater Archaeological Society of Chicago	Chicago, Illinois	Investigation, Action, & Conservation	https://www.uaschicago.org/
LAMP - St. Augustine Lighthouse Archaeological Maritime Program	St. Augustine, Florida	Investigation & Conservation	http://www.staugustinelighthouse.org/explore-learn/research-archaeology/
MMAP - Maryland Maritime Archeology Program	Crownsville, Maryland	Investigation	https://mht.maryland.gov/archeology_underwater.shtml
MAHHI - Maritime Archaeology and History of Hawaiian Islands Foundations	Honolulu, Hawaii	Investigation, Action, & Education	http://www.mahhi.org/

In many disciplines, including maritime archaeology, citizen science has significant impacts on the formation and execution of many research projects. Based on the evidence presented in this chapter, the field of citizen science allows the citizens to contribute to scientific research. The contribution is beneficial for both the citizens and scientists. This paper will explore the benefits of citizen science on-site recording and monitoring on sites similar to the *Admiral.* The goal is to explore the values of citizen science as a tool for maritime archaeology, especially when there a limitation in time and funding for a sizable project with reduced paid labor.

Chapter 4 - MAST (Maritime Archaeological Survey Team) – A Great Lakes Citizen Science Group

4.1 Start of MAST

MAST was founded in March of 2000 in response to the Abandoned Shipwreck Act (Pub. L. 100-298; 43 U.S.C 2101-2106) that signed into effect on April 28, 1988 (National Park Service, 1990). Under the act, the United States transferred the responsibility of abandoned shipwrecks to the states they are located in (National Park Service, 1990). Guidelines under the act are intended to improve the work conducted on the underwater cultural resources and help develop a relationship between sport divers, fishers, archaeologists, salvors, and interest groups (National Park Service, 1990). The law is meant to help recreational divers safely dive on the significant wrecks and help interest groups engage in shipwreck discovery, preservation, and conservation (National Park Service, 1990). It is important to note that the guidelines are advisory and non-binding (National Park Service, 1990).

The guidelines for the Abandon Shipwreck Act are listed below:

<u>The Abandoned Shipwreck Act Guidelines</u> (54 FR 13642, April 4, 1989) (National Park Service, 1990)

a) Locate and identify shipwrecks;
b) Determine which shipwrecks are abandoned and the criteria for assuming title under the Abandoned Shipwreck Act;
c) Determine which shipwrecks are historic;
d) Identify recreation and other values that a shipwreck may possess and the shipwreck's current and potential uses;
e) Provide for the long-term protection of historic shipwrecks;
f) Protect the rights of the owners of the non-abandoned shipwrecks;
g) Consult and maintain a cooperative relationship with various shipwreck interest groups;
h) Cooperate with State and Federal agencies and sovereign nations having an interest in shipwreck management;
i) Provide sport divers with reasonable access to explore shipwrecks;
j) Provide for public appreciation, understanding, and enjoyment of shipwrecks and maritime history;

k) Conduct archaeological research on shipwrecks where research will yield information important to understanding the past;
l) Provide for private sector participation in shipwreck research projects; and
m) Provide for commercial salvage and other private sector recovery of shipwrecks when such activities are in the public interest.

Comments and suggestions for the guidelines came from the public, State Federal Agencies, and various interest groups (a total of 66 individuals and organizations) (National Park Service, 1990). The guidelines provide a basis for and assist with shipwreck management, and intend for wrecks to be accurately surveyed, identified, evaluated, documented, interpreted, and protected (National Park Service, 1990). They also assist groups in conserving, storing, and maintaining any artifacts or archives related to the shipwrecks and other underwater cultural resources (National Park Service, 1990). Overall, the guidelines help state and federal agencies manage and control shipwrecks ownerships in their waters (National Park Service, 1990).

The Abandoned Shipwreck Act guidelines are divided into four parts (National Park Service, 1990). Part I provides individuals and organizations with essential definitions and terms. Part II contains regulations for the management of the shipwrecks, such as control or ownership, for the State and Federal agencies. Part III outlines the Abandoned Shipwreck Act that was passed by the United States Congress and signed by the President. Part IV provides a list of the shipwrecks that are currently listed or are determined eligible to be listed in the National Register of Historic Places (National Park Service, 1990).

In conjunction with the Abandon Shipwreck Act, the state of Ohio passed the Ohio Shipwreck Law (Code 1506.36) in 1993 (MAST Ohio, 2006). The governor then appointed the Submerged Lands Advisory Council (SLAC) to be a guide in maritime cultural resources to the Directors of the Ohio Historical Society (OHS) and the Ohio Department of Natural Resources (ODNR) (MAST Ohio, 2006). The SLAC represented the opinions of groups related to the lakes such as fishermen, lawyers, teachers, historians, salvors, sport divers, and other related interest groups (MAST Ohio, 2006).

The SLAC was responsible for the following: (1) develop salvage procedures and forms, (2) create a simplified version of the Ohio Shipwreck Law, (3) produce informative posters, (4) review and advise salvage requests, (5) educate divers in maritime archaeology through workshops, (6) place specific mooring buoys near shipwrecks, and (6) work toward preserving underwater cultural resources (MAST Ohio, 2006). The SLAC ended in 2004 and passed their work on to others (MAST Ohio, 2006).

4.2 Background of MAST

MAST was initially formed by Linda Pansing, Scott Pansing, Dr. Charles "Eddie" Herdendorf, and Joyce Hayward, some of whom were underwater archaeology students (MAST Ohio, 2019). The idea for MAST formed around 1996 to 1997 and the group was supported by the SLAC (MAST Ohio, 2006; MAST Ohio, 2019). The Submerged Lands Advisory Council also supported the founding of MAST in 1999 (MAST Ohio, 2019).

4.3 MAST Projects and Affiliations

MAST operates as a 501©3 non-profit organization. MAST has members from Ohio, the surrounding states, and Canada (MAST Ohio, 2019). MAST's overall mission statement is the following: "dedicated to the documentation, scientific study, and education about underwater cultural resources" (MAST Ohio, 2019). MAST's first initiative after formation was to take over the SLAC buoy venture, which focused on placing buoys near significant wrecks within Lake Erie to protect them from anchoring (MAST Ohio, 2019). MAST put their first set of mooring and buoy blocks on the following wrecks: *Morning Star, Sand Merchant, Craftsman, Admiral, Dundee,* and *Queen of the West* (MAST Ohio, 2019). The buoys are set to protect boats from anchoring onto and damaging the wrecks and are removed each winter and placed back every spring (MAST Ohio, 2019). The MAST team also passed out education materials about the wrecks to the local diving and boating community (MAST Ohio, 2019). Ultimately, MAST took over some of the initiatives of the SLAC once that committee was unsettled (MAST Ohio, 2019).

Overall, MAST became a group of individuals and supporters who took underwater archaeology workshops throughout Ohio, like workshops sponsored by Bowling Green University and the Great Lakes Historical Society (MAST Ohio, 2019). Other workshops were sponsored by Ohio Council of Skin and Scuba Divers, Inc., Submerged Lands Advisory Council, Ohio Department of Natural Resources (Coastal Management Program), Ohio Historical Society (Historic Preservation Office), and Save Ontario Shipwrecks (Ohio Chapter) (MAST Ohio, 2019). The Great Lakes Historical Society and National Museum of the Great Lakes has been the primary partner in all shipwreck studies with MAST since 2004 (MAST Ohio, 2019).

Today, the individuals come together under the supervision of a professional archaeologist to help the state of Ohio survey the wrecks of Lake Erie (MAST Ohio, 2019). At the time of the founding, only five of the over 1,400 wrecks on the bottom of Lake Erie have been surveyed and registered as an official archaeological site in Ohio (MAST Ohio, 2019).

MAST members assist with the surveys at the preliminary phase (MAST Ohio, 2019). Members have gathered background research and photographs of the chosen wreck (MAST Ohio, 2019). Citizen scientists from MAST also conduct other tasks such as placing a baseline, setting buoys, determining sections to survey, and performing side sonar scans (MAST Ohio, 2019). Once the site details for the vessel are set, the citizen scientists measure the vessel and collect detailed field notes (MAST Ohio, 2019). The field notes are then plotted and gathered onto a master site plan (MAST Ohio, 2019). Several dives are conducted until the site details are entirely collected (MAST Ohio, 2019). The survey then becomes part of an overall report of the wreck (MAST Ohio, 2019).

MAST writes up technical reports for all surveyed wrecks. The reports include information on the geology of the area surrounding the wreck, the foundation underneath the wreck, the bottom sediments, bathymetry, a history of the local area, and so much more (MAST Ohio, 2019). The reports help the wrecks become official archaeological sites. The *Adventure* was the first shipwreck in Lake Erie to be registered as an underwater archaeological site thanks to helping of MAST (MAST Ohio, 2019). MAST has also completed reports on the following wrecks: the *Hanna*, the *F.H. Prince*, the *Sultan*, and on wrecks and other underwater features surrounding Kelley's Island (MAST Ohio, 2019). Reports can be purchased through the Great Lakes Historical Society at the following link: http://www.nmgl.org/. The report on the *Sultan* is currently free (as of April 2020) and can be obtained at the following link: http://www.ohiomast.org/reports. The reports are a part of the overall goal to protect and preserve the wreck and its current knowledge for future generations.

Another project of MAST is to educate the public about the wrecks on the bottom of Lake Erie (MAST Ohio, 2019). The group helps the public understand the historical significance and value of the wrecks through a weekend workshop funded and co-hosted by GLHS-NMGL (MAST Ohio, 2019). Further information on the workshop will be detailed in section 4.5. MAST also educates the public with slates they developed in conjunction with Ohio Sea Grant on each wreck (MAST Ohio, 2019). The slates serve as site maps for people within the lake community, and each slate provides information on the vessel like its location and history (MAST Ohio, 2019). The slates are made with a sturdy plastic and measure to about 9.5 inches (24.13 cm) by 6.25 inches (15.25 cm) (MAST Ohio, 2019). They can be ordered through the

Ohio Sea Grant at the following link: http://www.ohiomast.org/diveslates. The funds from the slates help protect and preserve wrecks for future generations (MAST Ohio, 2019). Example of a dive slate is demonstrated in Figure 20. MAST also offers occasional First Aid and CPR classes to help keep their members feeling safer during any MAST activities (MAST Ohio, 2019).

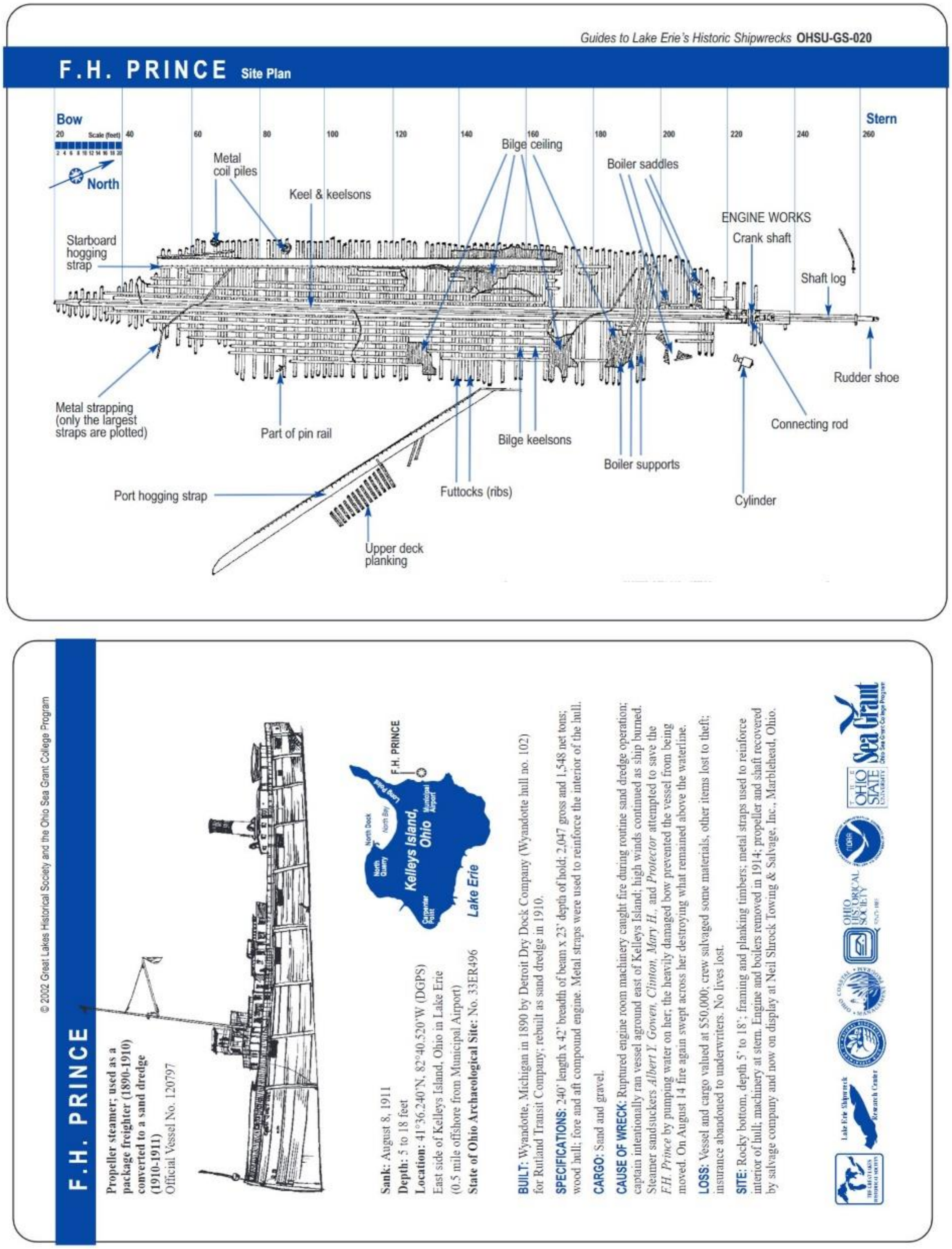


Figure 20.. Archaeological dive slate of the F.H. Prince created by MAST. [Source: MAST, 2019c]

MAST is currently affiliated with the following organizations: (1) The Great Lakes

Historical Society National Museum of the Great Lakes and Peachman Great Lakes Shipwreck Research Center, (2) the Ohio Department of Natural Resources, (3) Ohio Sea Grant, (4) Ohio History Connection, (5) Ohio Lake Erie Commission, (6) SOS, Save Ontario Shipwrecks, and (7) CLUE, Cleveland Underwater Explorers (MAST Ohio, 2006). The MAST bylaws govern memberships, the board of directors, board meetings, etc. (MAST Ohio, 2019). The bylaws are outlined online at the following weblink: www.ohiomast.org/bylaws.

4.4 MAST Achievements

MAST achievements are listed on Table 3:

Table 3. MAST Achievements

Year	Award	Organization	Description
2003	Sea Grant Blue Ribbon Award	National Sea Grant College	The best partnership publication in the National Sea Grant College Program in 2002.
2005	Public Education and Awareness Award (Co-Winners)	Ohio Historical Society Office of Historic Preservation	
2006	Ohio Lake Erie Award	Ohio Lake Erie Commission	The award was for MAST outstanding contributions to improve Lake Erie.
2008	Certificate of Appreciation	B.A.D	Ken Marshall was awarded the certificate for his work in designing and deploying the MAST moorings.

*Source: (MAST Ohio, 2019)

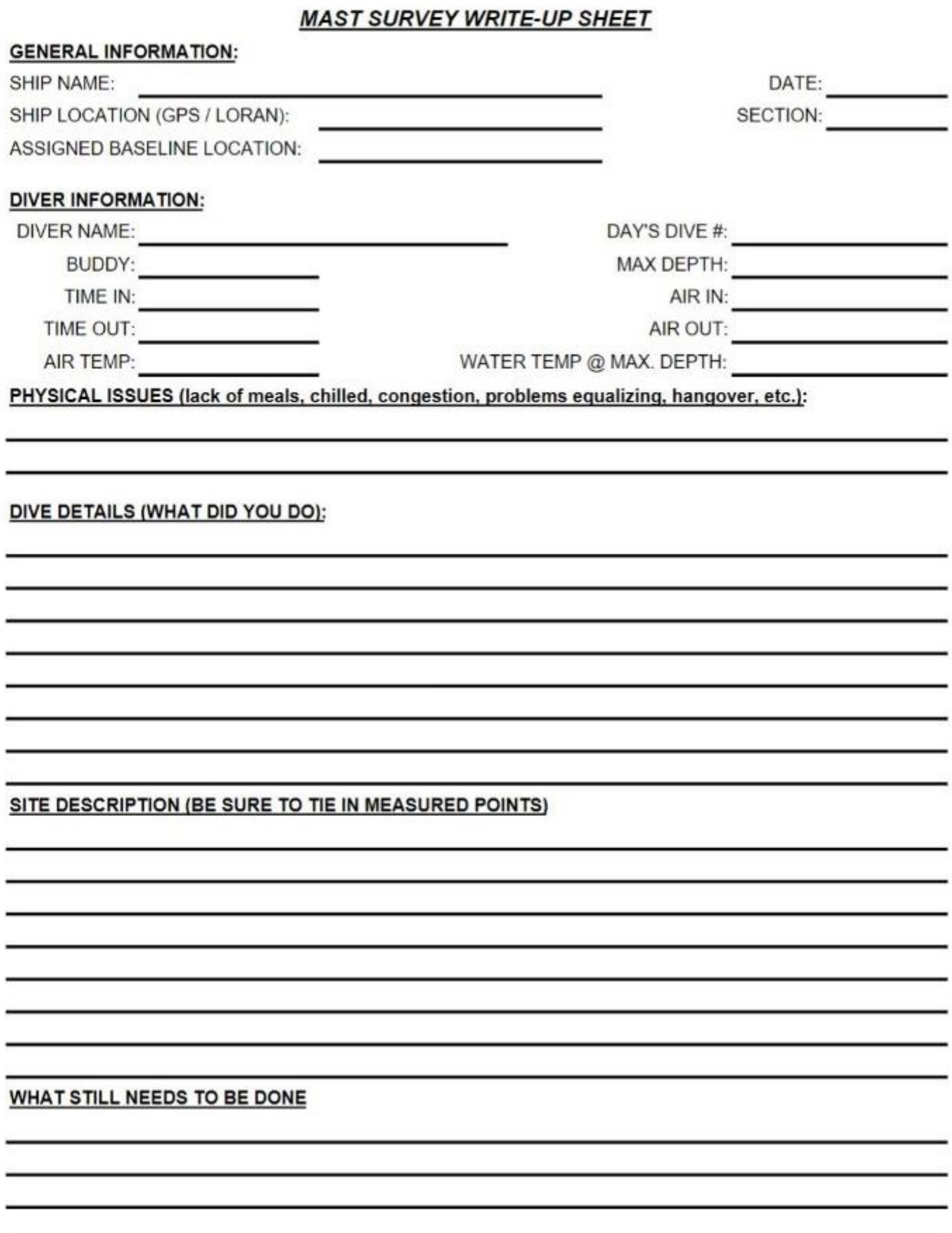
MAST has been mentioned in the news for assisting with the work done on the *Lake Serpent,* on the *Admiral,* and *Erie* (MAST Ohio, 2019; Yarborough, 2017). MAST and the archaeological coordinator of MAST Carrie Sowden were also talked about in the Toledo Blade (Skebba, 2017).

4.5 MAST Membership and Workshops

MAST currently offers the general public two different ways to become a lifelong member. The first requirement is to take the Basic Level Class workshop (MAST Ohio, 2006). The second option is to pay a membership fee to support the Great Lakes Historical Society and MAST (MAST Ohio, 2019b). The second option does not give the member access to any survey activities that involve scuba diving unless the member decides to take the workshop (MAST Ohio, 2019b).

Their workshop occurs every Spring and summer to anyone who would like to join and participate in the group voluntarily MAST Ohio, 2019). MAST utilizes people with skills in diving, surveying, drafting, researching, organizing, artwork, and wiring (MAST Ohio, 2019). MAST keeps its membership open to both divers and non-divers. The price of the workshops covers the course materials, sustenance, and a ticket to the annual MAST dinner program. The workshops span a total of three days. Both workshops are conducted at the National Museum of the Great Lakes in Toledo, Ohio (MAST Ohio, 2019b).

The Basic Workshop offers the following courses: Welcome to MAST, Laws and Ethics, Beginning Research, Ship Parts, Boat and Diving Safety, Survey Equipment, and Trilateration, Drawing and Techniques (courses may vary from year to year). The Basic Workshop also offers a dry run of the survey techniques that includes training on how to convert trilateration data into a site drawing. The students then practice all of the techniques underwater at the White Star Quarry in Gibsonburg, OH. The students learn how to use triangulation techniques with prepared MAST materials. The triangulation worksheet can be seen in the appendix 1 (Figure 21). Each student is also trained on how to fill out a MAST Diary detailing the events of each dive performed. The MAST Write Up Worksheet can be seen in the appendix 1 (Figure 22). Once a member completes the coursework and in-water training, they can join in on any future MAST surveys (MAST Ohio, 2019b).



MAST SURVEY WRITE-UP SHEET

GENERAL INFORMATION:

SHIP NAME: ______________ DATE: ______

SHIP LOCATION (GPS / LORAN): ______________ SECTION: ______

ASSIGNED BASELINE LOCATION: ______________

DIVER INFORMATION:

DIVER NAME: ______________ DAY'S DIVE #: ______

BUDDY: ______ MAX DEPTH: ______

TIME IN: ______ AIR IN: ______

TIME OUT: ______ AIR OUT: ______

AIR TEMP: ______ WATER TEMP @ MAX. DEPTH: ______

PHYSICAL ISSUES (lack of meals, chilled, congestion, problems equalizing, hangover, etc.):

DIVE DETAILS (WHAT DID YOU DO):

SITE DESCRIPTION (BE SURE TO TIE IN MEASURED POINTS)

WHAT STILL NEEDS TO BE DONE

Figure 21. Copy of MAST trilateration worksheet [Source: MAST]

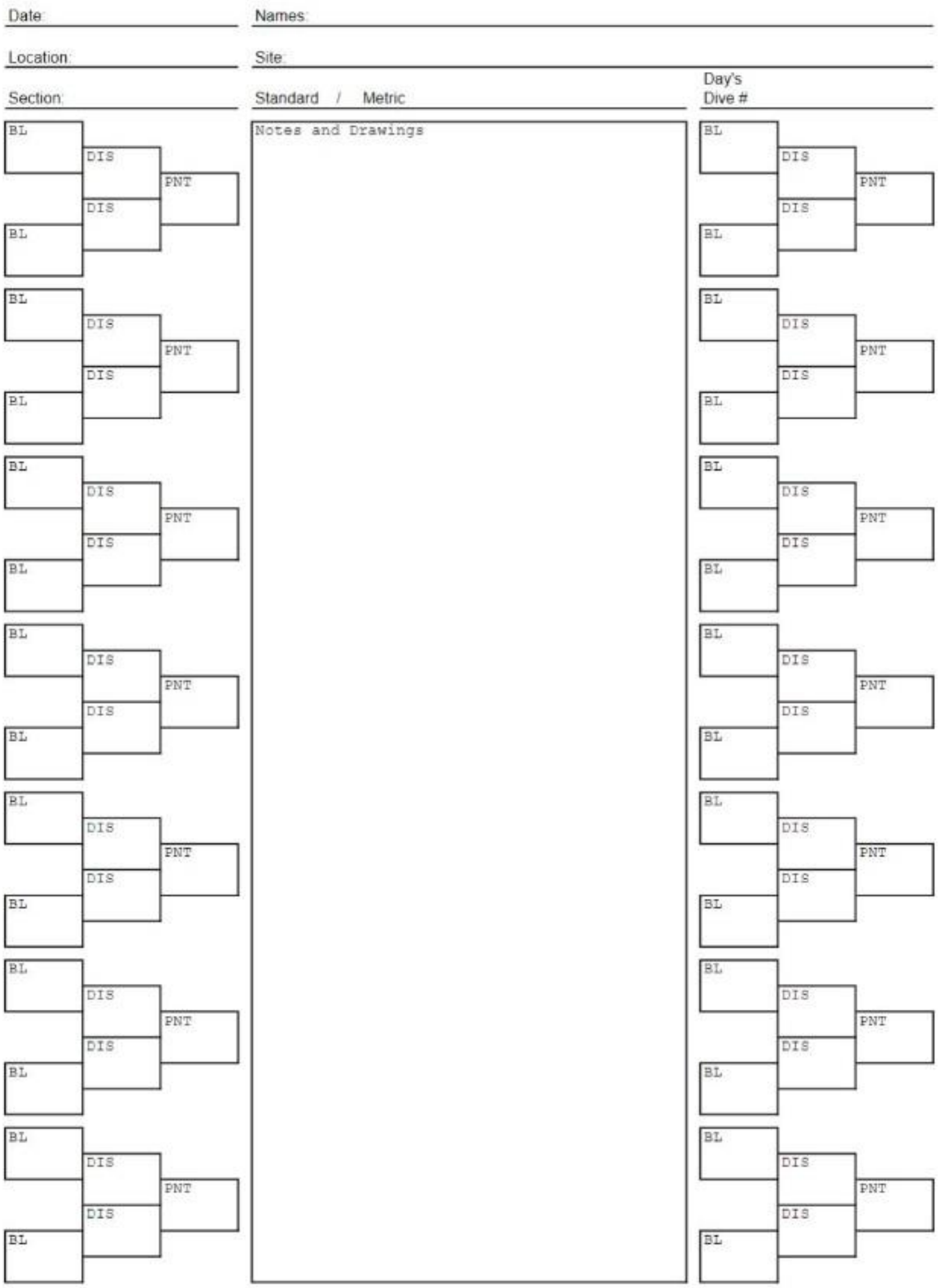


Figure 22. Copy of MAST dive log write-up worksheet [Source: MAST]

The Advanced Workshop offers the following courses: Survey Logistics, Underwater Notes, Above Water Reporting, Research, The Big Anchor Project, Shore Activities and Survey Management, and Dry Run and Debrief (the classes may vary from year to year). The Advanced Workshop allows the members to identify and catalog cultural sites, help manage the Basic members during any MAST surveys, and encourage them to lead their survey projects (MAST Ohio, 2019b).

Overall, the workshops allow new members to grow their knowledge in maritime and nautical archaeology and form new relationships with people with similar interests and likings. The workshops help spread a positive message about the importance of the Great Lakes underwater cultural heritage (MAST Ohio, 2019).

4.6 Significance of MAST

MAST has helped protect vessels that are valuable to anyone with a connection to Lake Erie (MAST Ohio, 2019). The people could include, but are not limited to, people who boat, fish, dive, or have a business in Lake Erie (MAST Ohio, 2019). It also includes people who have any genealogy connected to Lake Erie and its surroundings (MAST Ohio, 2019).

Chapter 5 – MAST Questionnaire

5.1 Summary of Questionnaire

Citizen science is described as involving members of the public in scientific research with both the members and the scientists benefiting from the interaction (Bonney *et al.,* 2009). MAST utilizes its members to gather detailed information on the wrecks, conduct surveys, write reports, and create and set buoys for the protection of some of the most significant wrecks in Lake Erie. For MAST to be considered as a citizen science engagement, the members need to profit from the experience as well (Follet and Strezov, 2015). To engage the experience and benefits of the members, a questionnaire was created online through the program Google Forms.

A questionnaire was sent out to MAST members to measure and quantify the members (1) overall experience, (2) reasoning to participate and join, (3) benefits and rewards, (4) total satisfaction with the course, training, and diving, (5) new skills and knowledge, (6) experience with the staff, scientists, and teachers, (7) appreciation toward underwater cultural heritage, and (8) requests for change and improvements. The entire questionnaire can be found in Appendix 1. The Faculty Research Ethics Committee from the University of Malta provided clearance and approved the survey.

5.2 Methodology of Questionnaire

As previously stated, the questionnaire was delivered through Google Forms. The link for the questionnaire was sent out through mass emails with four reminder emails being sent out throughout the months the survey was open. The emails were only sent to 45 members of MAST. With a small population (sample size) of 45 members, a pilot test, which is a small-scale test to test the procedures and mythologies for a larger scale, was not completed (Pilot Studies: Common Uses and Misuses, 2020). It would be challenging to get members to respond to two surveys, and the population had unique parameters (Pilot Studies: Common Uses and Misuses, 2020). The members that participated in the survey only attended the 2016 and 2017 MAST workshops. These were the members who had the opportunity to work on the *Admiral*. All of the members were given a chance to respond, and there was no sample methodology used. Allowing all members access to the survey, gave each member an opportunity to voice their opinions.

The questionnaire was done entirely online, so the data collection could be convenient for the members. An option on Google Forms allowed each participant to only take the survey once. The members could not take the survey once it was closed. The survey was anonymous, which allowed the members to answer without any fear of bias or consequences. The members were given approximately three months to complete the questionnaire in order to balance out any personal time constraints.

The questionnaire was developed through the following steps: (1) determine the variables to be tested, (2) generate closed-ended and open-ended questions for both controlled and open responses, (3) test the questionnaire through a few ineligible members to test comprehension and average completion time, and (4) assess the response rate for each question through Google Forms to accurately quantify each answer.

The questions varied from open-ended, multiple-choice, short-answer, and rating-scale. The ranking questions used a 10-point scale (with "1" being not satisfied at all and "10" being completely satisfied) to rate their overall experience with the teachings, training, total information, resources, staff, advice, safety, expectations, and likelihood to recommend. Google Forms tracked each response and kept the responses password protected.

Each member agreed to the Terms of Agreement, which outlined the purpose of the survey. The agreement also addressed the anonymity, the requirements of participation, and the use of the data. The two demographic questions were about their educational level and their age. The members were able to decline to answer the question about their age.

The questionnaire consisted of four parts. Part 1 included the demographic questions and the multiple-choice questions asking the members what they achieved and why they chose to participate. Part 2 covered the satisfaction questions about the overall experience from the course, the cost, and the survey. Part 3 was comprised of the opened ended questions exploring the positives and negatives of MAST, the criticisms, and (if any) their new appreciation and knowledge of underwater cultural resources. Part 4 explored the same aspects as part 3 but focused in the diving portion. Part 4 included both multiple-choice and open-ended questions.

5.3 Participation Pool

As mentioned before, the questionnaire was limited to the MAST members who attended the 2016 or 2017 Beginner or Advanced Workshops. A total of 22 respondents filled out the survey between June 2018 and September 2018. Respondents were primarily from the 2017 workshops with the remaining respondents from either both years or only from 2016 (Figure 23). All of the participants were scuba divers and participated in the diving survey of the *Admiral.*

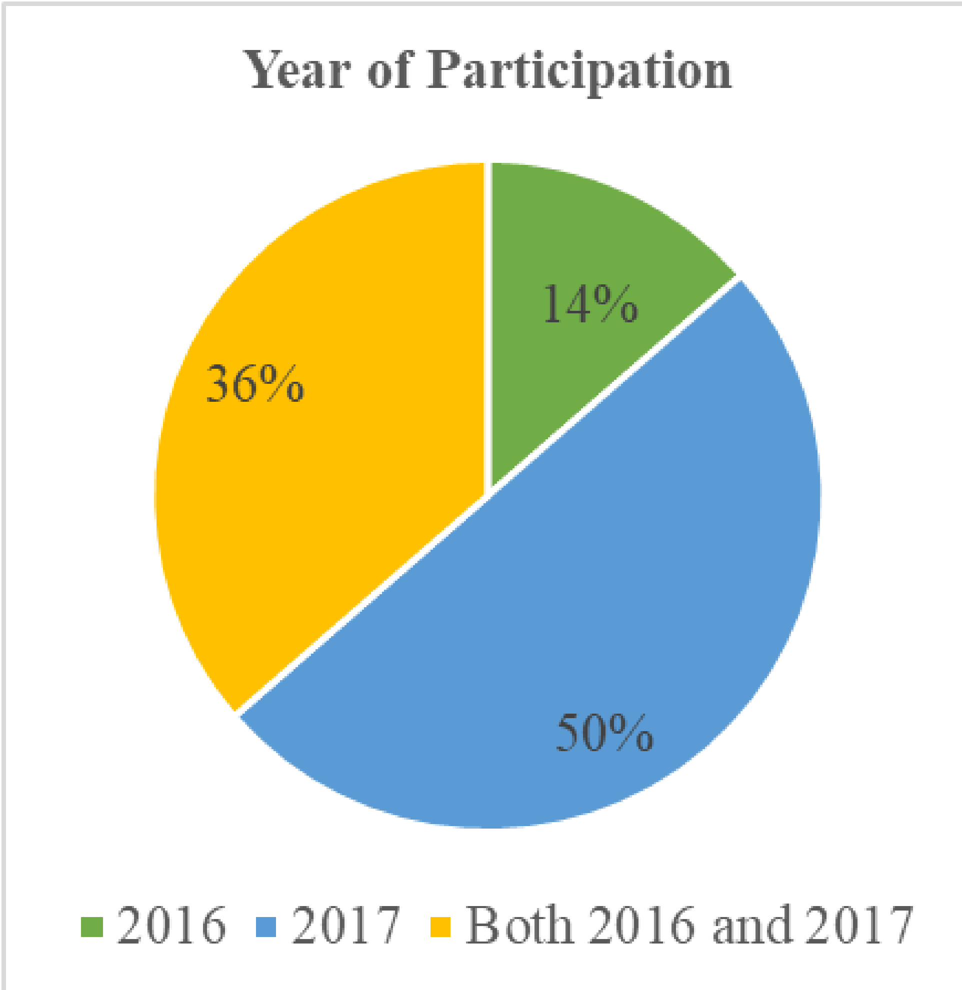


Figure 23. Year of participation results.

5.4 Results of the Questionnaire

The results from the 2017 and 2016 workshops were combined. The raw data for the survey can be found in Appendix 2. The ages ranged from 24 to 75, with the average age ranging from 40 to 55 years old. All of the participants had received a high school diploma or higher. Most participants either obtained a Bachelor's degree or a Master's Degree (Figure 24). The response rate was approximately 48%, and based on the Wiggins and Crowston's (2011) study, the response rate was high compared to other questionnaires sent by email (Scott *et al*., 2018;

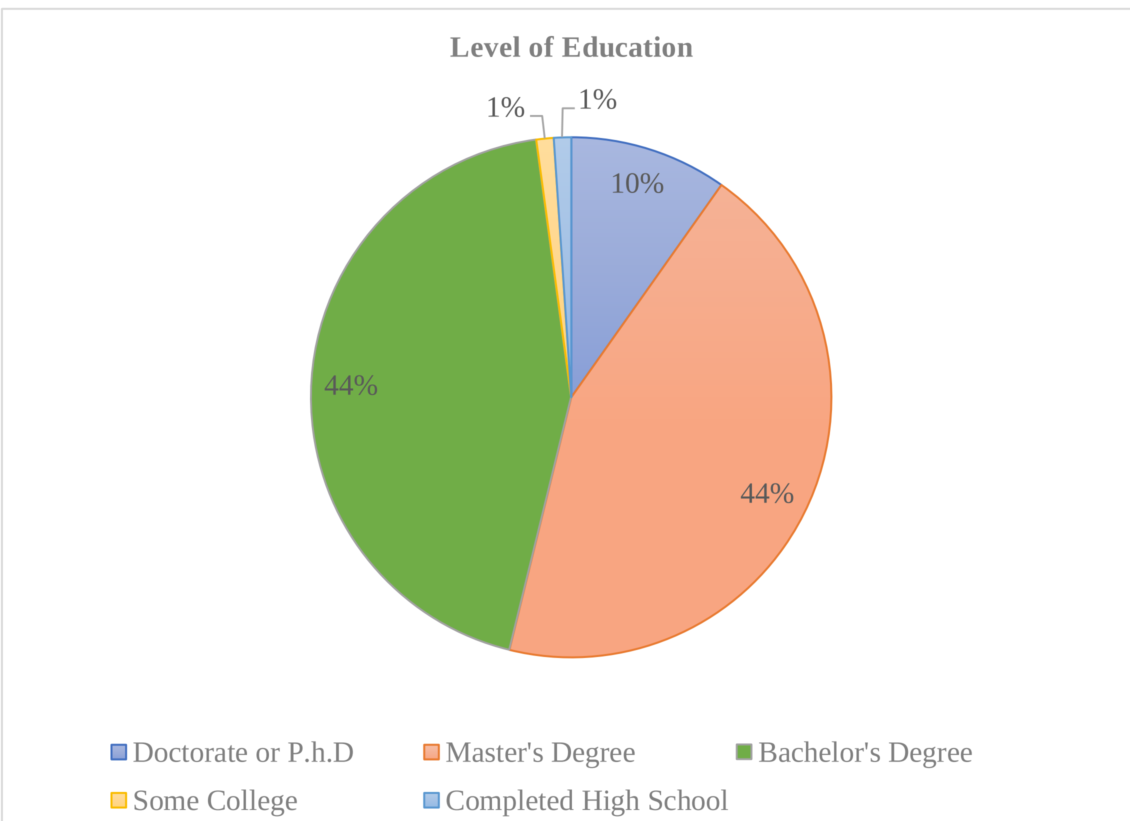


Figure 24. Results from the the level of education question.

Nov *et al.*, 2011). The rejection rate was 52%. Low response rates are generally typical in online surveys and surveys sent by email (not by mail) (Scott *et al.*, 2018; Nov *et al.*, 2011; Wiggins and Crowston, 2011; Curtis, 2015). The responses to the survey will be discussed in further detail throughout this section.

5.4.1 Experience with MAST

The participants joined MAST to gain new skills and knowledge (81.8%), to meet new people (40.9%), to improve on a hobby (54.5%), and for personal pleasure and interest (90.9%) (Figure 25). Participants left their experience with MAST with new valuable knowledge and skills (77.3%), new friends or acquaintances (90.9%), a better appreciation for maritime archaeology (86.4%), an improvement on their scuba diving (81.8%), and gained valuable information for their future/current career or pursuit for higher education (22.7% for both) (Figure 26). Others wrote in sharing similar benefits to either gain contacts within their profession or “warm-up” for their future graduate studies.

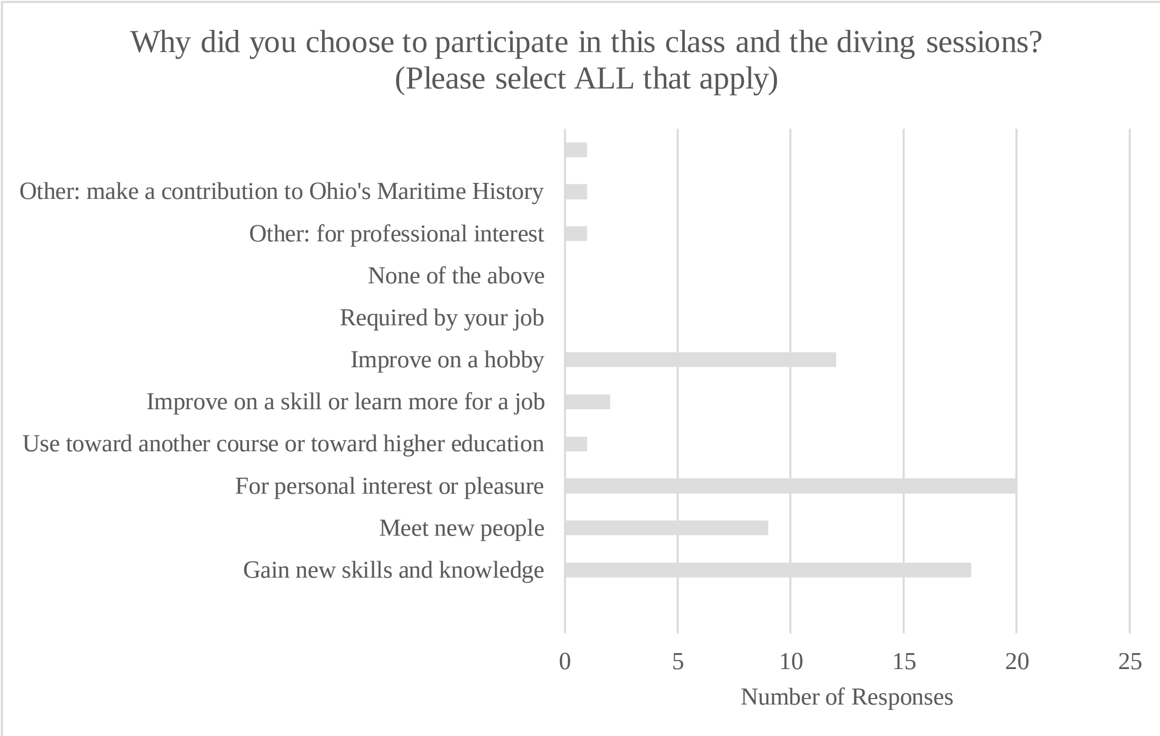


Figure 25. Results from the following question: why did you choose to participate in the class and diving sessions?

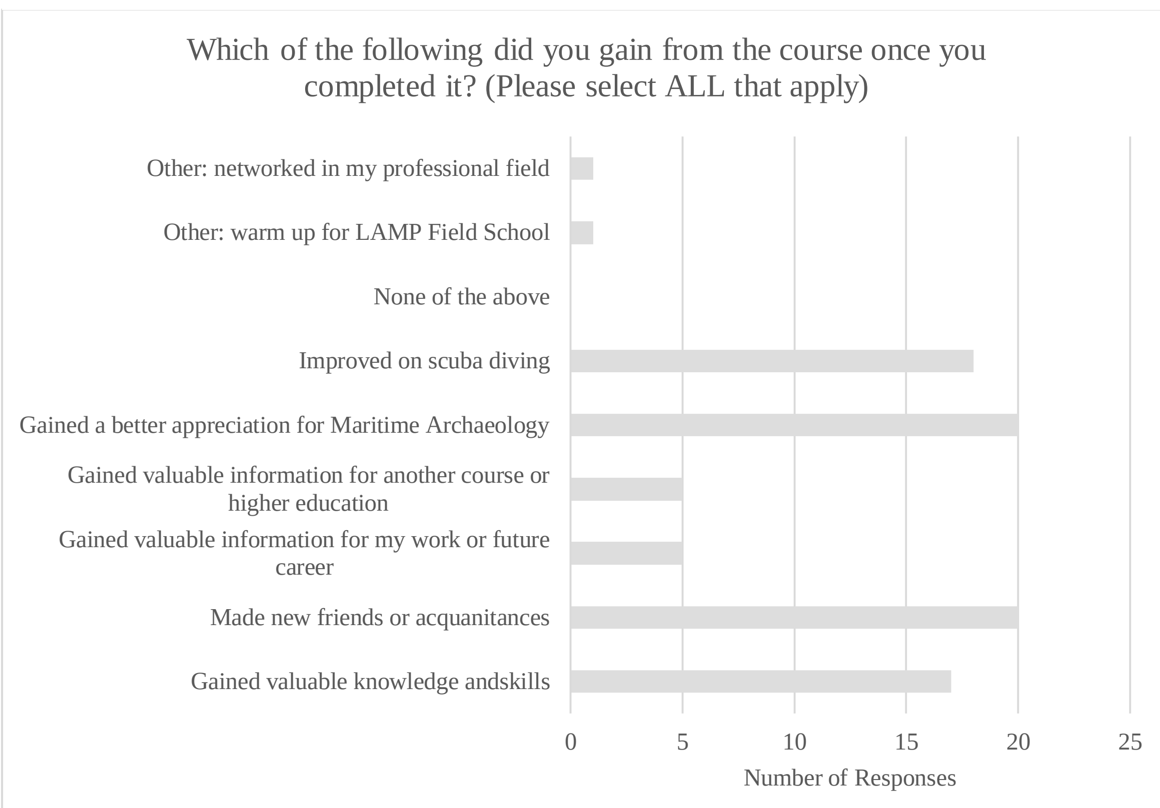


Figure 26. Results from the following question: which of the following did you gain from the course once you completed it?

About 54.5% of the participants were delighted (score 10 out of 10) with the teachings and training from the class and the scuba diving sessions (Figure 27), and 50% of the participants were completely satisfied with the information presented at the course (Figure 28). Over half (54.5%) of the participants were completely satisfied with the teaching and training staff (Figure 29). For the previous three questions, scores of at least 5 or above were granted. The resources provided throughout the course received mixed scores; however, the scores were generally positive. The scores ranged from 1 to 10. At least 4 of the participants were dissatisfied with the printed resources provided throughout the training and workshops (Figure 30).

The cost of the program received positive scores, with 95.5% of the scores being above a score of 6. About 40.9% of the participants were completely satisfied with the cost of the workshop, combined with the costs of the scuba diving sessions (Figure 31). The question did not specify whether or not this includes the cost of travel, housing, and sustenance.

The expectations of the course received scores of 6 and above, with about 45.5% being completely satisfied with the class and training (Figure 32). About 91% of the participants (20 out of the 22) would recommend the course to a family or friend (gave a response of 6 or more) (Figure 33). The participants stated that their best aspects of MAST were meeting others with similar interests, diving on underwater cultural resources, the lectures on the wrecks history and ship parts, learning to dive with a purpose, the teachers, and the hands-on in-water training.

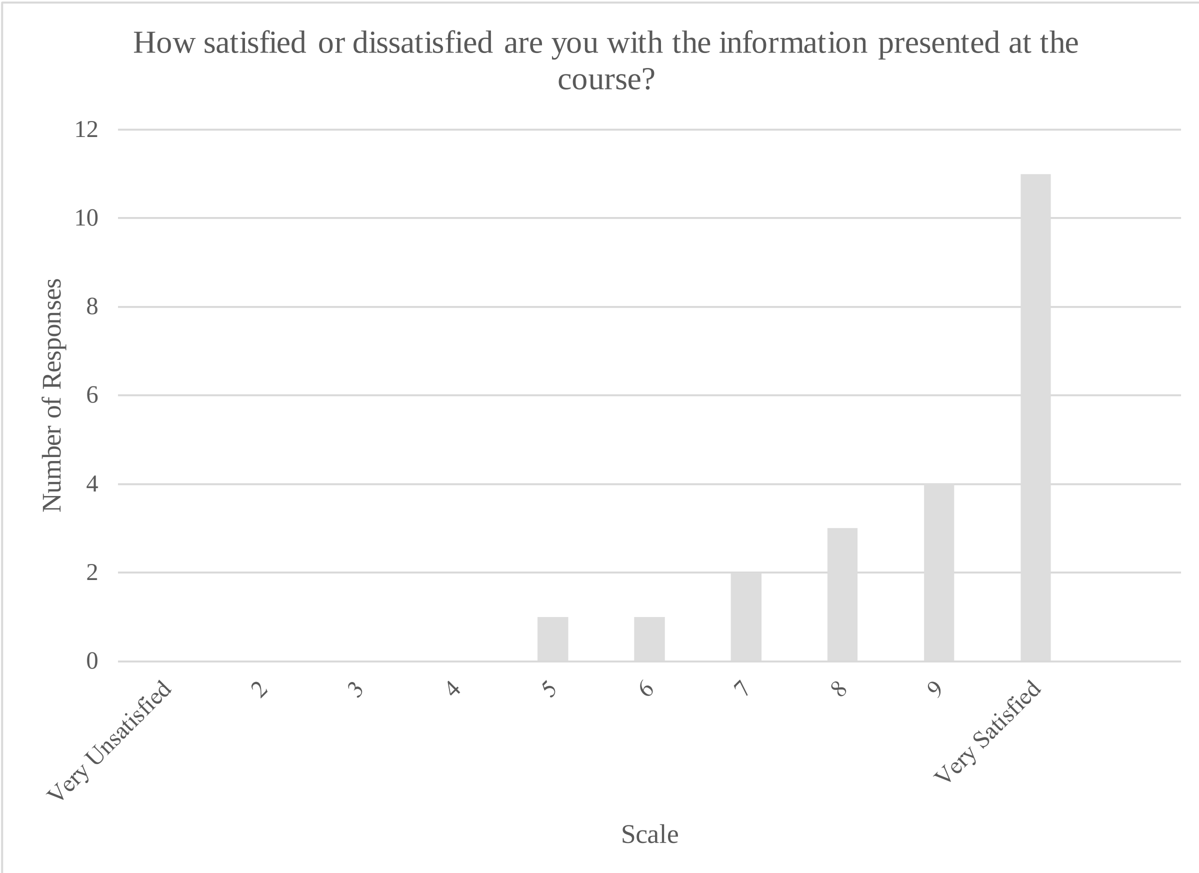


Figure 27. Results from the following question: how satisfied or dissatisfied are you with the information presented at the course?

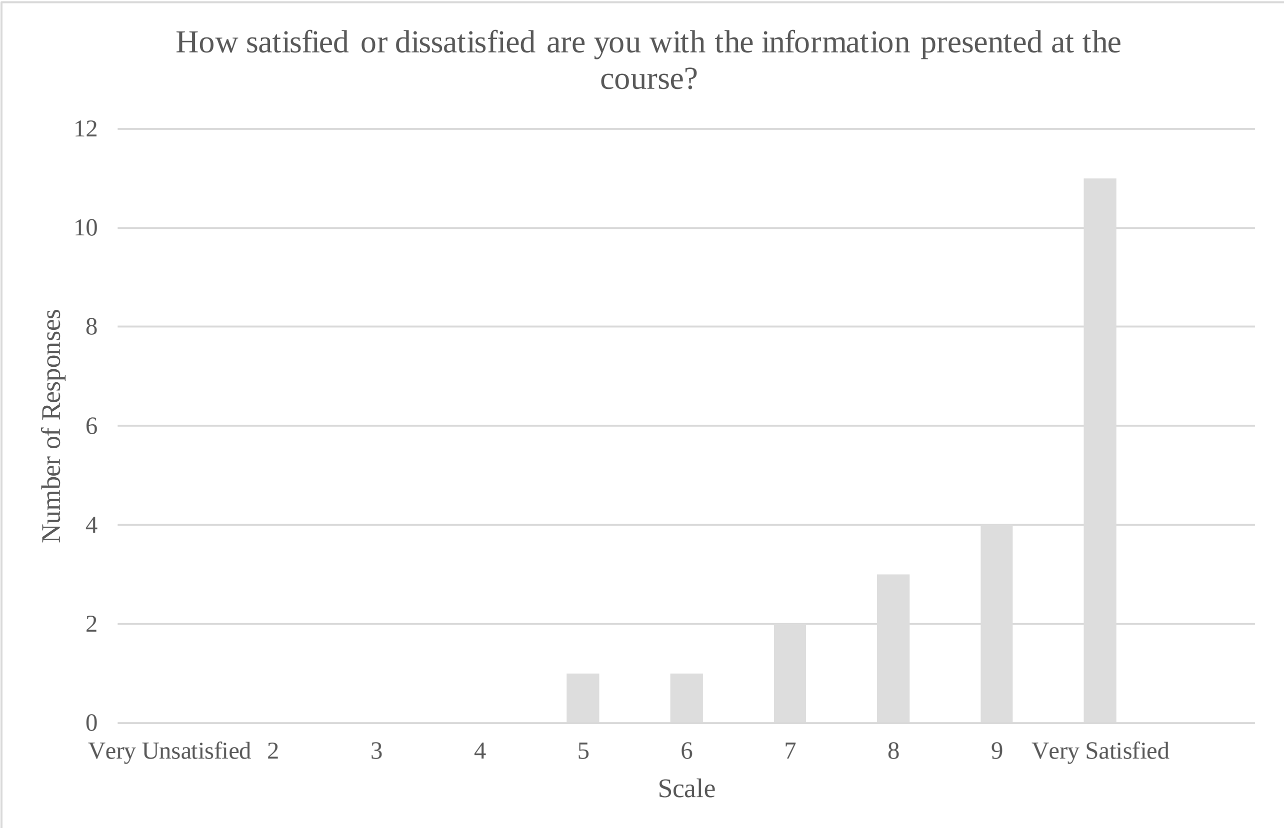


Figure 28. Results from the following question: how satisfied or dissatisfied with the information presented at the course?

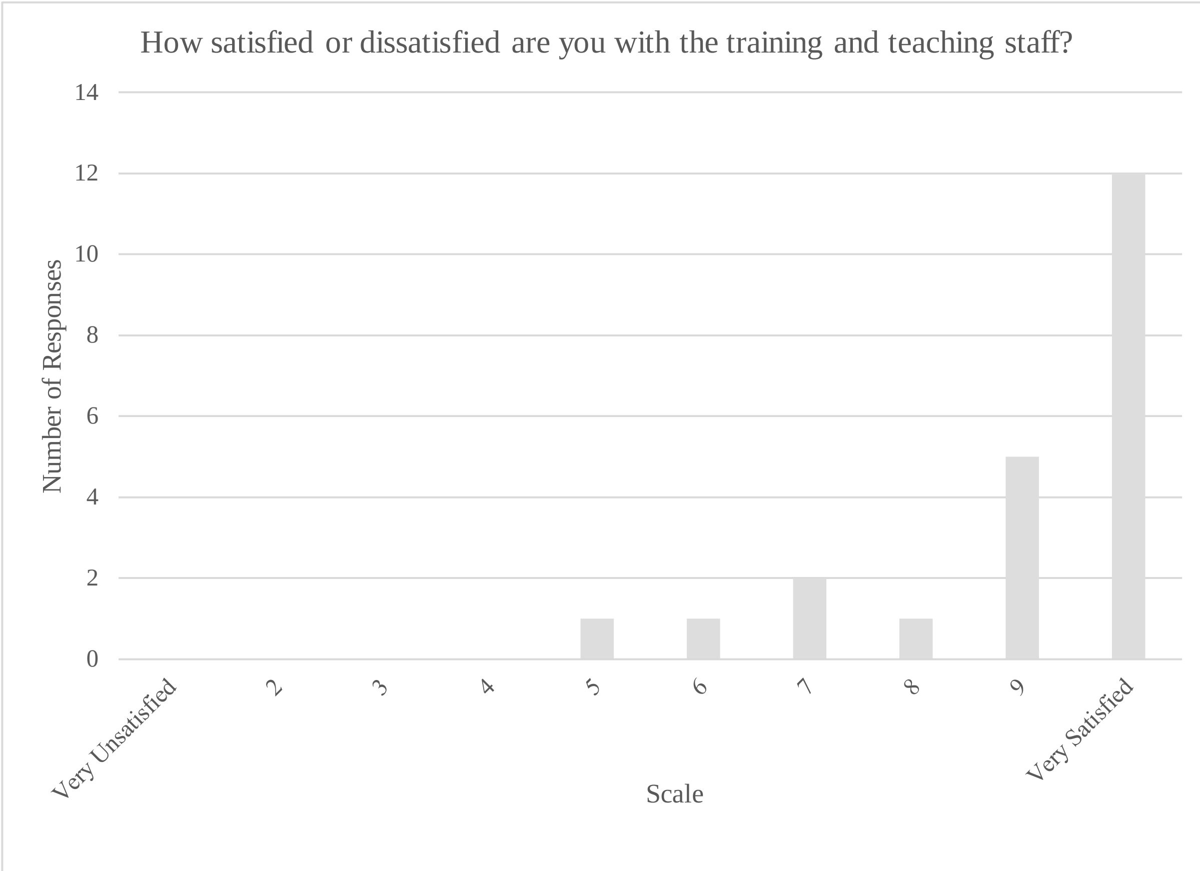


Figure 29. Results from the following question: how satisfied or dissatisfied are you with the training and teaching staff?

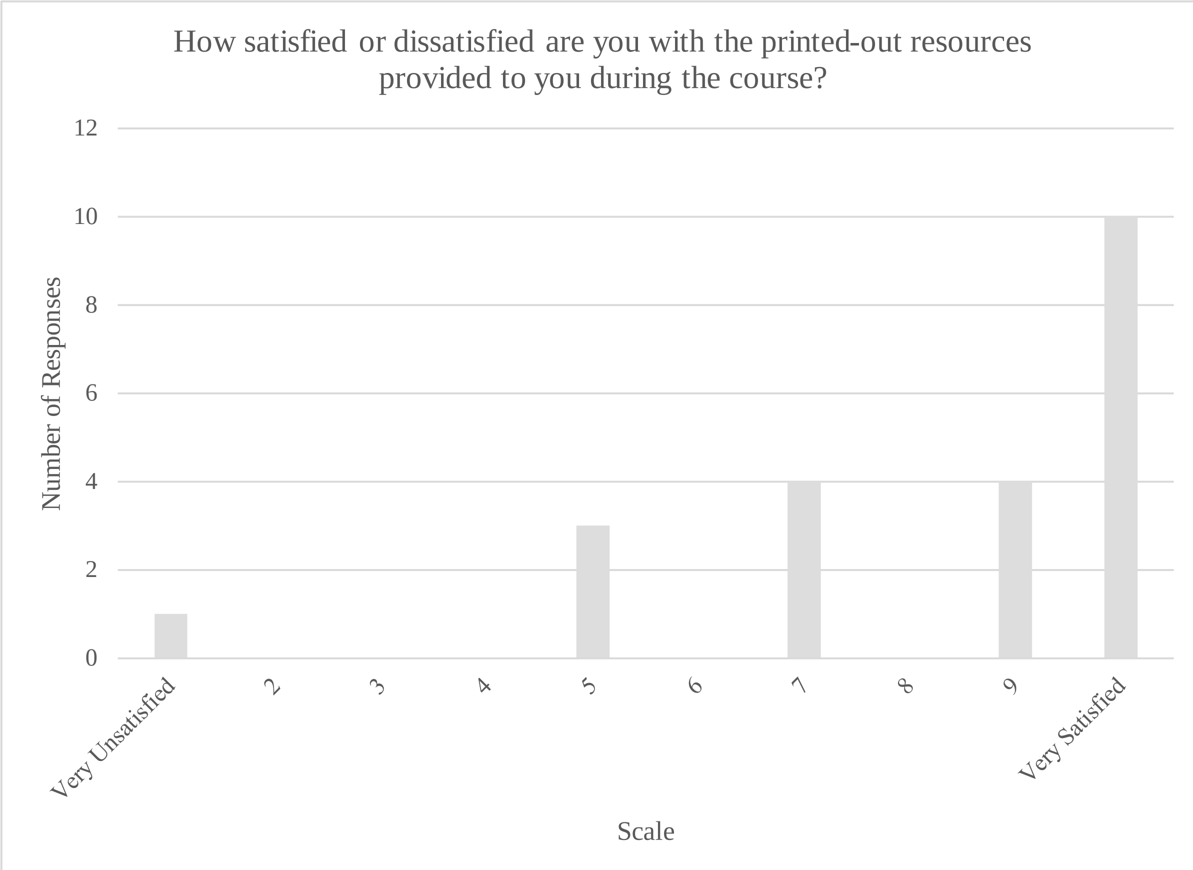


Figure 30. Results from the following question: how satisfied or dissatisfied are you with the printed-out resources provided to you during the course?

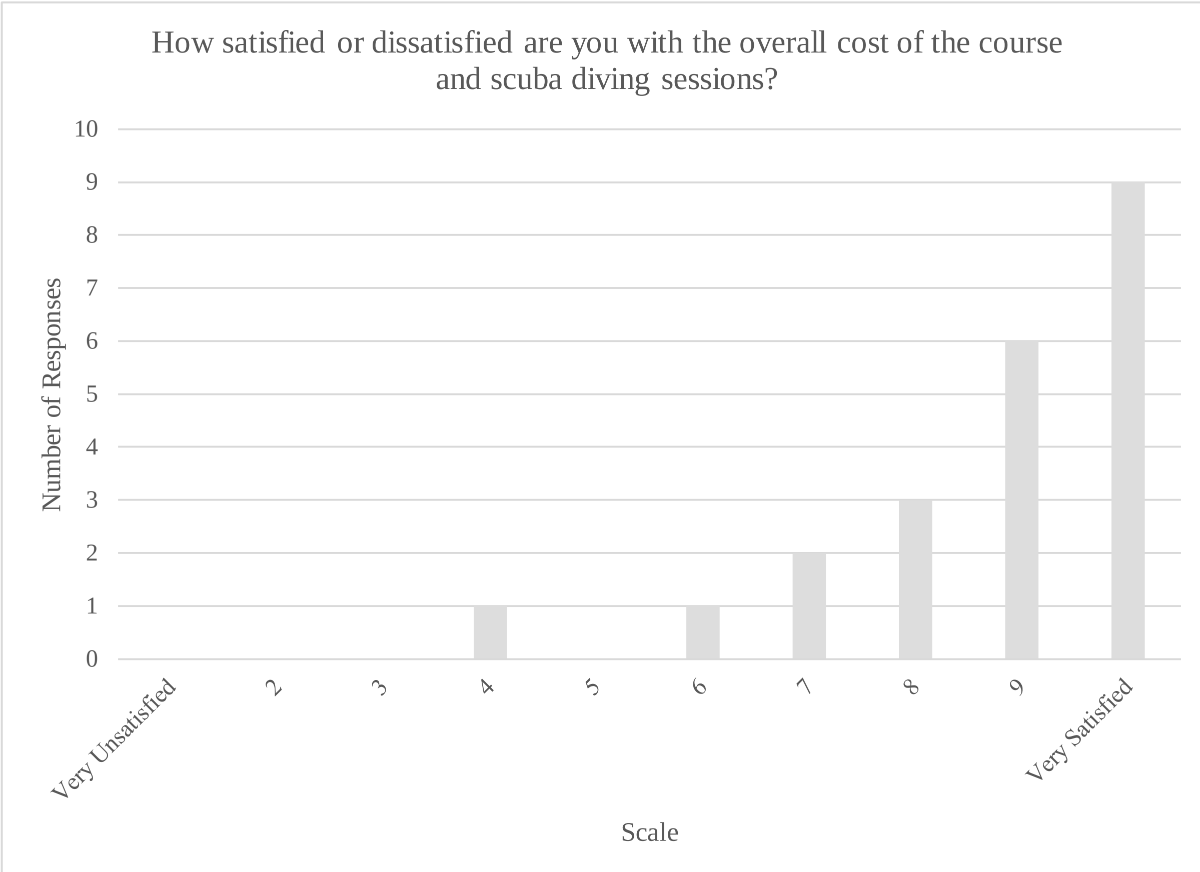


Figure 31. Results from the following question: how satisfied or dissatisfied are you with the overall cost of the course and scuba diving sessions?

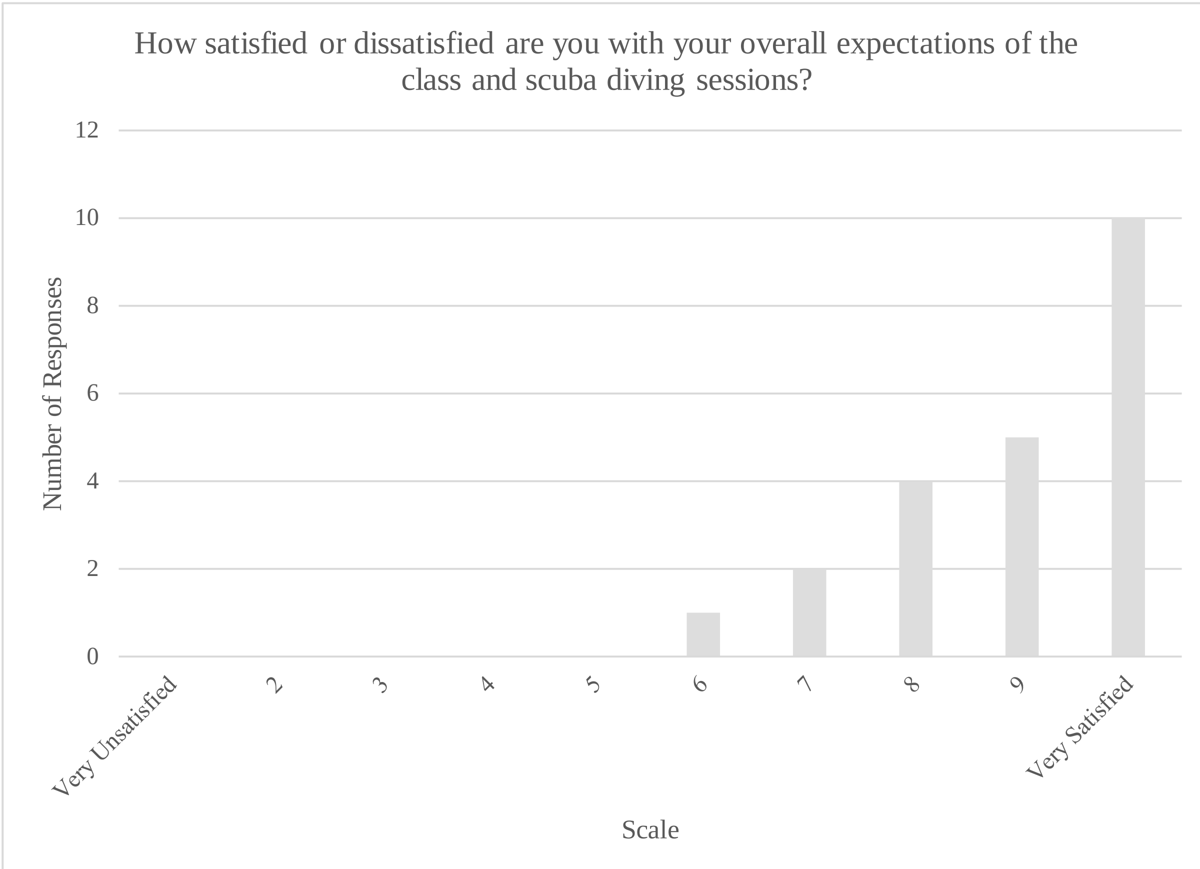


Figure 32. Results from the following question: how satisfied or dissatisfied are you with your overall expectations of the class and scuba diving sessions?

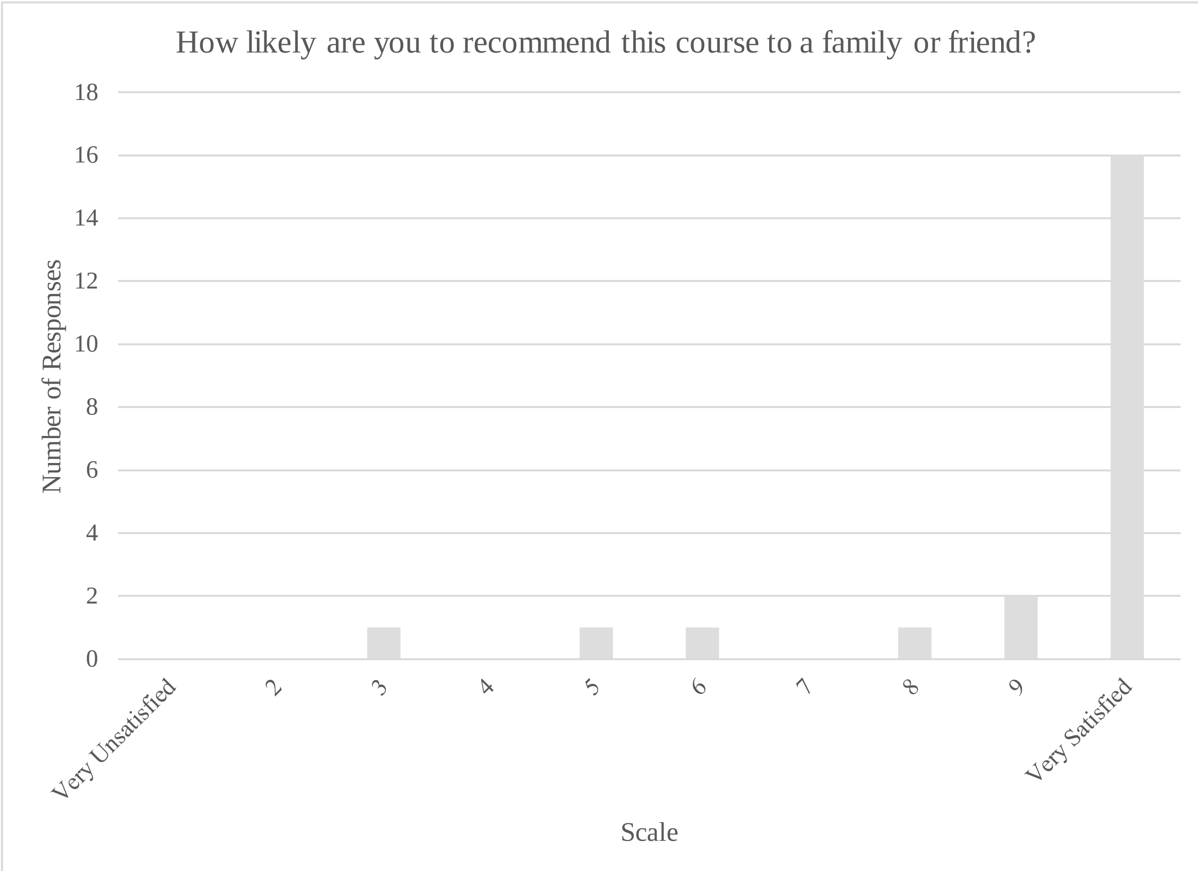


Figure 33. Results from the following question: how likely are you to recommend this course to a family or friend?

5.4.2 Attitude toward Underwater Cultural Heritage

After the course, most participants gained a higher appreciation toward underwater cultural heritage and the history of the Great Lakes, specifically Lake Erie. One participant stated that they "have a greater understanding of Lake Erie maritime history," while another said that they developed a "deeper appreciation for the history of Lake Erie." At least 63% of the participants responded positively to the question, do you feel closer to your local cultural heritage? Many of them learned new knowledge about shipwrecks, the history of Lake Erie, and the historical context behind Lake Erie ships. A participant stated that "diving on wrecks in my state of residence has given me a better understanding of the local maritime history."

Several of the participants gained a higher appreciation for the field of archaeology and/or history. A minimum of 72% of the participants answered yes to the following question: do you have a greater appreciation for archaeology and/or history after attending this course? They learned more about the amount of work that goes into the background research and fieldwork for each wreck. One stated, "I had never before realized the amount of work and preparation that goes into just the survey and research of one single wreck." Other participants learned more about background research and utilizing historical records. For example, one participant learned how to read and understand historical records properly. Another participant learned that not all of the historical records could be trusted 100%. The participant said that they did not "realize how unreliable the historical record was."

Many of the participants achieved a higher understanding of the importance of the protection of shipwrecks after the course. About 81% of the participants answered yes to the question, do you feel a stronger tie/support for the protection of shipwrecks after the course? One stated, "The Great Lakes are very important for many reasons and preservation of the Lakes, and the wrecks are paramount." Another stated that they "realize that it truly take(s) a community to keep the story of shipwrecks alive, and in tack for others to enjoy." Diving on local wrecks drove some of the participants to share the need to preserve wrecks with their friends and family. One participant said, "I get lots of questions from non-diver friends who still think that people dive wrecks to 'find treasure' and take it for themselves. I feel that anyone who attended the course will have a strong desire to educate others that this is not what we do."

5.4.3 Content Knowledge

The content knowledge presented in the workshops is done through lectures conducted by people with different experiences and backgrounds. The experience varies from professional maritime archaeologists to experienced MAST members. Members from Cleveland Underwater Explorers (CLUE) are also consistent lecturers. CLUE is a team of divers and histories who dedicate their time researching, documenting, and exploring underwater cultural heritage in the Great Lakes with a focus on Lake Erie. The group is based in Cleveland, Ohio. Overall, the students were satisfied with the content and information presented at the workshop. As previously mentioned, the breakdown of the responses demonstrates that 50% of the participants were delighted. The rest of the participants gave scores between 5 and 9.

5.4.4 Survey and Diving Experience

As stated before, MAST hosts a survey between June and August to gather and document underwater cultural heritage within Lake Erie and with other MAST members. The survey involves both scuba diving and non-diving members of MASTs. Tasks range from triangulation of the shipwreck underwater to mapping out the data on a boat plan on land. Other members are tasked with keeping track of the divers and making sure safety protocols are followed.

Scuba diving is a large portion of the survey since most of the surveys conducted by MAST is submerged underwater. Proper training and safety measures should be in place whenever scuba divers participate. The participants felt safe during the dive sessions and felt that proper safety support was provided. Everyone responded with a 6 or higher on the satisfaction scale. At least 59% of the participants responded with a 10 when asked if they were provided with proper safety support (Figure 34).

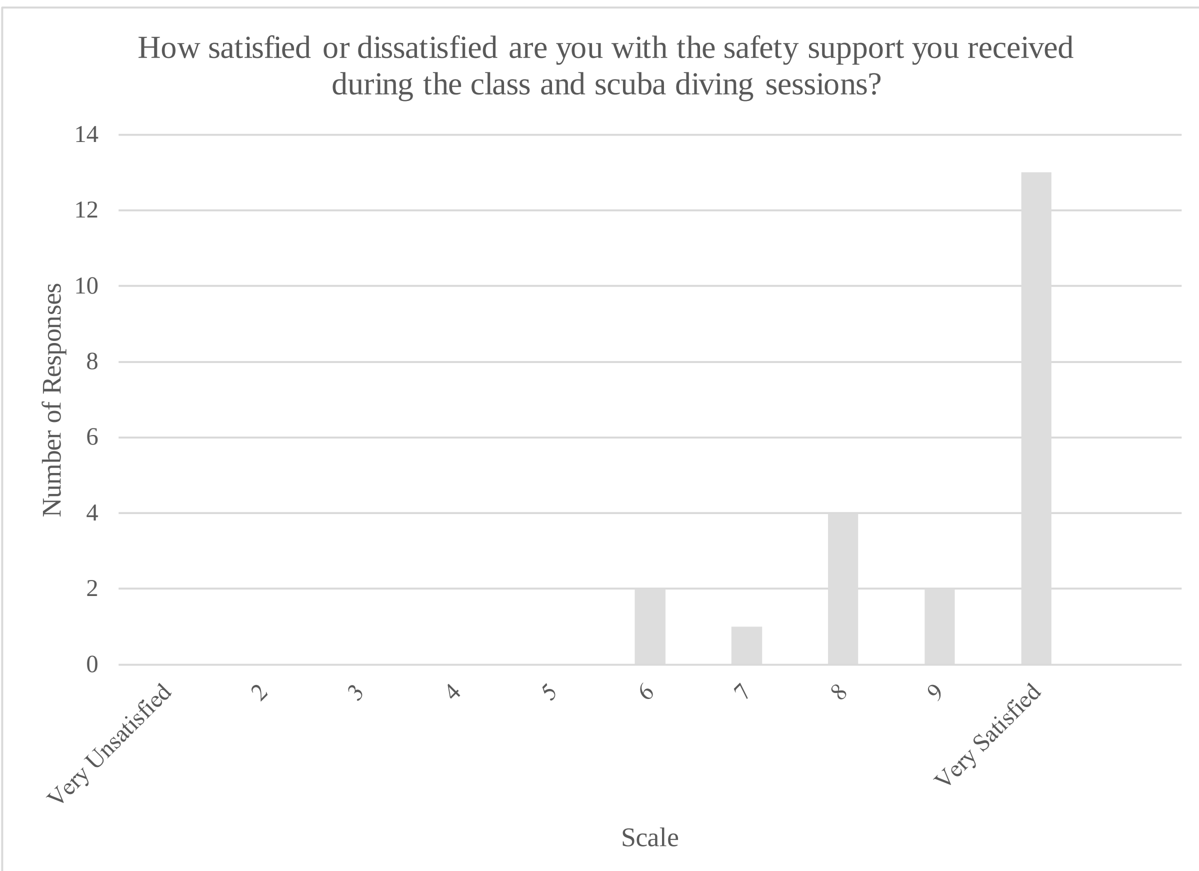


Figure 34. Results from the following question: how satisfied or dissatisfied are you with the safety support you received during the class and scuba diving sessions?

No one can dive with MAST until they complete the training sessions completed at White Star Quarry. Information about the sessions is mentioned earlier within the documentation. All of the participants of this survey were certified scuba divers. They also all participated in the diving sessions for the 2016 and 2017 surveys. The participants were certified by NAUI

(National Association of Underwater Instructors), PADI (Professional Association of Diving Instructors), SSI (Scuba Schools International), SEI (Scuba Schools International), SDI (Scuba Diving International), or through their university. All of the organizations listed are qualified to publish standards and award certifications for recreational scuba diving. The diving experience among the participants ranged from about 30 dives to over 1,500 dives.

The participants were given a chance to provide their opinions on the skills, aspects, and concerns about the diving practice and surveys. The divers listed several valuable skills and lessons they were able to gain from engaging in the underwater archeological survey and the corresponding training lessons. Several divers noted they improved on their overall dive skills and, more specifically, their survey archaeological surveying techniques. The training and in-water survey allowed them to strengthen their skills in neutral buoyancy, time-keeping, safety, communication with their buddy, navigation, and cold-water diving. More specifically to archaeology, the divers learned how to multi-task, communicate appropriately with their team underwater, work as a team underwater, and measure the shipwreck through triangulation. Other skills can be found in the responses in Appendix 2.

Overall, the participants thought the in-water training was valuable. At least 68% of the participants answered yes to the following question: did you find the training for the scuba diving sessions valuable and helpful? Some participants expressed interest in more detailed training and better refreshers for the Advanced students. One stated, “feel an annual practice session would be helpful to brush up on multi-tasking and taking underwater measurements.”

5.4.5 Criticism

The participants provided valuable criticism and ideas for improvement through the open-ended questions. However, a few contributors (36%) did not feel the need to offer any critique or response to the following question: what aspects of the course need improving? The rest of the participants did provide valuable criticism. One of the critiques focused on better communication. A participant stated that they want "more communication and opportunities to survey wreck sites."

Some of the participants would like additional and more up to date information provided in the lectures. Others expressed interest in learning about more modern techniques and learning more about the background reviews and literature searches. A few participants would like the information on triangulation updated in the lectures. The lectures currently educate the members on center-line triangulation even though MAST moved to perform fixed point triangulation in the field.

A few of the participants conveyed interest in assisting with the writing and publishing of the reports. Many would like more experience with mapping the wreck site onto a 2D site map. As mentioned before, others wanted a more in-depth experience with the background research. A few expressed an interest in the archival and background environmental research. One participant would like to help publish the reports at a quicker speed and have more responsibility within the reporting process. One participant stated that they would "appreciate knowing what was done with the data gathered," and another one said they would like to help "publish findings in a timelier manner."

5.5 Conclusion

Based on the questionnaire, MAST successfully provided the members who were a part of this questionnaire with a valuable citizen science experience. The students gained a higher appreciation of their local history. Other have expressed an interest in sharing the importance of the protection of shipwrecks. They were also able to understand the steps taken to monitor and report on a shipwreck accurately. The questionnaire demonstrated that MAST is a successful education-based citizen science program because most of their students left with a higher understanding of the field of science and the scientific process. What remains to be tested is how much MAST informed the general public beyond their students.

Even though MAST was successful in providing the citizens with valuable experiences, the group can improve more by allowing the citizens to have more responsibility throughout the entire scientific process. The improvement will help increase the members' knowledge base and relieve a large portion of the work from the professionals. A greater sense of trust between the members and the professionals will be the most valuable change for MAST. The members want to be a part of the whole scientific process and help with the publication of the work. MAST needs to reflect on both their accomplishments and their critiques to continue to grow as a citizen science organization successfully.

Chapter 6 – Methodology and Fieldwork

6.1 MAST Fieldwork

MAST Ohio conducted the fieldwork for the *Admiral* during the summer of 2016 and 2017. I, myself, participated during the summer of 2017. Carrie Sowden was the coordinator of the survey and is one of the leading archaeologists of MAST. Since the wreck is about 14 miles (1.61 km) off the shore of Cleveland, Ohio, the site was only accessible by boat. The survey team utilized the dive boat the *Holiday*, which use to be operated by Trident Marine. The fieldwork conducted by MAST on the *Admiral* was planned and concluded before the beginning of the dissertation.

The *Admiral* survey utilized a plain metric horizontal survey with a system of fixed control points along the edge of the shipwreck (VanZandt *et al*., 2016). The *Admiral* had a total of 22 control points along its frame (Figure 35). Yellow plastic cattle tags were used to mark and identify the sites. The cattle tags were tied down with zip ties (Figure 36) to avoid any significant damage to the wreck. The tags were extremely beneficial because they are bright yellow and are pre-numbered (VanZandt *et al*., 2016).

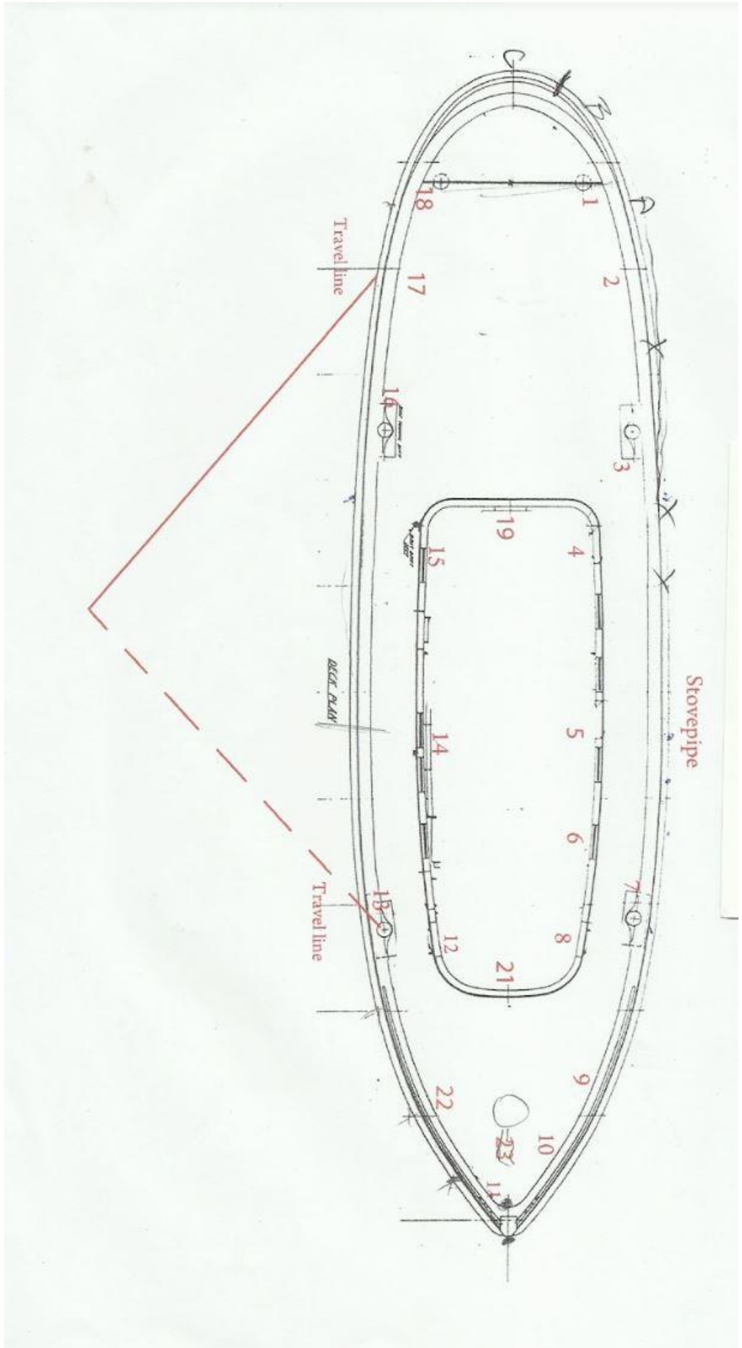


Figure 35. Figure drawing the of the Admiral demonstrating the location of the control points along the wreck [Source: MAST]

Figure 36. Photo of the number 2 yellow cattle cow tag tied to the Admiral with a zip tie [Source: Photography by Nancy Fisher]

All of the citizen scientists that participated in the survey were trained through the MAST Basic Workshop (further information on MAST and the Basic Workshop can be found in Chapter 3). Sowden and each dive team conducted a pre-planning session before each dive. Each team was shown the outline of the wreck (Figure 35) before the dive to be able to quickly locate their target markers and understand the day's tasks (VanZandt *et al*., 2016). All members were reminded to dive safely, and that safety was the survey's top priority. A dive safety officer was present for each of the dives. The dive teams conducted two dives a day and were given approximately 30 minutes for each dive to complete their assigned tasks. Each dive team had to check in with the dive safety officer before entering and after exiting the water.

The survey measurements were obtained through trilateration demonstrated by Figure 37 between the control points. Trilateration is the process when the distance of a placed point or object was measured out to two different control points (MAST Workshop 2017). The measurements should form a triangle with a 90° angle (MAST Workshop 2017). Each dive team also drew sketches of any specific object or area measured on the shipwreck. Figure 38 demonstrates a drawing of the starboard side of the pilothouse. Amanda Holdeman and I took the measurements. The measurements were recorded on the MAST survey sheet (Figure 21) after each dive. Recording sheets were printed out on Never-Tear synthetic note sheets and tapped down to underwater slates or plastic clipboards with pencils (Figure 39). This allowed for the measurements to be taken underwater. Each dive team took down a plum-bob with a float (Figure 40) in order to obtain accurate horizontal measurements and a roll-up vinyl tape (Figure 41). Tools were attached to a lanyard with a snap for safekeeping during the dive (Figure 39).

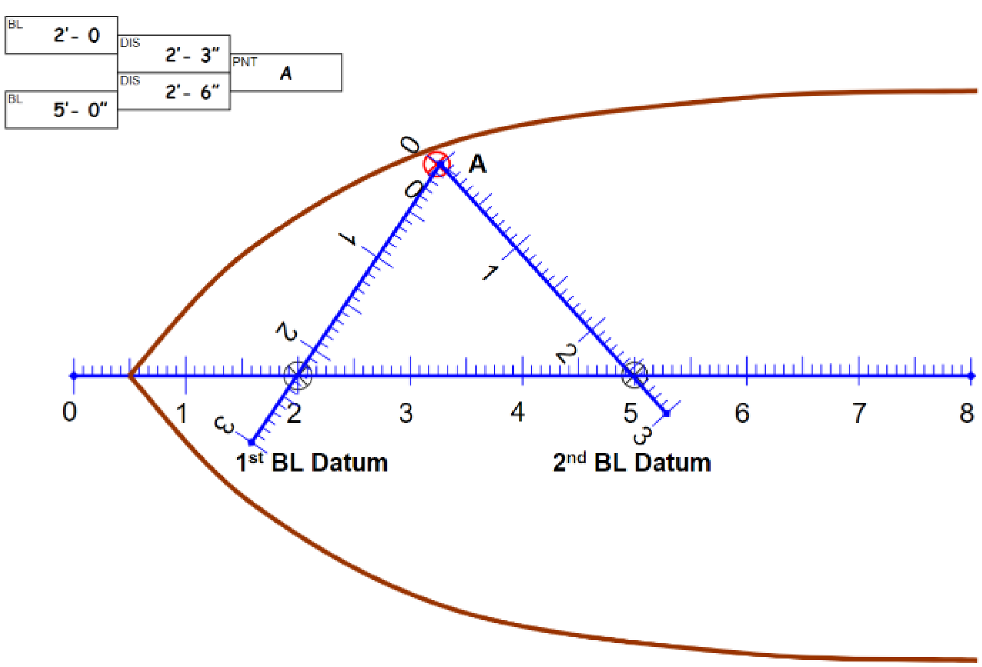


Figure 37. Graphic demonstrating the technique of trilateration used by MAST and how the method coordinates with their worksheet (graph was demonstrated during the MAST Basic Workshop) [Source: MAST]

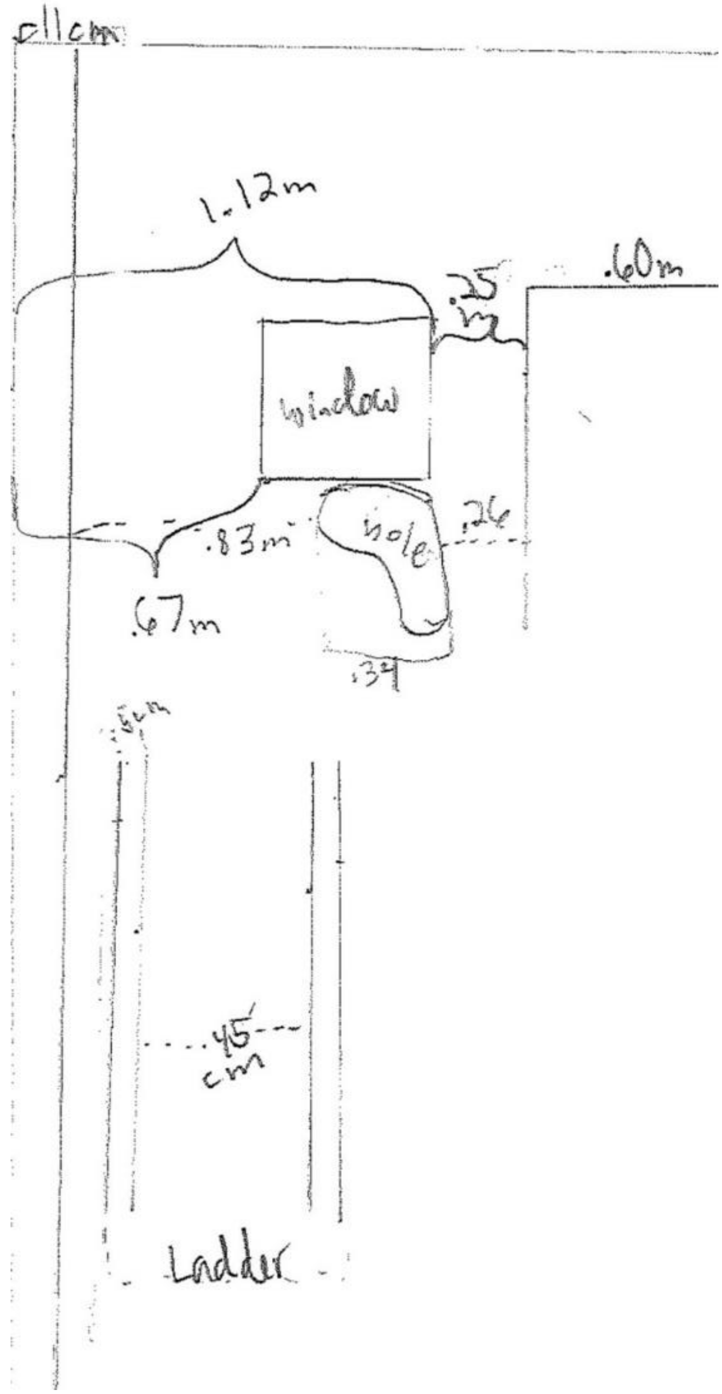


Figure 38. Drawings of measurements of the pilot house taken by Nancy Fisher and Amanda Holdeman [Source: MAST]

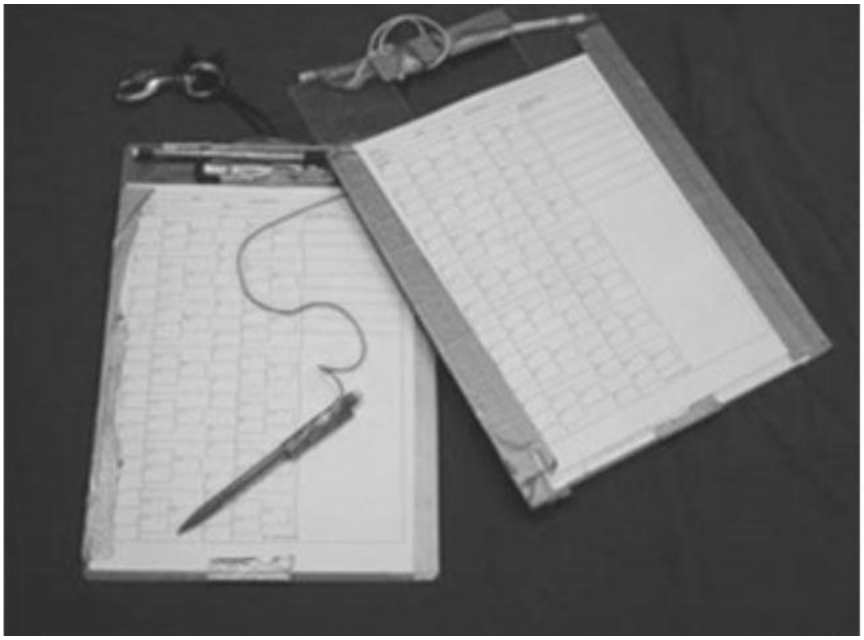


Figure 39. Photograph from the MAST Basic Workshop of the mylar worksheets taped to a clipboard with a pencil so the measurements can be recorded underwater. The clipboards were attached to lanyards to avoid being lost underwater [Source: MAST]

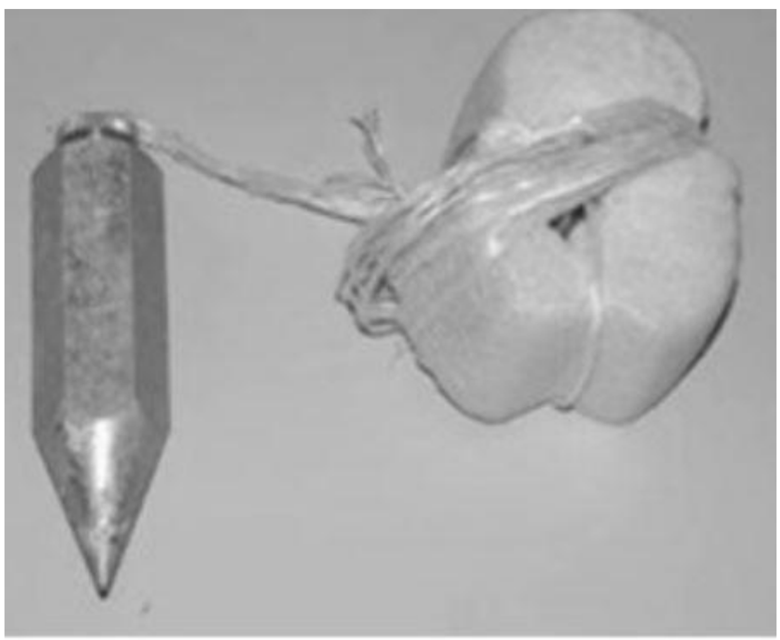


Figure 40. Photograph of the plumbobs used by the divers to take accurate horizontal plain measurements (image shown during MAST Basic Workshop) [Source: MAST]

Figure 41. Image of a basic roll up measurement tape used by MAST during the surveys [Source: (Everythingtrackandfield.com, 2019)]

The dive pairs went down in two separate groups to avoid any overcrowding and silting on the site. Each diver had to include their time in and out as well as their air in and out. The divers communicated through slates and tugs of the roll-up vinyl tape based on a plan discussed during the pre-dive. At the end of each dive, each team filled out a dive log (Figure 22), which outlines their activities during the dive and the weather parameters surrounding the dive, such as outside air temperature, water temperature, and underwater visibility. The divers transferred their drawings and data forms to dry sheets, which were scanned in for safekeeping.

6.2 Site Plan Methodology

The control point measurements from the citizen scientist divers were processed for validation in Site Recorder 4 (Figure 42). This method was done during the dissertation; MAST typically develops site plans through hand drawings. Site Recorder 4 is defined as "a versatile, geographic information system (GIS) designed for used in maritime, freshwater and intertidal archaeology" (Site Recorder 4 The GIS for Maritime Archaeology, 2007). The points were entered as "survey points." The following measured datum was incorrect according to Site Recorder 4:

Table 4. Site Recorder Corrected Datum

Control Points	Volunteer Measurement	Computerized Measurement	Error Margin
3 to 18	24.000 ft. (7.315 m)	24.275 ft. (7.399 m)	0.275 ft. (0.084 m)
1 to 2	8.083 ft. (2.464 m)	7.791 ft. (2.374 m)	0.292 ft. (0.089 m)
1 to 19	20.500 ft. (6.248 m)	20.718 ft. (6.315 m)	0.218 ft. (0.066 m)
16 to 19	8.917 ft. (2.718 m)	8.019 ft. (2.444 m)	0.898 ft. (0.898 m)
2 to 4	20.083 ft. (6.121 m)	20.939 ft. (20.939 m)	0.859 ft. (0.262 m)
14 to 16	29.917 ft. (9.119 m)	28.951 ft. (8.824 m)	0.966 ft. (0.294 m)

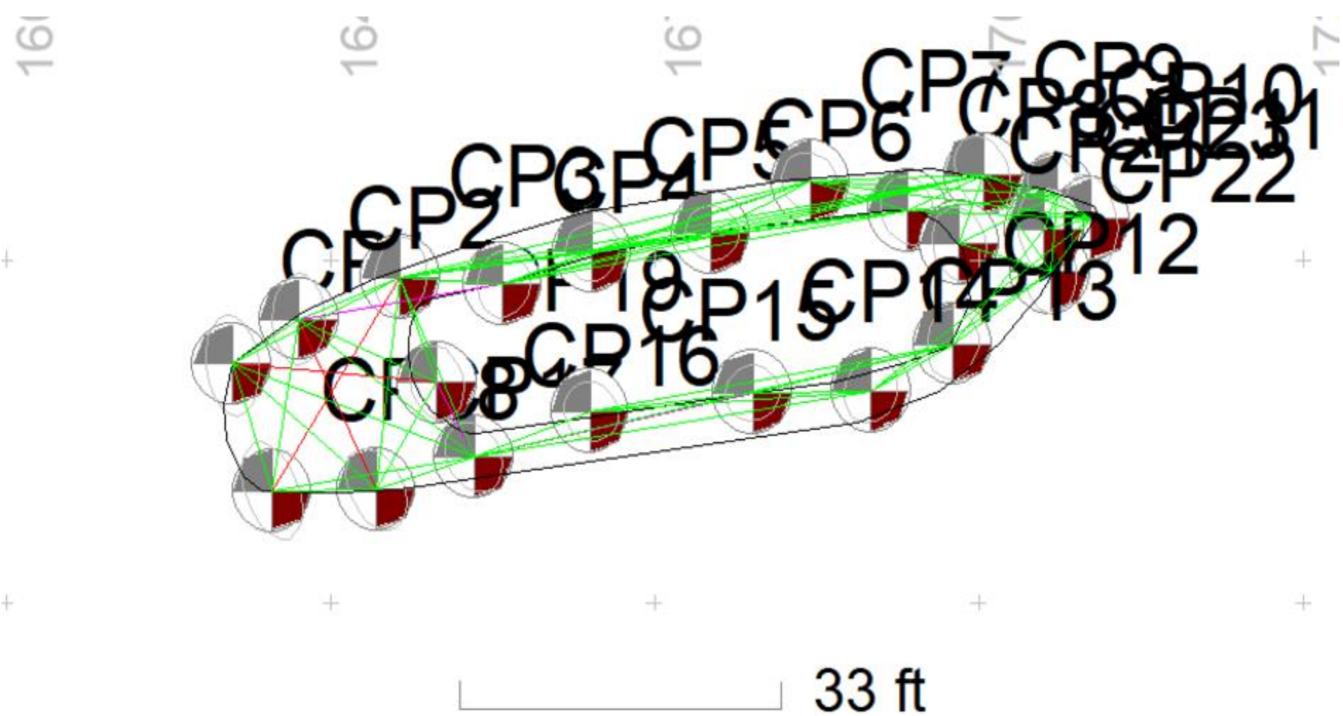


Figure 42. Image from Site Recorder 4 of the program automatically testing and adjusting the citizen scientists' data points [Source: Site Recorder 4]

A simple site plan (Figure 43) was put together solely based on the citizen scientists' data. Only a portion of the data was utilized because a large amount of the data was taken for 3D portions. The data used was used to build a view of the outline of the boat from the points collected by MAST. Profile plans of the wreck were not created of the *Admiral,* and therefore, the profile plans cannot be used to form any comparisons or contrasts to the measurements completed underwater by the members from MAST.

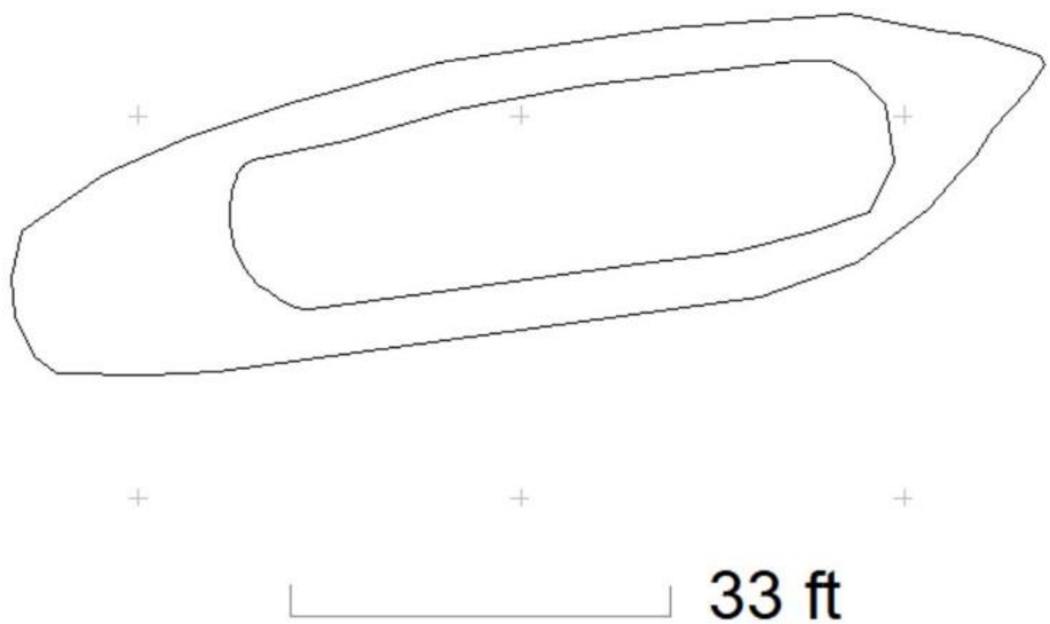


Figure 43. Simple site plan of the Admiral to demonstrate the accurateness of the citizen scientists' data. [Source: Site Recorder 4]

6.3 Photogrammetry Fieldwork and Methodology

The inspiration behind the photogrammetry fieldwork for this study was inspired by the work done by Van Damme (2015). Van Damme (2015) used Photogrammetry and Agisoft LLC to record a 17^{th} to 18^{th}-century Dutch shipwreck named *Oostvoornse Meer 8*. The shipwreck is located in an estuary in the North Sea near the city of Rotterdam that was dammed off in 1950 (Van Damme, 2015). The shipwreck is in a low visibility setting, with average visibility at about

1.64 feet (50 cm) (Van Damme, 2015). The site of the wreck is approximately 49.21 feet (15 m) by 26.25 feet (8 m) and is approximately 52.49 feet (16 m) deep. Shipworms (scientific name *teredo navalis*) have severely impacted the *Oostvoornse Meer 8* over the past few years (Van Damme, 2015).

The *Oostvoornse Meer 8* and the *Admiral* have a few similarities, which make the research completed by Van Damme an excellent case study to compare too. Both shipwrecks are located within low visibility zones (Van Damme, 2015). The *Admiral* has a range between 1 foot (0.31 m) and 20 feet (6.10 m). Each site is currently being endangered; the *Admiral* is being affected by zebra mussels, and the *Oostvoornse Meer 8* is being affected by shipworm (LaValle *et al*., 1999; Van Damme, 2015). Both sites have a complete length longer than 45 feet (13.72 m), which makes it difficult to obtain simple videos or camera shots of the site (Van Damme, 2015).

Photogrammetry was recently utilized by underwater archaeologists to obtain highly acute three-dimensional models of shipwreck sites (Van Damme, 2015). The tool is cost-effective and provides timely and more accurate models of the sites (Van Damme, 2015) Photogrammetry allows the archaeologists to record and monitor sites promptly while reducing human error and anthropogenic destruction (Van Damme, 2015; Yamafune *et al*., 2016). During the beginning of the 21st century, photogrammetry became a tool that allowed archaeologists to render three-dimensional models using one single camera (Yamafune *et al*., 2016). There are many names to describe Photogrammetry such as Multi-Image Photogrammetry, Close-Range Photogrammetry, Structure-from-Motion Photogrammetry, and Computer Vision Photogrammetry (Van Damme, 2015; Yamafune *et al*., 2016).

The most common software used to render a three-dimensional model is called Agisoft Photo Scan from the company Agisoft, LLC. Agisoft advertises their program as "a stand-alone software product that performs photogrammetric processing of digital image and generates 3D spatial data to be used in GIS applications, cultural heritage documentation, and visual effects production as well as for indirect measurements of objects of various skills" (Agisoft, 2019). The software has two editions, Professional ($3,499) and Standard ($179)(Agisoft, 2019). There is a discounted Educational program that comes in two versions, Professional edition ($549) and Standard edition ($59). Agisoft also offers a 30-day free trial for that offers that same function as the professional version (Van Damme, 2015; Agisoft, 2019). The program Photoscan generates point clouds from the pixels of the digital images to build a dense cloud and a mesh to obtain a three-dimensional model (Van Damme, 2015).

In order to perform a proper render in Photoscan, most underwater sites are relatively flat and have excellent lighting and good visibility (Yamafune *et al*., 2016). This research aims to test Photogrammetry on a site with less than ideal conditions with poor lighting and low visibility at a low cost. The site is also unique because the ship is standing upright on the lake bottom. The fieldwork was conducted in June of 2018. The weather was ideal with an average temperature of 85° F (26.67° C) with low clouds. A storm did prevent the boat from going out one day. The boat was provided by Scott Harrison, who also acted as the author's dive buddy for safety measures during each dive. Two other divers, Cindy LaRosa, and Kevin Magee volunteered to obtain video footage of the *Admiral* during the survey.

The conditions during the fieldwork remained relatively stable. The surface temperature of the water was approximately 67°F (19.44°C), and the bottom temperature at 65 feet (19.81 m) was about 48°F (8.89°C). There was a thermocline between 35 feet (10.67 m) and 40 feet (12.19

m). The bottom visibility was pretty good for the site and was between 2 feet (0.61 m) and 10 feet (3.05 m). The surface visibility was a lot better and was approximately 20 feet (6.10 m). The following information was obtained by dive logs completed by the author, Kevin Magee, and Cindy LaRosa.

Each diver followed a similar swim pattern (Figure 44) around the shipwreck site to obtain ample overlap to generate a high-quality three-dimensional image. Overlap in the images and videos is required for Photoscan to properly align and match the images to create a high-quality point cloud. The swimming pattern was based on the swim plan developed and executed by Yamafune (*et al*., 2016) (Figure 44) in order to obtain at least 60% overlap (Van Damme, 2015). Each dive team went down to either begin or complete a previous swim path. The dives were approximately 20 to 45 minutes and were performed with either wearing a 5mm wetsuit or a dry suit. Each team conducted two dives on one day, and then two dives were conducted by Scott Harrison and myself on three additional days. In order to obtain proper details of the wreck, the swim paths were performed between 2 feet (0.61 m) and 5 feet (1.52 m). A large amount of data was recovered and a video that was 26 minutes and 42 seconds long was cut and edited. Approximately only 35% of the videos collected were used.

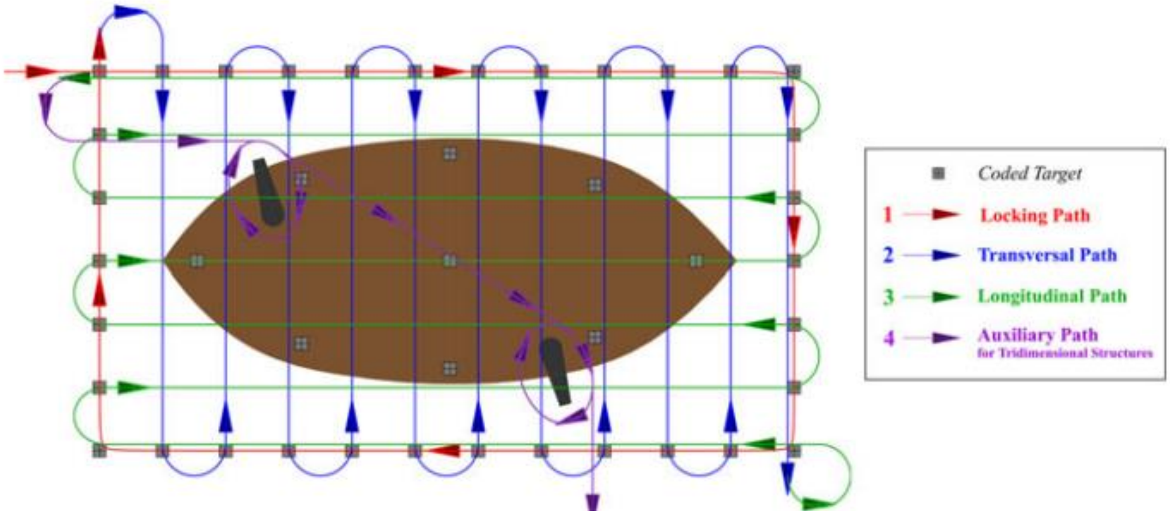


Figure 44. Swim pattern for best results for photogrammetry developed by Yamafune. The swimmers for the photogrammetry followed a similar swimming pattern [Source: Yamafune et al., 2016)

A GoPro HERO5 Black camera on a homemade camera mount (Figure 45) built by Jon Fisher and myself was utilized to capture the video footage. In order to avoid backscatter and assist with the murky green conditions, a single light was mounted about 6 inches (15.24 cm) from the camera using a bracket. The light was obtained through Amazon and was the Suptig Underwater Light Dive 84 LED (Figure 46). The inspiration behind the camera and light (Figure 47) set up was taken directly from the fieldwork conducted by Van Damme (*et al*., 2015).

Figure 45. Homemade camera mount designed by Nancy Fisher and Jon Fisher [Source: Photograph taken by Nancy Fisher]

Figure 46. Light utilized to avoid back scatter [Source: Amazon.com]

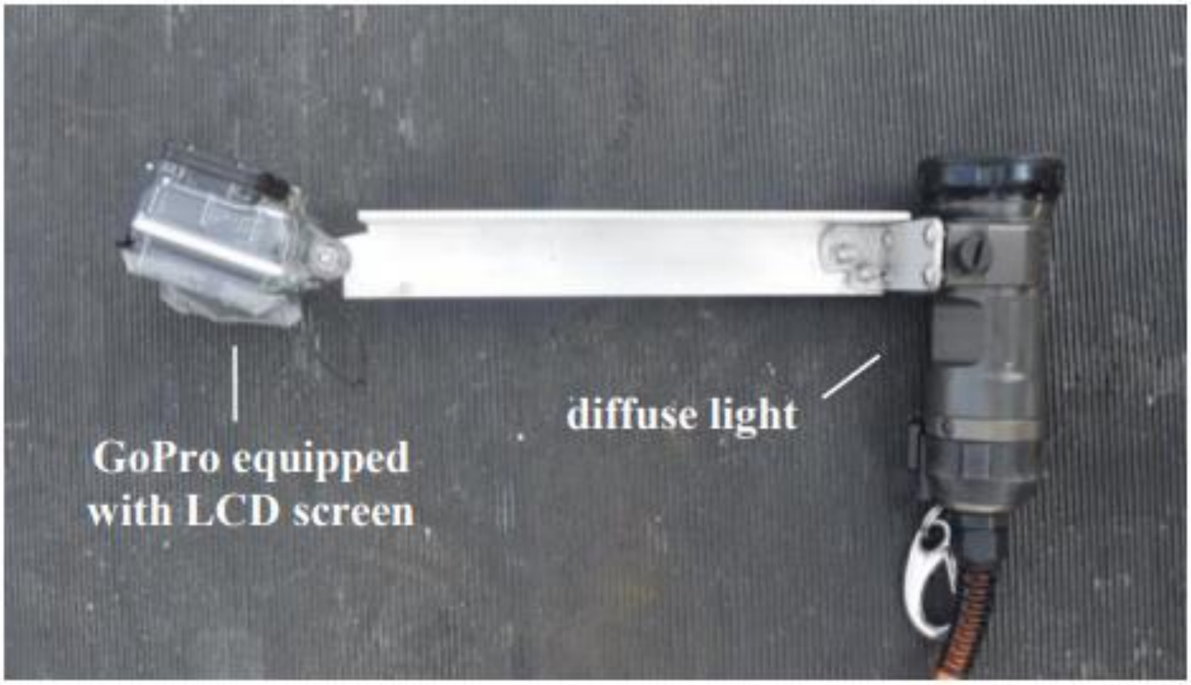


Figure 47. Mount used by Van Damme (2015) and the inspiration behind the mount designed for the survey on the Admiral [Source: (Van Damme, 2015)]

The Photogrammetry was processed on a Samsung laptop and was not processed at the site. The video footage and was edited with the program GoPro Quick. The methodology followed the Photoscan steps. The video was uploaded into Photoscan, and the program separated the video into a total of 1,497 video frames. Each processing set was tested. However, due to time constraints and processing capabilities, the setting "medium" was used. The laptop was a Samsung 9 Notebook with an 8th Gen Intel® CoreTM i7 Mobile Processor, Windows 10 operating system, an Intel® UHD Graphics 620 video card, and 8GB RAM. The system was able to allow Photoscan to run for at least 24 hours without any issues.

As previously mentioned, a total of 1,497 video frames were processed, of which only 141 frames aligned successfully. After the photos were aligned, a dense cloud was built, followed by a mesh. A proper model from Photoscan was not obtained even after several attempts. Only a model of the bit post was produced (Figure 48). We could also not gather an error margin through Photoscan.

Figure 48. Photogrammetry of front post of the Admiral [Source: Agisoft Photoscan]

6.4 Volunteer Videos and ROV Fieldwork

In order to obtain more video footage of the site, members from MAST Ohio volunteered their time and equipment. They attempted to gain footage between July and September of 2018. The following volunteers offered to obtain video footage: David McKinnon, Tom Szabo, Tina Pitre, Shelia Keith, James G. Foradas, Jennifer Sabo, Edward Noga, Donald Burden, Todd Felton, Lee A. Miller, Eric Matyac, Mark Groenhout, Erik Helgesen, Marc Duncan, Don Andree, and Robert Richards. Due to boat limitation and lousy weather, video footage was captured by Helgesen, Andree, and Groenhout. Some of the video footage and photo stills were added to the edited video for Photoscan.

Robotics classes run by teacher Robert Richards offered to focus their 2018 field day and ROV to the *Admiral.* They chartered the *Popeye* through the company Wildwood Marina. The field day happened on September 12, 2018. The ROV was a BlueROV2 with an externally mounted GoPro HERO 3 camera (Figure 49). The field of view was 110 degrees. The ROV was 18 inches (457 mm) in length, 13.3 inches (338 mm) in width, and 10 inches (254 mm) in height. The max depth is about 330 feet (100 m) with a max speed of 2 knots (1 m/s). Unfortunately, due to bad visibility (less than 1 foot [30.48 cm]), the dive had to be canceled, and no video footage was obtained.

Figure 49. Photograph of the BlueROV2 utilized by the students during the field school [Source: (Bluerobotics.com, 2019)]

Four students participated in the field day and filled out surveys based on their experience. They had ten multiple-choice questions ranging from strongly agree, agree, uncertain/not applicable, disagree, to strongly disagree. The questions for the survey can be found in the Appendix 3. All of the responses from the students were either strongly agree or agree. The students gained a stronger appreciation toward their local heritage, gained a stronger appreciation toward archaeology and history, increased their support toward the protection of shipwrecks and underwater culture, and found the overall experience informative and enjoyable. Each student agreed that they would like to learn more about underwater archaeology, cultural heritage, robotics, and continue to volunteer and be citizen scientists. The students learned about the surveying process, how to properly prepare for a survey, operate and troubleshooting an ROV, run a dive log, and how to be a part of a team. Even though they were unable to obtain video footage, the students learned valuable information on how to better improve the ROV for poor visibility in the future. Overall, every student found the experience valuable even though they did not obtain the desired results.

6.6 Discussion on Fieldwork and Methodology

The *Admiral* case study demonstrates that it is still difficult to acquire a photogrammetry model on large 3D shipwreck sites located in Lake Erie under strict budget and time constraints. It was challenging to produce a model with a small team and a low-cost camera with an average recording distance of about 2 to 5 feet (0.61 to 1.52 m). The higher technical ROV system and camera also had difficulty due to the low visibility. More fieldwork or a higher budget is currently required in order to obtain Photogrammetry on a low visibility shipwreck like the *Admiral.* Future fieldwork could possibly focus more on the overlap and the possible use of targets or markers (Figure 50) to help Photoscan recognize various angles of the wreck

(Tommaselli and Berveglieri, 2018). Another study could also focus on gathering information to find out the minimum visibility required to perform photogrammetry on large shipwrecks to save time in the field.

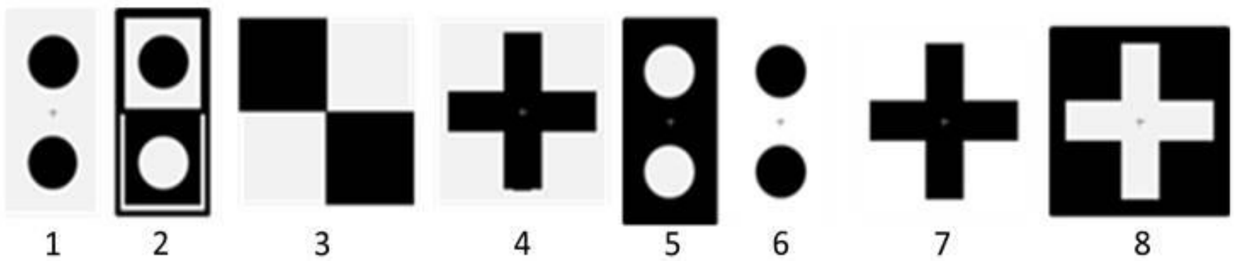


Figure 50.. Markers invented by Tommaselli and Berveglieri (2018) that exemplify markers that could benefit photogrammetry in low visibility water (Tommaselli and Berveglieri, 2018).

The fieldwork completed by MAST was educational but not entirely functional to monitor a wreck properly overtime. The citizen scientists (as demonstrated by the survey) were able to gather a large amount of unique hands-on experience and grow their appreciation for underwater heritage. However, the data gathered by the citizen scientists was not complete or comprehensive enough to build a scientifically accurate site plan for site monitoring. The data did not include all of the changes to the ship's frame. The data would be efficient enough to develop a 2D site plan.

A more comprehensive site plan could be drawn by hand; however, the inaccuracies would make it difficult to monitor the site over a long period of time. With the use of AutoCAD, a 3D model based on some of the citizen scientist's data and historical photos (Figure 51) was built with the help of citizen scientist Ibrahim Kasem. Both the site plan and 3D model could be used in an archaeological survey or investigation; however, the inaccuracies would make them difficult to be used for monitoring.

Figure 51. Model built-in AutoCAD with the help of citizen scientist Ibrahim Kasem [Source: Created by Ibrahim Kasem and Nancy Fisher]

Photogrammetry can show the changes in the wreck over time while taking accurate measurements of the wreck as well. The photogrammetry model of the shipwreck *Oostvoornse Meer 8* had an error margin of 0.0394 inches (4mm) (VanZandt *et al.*, 2016). In my opinion, the focus should now be placed on training the citizen scientists of MAST in Photogrammetry to be able to gather larger amounts of usable data and stay within certain budget and time constraints. Training MAST members in photogrammetry could become part of the existing workshop or taught separately. The data would need to be processed and properly tested before making any conclusions.

Chapter 7 – Discussions and Conclusions

Shipwrecks and other underwater cultural resources are essential historical time capsules to the local and surrounding communities that need to be protected and preserved. To adequately protect and preserve a shipwreck, the site needs to be monitored in a timely and proper manner in order to accurately record any damages. This research aimed to focus on methods to monitor low visibility and large-scale shipwreck sites under time and budget restrictions. Two options were considered, citizen science and photogrammetry. Both options did not come to measurable concluding results. Each option needs to further explored in order to be disregarded or not. Many studies have consistently proved photogrammetry as producing highly accurate and very detailed models. Citizen science has also produced desirable, scientifically accurate results while educating the public about the specific scientific field.

The overall results did not discount either fieldwork method. The data from MAST was meant for a 2D site plan and was also used to create a simple 3D model. However, the current MAST fieldwork methods utilizing trilateration would be challenging to be used toward data collection over an extensive period. It is also challenging to use trilateration to notice damages to a wreck site over time. Trilateration was time-consuming and open to a lot of human error. This chapter will further discuss the main findings and limitations of the study. The section will also discuss recommendations for further research on site monitoring and citizen science.

7.1 Main Findings

As previously mentioned, the fieldwork conducted by MAST and the fieldwork conducted by myself and a small team for the photogrammetry did not produce the desired results for long term site monitoring. As demonstrated by the research done on the *Oostvoornse Meer 8,* photogrammetry can be done on a low visibility wreck (Van Damme, 2015). However, the *Oostvoornse Meer 8* has less height to the site than the *Admiral.* The *Admiral* lays on the lake bottom upright, with most of the ship still intact. The *Oostvoornse Meer 8* site only includes the bottom of the hull, with most the ship no longer intact. The differences in dimensions made it easier for the divers on the *Oostvoornse Meer 8* to complete a constant swim pattern and achieve a high overlap for Agisoft Photoscan. The team was more significant in size and spent more time diving on the site. With a larger budget and a larger team, photogrammetry on the *Admiral* could become more probable. Other additional research could be beneficial, such as adding in markers to help Photoscan better align the video frames.

The questionnaire demonstrated MAST as being a proper Educational citizen science project (Wiggins and Crowston, 2011). The project educated the citizens on the importance of underwater cultural heritage and strengthened their appreciation toward underwater archaeology. Some of the citizen scientists left MAST with the intent to inspire and tell others about underwater archaeology and the importance of protecting underwater cultural heritage within the Great Lakes and, more specifically, Lake Erie. MAST showed their strengths as an Investigation citizen science group as well (Wiggins and Crowston, 2011). They have produced and completed multiple goals such as educating the public through dive slates and reports and protecting the shipwreck sites with personally engineered buoys (MAST, 2019cs)

7.2 Limitations

This section will discuss the limitations in the questionnaire, the MAST fieldwork, and the photogrammetry fieldwork. Due to the limited population and specific parameters, the questionnaire had a very limited audience. This made it difficult to conduct a pilot test or utilize any sampling methods. The questionnaire was sent out to everyone to gather more data and to avoid any bias in the selection process. The limitations regarding the questionnaire are also about the context of the questions.

Many of the questions contained positive statements, which may have triggered a positive response. There is an intrinsic bias. An example of the positive language is: How likely are you to recommend this course to a family or friend? Some questions were worded with both positive and negative language, such as “satisfied or dissatisfied.” However, some questions were missing the choice to choose a neutral statement like “do not know.” This forces the citizens to either choose a negative or positive response.

The MAST fieldwork was limited for this study because the fieldwork was conducted before the hypothesis was formed. The fieldwork was aimed towards a preliminary survey and not towards site monitoring. If the fieldwork was redone with the hypothesis already established, then the fieldwork may have been successful or slightly altered or changed to be successful. Many of the citizens who collected the data were not reachable in case any of the data included any human errors or typos. If the data analysis was conducted closer to the time the fieldwork was done, the results might have differed.

The fieldwork for the photogrammetry was conducted with extreme time constraints and a small budget. There were only five days available to finish the fieldwork. Better quality videos could have been captured with a better camera, improved lighting equipment, and more practice time. Proper training was not provided for the citizens who gathered the video. They only received a simple “how-to” print-out sheet. Training videos or a better pre-dive plan may have improved the data quality. The study was completed with many constraints in time, budget, and availability. Ideal parameters would have the data collected and analyzed within the same year for both the MAST and photogrammetry fieldwork.

7.3 Recommendations for Further Research

Both citizen science and photogrammetry should be used together to get the best results and to preserve and monitor shipwrecks accurately. MAST (or similar citizen science groups) could host a photogrammetry workshop to train the citizens on the proper methodology. The workshop could include background on photogrammetry, an introduction to programs like Photoscan, and training on proper swim patterns to achieve a large amount of overlap in the images or videos. The photogrammetry fieldwork would achieve the best results for site monitoring if it was done every 2 to 3 years.

Training could also be done online with proper print-out resources and instructional videos. The data then could be submitted through an open-source website. Proper parameters such as information on weather, dive time, visibility, camera specs, etc. should be submitted along with the video data. Instructions and courses on how to run Agisoft Photoscan (or a similar program) so the citizens could be a part of the entire scientific process.

As previously mentioned, improved markers could also be utilized to help Photoscan achieve better analytics. The markers should remain inexpensive. Improved technology, such as an underwater laser scanner from companies like 3D at Depth, could be used to gain enhanced imagery a lot quicker (Archaeological Sites and Wrecks, 2020). Conversely, the purpose of this study is to accurately monitor underwater sites on a budget. A large number of wrecks mainly located in less than ideal situations like Lake Erie, may not get the funding required to obtain higher-end technology. Citizen science was highlighted as a more cost-effective method with the added benefit of communicating with and teaching to a larger general audience. Any future research needs include these parameters to accurately yield results or probable solutions.

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Appendix 1: MAST Admiral Questionnaire

Section 1: Personal Questions

Terms of Agreement are at the end of the survey. If you choose to participate in this survey, it may take approximately 30 minutes to complete. Participation in this survey is anonymous as we do not ask for your name or contact information.

Year of Participation

- o 2016
- o 2017
- o Both 2016 and 2017

Education

- o Some Highschool
- o Completed Highschool
- o GED
- o Some College
- o Associate Degree
- o Bachelor's Degree
- o Master's Degree
- o Doctorate or P.h.D
- o Prefer not to say

How old are you?

Why did you choose to participate in class and the diving sessions? (Please select ALL that apply)

- ▪ To gain new skills and knowledge.
- ▪ To meet new people.
- ▪ For personal interest or pleasure.
- ▪ To use toward another course toward higher education.
- ▪ To improve one a skill or learn more for your job.
- ▪ To improve on a hobby.
- ▪ Was required by your job.
- ▪ None of the above
- ▪ Other… [Insert Text Here]

Which of the following did you gain from your course once you completed it? (Please select ALL that apply)

- ▪ Gained valuable knowledge and skills.
- ▪ Made new friends and acquaintances.
- ▪ Gained valuable information for my work or future career.
- ▪ Gained valuable information for another course of higher education.
- ▪ Gained a better appreciation for Maritime Archaeology.
- ▪ Improved on my scuba diving.

- None of the above.
- Other… [Insert Text Here]

Section 2: Satisfaction Questions

Please answer the following questions below as honestly as possible with "1" being not satisfied at all and "10" being completely satisfied.

How satisfied or dissatisfied are you with the teaching or training from the class or scuba diving sessions?
Very Dissatisfied 1 2 3 4 5 6 7 8 9 10 Very Satisfied

How satisfied or dissatisfied are you with the information presented at the course?
Very Dissatisfied 1 2 3 4 5 6 7 8 9 10 Very Satisfied

How satisfied or dissatisfied are you with the printed-out resources provided to you during the course?
Very Dissatisfied 1 2 3 4 5 6 7 8 9 10 Very Satisfied

How satisfied or dissatisfied are you with the overall cost of the course and the scuba diving sessions?
Very Dissatisfied 1 2 3 4 5 6 7 8 9 10 Very Satisfied

How satisfied or dissatisfied are you with the training and teaching staff?
Very Dissatisfied 1 2 3 4 5 6 7 8 9 10 Very Satisfied

How satisfied or dissatisfied are you with the advice you have been given about what to do after this class?
Very Dissatisfied 1 2 3 4 5 6 7 8 9 10 Very Satisfied

How satisfied or dissatisfied are you with the safety support you received during the class and the scuba diving sessions?
Very Dissatisfied 1 2 3 4 5 6 7 8 9 10 Very Satisfied

How satisfied or dissatisfied are you with your overall expectations of the class and scuba diving sessions?
Very Dissatisfied 1 2 3 4 5 6 7 8 9 10 Very Satisfied

How likely are you to recommend this course to a family or friend?
Very Dissatisfied 1 2 3 4 5 6 7 8 9 10 Very Satisfied

Section 3: Open-Ended Questions

Please answer the questions as well and as honest as you can.
If you answer is no, please leave the question blank.

Have you developed any new skills from the class or diving sessions that you did not already hold? If yes, please list the skills in the space below.

What were the best aspects of this course?

What aspects of the course need improving?

Have you participated in a similar course? If you, please provide as much detail on the course as possible.

Do you have a greater appreciation for archaeology and/or history after attending this course? If yes, please explain.

Do you feel closer to your local cultural heritage? If yes, please explain.

Do you feel a stronger tie/support for the protection of shipwrecks after the course? If yes, please explain.

Section 4: Multiple Choice and Open-ended Diving Questions

If you did not participate in the diving/training questions, please just answer the first and second question and skip the rest.

Did you participate in any of the scuba diving sessions?

- o Yes
- o No

If you did not scuba, can you please give a short reason as to why?

Are you a certified scuba diver?

- o Yes
- o No
- o Prefer not to say.

If you are a certified diver, what company is your certification from?

How many dives have you completed?

What were the most valuable skills/lessons you gained during the scuba diving sessions?

Are there any aspects of the scuba diving course that you think needs improvement? If yes, please explain.

Did you find the training for the scuba diving sessions valuable and helpful? If yes, please explain.

Section 5: Terms of Agreement

The purpose of this survey is to add valuable information to Nancy Fisher's master's dissertation through the University of Malta. The participation is anonymous. You are being invited to participate in this research because you attended the MAST class in 2016 or 2017 and had a chance to scuba dive on the *Admiral* shipwreck.

Your participation in this research is voluntary. You may choose to not participate in this survey. If you would like to withdraw your answers at any time, please email Nancy Fisher at ...

We will do our best to keep your information confidential. All data is stored in a password protected electronic format. To help protect your confidentiality, the survey will not contain information that will identify you. We do ask for your age, but you may decline to answer this question.

The results of this study will be used toward scholarly purposes only and the results may be shared with University of Malta representatives.

If you have any questions about the research study, please email Nancy Fisher at …

ELECTRONIC CONSENT: Please select the choice below.

Clicking the "agree" button below indicates:

- you participated in a MAST course.
- you voluntarily agree to participate.
- you agree with the 'Terms of Agreement'

Please select one option:

- o Agree
- o Disagree

Appendix 2: MAST/*Admiral* Survey Response

Please remember that all of the responses are anonymous and will remain anonymous. If any of the responses are blank, then the participant did not respond to the question. None of the answers were altered, even for grammar, and remain raw.

Survey Timestamp for Each Participant:

Participant	**Time Stamp**
1	2018/08/06 11:27:40 AM EST
2	2018/08/06 1:07:42 PM EST
3	2018/08/06 1:29:17 PM EST
4	2018/08/06 3:11:40 PM EST
5	2018/08/06 6:43:26 PM EST

6	2018/08/07 10:37:31 AM EST
7	2018/08/07 12:29:33 PM EST
8	2018/08/07 3:55:56 PM EST
9	2018/08/07 7:47:09 PM EST
10	2018/08/10 5:30:21 PM EST
11	2018/08/14 6:40:45 PM EST
12	2018/08/21 12:24:35 PM EST
13	2018/08/23 8:46:58 AM EST
14	2018/09/04 6:58:40 AM EST
15	2018/09/05 7:08:16 AM EST
16	2018/09/07 10:13:44 AM EST
17	2018/09/08 10:38:23 AM EST
18	2018/09/12 5:56:42 PM EST
19	2018/09/14 8:15:08 PM EST
20	2018/09/16 8:56:36 PM EST
21	2018/09/25 7:50:08 AM EST
22	2018/09/26 5:58:46 AM EST

Section 1: Personal Questions

Year of Participation

Participant	**Response**
1	2016
2	2017
3	Both 2016 and 2017
4	2017
5	2017
6	2017
7	2016
8	2017
9	Both 2016 and 2017
10	2017
11	Both 2016 and 2017
12	Both 2016 and 2017
13	2017
14	2017
15	2016
16	Both 2016 and 2017
17	Both 2016 and 2017
18	2017
19	2017
20	Both 2016 and 2017
21	2017
22	Both 2016 and 2017

Education Level

Participant	Response
1	Bachelor's Degree
2	Master's Degree
3	Master's Degree
4	Bachelor's Degree
5	Master's Degree
6	Doctorate or P.h.D
7	Master's Degree
8	Bachelor's Degree
9	Bachelor's Degree
10	Bachelor's Degree
11	Master's Degree
12	Master's Degree
13	Master's Degree
14	Master's Degree
15	Bachelor's Degree
16	Bachelor's Degree
17	Some College
18	Bachelor's Degree
19	Bachelor's Degree
20	Master's Degree
21	Doctorate or P.h.D
22	Completed Highschool

How old are you?

Participant	Response
1	60
2	75
3	49
4	71
5	56
6	45
7	38
8	24
9	49
10	64
11	47
12	55
13	26
14	47
15	29
16	66
17	50
18	45

19	40
20	56
21	63
22	55

Why did you choose to participate in this class and the diving sessions? (Please select ALL that apply)

Participant	**Response**
1	To gain new skills and knowledge.; To meet new people.; For personal interest or pleasure.; To improve on a hobby.; I've worked on several Maritime Archaeology projects
2	To gain new skills and knowledge.; For personal interest or pleasure.; To improve on a hobby.
3	For personal interest or pleasure.
4	To gain new skills and knowledge.; To meet new people.; For personal interest or pleasure.; To improve on a hobby.
5	To gain new skills and knowledge.; To meet new people.; For personal interest or pleasure.; To improve on a hobby.
6	To gain new skills and knowledge.; For personal interest or pleasure.; To improve on a hobby.
7	For personal interest or pleasure.; For professional interest
8	To gain new skills and knowledge.; To meet new people.; For personal interest or pleasure.
9	To gain new skills and knowledge.; For personal interest or pleasure.; To improve on a hobby.
10	To gain new skills and knowledge.; For personal interest or pleasure.; To improve on a hobby.
11	To gain new skills and knowledge.; To meet new people.; For personal interest or pleasure.; To improve on a hobby.
12	To gain new skills and knowledge.; To meet new people.; For personal interest or pleasure.; To improve on a hobby.
13	To use toward another course or toward higher education.; To improve on a skill or learn more for your job.
14	To gain new skills and knowledge.; To meet new people.; For personal interest or pleasure.; To improve on a hobby.; To make a contribution to Ohio's Maritime History
15	To gain new skills and knowledge.; For personal interest or pleasure.; To improve on a skill or learn more for your job.
16	To gain new skills and knowledge.; To meet new people.; For personal interest or pleasure.
17	To gain new skills and knowledge.; For personal interest or pleasure.
18	To gain new skills and knowledge.; To meet new people.; For personal interest or pleasure.; To improve on a hobby.
19	To gain new skills and knowledge.
20	To gain new skills and knowledge.; For personal interest or pleasure.; To improve on a hobby.
21	To gain new skills and knowledge.; For personal interest or pleasure.
22	For personal interest or pleasure.

Which of the following did you gain from the course once you completed it? (Please select ALL that apply)

Participant	**Response**
1	Gained valuable knowledge and skills.; Made new friends or acquaintances.; Gained valuable information for another course or higher education.; Gained a better appreciation for Maritime Archaeology.; Warm up for LAMP Field School in St. Augustine
2	Gained valuable knowledge and skills.; Gained a better appreciation for Maritime Archaeology.; Improved on my scuba diving.
3	Made new friends or acquaintances.; Improved on my scuba diving.
4	Made new friends or acquaintances.; Gained a better appreciation for Maritime Archaeology.; Improved on my scuba diving.
5	Made new friends or acquaintances.; Gained a better appreciation for Maritime Archaeology.; Improved on my scuba diving.
6	Gained valuable knowledge and skills.; Made new friends or acquaintances.; Gained a better appreciation for Maritime Archaeology.; Improved on my scuba diving.
7	Made new friends or acquaintances.; Improved on my scuba diving.; Networked in my professional field (maritime archaeology)
8	Gained valuable knowledge and skills.; Made new friends or acquaintances.; Gained valuable information for my work or future career.; Gained a better appreciation for Maritime Archaeology.
9	Gained valuable knowledge and skills.; Made new friends or acquaintances.; Gained valuable information for another course or higher education.; Gained a better appreciation for Maritime Archaeology.; Improved on my scuba diving.
10	Gained valuable knowledge and skills.; Made new friends or acquaintances.; Gained a better appreciation for Maritime Archaeology.; Improved on my scuba diving.
11	Gained valuable knowledge and skills.; Made new friends or acquaintances.; Gained a better appreciation for Maritime Archaeology.; Improved on my scuba diving.
12	Gained valuable knowledge and skills.; Made new friends or acquaintances.; Gained a better appreciation for Maritime Archaeology.; Improved on my scuba diving.
13	Gained valuable knowledge and skills.; Made new friends or acquaintances.; Gained valuable information for my work or future career.; Gained valuable information for another course or higher education.; Improved on my scuba diving.
14	Gained valuable knowledge and skills.; Made new friends or acquaintances.; Gained valuable information for my work or future career.; Gained valuable information for another course or higher education.; Gained a better appreciation for Maritime Archaeology.; Improved on my scuba diving.
15	Gained valuable knowledge and skills.; Gained valuable information for my work or future career.; Gained a better appreciation for Maritime Archaeology.; Improved on my scuba diving.
16	Gained valuable knowledge and skills.; Made new friends or acquaintances.; Gained a better appreciation for Maritime Archaeology.
17	Gained valuable knowledge and skills.; Made new friends or acquaintances.; Gained a better appreciation for Maritime Archaeology.; Improved on my scuba diving.
18	Gained valuable knowledge and skills.; Made new friends or acquaintances.; Gained a better appreciation for Maritime Archaeology.; Improved on my scuba diving.
19	Gained valuable knowledge and skills.; Made new friends or acquaintances.; Gained a

	better appreciation for Maritime Archaeology.; Improved on my scuba diving.
20	Gained valuable knowledge and skills.; Made new friends or acquaintances.; Gained valuable information for my work or future career.; Gained valuable information for another course or higher education.; Gained a better appreciation for Maritime Archaeology.; Improved on my scuba diving.
21	Gained valuable knowledge and skills.; Made new friends or acquaintances.; Gained a better appreciation for Maritime Archaeology.
22	Made new friends or acquaintances.; Gained a better appreciation for Maritime Archaeology.; Improved on my scuba diving.

Section 2: Satisfaction Questions

Please answer the following questions below as honestly as possible with “1” being not satisfied at all and “10” being completely satisfied.

How satisfied or dissatisfied are you with the teaching or training from the class and scuba diving sessions?

Participant	**Response**
1	8
2	6
3	9
4	10
5	10
6	6
7	9
8	10
9	10
10	10
11	10
12	10
13	10
14	10
15	6
16	5
17	8
18	10
19	8
20	10
21	10
22	5

How satisfied or dissatisfied are you with the information presented at the course?

Participant	**Response**
1	10
2	10

3	9
4	10
5	10
6	7
7	9
8	10
9	10
10	10
11	8
12	9
13	6
14	10
15	8
16	7
17	8
18	10
19	9
20	10
21	10
22	5

How satisfied or dissatisfied are you with the printed-out resources provided to you during the course?

Participant	Response
1	9
2	5
3	9
4	10
5	10
6	7
7	9
8	10
9	10
10	10
11	1
12	10
13	5
14	10
15	7
16	7
17	7
18	10
19	10
20	9
21	10
22	5

How satisfied or dissatisfied are you with the overall cost of the course and scuba diving sessions?

Participant	Response
1	9
2	6
3	9
4	10
5	10
6	9
7	8
8	10
9	10
10	10
11	10
12	9
13	8
14	9
15	9
16	7
17	7
18	10
19	8
20	10
21	10
22	4

How satisfied or dissatisfied are you with the training and teaching staff?

Participant	Response
1	7
2	10
3	9
4	10
5	10
6	7
7	8
8	10
9	10
10	10
11	10
12	10
13	10
14	9
15	6
16	9
17	9

18	10
19	9
20	10
21	10
22	5

How satisfied or dissatisfied are you with the advice you have been given about what to do after this class?

Participant	Response
1	9
2	5
3	9
4	10
5	10
6	6
7	4
8	10
9	8
10	10
11	8
12	9
13	9
14	8
15	5
16	5
17	7
18	8
19	9
20	10
21	10
22	6

How satisfied or dissatisfied are you with the safety support you received during the class and scuba diving sessions?

Participant	Response
1	10
2	8
3	9
4	10
5	10
6	9
7	6
8	10
9	10
10	10
11	10

12	10
13	10
14	10
15	8
16	7
17	8
18	10
19	8
20	10
21	10
22	6

How satisfied or dissatisfied are you with your overall expectations of the class and scuba diving sessions?

Participant	Response
1	9
2	10
3	9
4	10
5	10
6	7
7	8
8	10
9	10
10	10
11	9
12	10
13	9
14	10
15	7
16	8
17	8
18	9
19	8
20	10
21	10
22	6

How likely are you to recommend this course to a family or friend?

Participant	Response
1	10
2	5
3	10
4	10
5	10
6	6

7	10
8	10
9	10
10	10
11	10
12	9
13	10
14	10
15	8
16	9
17	10
18	10
19	10
20	10
21	10
22	3

Section 3: Open-Ended Questions

Please answer the questions as well and as honest as you can.
If you answer is no, please leave the question blank.

Have you developed any new skills from the class or diving sessions that you did not already hold? If yes, please list the skills in the space below.

Participant	Response
1	Trilateration measuring
2	No
3	Improved my low viz diving abilities
4	
5	Improved buoyancy
6	Learned a method of underwater surveying.
7	No new skills gained, but I appreciated the chance to enhance my trilateration skills.
8	PADI archaeological diver certification
9	Working with tools under water
10	measuring objects underwater, Plotting points on a wreck diagram
11	Low visibility diving and gaining a higher comfort level, multi-tasking while diving, practice in being able to make mental notes while diving and recalling later, appreciation for underwater archeology,
12	how to properly, measure wrecks and how to leave it for future enjoyment by others.
13	Trilateration
14	Networking with amazing divers
15	Trilateration, using a plum bob underwater, working underwater, bouyancy
16	How to measure and record underwater

17	
18	How to do survey measurements. Also an appreciation of "task-oriented" SCUBA diving.
19	Triangulation
20	Locating items along the wreck utilizing triangulation - then representing these on the wreck drawing after my dive
21	Underwater trilateration
22	

What were the best aspects of this course?

Participant	Response
1	Meeting others interested in maritime Archaeology
2	Diving on a wreck in Lake Erie
3	The research course and the hands-on in water.
4	
5	Use of u/w navigational tools
6	The embedded history lesson, and the detailed ship parts lecture.
7	Great speaker, great teachers. Ability to network with divers from Ohio and the surrounding region.
8	The patience and expectations of the instructors. It was very encouraging.
9	Learning about Maritime Archeology
10	The dives working on a wreck
11	The sense of using diving for a greater purpose rather than just to go diving.
12	how to measure, and adjust diving with extra gear. getting a better understanding of the Great Lakes.
13	Archeological tasks
14	I loved everything
15	background information
16	Working together with others with similar interests and skills
17	
18	History and construction of ships and shipwrecks.
19	Learning the history ships
20	Wide coverage of all things Arch.
21	Gained an appreciation of the difficulties of archeological research
22	Meeting others interested in maritime Archaeology

What aspects of the course need improving?

Participant	Response
1	Level 2 students that instruct need practical experience or a skill review. The pair I had kept telling us the wrong way to do things. Turned out they hadn't actually dove on a wreck.
2	More accurate reading of water conditions
3	na
4	
5	None
6	I would like to learn more and at a much faster pace. I thought that the

	course moved much too slowly.
7	Better communication by MAST after course is completed. Despite being a MAST member since I completed the workshop, I haven't received an email from MAST about summer dive opportunities since 2016. I have had to ask other MAST members about the dates of dive weekends; it seems the dive weekends are only announced to new members and workshop teachers after completion of the workshops. As far as I can tell from talking with other MAST members, no emails are sent to existing MAST members and nothing is posted online. Why the lack of communication with existing members?
8	
9	Advanced class covers a lot in a short period
10	
11	I would appreciate knowing what was done with the data gathered.
12	
13	How tasks play into the bigger picture
14	More communication and opportunities to survey wreck sites
15	technical techniques underwater
16	
17	
18	Could use more practical training on different measurement methods. We focused on center-line tri-lateration, but when I got to the Admiral it used fixed points.
19	More space
20	Work papers need to be updated
21	Literature searches
22	Publish findings in a timely manner.

Have you participated in a similar course? If yes, please provide as much detail on the course as possible.

Participant	**Response**
1	Did a month long field school at LAMP in St. Augustine Florida.
2	Nothing even close.
3	
4	
5	No
6	No.
7	No
8	
9	No
10	
11	No.
12	
13	Masters degree
14	None
15	no
16	

17	
18	No
19	No
20	I've not.
21	No
22	Did a month long field school at LAMP in St. Augustine Florida.

Do you have a greater appreciation for archaeology and/or history after attending this course? If yes, please explain.

Participant	Response
1	Yes
2	My appreciation for underwater archaeology expands each time I visit another wreck. I am a heavy duty amateur diver but still learn every time I visit a treasure such as the Willis.
3	Always. Every experience helps build my knowledge base.
4	Yes, Appreciate the effort it takes to document and recognize all the significant objects.
5	Yes
6	Yes. I enjoyed hearing about the various shipwrecks, and some of the Great Lakes history.
7	No, but I have a greater understanding of Lake Erie maritime history.
8	Yes-- I have a much greater appreciation for the history and archaeology of the Great Lakes. I've become more interested in reading about the history of the region.
9	I have a much greater appreciation and understanding of what is involved
10	Yes, what it takes to properly document a wreck
11	I have a greater appreciation for the challenges of underwater archeology. I don't feel the Admiral or other field work in which I have participated are historically significant though. But, I understand MAST is limited by resources and proximity to the wrecks.
12	
13	
14	Yes, I learn something new every lecture
15	yes i did not realize the complexity of doing all of the archaeology underwater and figuring out the history of each wreck
16	Yes. Realalizing that it's important to measure change not create it .
17	
18	Yes. I had never before realized the amount of work and preparation that goes into just the survey and research of one single wreck.
19	Yes, deeper appreciation for the history of Lake Erie.
20	I've always enjoyed history, but from a 30,000' level. I appreciate learning the history of wrecks, placing these with in the context of the era they were operating and thinking about the overall scope.
21	I did not realize before how unreliable the historical record was.
22	Yes

Do you feel closer to your local cultural heritage? If yes, please explain.

Participant	**Response**
1	Not really, I already knew quite a lot about it through various readings I've done.
2	I feel closer simply recognizing how large are the Great Lakes and what a super highway they actually are.
3	Yes. Doing research on wrecks such as the Admiral always brings me a greater appreciation for our local cultural heritage.
4	Yes, learn more about local wrecks
5	No
6	Yes. I have a new appreciation for the importance of the Great Lakes in US history.
7	Yes. Diving on wrecks in my state of residence has given me a better understanding of the local maritime history and helped me make friends with like-minded individuals.
8	Yes-- I am able to now participate in the archaeology of my local area and understand more about local laws and preservation efforts that are in place to protect the underwater cultural heritage.
9	I have learned a great deal about Ohio's history in the process
10	Yes seeing wrecks in the Great Lakes is like visiting a location of a historical event, reflecting the maritime history around us
11	No, however, I do feel a connection to the Lake Erie Maritime community through MAST.
12	
13	Greater appreciation for the role the great lakes play in the development of the region
14	Yes, the more I learn, the more I love it.
15	a bit, i think its very interesting to work on old wrecks
16	Always lived around the great lakesx
17	
18	Absolutely. Especially since after posting about my participation on social media, I found out that a High School classmate of mine had a grandfather who died on the wreck of the Admiral. Knowing the history, and touching the wreck myself made me really think of the tragedy of it.
19	Somewhat, Iâ€™ll need to study more of it.
20	Not particurally
21	It gave me a much better perspective of how dangerous Great Lake shipping is.
22	Not really, I already knew quite a lot about it through various readings I've done.

Do you feel a stronger tie/support for the protection of shipwrecks after the course? If yes, please explain.

Participant	**Response**
1	It reinforced what I already felt about trying to preserve wrecks
2	I think MAST and the Museum at Toledo do great work in protection of

	wrecks and of Lake Erie.
3	I've always felt a strong support for protection of wrecks.
4	Yes, realize how important it is to keep sites in tack so others can enjoy
5	Yes, an appreciation of how important travel by water to support the economy.
6	Yes. The history and cultural protection aspect was what led me to enrolling in the course in the first place.
7	No, but as a maritime archaeologist, I was already firmly in the shipwreck preservation camp.
8	Yes
9	Given my training, I feel I have an obligation to help as I can
10	yes, because you want it preserved for other divers to enjoy
11	Yes, the Great Lakes are very important for many reasons and preservation of the Lakes and the wrecks are paramount.
12	I now realize that it truly take a community to keep the story of shipwrecks alive, and in tack for others to enjoy.
13	
14	Yes, I feel better educated and know whom to call for followup questions or reporting.
15	yes
16	Yes. If not protected natural change is corrupted.
17	
18	Yes, and I get lots of questions from non-diver friends who still think that people dive wrecks to "find treasure" and take it for themselves. I feel that anyone who attended the course will have a strong desire to educate others that this is not what we do.
19	Yes, I appreciate the learning the history and sharing it with others.
20	Yes, I started diving in the 80's, I'm happy that now wrecks are protected in many areas.
21	I guess I always did, but it's good to be more involved.
22	It reinforced what I already felt about trying to preserve wrecks

Section 4: Multiple Choice and Open-ended Diving **Questions**

If you did not participate in the diving sessions/training, please just answer the first and second question and skip the rest.

Did you participate in any of the scuba diving sessions?

Participant	**Response**
1	Yes
2	Yes
3	Yes
4	Yes
5	Yes
6	Yes

7	Yes
8	Yes
9	Yes
10	Yes
11	Yes
12	Yes
13	Yes
14	Yes
15	Yes
16	Yes
17	Yes
18	Yes
19	Yes
20	Yes
21	Yes
22	Yes

If you are a certified diver, what company is your certification from?

Participant	Response
1	SDI & PADI
2	PADI from Central Coast Dive Center in Kentucky
3	Padi
4	SEI
5	PADI
6	PADI
7	YMCA and NAUI
8	PADI
9	PADI & SDI
10	SSI
11	PADI and NAUI
12	PADI
13	Ssi
14	PADI
15	PADI
16	Ssi
17	PADI
18	PADI & SSI
19	Ohio State University
20	PADI, IANTD, SSI
21	NAUI and PADI mostly
22	

How many dives have you completed?

Participant	Response
1	1500+

2	143
3	500+
4	200
5	180
6	~100
7	200+
8	30
9	260
10	over 350
11	127
12	46
13	40
14	70
15	1000
16	250
17	250
18	135
19	30+
20	1,000 +
21	A little less than 400
22	800+

What were the most valuable skills/lessons you gained during the scuba diving sessions?

Participant	Response
1	Trilateration underwater
2	Neutral buoyancy practice. Rescue diving, actually used once.
3	Improving my multi-tasking at depth
4	
5	Safety. Adherence to dive time under water.
6	Multi-tasking with the survey equipment.
7	Nothing new to me, but I think the dive sessions reinforce for workshop participants how important it is to plan tasks before getting in the water so communication is easier and work gets done more quickly.
8	How to effectively communicate with my partner
9	Ability to practice and improve prior to field work
10	Measuring as a team
11	Managing low visibility and a defined task list in limited time.
12	proper way to measure
13	Navigating
14	Multitasking with buoyancy and control
15	improving my underwater multitasking skills
16	Teamwork and communications
17	
18	I learned that I need to be better prepared for cold water diving in the Great Lakes. As a result I went on to get Dry Suit certification and do more cold water diving in the Great

	Lakes.
19	Manipulating tools while trying diving
20	Importance of Buoyancy as well as Arch. by brail
21	Underwater task loading
22	

Are there any aspects of the scuba diving course that you think needs improvement? If yes, please explain.

Participant	Response
1	Maybe a buoyancy review at the quarry before the actual shipwreck dives. A few people struggled which adversely effects visibility.
2	Like to see the expense made more manageable.
3	no
4	
5	No
6	While I understand why the course is held so early in the season, the coldness of the water makes learning more challenging. I would suggest holding the course later in the summer.
7	No, I thought it was a great course to introduce divers to archaeological recording and task loading.
8	
9	More time on impact of task loading under water
10	Longer bottom times
11	I feel an annual practice session would be helpful to brush up on multi-tasking and taking underwater measurements. This could be accomplished at White Star or Gilboa as a volunteer activity.
12	
13	
14	N/A
15	under-prepared for the cold water
16	
17	
18	
19	No
20	Need to better develop the plan prior to starting dives
21	No
22	Maybe a buoyancy review at the quarry before the actual shipwreck dives. A few people struggled which adversely effects visibility.

Did you find the training for the scuba diving sessions valuable and helpful? If yes, please explain.

Participant	Response
1	The quarry dives are definitely an eye opener. It's not as easy in the water to control the tape measure, plumb bob and write on the clipboard.
2	Yes.

3	
4	
5	Yes. The training prepared me for onsite diving.
6	Any chance to challenge myself, I find valuable. Apart from the surveying itself, doing these tasks improves my diving skills and safety.
7	Yes, the field training really brings home everything you learn in the workshop course.
8	Yes-- it was necessary to have the underwater practice with my partner so that we could learn how to work and communicate well with each other
9	
10	
11	Yes, particularly the practice session at White Star Quarry. This afforded me the experience of managing a defined task list, taking underwater measurements, and adjusting to the underwater situation.
12	Provided an opportunity to for hands on experience.
13	Practice for real thing
14	Sure...no specific SCUBA instruction, but getting a briefing beforehand made me more comfortable with what to expect at the site.
15	yes but individual feed back would be helpful. Doing training with another person who has never done it was only moderately helpful. Partnering experienced divers with newbies to the skills would make a big improvement.
16	
17	
18	Yes, the on-land training was great, but the SCUBA training sessions at the quarry really made me aware of the task-loading that you get from carrying a measuring tape, plumb bob, and clipboard. All this while maintaining good buoyancy and diving safely. I really enjoyed the challenge.
19	Yes, in water practice was essential to success on the survey dive
20	Yes => working through triangulation for the first time is something that needs to be trained...takes time
21	It was good practice for the task loading of the actual dives.
22	The quarry dives are definitely an eye opener. It's not as easy in the water to control the tape measure, plumb bob and write on the clipboard.

Section 5: Terms of Agreement

Participant	Response
1	Agree
2	Agree
3	Agree
4	Agree
5	Agree
6	Agree
7	Agree
8	Agree
9	Agree
10	Agree
11	Agree
12	Agree
13	Agree
14	Agree
15	Agree
16	Agree
17	Agree
18	Agree
19	Agree
20	Agree
21	Agree
22	Agree

Appendix 3: Students Field School Survey

The Admiral Student Participation Survey

This survey is anonymous, please DO NOT write your name anywhere on this survey.

Thank you for participating and helping out with the Admiral Wreck Survey! Your help is greatly appreciated. We ask that you please fill out this survey so we can gather information on your experience as a citizen scientist.

Please complete the following questionnaire with specific regard to the above enquiry, by placing a CROSS [X] in the appropriate box

Helpful Terms: Citizen Science: scientific research conducted, in whole or in part, by amateur (or nonprofessional) scientists OR: projects in which volunteers partner with scientists to answer real-world questions.	**strongly agree**	**agree**	**uncertain/ not applicable**	**disagree**	**strongly disagree**
1. I feel a stronger appreciation toward my local heritage.	☐	☐	☐	☐	☐
2. I feel a stronger appreciation/interest toward archaeology and history.	☐	☐	☐	☐	☐
3. I gained a stronger support toward the protection of shipwrecks and underwater cultural heritage.	☐	☐	☐	☐	☐
4. My experience increased my interest toward science.	☐	☐	☐	☐	☐
5. I found this experience educational and informative.	☐	☐	☐	☐	☐
6. I am glad I volunteered with this survey. This experience was enjoyable.	☐	☐	☐	☐	☐
7. I will continue to volunteer and be a citizen scientist.	☐	☐	☐	☐	☐
8. I would like to learn more about maritime archaeology and underwater cultural heritage.	☐	☐	☐	☐	☐
9. I would like to learn more about ROV's and robotics.	☐	☐	☐	☐	☐
10. I was given the proper information/training to enjoy and participate in this experience.	☐	☐	☐	☐	☐

Please answer the questions as well and as honest as you can.

11. What where the best aspects of this experience?

____

____

____

12. What aspects of this experience would you change/improve?

____

____

____

13. Did you develop any new skills during the experience? If yes, please list any new skills.

____

____

____

14. What was the most valuable knowledge gained from this experience?

____

____

____

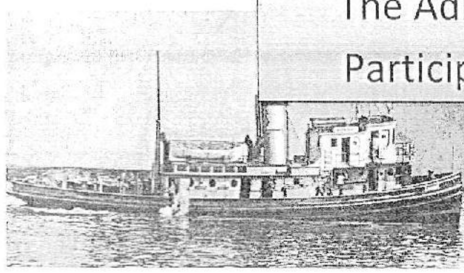
15. CONSENT: Do you give consent for this information to be used toward the Admiral Survey? Please CHECK (✓) one of the following answers.

- YES
- NO

Thank you again for your participation in the Admiral Wreck Survey! ☺

Appendix 4: Students Field School Surveys Responses

The Admiral Student Participation Survey



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Thank you for participating and helping out with the Admiral Wreck Survey! Your help is greatly appreciated. We ask that you please fill out this survey so we can gather information on your experience as a citizen scientist.

Please complete the following questionnaire with specific regard to the above enquiry, by placing a CROSS [X] in the appropriate box

Helpful Terms: Citizen Science: scientific research conducted, in whole or in part, by amateur (or nonprofessional) scientists OR: projects in which volunteers partner with scientists to answer real-world questions.	strongly agree	agree	uncertain/ not applicable	disagree	strongly disagree
1. I feel a stronger appreciation toward my local heritage.	[X]	[ ]	[ ]	[ ]	[ ]
2. I feel a stronger appreciation/interest toward archaeology and history.	[ ]	[X]	[ ]	[ ]	[ ]
3. I gained a stronger support toward the protection of shipwrecks and underwater cultural heritage.	[X]	[ ]	[ ]	[ ]	[ ]
4. My experience increased my interest toward science.	[X]	[ ]	[ ]	[ ]	[ ]
5. I found this experience educational and informative.	[X]	[ ]	[ ]	[ ]	[ ]
6. I am glad I volunteered with this survey. This experience was enjoyable.	[X]	[ ]	[ ]	[ ]	[ ]
7. I will continue to volunteer and be a citizen scientist.	[X]	[ ]	[ ]	[ ]	[ ]
8. I would like to learn more about maritime archaeology and underwater cultural heritage.	[X]	[ ]	[ ]	[ ]	[ ]
9. I would like to learn more about ROV's and robotics.	[X]	[ ]	[ ]	[ ]	[ ]
10. I was given the proper information/training to enjoy and participate in this experience.	[X]	[ ]	[ ]	[ ]	[ ]

Please answer the questions as well and as honest as you can.

11. What where the best aspects of this experience?

Some of the best aspects of this experience was the captain was very understanding throughout our process.

12. What aspects of this experience would you change/improve?

All and all the experience went very well. I wouldn't change or improve anything about the experience.

13. Did you develop any new skills during the experience? If yes, please list any new skills.

I didn't learn any new skills during this experence.

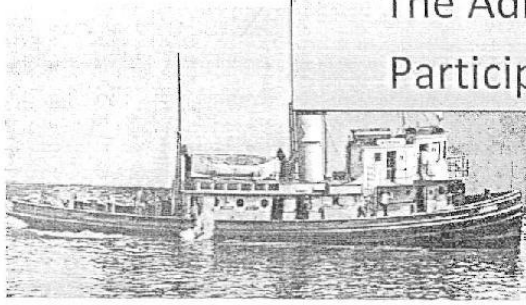
14. What was the most valuable knowledge gained from this experience?

The most valuable knowledge that showed great importance would be to be prepared for anything.

15. CONSENT: Do you give consent for this information to be used toward the Admiral Survey? Please CHECK (✓) one of the following answers.

- ✓ YES
- o NO

Thank you again for your participation in the Admiral Wreck Survey! ☺



The Admiral Student Participation Survey

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Thank you for participating and helping out with the Admiral Wreck Survey! Your help is greatly appreciated. We ask that you please fill out this survey so we can gather information on your experience as a citizen scientist.

Please complete the following questionnaire with specific regard to the above enquiry, by placing a CROSS [X] in the appropriate box

Helpful Terms: Citizen Science: scientific research conducted, in whole or in part, by amateur (or nonprofessional) scientists OR: projects in which volunteers partner with scientists to answer real-world questions.	strongly agree	agree	uncertain/ not applicable	disagree	strongly disagree
1. I feel a stronger appreciation toward my local heritage.	X				
2. I feel a stronger appreciation/interest toward archaeology and history.		X			
3. I gained a stronger support toward the protection of shipwrecks and underwater cultural heritage.		X			
4. My experience increased my interest toward science.	X				
5. I found this experience educational and informative.		X			
6. I am glad I volunteered with this survey. This experience was enjoyable.		X			
7. I will continue to volunteer and be a citizen scientist.	X				
8. I would like to learn more about maritime archaeology and underwater cultural heritage.		X			
9. I would like to learn more about ROV's and robotics.	X				
10. I was given the proper information/training to enjoy and participate in this experience.	X				

Please answer the questions as well and as honest as you can.

11. What where the best aspects of this experience?

being able to work on reeal world Prosects, and to get to drive the ROV after building it.

12. What aspects of this experience would you change/improve?

Being more PreParced, we went not Knowing Vizability and Couldn't see once we got to about 10m.

13. Did you develop any new skills during the experience? If yes, please list any new skills.

Yes, being able to work efficent on a boat.

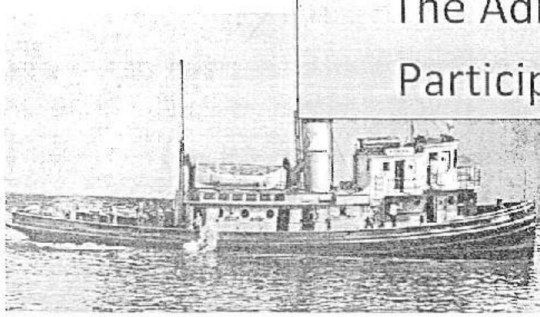
14. What was the most valuable knowledge gained from this experience?

Knowing that you might not be able to find what you set out for, but Knowing that there are more improvements to be made.

15. CONSENT: Do you give consent for this information to be used toward the Admiral Survey? Please CHECK (✓) one of the following answers.

- YES
- NO

Thank you again for your participation in the Admiral Wreck Survey! ☺



The Admiral Student Participation Survey

This survey is anonymous, please DO NOT write your name anywhere on this survey.

Thank you for participating and helping out with the Admiral Wreck Survey! Your help is greatly appreciated. We ask that you please fill out this survey so we can gather information on your experience as a citizen scientist.

Please complete the following questionnaire with specific regard to the above enquiry, by placing a CROSS [X] in the appropriate box

Helpful Terms: Citizen Science: scientific research conducted, in whole or in part, by amateur (or nonprofessional) scientists OR: projects in which volunteers partner with scientists to answer real-world questions.	strongly agree	agree	uncertain/ not applicable	disagree	strongly disagree
1. I feel a stronger appreciation toward my local heritage.	X				
2. I feel a stronger appreciation/interest toward archaeology and history.	X				
3. I gained a stronger support toward the protection of shipwrecks and underwater cultural heritage.	X				
4. My experience increased my interest toward science.	X				
5. I found this experience educational and informative.	X				
6. I am glad I volunteered with this survey. This experience was enjoyable.	X				
7. I will continue to volunteer and be a citizen scientist.	X				
8. I would like to learn more about maritime archaeology and underwater cultural heritage.	X				
9. I would like to learn more about ROV's and robotics.	X				
10. I was given the proper information/training to enjoy and participate in this experience.	X				

Please answer the questions as well and as honest as you can.

11. What where the best aspects of this experience?

Getting to learn more about local history and getting more experience on our new ROV.

12. What aspects of this experience would you change/improve?

Overall, I think this was a great learning experience and I don't feel there is much to change.

13. Did you develop any new skills during the experience? If yes, please list any new skills.

Yes, I learned how to efficently run a dive log.

14. What was the most valuable knowledge gained from this experience?

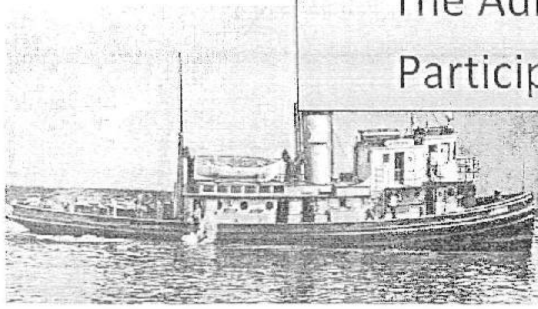
I learned some trouble shooting with the ROV and how to run an efficent dive log.

15. CONSENT: Do you give consent for this information to be used toward the Admiral Survey? Please CHECK (✓) one of the following answers.

- ✓ YES
- NO

Thank you again for your participation in the Admiral Wreck Survey! ☺

The Admiral Student Participation Survey



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		strongly agree	agree	uncertain/ not applicable	disagree	strongly disagree
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2.	I feel a stronger appreciation/interest toward archaeology and history.		X			
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4.	My experience increased my interest toward science.		X			
5.	I found this experience educational and informative.	X				
6.	I am glad I volunteered with this survey. This experience was enjoyable.		X			
7.	I will continue to volunteer and be a citizen scientist.		X			
8.	I would like to learn more about maritime archaeology and underwater cultural heritage.		X			
9.	I would like to learn more about ROV's and robotics.	X				
10.	I was given the proper information/training to enjoy and participate in this experience.	X				

Please answer the questions as well and as honest as you can.

11. What where the best aspects of this experience?

For me, since I'm new, it allowed me to see/learn how the team runs on the water. Overall it showed us more of what we need to do before Samoa.

12. What aspects of this experience would you change/improve?

I don't think I would change anything from this trip.

13. Did you develop any new skills during the experience? If yes, please list any new skills.

I don't think I developed any new skills from this experience.

14. What was the most valuable knowledge gained from this experience?

Knowing how the the team runs & functions was very knowledgeable for me.

15. CONSENT: Do you give consent for this information to be used toward the Admiral Survey? Please CHECK (√) one of the following answers.

- [x] YES
- [ ] NO

Thank you again for your participation in the Admiral Wreck Survey! ☺