

Abstract

DEFENDING THE EAST COAST:
ADAPTING AND CONVERTING COMMERCIAL SHIPS FOR MILITARY OPERATIONS

By

William Scott Sassorossi

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Director: Dr. Nathan Richards

DEPARTMENT OF HISTORY

The United States was not fully prepared for war in the Atlantic Ocean directly after the bombing of Pearl Harbor on 7 December 1941. Closely following the attack, Germany declared war on the United States and Hitler's deadly U-boats would soon arrive along the East Coast to wreak havoc on merchant shipping. Plans and operations needed to be put in place to counter the U-boats' ability to strike unprotected ships and to do so, unconventional means were used. By acquiring ships of all types from both public and commercial sectors and adapting some for military use, the United States Navy quickly enabled a serviceable military response to the U-boat menace.

This study will focus on converted fishing trawlers used for military action, specifically those wrecked off the coast of North Carolina. The vessels HMS *Senateur Duhamel* and HMT *Bedfordshire* were loaned to the United States by the British Royal Navy to assist in anti-submarine duties in February, 1942. Soon thereafter, YP-389, an American built vessel, was put into service as well. All of these vessels were used commercially prior to the outbreak of the war and then converted for military operations. The purpose of this study is to better understand each

ship's use as a military vessel, including how each was adapted for military use and why they were chosen for certain operational duties. It is also the purpose of this study to reassess Keith Muckelroy's claim that archaeologists do not need to study modern ships built according to plan, by testing if records pertaining to the modifications made to each vessel match the archaeological evidence. Combining historical and archaeological references this study hopes to process the information and determine the success of each vessel, validate whether or not modifications were made according to plan, as well as to understand broader military modification of commercially adapted vessels.

DEFENDING THE EAST COAST:
ADAPTING AND CONVERTING COMMERCIAL SHIPS FOR MILITARY OPERATIONS

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By
William Scott Sassorossi

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William Scott Sassorossi

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By
William Scott Sassorossi

APPROVED BY:

DIRECTOR OF THESIS: _____
Nathan Richards, Ph.D.

COMMITTEE MEMBER: _____
Wade Dudley, Ph.D.

COMMITTEE MEMBER: _____
Bradley Rodgers, Ph.D.

COMMITTEE MEMBER: _____
Joseph Hoyt, MA

CHAIR OF THE DEPARTMENT OF HISTORY: _____
Gerald J. Prokopowicz, Ph.D.

DEAN OF THE GRADUATE SCHOOL: _____
Paul Gemperline, Ph.D.

DEDICATION

This thesis is dedicated to the sailors who lost their lives while in service aboard HMT *Bedfordshire* and *YP-389*, as well as to all our service men and women in hopes of recognizing the countless untold stories of their bravery, selflessness, and sacrifice.

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CHAPTER ONE: INTRODUCTION

Introduction

The bombing of Pearl Harbor on 7 December 1941 brought the United States into the Second World War. As full scale preparations for war had yet to be fully implemented, the attack caught the United States completely off guard. Thrust into the fighting, the United States would have to reorganize all resources, both military and civilian, to help supply armed operations. Shortly following the Japanese attack, Germany and Italy also declared war on the United States, opening up a second front and forcing war into two oceans. This immediately stretched available resources to the limits. On land, the Army had yet to be fully organized for war, even as war in Europe had broken out, United States Army troop levels remained close to pre-war levels of 190,000 personnel as, “the manpower [sic] ceiling was lifted to no more than 227,000” (Perret 1991:26). The Army was lagging behind the Navy in terms of equipment and manpower necessary to engage in a full scale war.

Of the two branches, the United States Navy was in a better position for war. At Pearl Harbor, the Pacific Fleet had been dealt a heavy blow by the Japanese, but not a fatal one. While many ships and aircraft were destroyed, sunk, or heavily damaged, the Navy’s carrier group had not been attacked. This provided a positive point to an otherwise tragic event. Naval strategy leading up to this moment was geared toward engaging Japan in the Pacific, seeing Japan as a greater threat and, therefore, the focus of an increased naval presence on the West Coast (Abbazia 1975:29). Although Japan was able to strike first and greatly damage a portion of the United States Navy in the Pacific, there would remain a sizable force with the United States Navy could still wage war.

The situation was different in the Atlantic. Military strategic focus was to provide the Pacific Fleet with a large force, thus leaving the Atlantic seaboard grossly undefended and lacking a large military surface fleet to deal with the oncoming German U-boat threats (Howarth 1990:394). Although officially neutral at the outset, the United States still offered support to the Allies in the form of the Lend-Lease program, as well as the destroyers for bases deal with the United Kingdom, which depleted available United States Naval forces in the Atlantic. Because of these influences, the war would be waged differently in the Pacific and the Atlantic, with different types of challenges facing the United States. In the Pacific, classic Mahanian strategy was employed, producing large scale navies seeking a decisive victory over one another, whereas in the Atlantic, convoy operations sending much needed battle supplies to Europe necessitated protection by developing anti-submarine technology, resulting in different vessel allocation for each theater (Sadkovich 1990:4). The German U-boat campaign would necessitate a different response, as compared with the Japanese Imperial Navy.

In the opening months of 1942, German U-boats would operate along the American East Coast destroying merchant and cargo ships at an alarming rate. In the month of January, 1942 alone, over 296,000 tons of merchant shipping was lost to U-boat attacks (Marolda 1998:180). It would take time for adequate ships to be built and put into service long the East Coast that could stop the onslaught of the German U-boat attacks. To deal with the U-boats, it was necessary to implement a stop gap of some sort to help protect and defend the East Coast as best as possible until the necessary ships became available.

Both the United States Navy and British Royal Navy employed drastic policies in hopes of stopping or limiting these attacks. Ships of every size and class, both commercial and private, would be pressed into service. Vessels added to the naval inventories included fishing trawlers,

steamers, motor boats, tug boats, and even yachts (Scheina 1982:x). Anything available to help operationally would then be converted and outfitted with armament for both offensive and defensive purposes. These drastic policies were necessary to both the United States and United Kingdom for defending the vital merchant and supply shipping traveling up and down the East Coast. Critical adaptations were made to each of the ships employed, and with combined effort these vessels would play a crucial role in defending the East Coast before mightier naval craft and other defense resources could be provided.

Prior to the United States' involvement in World War Two, the United Kingdom had been battling German U-boats for over two years. Following the First World War, in which German U-boats caused catastrophic damage to shipping, a review of anti-submarine capabilities was undertaken by British Admiralty. Within this review it was realized there was a shortage in coastal escorts to aid in the defense against U-boat attacks. To remedy this, the Royal Navy concluded, "that much of this shortage could be made good by converted trawlers and in 1933 the *James Ludford* was fitted out as a prototype AS (anti-submarine) trawler. She was given an ASDIC set, twenty-five depth charges and a 4-inch gun. After experience with her, a number of other trawlers were converted" (Brown 2006:146). Shortly after the beginning of World War Two, British vessels of all types would be taken in for conversion modifications, similar to that of *James Ludford*. This conversion process would be utilized throughout the war and on both sides of the Atlantic as a way of defending against German U-boat attacks.

There were many different types of vessels utilized to deal with the U-boat threat and, for the purpose of this study, three vessels have been selected that were adapted for military use. Two of these, HMS *Senateur Duhamel* and HMT *Bedfordshire*, were part of a trawler force sent from England, in a form of reverse Lend-Lease, to help the United States fight against the

German U-boats. Converted in late 1939 and early 1940, these vessels were called into service early in the war from previous commercial fishing work. Both ships measured about roughly the same length and could attain a maximum speed of about 12 knots. They were also outfitted with the latest sonar equipment and each armed with a 4-inch deck gun (Hickam 1989:200). The third vessel, *YP-389*, also a former fishing trawler, was requisitioned by the United States Navy and converted for military use. American built and originally named *Cohasset*, *YP-389* (the designation “YP” stands for Yard Patrol) measured 103 feet long and 22 feet at beam and was outfitted with a 3-inch .23 caliber deck gun, two .30 caliber machine guns, and a total of six depth charges (Yarnell 1996; Wagner 2012:6). All three vessels performed operations off the coast of North Carolina and were lost during military action.

These selected vessels were utilized differently depending on mission type and the effectiveness of their military conversions will be analyzed. In addition to military adaptations, there may be evidence of habitability modifications made for the change in operating climate, increased crew capacity, and function of each of these vessels. These adaptations are important in deciphering the overall success and effectiveness of the conversion process of each vessel. The following sections will describe theories on naval adaptation and the decision making process as well as the major research questions driving this project. Previous research will also be explored and analyzed to help provide background for the methodology of this study. Each of these aspects will be combined to provide for a final analysis of the main research questions and ultimately determine the success of these craft as well as to better understand modification processes for converting non-military vessels.

Research Questions

The present study seeks to examine theories of technological change in concert with tenets of behavioral archaeology and site formation theory to help determine the process of naval adaptation of non-military vessels for military use. The use and conversion of these ships presents many questions, but the primary question focuses on what decisions were made to bring these vessels into the war and their examples of naval adaptation and technological change. The following is a listing of the primary and secondary research questions designed for this study. It is through extensive research that these questions can hope to be answered.

Primary

- What does the examination of adapted commercial vessels used for military operations tell us about models of technological change as well as the effectiveness of these changes?

Secondary

- Are we able to establish whether or not the historical and archaeological records match?
Does this refine, redefine, or refute the processes associated with technological change?
- What are possible explanations if the records do not match?
- Are there differences in the historical record compared with primary, first-hand experience/evidence?
- What are the main influences upon the conversion process (technology, conflict, administrative attitudes, and availability of resources)?
- How were the ships chosen and the adaptations determined? Are there particular hallmarks of wartime adaptation?
- Who ultimately had the final say in what is added/subtracted to each vessel?

- Did the conversions influence the creation of other types of vessels produced for the war effort?
- Understanding the choices made, what does this tell us about how people assess older technologies for eventual adaptation?
- Are conversions made to the vessels that are not purely military in nature, but necessary for the change in operations?

With the stated questions, a research design is put together to include previous research already undertaken on this subject as well as new research needed in hopes to make determinations of technological change.

Previous Research

To set a context for this study, the history of the Battle of the Atlantic and of the naval policies leading up to and during the war must be examined. Previous research focusing on the Battle of the Atlantic has been quite extensive. Works focusing on the general conflict (King 1946; Morison 1947; Churchill 1950; Abbazia 1975; Van der Vat 1988; Simpson III 1989; Howarth 1990; Sadkovich 1990; Ireland 2003), the development of United States and the United Kingdom naval policies (Ballantine 1949; O'Brien 1963; Manson 1990; Perret 1991; Simpson 1991; Marolda 1998; Brown 2006; Hone 2006), and selected ship information (Scheina 1982; Hickam 1989; Hutson 1990; Cheatham 1995; Yarnell 1996; Naisawald 1997; Lenton 1998; Toghil 2004; Brown 2006; Lavery 2006; Wagner 2012), have all contributed to the history of the adapted vessels used in this study.

A significant amount of archaeological evidence on the selected vessels has been produced by the National Ocean and Atmospheric Administration's *Monitor* National Marine Sanctuary (NOAA MNMS) continuing research of World War Two shipwrecks off of the North

Carolina Coast. Beginning in 2008 and continuing through 2014, each year has produced different findings. The first season in 2008 focused on U-boat wrecks, followed by reports on HMT *Bedfordshire* and locating *YP-389* in 2009 (NOAA 2008, 2009). HMS *Senateur Duhamel* was documented photographically in the summer of 2012 as well. With these surveys and evidence, valuable information including site locations, photo mosaics, and important video displaying armament features on *YP-389*, for example, will be significant to this project.

Other previous work on World War Two in North Carolina waters has included two Master's theses. John Wagner's (2010) thesis *Waves of Carnage: A Historical, Archaeological, and Geographical Study of the Battle of the Atlantic in North Carolina Waters*, utilizes information from the research expeditions completed by NOAA. A focus on battlefield archaeology, this thesis is an examination compiling both the historical and archaeological record of the Battle of the Atlantic off the North Carolina Coast. Another thesis that provides information pertaining to this project is Chris Cartellone's (2003), *Trawlers to the Rescue: the Role of "Minor War Vessels" in Securing the Eastern Sea Frontier, 1942*. Cartellone focuses on the history of the naval group of British fishing trawlers converted for anti-submarine warfare that were leased to the United States. The trawlers included both HMS *Senateur Duhamel* and HMT *Bedfordshire*. Utilizing all of these resources helped to provide valuable background, context, and supplementary historic information that were used to locate additional primary sources necessary to answer the primary and secondary research questions.

Theory

Multiple theories were utilized and presented in this study, including theories concerning naval adaptation and technological change. General examinations of how change happens, specifically targeting naval adaptations, were also studied. According to Don Leggett, there are

models for technological change that dominate maritime historical review, “the heroic inventor, the evolution of technology, and technological determinism” (Leggett and Dunn 2012:5). The *heroic inventor* model maintains that an individual (such as Isambard Kingdom Brunel) inventor helped create great changes in innovation without being fettered by outside institutions or other individuals. The second model, *technological evolution*, as stated by Leggett suggests, “technical developments follow a progressive course, largely independent of cultural or political influences, and that these developments affect societies in ways that are materially dependent, rather than socially conditioned” (Leggett and Dunn 2012:5). A third model, known as *technological determinism*, communicates that technological change is a factor and an un-complicated agent of change, as a part of social, cultural and economic transformation (Leggett and Dunn 2012:6). The fourth model examined, *technological momentum*, includes social factors influencing technological change as well as providing a tool or mechanism to influence social change. Each of these models is vastly different and could possibly explain the advancement of military adaptation in commercial ships.

It is important to mention that most of these models associate technology and economics as being intertwined. As stated by Nathan Richards, “it is almost impossible to separate the technological and economic aspects of any aspect of history. This is because economic development is often dependent on technological innovation and diffusion, and these processes themselves are dependent on economic development” (Richards 2008:49). This is supported by research in a range of studies (Kasper 1980; Henning and Henning 1990; Ojala 1997) outlining the relation of economics and technological change. Cost effective countermeasures used in naval adaptation are often inventive and the manner in which modifications occur are a result of a model of technological change which exists within an underlying economic framework. The

economic aspects of technological change of the conversion process of the selected vessels will be expanded upon in Chapter Six.

It was necessary to determine which of these models was most likely to drive the conversion and adaptation process. Further explanation and details of each model, discussed in Chapter Three, helped to determine the transformation processes of the selected adapted vessels. By determining the model by which the technological changes are made highlights the overriding concept of conversion processes made throughout the war effort. The adaptations of the selected ships, *YP-389*, *HMT Bedfordshire*, and *HMS Senateur Duhamel*, may not fit completely into one model of technological change, as there were many influences throughout the conversion process, but it was necessary to determine which model fits best to further examine the possible success of each ship type.

Behavioral Archaeology also heavily influenced the direction of this study. Michael Schiffer (the founder of Behavioral Archaeology) contends that, “the subject matter of archaeology is the relationships between human behavior and material culture in all times and places” (Schiffer 1995:69). Within the tenets of Behavioral Archaeology, Schiffer explains different strategies for approaching research questions to better understand archaeological phenomena. One strategy he endorses of benefit to this project focuses on, “the pursuit of general questions in the study of past material remains to derive behavioral laws of wide applicability that illuminate past as well as present human behavior” (Schiffer 1995:71). Essential to the outcome of this study is the determination of the archaeological evidence as reflecting past human behavior and these influences on current naval military strategy.

This study also seeks to test Keith Muckelroy’s assertion that archaeologists have no need to study modern ships due to the availability of ship plans. As is discussed further in

Chapter Three, Muckelroy was more focused on uncovering information of vessels from earlier, less modern, times when ship plans may not have been as accurately reflected within the building process (Muckelroy 1980:10). Working to match the historical and archaeological records to determine the naval adaption processes was essential to this study. The results of this study will be discussed in the analysis section and, if the historical and archaeological evidence do not match it may contradict Muckelroy's stance.

Finally, understanding the site formation processes that acted on the three aforementioned ship wreck sites was vitally important to this project. The archaeological records of these converted naval vessels held clues to naval adaptations not reflected (or represented imperfectly) in the historical record, but time may have distorted or disturbed such evidence. If aspects of a site had been compromised, due to either human or natural causes, every effort was made to attempt to compare the historical record, using ship plans and construction reports, to the archaeological remains. By using the available historical and archaeological information in concert, a determination of the success of the adapted vessels was made.

Methodology

The methodology for this study combined both historical and archaeological approaches. This study qualitatively assessed the archeological record in order to refine, refute, and possibly reassess the understanding of the naval adaptation processes, as currently defined by historians. While the primary focus for this study concerns converted World War Two era vessels, military naval adaptation has occurred throughout history. In addition to the study of World War Two, similar historical examples of conversions are included to provide context for conflict based adaptation. To do this, historical records came from primary and secondary sources, presenting

an outline of expectations for the archaeological record. The archaeological work tests the historical record and elaborates on our understanding of maritime adaptation processes.

Historical Methodology

The historical research focused primarily on three main areas: pre-war United States naval policy, planning, and production; individual vessel information; and early war engagement strategy. Information for the first topic regarding pre-war naval policy came from both primary and secondary resources and provided a base from which to formulate reasons why the United States needed to utilize commercial vessels for military use. Primary sources included accounts of the Washington Naval Treaty which were greatly influential in 20th century naval policy, as well as policy decisions made by President Franklin Roosevelt, as documented by Samuel Elliot Morrison and Edward J. Marolda respectively. These sources were available at East Carolina University's Joyner Library. Secondary sources reviewing these documents were also located there as well. Overall, results of imposed naval doctrine of this period was very influential in creating a need for use of converted ships and understanding these policies helped to produce a better idea of how the selected vessels were chosen and utilized.

Focusing on the history of each selected vessel incorporated both primary and secondary sources. Operations orders as well as sinking accounts provided information on how each vessel was used by the Navy. It was also necessary to procure original ship plans as well as budgetary orders to better understand the conversion process. Detailed plans of conversions were unavailable, however, piecing together conversion orders with original builders plans provided an opportunity for this information to be compared with the archaeological evidence. Primary sources documents of ship plans and orders were located in both the National Archives in College Park, Maryland as well as the Aberdeen Maritime Museum, in Aberdeen, Scotland.

Secondary sources, such as a retelling of the fate of the crew on board HMT *Bedfordshire* were located at East Carolina University's Joyner Library.

The third historical focus incorporated the history of these vessels among a larger naval strategy. Again, using primary and secondary sources to review the response to the U-boat campaign, the behavior of Navy commanders and their incorporation and usage of these converted and adapted vessels helped provide evidence on how each vessel was chosen for duty. Primary sources located at the Naval Archives detailing Eastern Sea Frontier operations proved vital to this project. Secondary sources, including Homer Hickam's *Torpedo Junction* and James Cheatham's *The Atlantic Turkey Shoot*, proved very helpful to determine daily functions of each vessel. These were also located at Joyner Library. By combining these three facets of the historical record, an assessment of the archaeological record was greatly enhanced.

Much of the historical research legwork has already been undertaken. John Wagner, a graduate of the East Carolina University Maritime Studies Program, was able to gain valuable resources from the National Archives regarding specific modifications and conversions to United States Navy and United States Coast Guard vessels, including *YP-389*. He has shared this information, which includes ship plans and conversion reports. This information was located in the Bureau of Ships, Record Group 19, located at the National Archives in College Park, Maryland. Providing a great foundation for this project, further exploration of the National Archives was necessary for possible modifications and historical background for HMT *Bedfordshire* and HMS *Senateur Duhamel*. Additional information necessary to understanding the transformation of the vessels are also located in *Lloyd's Register of Shipping*, as details regarding each vessel was kept in this registry for insurance purposes. Other information was also located in the Aberdeen Maritime Museum in Aberdeen, Scotland. Primary sources are

available there, specifically about HMS *Senateur Duhamel* regarding builder's plans and original design as well as more detailed information about life aboard the converted vessel. Information such as this was vital to the success of this project.

Archaeological Methodology

The second component involves archaeological aspects of individual ships. There has been a large amount of archaeological data already recovered by NOAA on the Battle of Atlantic expeditions, including exploration of the sites of YP-389, HMT *Bedfordshire*, and HMS *Senateur Duhamel* that have culminated in scaled site drawings, sonar imagery, as well as extensive collections of video and photo footage of the ship wrecks. Assessment of the information already collected determined that there was no need to create further expeditions to the wreck sites. Certain details within the archaeological record, specifically military alterations, were evaluated and it was determined the information already collected was sufficient for the purpose of this study. This information set was relied on heavily and provided the foundation for analysis of alterations and modifications made to each selected vessel.

Analysis

Analysis of the historical and archaeological research is the most important part of this study. Aspects such as construction and conversion plans as well as weapons reports are important for both the historical and archaeological assessment. If the archaeological evidence matches the historical documentation, and conversely if they do not match up, this is all part of the assessment of converted military craft. If the records match in all cases then this gives credence to Muckelroy's assertion regarding modern wreck sites. However, if the records match in only some of the cases, and for that matter, do not match in any of the cases, then it is necessary to reevaluate our understanding of naval adaptation.

To best process the information as well as display results, digitized graphic models of each of the vessels were created. For each vessel complete, to scale, representations were created using original dimensions, ship plans, and aspects of the conversion process. This information came from the historical research and then was input into the graphic, three dimensional (3D) modeling program *Rhinoceros 5.0*. An example of what these graphics look like is seen below in Figure 1.1, representing various phases of construction of USS *Mendota*.

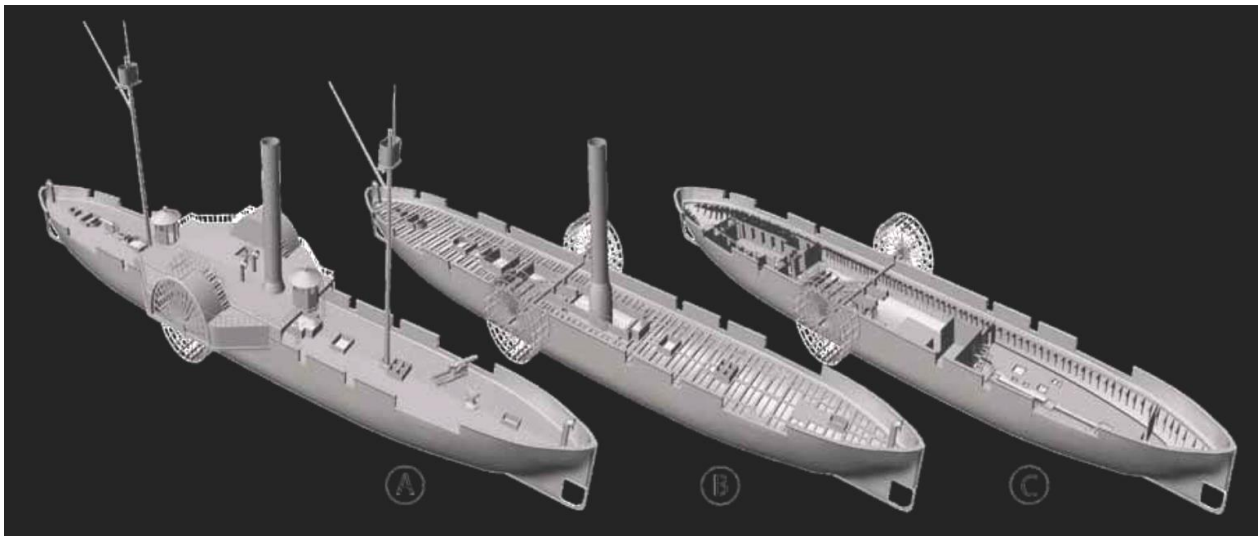


FIGURE 1.1. A model reconstruction of USS *Mendota* created by Brian Diveley. (Courtesy of Brian Diveley, 2008.)

A total of four sets, or Groups, of models were created to represent the various stages of life for each vessel. There are two model Groups created from the historical evidence to reflect original design as well as the converted features for each of the vessels. Also, each vessel has a representation created of the archaeological remains, detailing what can still be identified from the ship's structure and adaptations. This information is represented in a similar fashion as to what is exemplified in Figure 1.2.



FIGURE 1.2. A site reconstruction of a section of USS *Ostego*, created by Brian Diveley. (Courtesy of Brian Diveley, 2008.)

The combination of the historical and archaeological data and the digital creation components provides for a qualitative assessment of the converted vessels and helps to refine, refute, or reassess our understanding of the naval adaptation process as currently outlined in the historical record. The combination of historical and archaeological data used to create the digital models allows for detailed analysis and assessment. Drawing conclusions from this assessment will help to determine the answers to the primary and secondary research questions. Following these conclusions, further recommendations can be made for future research regarding military conversion and adaptation procedures.

Conclusion

The success of this project is based on the ability to make a determination of a model of technological change for the conversion process of the selected vessels. These vessels are just a few of thousands converted throughout the war for military use. The method of their conversion and adaptation process, as well as their use following modification, can help to identify the

reasoning for selecting vessels of this type. Overall, the use of the selected vessels in this study, and the many others like them, played a huge role during the Battle of the Atlantic and ultimately bringing about a victorious end to the war for the Allies.

CHAPTER TWO: HISTORY OF NAVAL ADAPTATION

Introduction

Ships have been utilized by humans for thousands of years and their functions are as varied as the cultures operating them. Some of the uses for ships include transportation, trade, fishing, pleasure, and war. Ships are created and designed with a certain purpose in mind, depending on the needs of the user. Ultimately, a ship will be used in its intended fashion for however long a situation merits. At some point, a ship will fall out of favor with its intended use and an owner will need to make necessary decisions as to the next course of action for that ship. Ships can be discarded, sold, abandoned, or repurposed and there are many reasons for this to occur. Some reasons for change in use include reaching a point of outdated technology, need for different use (such as military necessity), significant damage and needing of repairs, insufficient funding to carry on a practice, or loss of interest in using the ship. It is at this juncture in the life of a ship in which conversions may occur, which is considered naval adaptation.

Ships will go through a transformation process based on many different factors. Adaptations to a vessel account for the many different influencing factors. Military necessity as an influencing factor of naval adaptation will be examined in this chapter. This mode of adaption is determined as meeting the perceived needs of a navy in the face of military threats. In this sense, naval adaptation requires a shift of resources or strategy to deal with military challenges. Warfare has a huge influence on naval adaptation. Throughout history, navies have needed to adjust to certain variables to survive and be successful. A navy that is able to adapt to its enemies' weapons and tactics has a greater chance at survival. Using a finite supply of resources, naval commanders must make decisions to ultimately create victorious ships and fleets.

In responding to a military danger, such as a new technology, superior forces, or economic necessity, naval adaptation will occur. One example of meeting this need is by

adapting and converting commercially built vessels to counter such military threats. Warfare often spurs creative measures and is a driver of technological change. This being so, “wartime innovation thus becomes one of the extent to which organizational learning can take place under the unique conditions of war. While constraints exist, so do opportunities. Opportunities for innovation exist because both old and innovative methods can be tested in combat and compared” (Rosen 1991:22-23). Naval adaptation forces leaders to recognize problems and reorganize resources to best overcome challenges. Testing of new strategies may be introduced to cost effectively or economically overcome enemy technology or numerical superiority, often resulting in new forms of craft and/or armament. All available resources are utilized, resulting in new methods for dealing with the enemy.

The following historical examples demonstrate some of the necessary adaptations naval commanders made to position themselves for the best chance at victory. They illustrate a broad spectrum of behaviors representing conversion and adaptation techniques from a variety of historical periods. These examples represent similar iconic, western European ideologies and demonstrate naval adaptation in the face of military necessity. There are other historical examples of conversion and adaptation methods that are too many to list and beyond the scope of this thesis, however, these selected examples fall within a similar time period and scope, reflective of the converted vessels selected in this project. Naval adaptation and modification processes occur as certain military threats are manifest to the leaders of each example, resulting in an innovative method to counter the enemy. Each example is slightly different in the manner in which a perceived threat was acknowledged but the resulting responses demonstrate the ability for military adaptation.

War of 1812

The United States continued to grow both economically and geographically following the end of the Revolutionary War. However, by the beginning of the 1800s American merchant ships were having difficulties trading in Europe due to trade restrictions enacted by both France and Great Britain. These two nations were continually at war with each other throughout this period and it greatly affected the surrounding European countries as well as the United States' economic capabilities. Compounding the issue of restricted free trade for the United States was the continued French and British practice of impressing American sailors (Benn 2002:11-19). Both French and British naval vessels made a habit of stopping American shipping and taking sailors deemed to be deserters. In many instances, these sailors were American nationals. Great Britain was the greatest offender of this in the mind of the leaders of the United States. Tensions would continue to grow between these two countries until American 'War Hawks' of southern and western states pushed for a declaration of war (Mahon 1972:31; Gardiner 1998:19). War was declared on 18 June 1812 and the United States entered into its second war with Great Britain.

The declaration of war left a country scrambling to field a strong military. Between the army and navy, the navy was the better prepared, having a small number of warships available and a supply of merchant ships and sailors available (Gardiner 1998:22). However, the United States Navy would need to engage the largest navy in the world at the time. President James Madison developed a strategy to deal with the British Royal Navy. By not relying on the United States Navy to go completely head to head with the Royal Navy, "Madison intended to unleash hundreds of privateers and bring pressure on British commerce, as privateers had done so successfully during the War of Independence" (Daughan 2011:31). United States privateers would hopefully create economic strife, to the point the Royal Navy would be forced to keep the

majority of its fleet tied up guarding their merchant ships. Seen as the greatest threat to American military strategy, the Royal Navy needed to be occupied elsewhere for the American army to have a chance to succeed with its plans. For this to happen, it was necessary to utilize and mobilize the merchant fleet to help with the war effort.

Privateers came from many different backgrounds, but the majority of them operated on former merchant ships. Privateers were not part of the navy, but rather private citizens, “issued with “letters of marque and reprisal” allowing their citizens to attack enemy shipping in wartime” (Marrin 1985:77). Ships could be built for this endeavor, with an emphasis for speed, and prewar vessels needing a necessary overhaul to prepare for the increased risk of raiding merchant ships. There was a steady supply of available ships, either in the process of being built or ready for conversion, as previous trade restrictions on American merchants had kept a good number of ships in port. With a hostile enemy on the open sea, “the American merchant marine turned to privateering with gusto” (Gardiner 1998:27). Personnel and resources were available and ready to be utilized.

Adapting former merchant ships for armed privateering focused on a few key areas. Ships needed to be converted to add both weaponry as well as a larger crew. This is because,

...an armament sufficient at least to outfight the guns carried by many British merchantmen was also necessary, as well as a numerous crew to overpower the victim when alongside and to supply crews for taking prizes to port. Hard fighting was not usually expected, but there were owners who strengthened the sides of their ships to keep shot out, mounted batteries of powerful guns, and sent out veritable ships of war representing a large outlay of capital (Forester 1956:86).

These conversions necessitated making use of cargo hold space for the larger crew as well as adding to the military inventory currently utilized on each ship. By adding additional crew and arms, the cargo space needed to be altered, but not necessarily in a permanent fashion. Following

privateering raids and a foreseeable end to a war, these merchant ships would ultimately need to return to transporting cargo in their original design. But for the time, these ships were outfitted with considerable crew and weaponry, ready to make chase on the open seas.

The success of the American privateering fleet was considerable. In a review of the War of 1812, Admiral E.M. Eller, the Director of Naval History for the Department of the United States Navy, describes, “these converted merchant ships, operated privately for a hoped-for profit, were by no means the deciding factor in the sea war, but privateers captured British merchant ships, sometimes sank them, and in general greatly hindered British use of sea highways” (Eller in Jones 1967:ix). At the early outset of the war, “there were some 600 United States privateers prowling the oceans, and these were a real makeweight in the final outcome. In four months they captured 219 vessels carrying 574 guns and 3,108 men” (Mahon 1972:62). In one example “the *Yankee* privateer out of Bristol, Rhode Island, alone made forty captures, which translated into \$3 million dollars for the investors” (Daughan 2011:324). *Yankee* was a brigantine at 120 feet long and carried over thirteen cannon. Converted from the slave trade service to take part in privateering, it was financed by James deWolf (Good 2012:102; Warwickhistory.com 2013). A few other privateers, like *Yankee*, were able to accomplish as many captures, but the effects were all well felt by the British merchants.

The success of the privateers and their converted vessels helped to bring legitimacy to American naval abilities. Although the War of 1812 was not determined by the use of privateers, the converted vessels played a significant role in the war. Their use demonstrated the ability of the American leadership to recognize the obvious threat of a larger navy, its own naval limitations, and to expertly make best use of available resources. Their use was greatly needed to help the war effort and ultimately brought about an end to the war.

Confederate Ironclads

In the American Civil War, similar issues faced the Confederate Navy as did the United States Navy in 1812. At the outset of the Civil War, Confederate states were faced with a gigantic problem off their coasts. Union military strategy called for a blockade of the Confederate states, especially harbor and port cities, utilizing the vastly greater strength of its available naval resources. The threat of the Union Navy's greater numbers severely limiting the Confederacy's ability to acquire resources and supplies by blockading vital ports and coastline was an all too real problem for the leaders of the Confederacy. The Confederacy did not have a Navy to compare with the Union at the outset of the war, nor the industrial resources to match, posing a very difficult task to the Confederate leaders (Park 2007:3). The threat of being locked in and having vital supplies blockaded from overseas, was the biggest task for the Confederate Navy to overcome. To possibly counter the strength of the Union Navy's blockade as well as protect the vital river systems of the interior, innovative measures would be essential. With a limited supply of resources, Confederate innovators needed to be creative and design a vessel with potential to change the course of the war. That vessel was *CSS Virginia*.

CSS Virginia (Figure 2.1) would ultimately be developed as an attempt to achieve a military advantage while making use of limited resources. Military necessity dictated fundamental change in thinking about procuring and establishing a formidable response to the Union Navy.

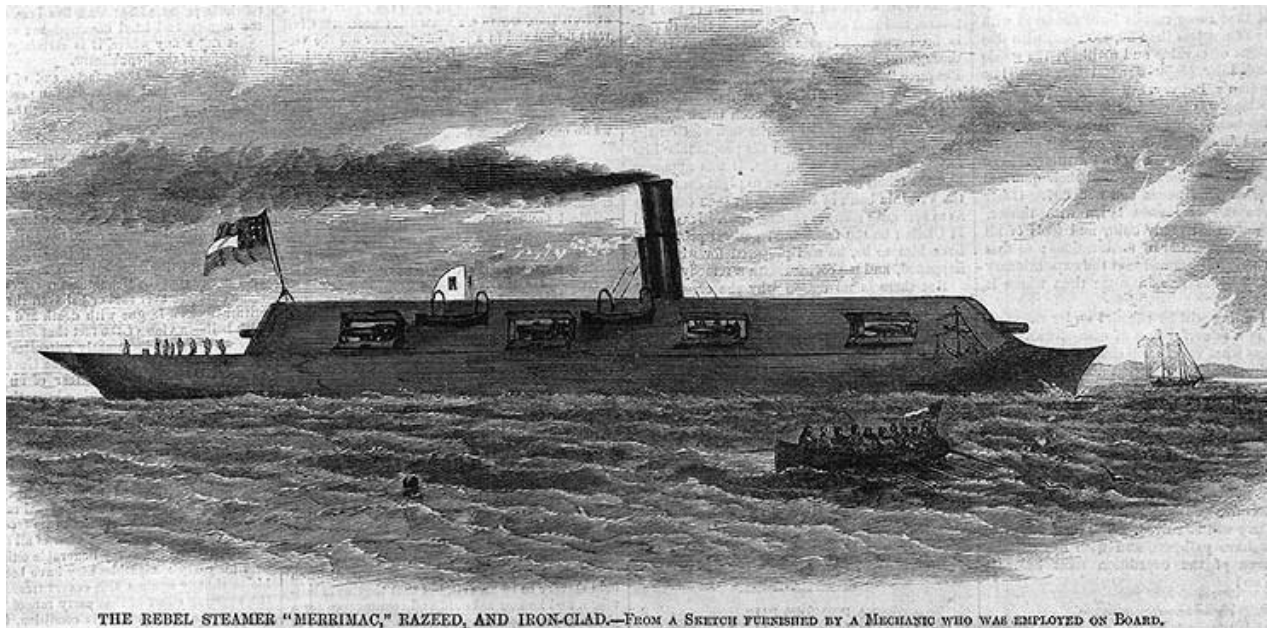


FIGURE 2.1. Line engraving published in "Harper's Weekly", 1861. Entitled "The Rebel Steamer 'Merrimac', Razed, and Iron-Clad -- From a Sketch furnished by a Mechanic who was employed on Board." (Courtesy of U.S. Naval Historical Center.)

CSS *Virginia* would be one of the first ironclad ships, innovative for the time period. The secretary of the Confederate Navy, Stephen Mallory, wrote in the early weeks of the war,

I regard the possession of an iron-armored ship as a matter of the first necessity. If we...follow their (the United States Navy)...example and build wooden ships, we shall have to construct several at one time; for one or two ships would fall an easy prey to her comparatively numerous steam frigates. But inequality of numbers may be compensated by invulnerability; and thus not only does economy by naval success dictate the wisdom and expediency of fighting with iron against wood, without regard to first cost (Mallory in Still 1971:10).

Mallory convinced others in the Confederate leadership very early on in the war about the need to create this advantage versus the Union Navy's numerical strength. It would have been impossible to compete economically and industrially to produce the required number of naval vessels to combat the Union Navy head on. The hope was to create a vessel to make all others obsolete.

To create the envisioned ironclad, resources needed to be procured. Few resources could be made available to produce an entirely new vessel so it would be necessary to utilize some

spoils of war. Very early in the war, the Confederate Army had taken Gosport Navy Yard. In April of 1861, before fully taken into control of Confederate hands, remaining ships were scuttled and sunk at the yard by Union forces. It was hoped the ships would be ineffectual following their destruction and thus not able to be used by the Confederates. Among these ships was the steam frigate USS *Merrimack*, which was burned to the water line and intentionally sunk (Trexler 1938:11). With some ingenuity, Confederate engineers were able to raise the remaining hull, complete with steam engines. Investigating the engines proved the salt water in which they had rested had indeed corroded them, however, it was assumed they could be restored.

The plans for an ironclad could be adapted to the existing structure and *Merrimack* provided the best opportunity for quickly producing this type of warship. In addition to steam power, plans were made to create a sloped casemate, reinforced by metal. A four inch thick armor plating, two layers of two inch thick converted railroad ties, was created to achieve assumed impregnability (Engle 1975:184; Quarstein 2012:66). The two inch railroad ties would be laid on top of one another to give a complete four inch thick armor plate casemate.

To accomplish all the necessary conversions, a large labor effort was needed, using over 1,100 men and more than eight months of work. The, “transformed *Merrimack* was two hundred and sixty-two feet, nine inches from stem to stern. The sides of the armored superstructure, or casemate, which was 170 feet long at its base, were at an angle of approximately thirty-six degrees, and both casemate’s ends were horizontally rounded” (Still 1971:24). The sloped armor would allow for enemy fire to deflect off the hull, protecting the interior of the ship. On 17 February 1862, *Merrimack* was rechristened as CSS *Virginia* and launched from Gosport Navy Yards.

The success of CSS *Virginia* as a converted warship is well documented. Prior to the battle between the Union ironclad USS *Monitor* on 9 March 1862, CSS *Virginia* inflicted great destruction upon the Union Navy outside of Hampton Roads, Virginia. On 8 March 1862, the day before meeting USS *Monitor*, CSS *Virginia* engaged USS *Cumberland* in battle and sank the fifty gun Union frigate. USS *Congress* also tried to engage CSS *Virginia* but found it was outmatched. In an effort to evade further destruction, USS *Congress* ran aground but caught fire and burned and would end up sinking as well (Still 1971:29-31). The next day, the two ironclads would duel.

USS *Monitor* was built differently and had fewer guns than CSS *Virginia* but the two engaged in a battle that ultimately had no victor. Following the battle, CSS *Virginia* made its way toward Norfolk, Virginia. Within a few months, however, CSS *Virginia* was purposely sunk in an effort to keep the ship out of the hands of the advancing Union army (Daly 1957:179). Scuttling the vessel was the only way to keep it out of Union control and possibly turned upon the Confederates themselves. Losing such a technological marvel was a tremendous blow to the spirits of the Confederate leaders.

The impact of CSS *Virginia* cannot be understated. With its successful use in battle as well as taking USS *Monitor* head on, a new age in warship design was ushered in. It was evident the notion of an all wooden fighting ship had become obsolete. Increased effectiveness of artillery shells necessitated innovation in ship design. Wooden ships may have been less costly to build, but armored ships would be the way of the future. The Confederate leaders, realizing the great threat posed by the Union Navy as well as the limitations of their own Navy, took advantage of the few resources they had to create a formidable fighting ship. By demonstrating the ability of the converted vessel in battle against the purpose built USS *Monitor*, CSS *Virginia*

validated the decisions of Confederate leaders. Similar designs and other ironclads would be created by the Confederacy throughout the Civil War, following in the example of CSS *Virginia*. Ultimately, CSS *Virginia* pioneered a successful conversion process by utilizing a former wooden ship and converting it into an impregnable armored built warship.

British Q-Ships

Building upon the success of the ironclads of the Civil War, navies from around the globe began a great overhaul of their fleets. Iron plating and steam power would prove to be the next form of military technology. Gone would be the days of heavily armed wooden vessels driven by sail. Over the next half century an arms race started and buildup of naval technology would yield great battleships, covered in thick armor plating and mounting heavy guns. These mighty ships would eventually have the ability to steam around the globe and fire large shells over great distances. The buildup of these great vessels did not come without a large financial cost as well as other issues. For example HMS *Dreadnaught*, a British battleship completed in 1906, cost over £1,750,000 British pounds to build (Parkes 1990:477). Other countries followed suit and by the early 1910s, tensions had reached a boiling point across Europe over multiple issues, one being this intensified arms race. At the end of 1914, all of Europe would be plunged into a great war and the navies of European countries would be put into action (Black 2011:34).

At the outset of the war, Britain held a distinct advantage in battleship and destroyer numbers. Compared with Germany, Britain maintained a superior surface fleet in numbers as well as in size of guns and speed of ships, however, not in armor (Hough 1983:51). Germany would come to eventually rely upon its U-boats to wage war on the open seas, rather than fully engaging the British Royal Navy in consistent, head to head battles such as the Battle of Jutland. Each nation had invested heavily in these large, costly battleships that,

both navies possessed one common characteristic: such heavy emphasis had been laid on the quality and high cost of the ships that the practice of preservation had overtaken the practice of risk-taking which had governed war at sea since the galley battles in the Mediterranean a thousand years before Christ. British and German tactical doctrines pointed to self-protection and evasion rather than a reckless eagerness to get at the enemy (Hough 1983:52).

Using the superior numbers, Britain was able to bottle up Germany's surface fleet in home ports and put pressure on German economy. This was a major problem for Germany and, "gripped by Britain's stranglehold on German trade, the German navy resorted to the weapons that conventional thinking had regarded as secondary- submarines and mines. It ultimately developed the submarine cruiser, a new engine of war without legal precedent in international law" (Hadley 1995:17). Germany responded in a way it only could, by unleashing their U-boat fleet.

In mid-February 1915, German U-boats considered all waters surrounding Great Britain a theater of war. This included both military and commercial vessels as potential targets. Germany declared to all enemy merchantmen they would be sunk, without assurance that the crews and passengers could always be saved. U-boat commanders nevertheless would try to alert a ship prior to sinking it, as had been practice in commerce raiding (Birnbaum 1970:24). The increased numbers of U-boats began to strike with lethal efficiency. British merchant shipping was targeted and neutral countries were warned not to operate in these waters. By attacking the British merchant shipping, Germany hoped to strangle the island nation by cutting off vital resources. German U-boats began their attacks and, "at the outset of the U-boat campaign, the Royal Navy was at a complete loss as to how to deal with it" (Bridgland 1999:3). The German U-boat was an unprecedented threat to Great Britain. Innovative and creative measures were desperately needed to deal with the U-boats and help protect merchant shipping and ultimately save the country from supply shortages.

Many ideas were proposed, but one of the more creative concepts came following the updated declaration made by Germany in February, 1915. The suggestion was to create decoy ships, to act as merchant ships, but to actually be armed and able to sink a U-boat. The plan called for the,

Admiralty to take up a number of merchantmen and fishing craft, arm them with a few light quick-firing guns, and then send them forth to cruise in likely submarine areas, flying neutral colors. This was perfectly legitimate under International Law, provided that before opening fire on the enemy the neutral colors were lowered and the White Ensign was hoisted. Seeing that the enemy was determined to sink merchantmen, the obvious reply was to send against them armed merchantmen, properly commissioned and armed, but outwardly resembling anything but a warship (Chatterton 1972:4-5).

It was an innovative, cost effective idea based on necessity, as by the end of April, 1915, German U-boats had successfully sunk eighty-eight ships, compared to only five losses (Bridgland 1999:4). In the following images (Figures 2.2 and 2.3), examples of weapon concealment are presented, from the British ship *Hyperbad*. Other forms of submarine detection were being developed, but were still in their infancy, so it was decided to put decoys to work.

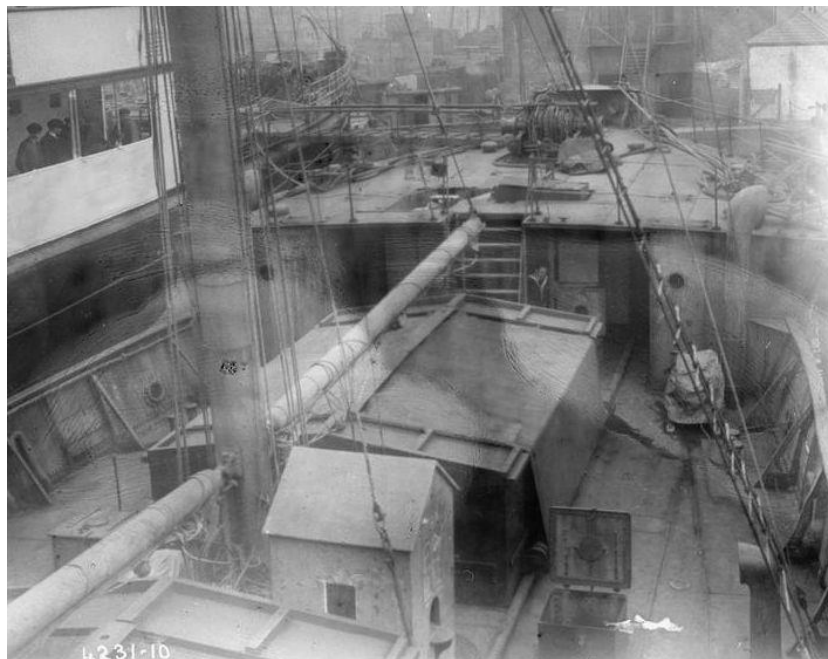


FIGURE 2.2. British "Q" ship Hyderabad; Cargo hatch concealing Sutton Armstrong bomb thrower. Date unknown. (Courtesy of Imperial War Museum.)



FIGURE 2.3. British "Q" ship "Hyderabad"; Sutton Armstrong bomb thrower concealed in cargo hatch. Ready for action. Date unknown. (Courtesy of Imperial War Museum.)

One of the most successful of the decoy ships, *Loderer*, was commanded by Commander Gordon Campbell, credited with sinking *U-68*. *Loderer* was a 3,200 ton ex-collier converted to carry three 12-pounder guns, one 18-hundredweight gun, two 12-hundredweight guns, and a maxim gun. It would be necessary to hide these weapons and, “the ‘heavy’ 12-pounder was concealed under a false steering engine housing right aft. To add reality to this, a pipe was fed to it from the real steering engine, amidships, so that a wisp of steam would always be seen hanging over the stern of the *Loderer*, as if there were a donkey engine inside, rather than a gun” (Bridgland 1999:13). The decoy ships were designed to lure U-boats close, acting as merchant or fishing ships displaying neutral colors, and when in range, uncover the hidden guns and attack the U-boat. As practiced the,

U-boat usually surfaced on sighting its intended victim and then, with or without warning, opened fire and sank the ship with gunfire, reserving torpedoes for special occasions and targets, like ocean liners and warships. On sighting a surfaced U-boat, a ‘panic party’ would noisily take to the Q-ship’s boat, while the

gun crews remained concealed awaiting their opportunity of giving the enemy a short, well aimed, and fatal volley (Hough 1983:304).

It was a very risky endeavor, which required steady nerves of the volunteer force. As success with these tactics grew, decoy ships, now called “Q-ships,” increased in numbers. Many of the Q-ships fell under the overall command of Admiral Lewis Baylay, an enthusiast and great proponent of the decoy ship method (Chatterton 1972:46). Much of the success of the Q-ships was due to luck. Their numbers were still few with a vast area to cover. Still, the use of the Q-ships greatly influenced the procedures of the German U-boats.

Q-ship numbers increased to close to 80 by the beginning of 1917. However, their practicality would soon fall out of favor as different factors made their need obsolete (Chatterton 1972:242). Most important of these factors was the decision by the German command to go ahead with unrestricted submarine warfare. Influenced by Q-boat techniques, yet fearful of angering neutral nations who might side with their enemies, German leaders were nonetheless forced to let their U-boats attack any vessel without warning. On 1 February 1917, Germany announced the use of unrestricted U-boat warfare (Coletta 1996:195-196). Without the need of U-boats to surface to attack ships, decoy ships would have a very limited use. U-boats were especially successful in the following months but the gamble did not pay off in the long run as the United States would soon enter on the side of Great Britain and the Allies, seeing unrestricted U-boat warfare as the final straw of German aggression.

The use of the Q-ships as an economical response to a military threat was quite successful. Given their small numbers, and relatively small cost, the tactics employed greatly changed the method of a U-boat attack. Unsuspecting U-boats could be caught unaware and fall victim to the hidden guns. Converted ships like *Loderer* were able to successfully sink U-boats using this tactic. In an attempt to limit merchant shipping losses, the Royal Navy was creative

and utilized resources otherwise considered unfit for combat. Techniques such as this forced Germany to change tactics and ultimately lose the war, as American intervention helped to turn the tide of the continental conflict, bringing the war to a close by the end of 1918.

Inter-war German U-boat Designs

In a different form of naval adaptation, as compared with previous examples of converting ships, the advancement of German submarine technology during the inter-war years details how leadership adapted to legal restrictions emplaced upon them and still managed to enhance existing technology. The end of First World War in 1918 brought with it a heavy price to pay for Germany under the Versailles Treaty. Under the terms of the agreement, Germany was ordered to dismantle much of its military, including its substantial submarine force. As discussed above, Germany's U-boats had been very effective to disrupting Allied merchant and cargo shipping during the war, sinking an estimated 6,692,000 tons of British shipping alone (Manson 1990:31). In the following decades, restricting submarine use was emphasized by many of the Allied nations, limiting the numbers built and rules of war. Meanwhile, Germany began to recover from the harsh treatment received from the Versailles Treaty and started rebuilding its military. Germany developed its submarine force by contracting much of the work out to other nations. Still working under the terms of the Versailles Treaty, Germany through the 1930s would develop technological advances for its submarines outside of its own borders (Showell 1987:12).

Prior to the Anglo-German Naval Agreement of 1935, in which naval restrictions were eased on German naval buildup, German naval leaders were not able to test and develop new submarine technologies. The harsh terms of the Versailles Treaty, which limited new weapon development as well as confiscating already built military ships, did not stop the German

leadership to from weapons development. They were not willing to sit idly by while other nations built up their forces and developed new technologies. These harsh terms were perceived as a great threat to any future development of the country and especially the military. Keeping up with submarine technology was of great necessity to the German leadership as it had been a hugely successful instrument of war for the German military and a tool that would not be quietly put away. To continue developing the growth of the highly successful U-boat technologies from World War One, while at the same time keeping within the rules of the Versailles Treaty, German commanders made covert plans (Showell 1987:12; Stern 1991:12).

Lacking physical resources, German leaders still had plenty of talented former commanders as well as all the records and building plans from World War One to use at their disposal. Germany re-established the Imperial Navy into the Reichsmarine in the early 1920s. The Reichsmarine then, “encouraged the formation of the clandestine ‘Submarine Development Bureau’ to keep abreast of the latest underwater developments” (Showell 1987:12). This bureau operated out of the Netherlands with the purpose of using, “genuine work for foreign governments as a means of developing standard designs of eventual use to the Germans themselves” (Ireland 2003:17). It was an opportunity to covertly develop technology without risking penalties under the Versailles Treaty.

The first of these overseas ventures came with the development of the navy of Argentina. In 1921, “the Argentinian [sic] Navy obtained the services of KK a.D. Karl Bartenbach, commander of the Flanders Flotilla during the war, to help them create a submarine branch. The plans developed for Argentina involved the construction of a fleet of ten submarines based on German models from the recent war” (Stern 1991:12). Construction would be done on foreign soil, not in Germany. Using the successful plans from World War One as a base, German

engineers could continue to develop new types of submarines for other countries, all the while gaining valuable information for their own submarine development.

Submarine development would continue in this fashion until 1932. Successful agreements were also made between the Netherlands, Spain, Japan, and Finland to build submarines in those countries (Mason 1990:50). Also, “the Bureau worked with at least 19 nations to develop more than 50 projects. Many of these never progressed beyond the initial design stage and a number were not laid down until after the re-establishment of submarine construction in German yards, but sufficient programs went ahead to give Germany a good start when she resumed building in 1935” (Showell 1987:12). Germany began to openly rearm following the Geneva Disarmament Conference of 1932, however, with the use of this covert bureau, informational growth had continued to be fostered and developed throughout the course of disarmament.

German leaders were able to successfully continue developing their own submarine technology. By contracting out work on submarine development to other countries, it was not a direct violation of the Treaty of Versailles but a way for the military to continue growing a knowledge base for the eventual use and development of their own submarines. The following image (Figure 2.4) is a plan design for a type VII U-boat, ultimately *U-580*.

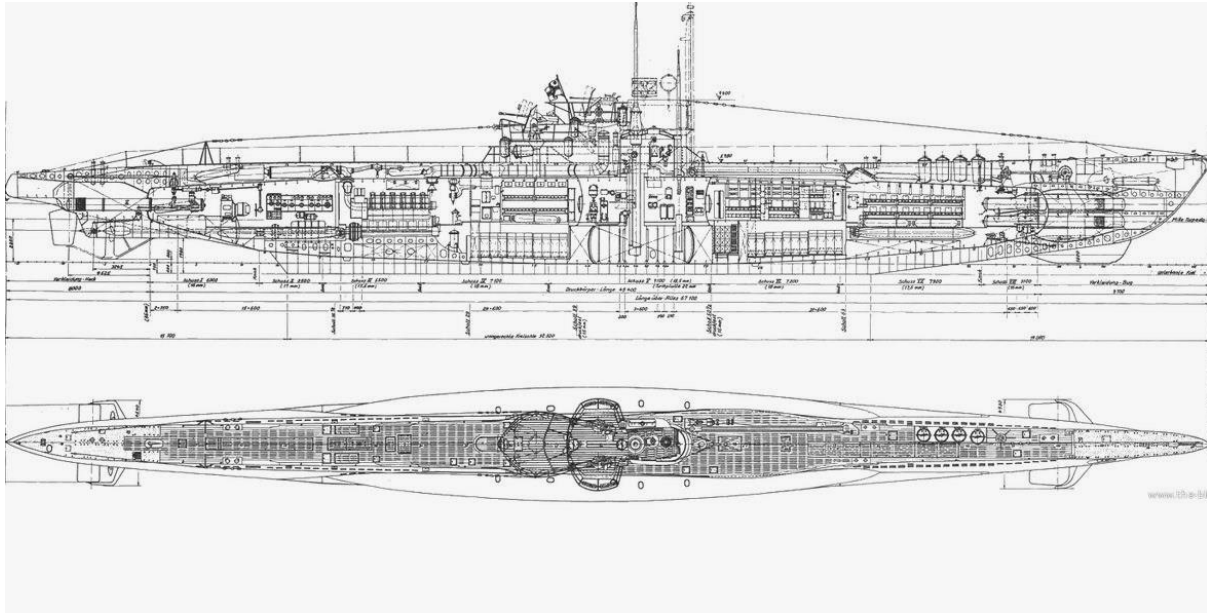


FIGURE 2.4. Plan diagram of a type VII C U-boat, *U-580*, built in 1941. (Courtesy of wrecksite.eu.)

In June of 1935, the Anglo-German Naval Agreement was signed and Germany was now allowed to re-build a portion of its navy. Soon, the information and technology garnered after years of contract work would be utilized (Showell 1987:13).

The threat of losing a technological race and remaining relegated as a secondary power was the greatest fear of the German government. Seething from the strict limitations placed on them following the First World War, German leaders were determined to continue developing U-boat technology and not be left behind the advancements of other countries. U-boats in World War Two would be employed with lethal capabilities, much of which were developed during the period between wars. The success of these U-boats is well documented and will be analyzed further in this study.

Conclusion

Naval adaptation is a continuing and ever changing process. These examples demonstrated a response to diverse military necessities resulting in successful adaptations or conversions, which allowed, in each instance, for the innovator to gain an upper hand against

their enemy. Although independent in nature of design and separated by different time periods, these naval adaptations were experienced and utilized for many of the same reasons. There was an obvious threat or challenge that needed to be met and only a finite set of resources available to make that happen. These threats made leaders reevaluate their available resources and conditions, forcing them to be inventive and resourceful. Adapting older or different vessels for new work was one of these innovations.

Historical examples of naval adaptation and conversion are important to this study. In examining converted vessels from World War Two, similarities of adaptations and modifications from previous wars may be evident. Each of the selected vessels will be analyzed for the reasons of their conversion as well as the resources made available to make such conversions. The manner of such adaptations will be analyzed to determine if ultimately they were successful in their new found use.

CHAPTER THREE: THEORIES OF ARCHAEOLOGICAL SITE FORMATION AND TECHNOLOGICAL CHANGE

Introduction

The purpose of this project is to determine methods for converting and adapting commercial craft for military use. The selected vessels, *YP-389*, *HMT Bedfordshire*, and *HMS Senateur Duhamel*, were commercial fishing trawlers adapted and transformed for military operations during World War Two. Each vessel was lost during the war; however, shipwreck remains still may provide archaeological evidence for better understanding methods for converting commercial craft for military use. To interpret available evidence and determine methods of converting nonmilitary craft, two main paradigms will be utilized: site formation theory and theories of technological change.

Understanding theories of site formation helps to interpret what has happened to submerged archaeological features. Site formation processes are essentially forces that alter, distort, or remove evidence from shipwreck sites. The archaeological records of these converted naval vessels may hold clues to naval adaptations not reflected (or represented imperfectly) in the historical record. As will be discussed, site formation processes originate from different sources including human interaction and natural phenomena that ultimately alter the shipwreck remains.

Following the forensic examination of the submerged shipwrecks, it is possible to comment about technological change. An examination of multiple theoretical models of technological change will assist determining whether evidence from the historical records may be represented as emblematic features on the archaeological sites. This information, again, may be imperfectly reflected in the historical record, however, still be represented in the

archaeological evidence. Specific features located at the site may be representative of a model of technological change, resulting from certain technological endeavors and decision making processes. By identifying different models of technological change it becomes possible to classify such features.

This chapter will identify, in two main sections, theories of site formation and theories of technological change. Beginning with site formation processes, two main theorists are presented, both of whom created concepts for describing archaeological site formation and the manner in which sites are affected. Different models of technological change are presented next to develop a context in which to evaluate the adaptation process of the selected vessels. Using evidence of site formation processes as a guide to interpret shipwreck remains, the challenge will be to identify how archaeological evidence might reflect a certain model of technological change. By determining how the archaeological evidence possibly fits within a model of technological change, a determination of the manner in which the conversion and adaptation process took place in the selected vessels can be established.

Site Formation Processes

Interpreting the remaining archaeological evidence of the selected vessels is important to ultimately decipher the methods for converting commercial craft for military use. By understanding the changes a shipwreck undergoes, an archaeologist may more accurately interpret the existing remains to determine what the vessel once looked like and how it operated. Underwater archaeological remains undergo various degrees of change due to many different factors, and these factors, or processes, need to be identified to recognize what is happening at the shipwreck site. Site formation processes have been identified by archaeologists for, “determining how material was transferred from a systemic to an archaeological context and

what happened to that material after it was deposited in the archaeological record” (Trigger 2006:427). To better understand site formation processes, two theorists are presented who have provided methods for describing archaeological site formation. Keith Muckelroy and Michael Schiffer both developed theories, complementary in many aspects, for explaining affects to archaeological site remains and how a site changes over time. Beginning with Keith Muckelroy, explanations of these processes are established.

Keith Muckelroy, a maritime archaeologist, developed his theory of site formation processes during the 1970s with an understanding that multiple factors influenced available remains of an archaeological site. Muckelroy stated to best understand maritime archaeology,

its principle sources of data lie in the remains of such activities preserved on the seashore or sea-bed, it follows that the interpretation of such data is closely bound up with an understanding of what is involved in a shipwreck. The shipwreck is the event by which a highly organized and dynamic assemblage of artifacts are transformed into a static and disorganized state with long-term stability (Muckelroy 1978:157).

The shipwreck event in and of itself is important, but for an archaeologist to best understand the evidence, according to Muckelroy, there must also be an understanding of the underwater conditions following the ship settling. He states, “the nature of the sea-bed deposit is the main determining factor in the survival of archaeological remains under water” (Muckelroy 1978:163). From the shipwreck event, the vessel settling on the seabed, and to environmental influences, the archaeological remains are influenced by multiple factors. These, according to Muckelroy, are called *scrambling devices*.

The wrecking event is in itself a scrambling device. The wrecking event,

...constitutes the first stage in the rearrangement of the elements of a vessel which interests the researcher, and is covered by the title ‘process of wrecking’. This definition is thus a broad one, including the continued break-up of the wreckage on the sea-bed as well as the stages by which it got there, up until the time when it becomes part of the seascape (Muckelroy 1978:169).

A scrambling device is essentially any force which moves or degrades evidence, therefore disturbing the context of the archaeological site. The flow chart below (Figure 3.1) examines Muckelroy's process of the wrecking event.

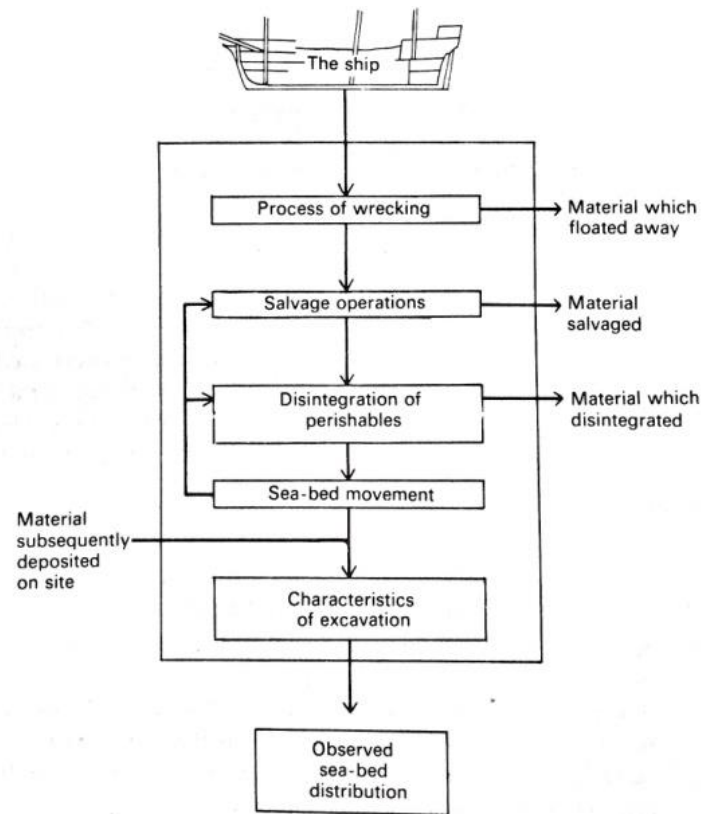


FIGURE 3.1. Flow diagram displaying the evolution of a shipwreck (Muckelroy 1978:158).

Muckelroy includes other scrambling devices that are responsible for the loss of archaeological context. Shifting seabed movement is one of these influences. Muckelroy states, “sediment disturbance is obviously primarily the result of water movement, i.e. by tidal currents or wave action. The former can occur at any depth and with any force, according to circumstances, but the latter has more limited application” (Muckelroy 1978:176). Wave action, tidal action, and sea currents all move water and sediment in various ways, all interacting with the shipwreck. One of the problems for a researcher is the possibility of misinterpreting the context of the remaining evidence. Understanding that environmental factors influence an

archaeological site in different ways means no site will compare exactly with another and a broader environmental awareness is necessary for each shipwreck.

Muckelroy also points out other influences that create contextual problems for researchers. Among these are *extracting filters*. Extracting filters are mechanisms that remove articles from the shipwreck. Muckelroy points to, “three processes which lead to the loss of material from a wreck-site are the process of wrecking, salvage operations, and the disintegration of perishables” (Muckelroy 1978:165). The process of wrecking, along with being a scrambling device, is also considered an extracting filter. In the wrecking event, articles are lost from the ship, either intentionally as cargo or armament may be discarded, or accidentally as features could be broken, that do not end up being part of the final assemblage of the vessel. Salvage operations, a human behavior, occur as a result of individuals locating and accessing a shipwreck to remove certain articles, disrupting the archaeological remains. The removal of articles from the site necessitates further consideration and interpretation by the archaeologist because of added distortion to the archaeological remains. With regard to the disintegration of perishables, this also impacts the context of the shipwreck, as evidence of cargo may be lost, creating difficulties in determining ship type. Extracting filters are ultimately a combination of human and natural influences that remove features from the shipwreck site.

Continuing in this vein and with respect to this specific study, archaeological remains help to determine what was actually held as cargo or specific modifications made to a ship, rather than what may have been alleged to be carried or adapted. Muckelroy details, “with both warships and merchantmen, the great strength of the evidence from the sites themselves is that it shows, albeit partially, what the ship was actually carrying, as opposed to what the documents say she should have been carrying” (Muckelroy 1978:220). This aspect is extremely important

for the purpose of this project. Specifically in regard to this study of modern era vessels, the archaeological evidence can help determine modifications made or, equally possible, not made. However, Muckelroy does not necessarily view modern ships as good targets for archaeological survey. In a possibly contradictory statement, Muckelroy proclaims,

since the development of the aqualung, divers have taken a great deal of work on early steamships, American Civil War gunships, World War I battleships, and even World War II aircraft. But while such enterprises are interesting, and sometimes furnish useful displays for museums, they are not archaeology. As an academic discipline, archaeology interprets the past on the basis of surviving objects; it becomes redundant at that point in the past after which surviving records, descriptions, plans, and drawings of contemporary objects can tell us more about the culture of the time than we can learn by digging up a few relics (Muckelroy 1980:10).

A goal of this project is to determine whether or not this statement is necessarily accurate, in that the determination of archaeological evidence could possibly be different from surviving historical documentation. Nonetheless, Muckelroy's assertions are direct and analytical in nature. The main ideas driving Muckelroy's theory are the following of precise, scientific processes, with little use for speculation.

Some have seen limitations in Muckelroy's approach to focusing on natural causes in site formation processes. Martin Gibbs, when referencing the use of Muckelroy's theory in his own work with shipwreck survivor camps in Australia states, "in particular, Muckelroy emphasized natural forces over cultural influences, representing the latter as 'salvage in antiquity,' without elaborating or discussing the possible effects of these processes on later parts of the site formation sequence" (Gibbs 2003:138). Ultimately, Muckelroy does concede there are limitations on focusing primarily on site remains for analysis by stating, "archaeological evidence possess its own inherent weaknesses, notably in being unable to shed light on people's motives or ideas, so that the various disciplines should generally be seen as complementary and

equal rather than conflicting or in some sort of hierarchy” (Muckelroy 1978:216). It is important to include the human element in site formation processes, one which Michael Schiffer presents in his theory.

Michael Schiffer, a terrestrial archaeologist, emphasizes a broader scope of site formation processes, including human behavior as a substantially influential factor. This body of theory is called *behavioral archaeology*. As part of behavioral archaeology and site formation processes Schiffer states, “artifacts recovered archaeologically have been deposited by adaptive systems and subjected to other cultural and natural processes” (Schiffer 1983:676). The archaeological record can be divided as exhibiting natural or behavioral, or cultural, transformation processes. Schiffer states, “formation processes are of two basic kinds: cultural, where the agency of transformation is human behavior; and non-cultural, in which the agencies stem from the processes of the natural environment” (Schiffer 1996:7). These two are ultimately labeled *n-transforms*, non-cultural (sometimes referred to as “natural”), and *c-transforms*, for cultural. Muckelroy, as previously stated, relied heavily on the non-cultural processes, *n-transforms*, to describe the evidence represented at an archaeological site. Schiffer, while inclusive and understanding of the large impact of *n-transforms*, adds the element of cultural processes, *c-transforms*, to the formation process of the archaeological site.

C-transforms are quite different from *n-transforms* in that *n-transforms* have a defined, scientific process which can be utilized universally; *c-transforms* often come from human behavior and are open to multiple interpretations (Richards 2008:53-54). This certainly does not make the behavioral aspect any less important to the study of site formation, rather, it allows for behavioral analysis to be offered as an aid in explanation of what is happening at an archaeological site. Schiffer believed that the archaeological record represents a, “distorted

reflection of a past behavioral system” (Schiffer 1976:12). In describing c-transforms, Colin Renfrew and Paul Bahn add, “c-transforms involve the deliberate or accidental activities of human beings as they make or use artifacts, build or abandon buildings, plow their fields and so on” (Renfrew and Bahn 2000:52). In behavioral archaeology and understanding c-transforms, it is important to recognize that humans have a definite impact on an archaeological site and that there are many ways in which an archaeological site can be influenced due to human activity.

When discussing maritime archaeological sites the reality is they are constantly vulnerable to salvage operations as well as commercial fishing practices, both distinctly human activities. Salvage operations, as briefly discussed by Muckelroy, vary widely from each site but can ruin the integrity of the shipwreck, often greatly disturbing and altering the context of the archaeological evidence (Muckelroy 1978:166). Salvage operations can occur immediately following a wrecking event, sanctioned to gather cargo or other features thought to be recoverable. Salvage operations can also be unsanctioned, as features of a shipwreck could be highly valuable and sought after. Destroying ship features to gain access to valuables is one way salvage operations occur. Irresponsible divers can also impact maritime sites as well, by looting or salvaging “interesting” pieces of a shipwreck. Removal of important features, such as structure or armament, destroys the integrity of the remains.

Another human influence on the archaeological record of maritime wreck sites comes from the fishing industry. Commercial fisherman, often through inadvertent behavior, can completely destroy the artifacts remaining of a shipwreck. When discussing the technique of trawl fishing practices interfering with wreck sites, Brendan Foley states more modern wrecks,

may be able to withstand a few net snagging events before being torn apart. However, ancient shipwrecks are more delicate. Because the wooden hull is consumed by a variety of animals, an ancient shipwreck typically consists of ceramic or inorganic artifacts lying on the sea floor. If a trawl net is dragged

through an ancient wreck, these delicate objects will be smashed and scattered. Repeated trawls may eliminate all traces of the wreck (Foley 2007).

Gear, such as fishing nets, can get caught in archaeological remains, possibly dragging objects across expanses, and disrupting the context of the shipwreck. Indeed, human interaction on a shipwreck in these forms can greatly disturb the context of the remaining archaeological record, greatly impeding further interpretation.

The manner in which an object is used is another way of analyzing archaeological evidence. Michael Schiffer examines the methods of how objects were used by humans as a way of interpreting the archaeological record. Schiffer details *reuse* of an object, meaning there are often multiple ways an object can be used from its original intended purpose. To establish a working definition of reuse, Schiffer states, “reuse can be defined as a change in the user or use or form of an artifact, following its initial use. When an object breaks, wears out, or for other reasons can no longer carry out its utilitarian or symbolic functions, opportunities for reuse arise” (Schiffer 1996:28). Objects can be utilized in various ways by different individuals or cultures. An example of reuse of an object could include a ship, used multiple times by various owners for the same practice, or used in a different manner, but the design remains the same.

The process for reuse of particular objects found at an archaeological site will ultimately have cultural contexts, and inferences need to be made that are necessary for analysis. Given the ability to determine how an object, found in the archaeological record, was used, interpretations can be made about the culture using the object and the reason for it being located in a specific area. If there are multiple functions for an object, each purpose could provide for a different explanation for the object being deposited in a specific area. The challenge for an archaeologist is to correctly interpret the use of the object as it is displayed in the archaeological record.

There are different forms of reuse as interpreted by Schiffer, offering several behaviors exhibited by an individual or culture. The varieties of reuse include, *lateral cycling*, *recycling*, *secondary use*, and *conservatory processes*. Each of these forms of reuse is distinct and offers different examples of an object's use. In examining the form of *lateral cycling*, Schiffer defines this as, "only a change in an artifact's user. The transfer of artifacts from individual to individual and social unit constitutes lateral cycling as long as the form and use are not altered" (Schiffer 1996:29). This is the simplest form of reuse, in that the object is not altered aesthetically or functionally. Lateral cycling allows for similar use and function of an object which can be passed through different ownership. Fishing trawlers, for example, could be passed down through families or sold between different owners, but the form and function remain essentially the same. The notion of lateral cycling is broken, however, when a fishing trawler is used as a patrol boat. Archaeologically, this aspect could present issues for the identification of specific owners or users, but in most instances, the function of the object can still be discerned.

Differing from lateral cycling is *recycling*. Recycling is, "the return of an artifact after some period of use to a manufacturing process" (Schiffer 1996:29). This process takes an object through a manufacturing process, resulting in a new product as well as a loss of identity of the former object. For example, recycling of ships and specifically the material used to make them, allows for the creation of new vessels. This could include using hull plating from one ship to then be used for the creation of a different ship as well as many other repurposing functions. For converted fishing trawlers, equipment could be added from older, outdated military vessels. Recycling could pose archaeological interpretation problems as well, specifically if recycled material is not differentiated within the context of the entire site. However, if the material has

been stripped of previous its use features and is identical to the other structure, this may not present an issue for interpretation of use.

Secondary use, as a third form of reuse, does not necessarily require extensive modifications. Essentially, it is the change of a function of an object without making large alterations to the form of the object. An example of secondary use may be the, “conversion of vessels into secondary support roles, such as hulks and lighters, or other more specific and distinctive functions” (Richards 2008:55). There would be little, if any, modifications or alterations made to vessels of the original type and therefore this would be more of a change of purpose for the vessel. Fishing trawlers, if not converted in any fashion, could still act as patrol vessels, essentially changing behavior and function without changing design. At an archaeological site, the ship type may indicate a certain purpose; however, the reason for the ship’s loss could have resulted from a different activity, therefore, complicating the issue for identification and function.

The last of the four reuse varieties, *conservatory processes*, exhibits, “a change in an artifact’s use- and often its function- such that permanent preservation is intended” (Schiffer 1996:32). This variety may not fit exactly with this study as it deals with preservation. An example of this might be the use of USS *Constitution* as a preserved vessel, on display to the public for historical purposes, as opposed to it remaining in service as a war vessel. It is no longer an active warship as it is now preserved to display historical aspects of the time period in which it operated.

Models of reuse are characteristics of human behavior and are considered c-transforms. Human decision making plays a large part in the available remains as well as helping to determine reasons for the evidence to appear. It is important to note, “the relationships between

people and artifacts are discussed in terms of regularities discerned in processes of manufacture, use, and disposal that make up the life histories of material things” (Skibo and Schiffer 2008:6). The vessels in this study were manufactured, used, and then repurposed with distinct modifications, all possibly following a similar method for conversion. Having these modifications and a change in function represented in the historical record will ultimately aid in analyzing the archaeological remains.

Keith Muckelroy’s and Michael Schiffer’s descriptions of site formation processes provide indicators in which to examine the archaeological record. Muckelroy focuses on natural influences as determining the remains of the archaeological evidence, whereas Schiffer provides aspects of a cultural and behavioral context in the evaluation of the archaeological record. Utilizing both theorist’s positions on site formation to establish possible processes encountered at each shipwreck is necessary for the interpretation of the remaining archaeological evidence. Understanding the context of the archaeological evidence helps determine what the provenance of materials that persist on a present-day shipwreck may be, and therefore may also help to interpret how evidence of technological change may be preserved in the archaeological record.

Technological Change

The method in which conversion and adaptation of the selected vessels took place derives from a form of technological change. Along with discussing site formation processes, Schiffer mentions that, “technical choices determine the formal properties, attributes, of artifacts” and that, “every technological process involves a sequence of behaviors that results from specific technical choices” (Schiffer and Skibo 1987:599). Essentially technological change begins with assessments of an object’s current function or use. These assessments are the determining factors upon which technological change or adaptation will be made and a resulting alteration that may

take place. In effect, technological advances are the direct results of many influencing factors, based on decision making processes. The conversions and adaptations made to the selected vessels of this study are a direct result of a method of technological change.

Technological change can occur for many different reasons and develop in different ways. Schiffer, when discussing technological change of an object, states, “the ultimate source of most artifact innovations (and deletions) is changes in the functional field, which stem from factors of lifeway, social organizations, and prior changes in the functional field” (Schiffer and Skibo 1987:598). The “functional field” is what tasks or functions an object performs. When an object’s use and needs are altered, technological change will occur. Utilizing Schiffer’s model on reuse within site formation processes as pertaining to technological change, human behaviors and needs will ultimately dictate technological changes.

To establish a context for these conversion and adaptation processes made to the selected vessels, different models of technological change must be evaluated. Each technological change model incorporates different influencing factors which bring about innovation, adaptation, or change. Similar influencing factors may be prevalent in each model, but ultimately they represent different methods for creating technological change. For the purpose of this study four models of technological change will be examined, the first being the role of the *heroic inventor*.

The heroic inventor model of technological change focuses on the exceptional advances made by a single person. This model, as defined by Don Leggett and Richard Dunn, state, “in the heroic inventor model of technological change a single individual is claimed to make great leaps in innovation, seemingly apart from contemporaries, constraining institutions or the requirements of those who use technologies” (Leggett and Dunn 2012:5). It is this singular inventor, free from outside influences, which will make a significant change to the current form of technology.

Technological change comes not from a group of individuals, but rather a singular entity who establishes a new technology or improved object.

The heroic inventor model may have originated as a mechanism for promoting economical advancements of a country or explaining the strength of a certain economy. It was often used during the 18th and 19th centuries, which oversaw a period of rapid innovation and growth. As Christine Macleod writes, “explanations of Britain’s extraordinary growth in prosperity since the eighteenth century were increasingly couched in terms of technological change, often by reference to particular inventors,” (MacLeod 2007:3). An example of an inventor placed into this model is Isambard Kingdom Brunel, a leader of modern oceanic commerce ship design during the rise of industrialized United Kingdom. Literature about Brunel is extensive, with works that include *Isambard Kingdom Brunel: A Biography* (Rolt 1959), *Isambard Kingdom Brunel: Engineering Knight – Errant* (Vaughn 1991), and *Brunel: Life and Times of Isambard Kingdom Brunel* (Buchanan 2002). The story of his life’s work is obviously celebrated by many.

Hoping to create a reinforced ship capable of limited refueling, Brunel in the early 1850s, “envisaged an iron ship, double-skinned below the water-line and compartmentalized by lateral bulkheads, with longitudinal bulkheads running the length of the ship.” These developments were new and pioneering and, “actual construction, depending upon the riveting of a huge number of wrought iron plates and beams in a most innovative form, was beyond the competence of all traditional shipbuilders of the time, and depended heavily on the expertise available at Scott Russell’s shipyard.” The resulting ship, *Great Eastern*, was launched in 1858, measuring 692 feet long with five funnels and six masts for ancillary sail power (Buchanan 2002:118-119). This ship was hailed by economic leaders and the public as a great success, displaying financial

prominence, and because of this, Brunel had his status raised above all other technological contributors.

But the idea of Brunel being the single inventor of a new technology seems unlikely, in that there were others working in a similar fashion to advance ship technology. The heroic inventor model advances and glorifies the technological prowess of individual members within a country or society, but it does not necessarily represent a true method for technological change. Stating this difficulty of accurately attributing rightful ownership of ideas, John Lienhard states, “none of us is ever really first to produce any technology. Our inventions always build upon antecedents” (Lienhard 2006:14). Positively identifying a single person as the sole inventor of a new technology is very difficult as multiple individuals can claim a connection or be attributed to a new technological advance. Lienhard also states,

we have assigned inventors to each of those technologies, and it might often seem that we did so by tossing the names of people in these technologies into a hat and pulling on out. Fulton, Morse, the Wright brothers, and Edison all made huge contributions that served to consolidate each of their technologies. But to call any of them a primary inventor of their technology is a little like naming the inventor of the first doughnut hole (Lienhard 2006:11).

In as much as it is difficult to truly name a single inventor of a technology, the reasoning for doing so certainly has had its advantages. For example, the inventor is recognized for their achievements, especially if there is a financial windfall and many profit from the technology.

Continuing to find faults with the heroic inventor model, John M. Staudenmaier reiterates, “identifying the true inventor is not always the simple matter of establishing who first conceived of a given design concept. It can be argued that an individual ‘invents’ a new concept only when s/he recognizes its usefulness and succeeds in communicating its importance to an appropriate audience” (Staudenmaier 1985:40-41). The heroic inventor model, however, does not account for the other individuals working to achieve the same end, or, highlight the failures

along the way to success. Echoing this sentiment, Ben Marsden and Crosbie Smith in discussing the invention of the steam engine, state, “for every successful Watt engine with separate condenser, there were untold rivals, vaunted to supersede steam in all its industrial applications, yet in final analysis, unable to realize the advantages promised on paper or indicated in elaborate demonstrations” (Marsden and Smith 2005:6). It is not completely accurate to claim one individual as a sole inventor.

The heroic inventor model is still pervasive as a descriptor of historical events. Leggett and Dunn point out, “nevertheless, heroic stories remain powerful cultural narratives in the commemoration of technology where the single authorship of objects can be easier to understand and celebrate than the work of a complicated and expansive social network, within which authority, intention and identity are ‘constructed’ and transmitted” (Leggett and Dunn 2012:5). Simplistic analysis of the extensive work done by an individual, such as Brunel, provided encouragement for a population to rejoice in the prosperity of the nation. The heroic inventor model does not necessarily account for all the other groups working toward similar goals and the failures incurred along the way, which can be as important as the successes. There are other models, to be discussed, that account for more in depth analysis of a technological change, rather than focusing on promoting individual success.

A second model for technological change, identified as *technological evolution*, is seen as opposition to the model of the heroic inventor. The technological evolution model, as described by Leggett and Dunn, “weaves technological change into the fabric of maritime history without reflexive consideration, by shrouding the agency of actors and the cultural specificity of technical decision making” (Leggett and Dunn 2012:5). In essence, this model illustrates technological change as a progressive movement, incorporating a larger set of actors working

toward technological change, without identifying singular actors as sole creators of change. This model is a critique of the heroic inventor model and incorporates a larger set of influences acting for technological change.

Technological evolution produces advances made in progressive and incremental manners, ultimately resulting in a change to a society's culture. Reinforcing the explanation of this model, as quoted previously in Chapter One, states, "that technical developments follow a progressive course largely independent of cultural or political influences, and that these developments affect societies in ways that are materially dependent, rather than socially conditioned" (Leggett and Dunn 2012:5). Technological progress evolves over time, harnessing the work and effort of many individuals, and affecting change in the cultures which utilize such technology. The technological evolution model dictates technology has the ability to change societal structures that depend on technology, but not necessarily societies bound by material needs.

The technological evolution model provides basic understanding of the process of technological change. S.C. Gilfillan explains this further by stating, "an invention is an evolution, rather than a series of creations, and much resembles a biologic process, because it has a basic kinship with this, through innate human mentality" (Gilfillan 1970:5). Reducing technological change to an evolutionary and forward moving process simplifies the method in which objects are adapted or created. Comparing technological change to biological processes emphasizes the influence of many individuals working for change, rather than a singular inventor creating a radical and revolutionary idea. But it also demonstrates, as with biological evolutionary processes, there are ages of stagnation as well as progress. Gilfillan states,

we are again reminded of our biological parallel, wherein evolution proceeds by far the most rapidly in those rare periods of climatic stress, which massacre old

types and seem to breed new ones which can meet the new conditions, like the glacial age that produced man. Mutation or extinction, those are grim Nature's alternatives when conditions change and strong rivals appear (Gilfillan 1970:19).

Viewing technological change in this manner can account for the periods of little innovative practice as opposed to times of rapid change. Technological evolution is ultimately a model representing change resulting from larger group influences and periods of stagnation as well as fervent progress.

Technological evolution runs counter to the previous heroic inventor model and has also become widely accepted because it incorporates more people acting toward a common end. The heroic inventor model provides a simplistic view of difficult technological endeavors.

Technological evolution, while inclusive of more workers involved toward a common goal, has limits to its use as a model. The model focuses on ever progressing technological advances that are not necessarily reflective of the will of society. These advances affect society, but in turn are not the result of the needs stemming from societal demands. Other models will be discussed that display this dynamism.

Very similar to technological evolution, a third model for technological change is entitled *technological determinism*. Technological determinism is described as a straightforward, ever progressing process of technological change. In an effort to try to define technological determinism, Bruce Bimber states there is no single, unified definition of technological determinism, however,

the first component of this view is that technological determinism should hold that history is determined by laws or by physical and biological conditions rather than by human will; this makes it deterministic. A generally accepted definition of determinism, apart from the study of technology, is the doctrine that future phenomena are causally determined by preceding events or natural laws (Bimber 1994:86).

Determinism as a mechanism for technological change is therefore formulaic and systematic, accepting of little variance and following a direct path. To corroborate this view, Staudenmaier states, “for a determinist, the progressive development of technology resembles the unfolding of necessary implications in a mathematical formula...more than it does a genuine historical process” (Staudenmaier 1985:147). This method of promoting technological change as a formulaic process forces change on a society. Leggett and Dunn state, “inherent in this model is the assertion that technology, and its intrinsic characteristics, affect change in an inevitable way that necessitates action in the surrounding world, often reducing the complexities in a group’s interaction with technology” (Leggett and Dunn 2012:6). Technological advances, in a sense, move forward in a constant, progressive fashion, without regard to social, political, or cultural factors able to change direction of technological advancement. Rather than having issues force the technological change, it is often looked at the other way, technological change influencing societal change. Technological determinism, however, does not identify any societal issues as promoting technological change.

It should be pointed out there is a form of study that has similar properties as technological determinism, as well as aspects of technological evolution. *Teleology*, “is defined as ‘the doctrine or study of ends or final causes’. This definition contains a technical term, ‘final causes’, not much used nowadays. A more familiar word would be ‘purposes’. Questions about teleology are, broadly, to do with whether a thing has a purpose, and, if so, what that purpose is” (Woodfield 1976:1). Essentially, an object can be explained by the purpose it serves rather than the causes it elicits. As opposed to observing technological progress in a manner that is constantly evolving in some fashion or is predetermined, teleology focuses on the final purpose of the object, determining whether it can be considered useful. Often philosophical in nature and

derided for lack of scientific methodology (Wright 1976:1), teleology still offers insight into technological progress, often interwoven within the ideas of technological evolution and technological determinism as critiques of functional use of an object are undertaken. Teleology may provide a way of evaluating the use of an object, but it does not necessarily provide a history of an object's development, which is accounted for within technological evolution and technological determinism.

Technological determinism, although straightforward in reasoning, does not account for human inspiration as a mechanism of progress. In essence, technological determinism has a set form in which developments follow and, apart from the first technological invention, advancements are predetermined. Social changes resulting from technological advances have thus far been the focus of the technological change models. Each model has expanded upon this aspect. However, change is necessarily more than a one-way street, as there needs to be accommodation for social aspects influencing technological change. To incorporate a wider view of technological change, a fourth model must be examined.

Technological change has been interpreted as influencing social change. This has been apparent especially in the technological evolution and determinism models. However, there is a need to describe another function of technological change. Technological change can come from the effects of societal change. The commitment of individuals within a culture to change a current state can bring about technological change. To Staudenmaier, technological determinism does not account for the motives of individuals to change their current status. To expand beyond technological determinism, Staudenmaier states,

for determinism, the dynamism of technological change is exclusively technological: the unfolding, in necessary sequence, of technological progress. Its relationship with culture is a one-way causal impact. By contrast, the momentum model understands the very dynamic of technological change as the result of some

technical design embodied within a culture. Far from having an independent and necessary dynamism of its own, technical design has no force whatever unless it has become embodied in the choices and commitments of some set of cultural institutions or individuals. Thus the technology-culture relationship is intrinsically mutual (Staudenmaier 1985:154).

This fourth model is described as *technological momentum*. Thomas P. Hughes discusses the differences between technological determinism and technological momentum by stating determinism is the, “belief that technical forces determine social and cultural changes. Social construction presumes that social and cultural forces determine technical change. A more complex concept than determinism and social construction, technological momentum infers that social development shapes and is shaped by technology” (Hughes 1994:102). This mutual idea that technological change is affected by social influences as well as effecting social change, is a more inclusive model for determining the process of modification or adaptation.

Societal influences certainly dictate the need for technological advancement. In many of the models, technological change is a straightforward process with little regard to societal issues that can provide inspiration or acceptance. Technological momentum helps with the explanation of change to an object and the manner in which it evolves, interacting with the needs of the people. Success of the technological change is dependent on meeting those needs. To further illustrate this point, Gilfillan states, “an invention coming before its time remains undeveloped and practically useless” (Gilfillan 1970:12). If a society is not ready or willing to accept an invention or innovation, the technology goes unused. Technological change is dependent on the needs of individuals or society and the response the changes elicit. Technological momentum, as a model, accounts for a society influencing and being influenced by technological change, something not necessarily accounted for in the other models.

Again, technological change models vary in different ways but also have similarities. Each tries to account for and explain the progress a society makes through the innovation process. The invention and adaptation process is difficult to manage and detail but each of these models conveys an explanation for technological change. By understanding the concepts of each technological change model, the next step is to determine the best fit for the conversion process of the selected vessels. Determining the correct model for technological change will help to evaluate the effectiveness of the conversion process of the selected vessels as well as understand other similar type conversions and if they fit within the same model for technological change. It is necessary to understand that all, some, or none of the models for technological change fit exactly with the evaluation of the conversion process. This aspect, as well as how archaeological remains might fit within each technological model, is further elaborated on next.

Conclusion

By understanding how site formation processes have impacted archaeological evidence, it becomes possible to then analyze shipwreck sites according to paradigms of technological change. Site formation processes allow for a way to assess overall distortion occurring to the archaeological remains, specifically, what has happened and what is currently happening to the shipwreck. These processes allow for evidence located within the archaeological remains to be attributed to resulting from natural processes or human behavior. Once a determination of what has been moved, altered, or transformed at a site, the remains can be compared with the historical record. Correlations between the two are possible and interpretations can be made as the objects move from a systemic to archaeological context. Within the systemic context, original purpose built features as well as converted features may be evident, which ultimately displays the transformation of the commercial fishing vessels to military use. Evaluating this

aspect will allow for an assessment to the accuracy of the historical record and possibly lead to a determination for a model of technological change.

The shipwreck remains may be indicative of a model, or models, of technological change. For example, how certain remains represent evidence of the heroic inventor model could be manifested in a certain armament feature, designed by one person for a specific purpose, which is only evidenced in these types of vessels. Conversely, conversion features that are common throughout each vessel may be representative of the technological evolution or determinism model. Ultimately, it is a purpose of this study to analyze the historical and archaeological records to best determine the course in which conversions were made to the selected vessels and the reasons dictating the conversion process.

In determining possible outcomes for this project, ideally, the historical record should provide information on the process of adaptation and the method in which certain conversion methods were carried out. It is expected the conversions were similar in fashion for both the British and American vessels, resulting from a common idea or source. Information regarding the decision making process and the method of conversion should be represented in the historical record. Additionally, the evidence located within the archaeological record would be reflected as matching aspects of the conversion process listed or described in the record.

However, it is understood there may not be enough information available in the historical record or the ability to analyze the archeological remains to accomplish these goals. The historical records may not provide a complete analysis of the conversion process, especially if certain information is missing. The archaeological evidence may reveal both natural and cultural influences, confusing or detracting from the context of the remains and making it difficult to determine the mode of technological change. This information will be presented in Chapter Five,

focusing on each vessel. Regardless of the evidence provided, the methodology will remain the same and an evaluation regarding the final historical and archaeological information will determine the effectiveness of the converted vessels.

CHAPTER FOUR: METHODOLOGY

Introduction

To accurately detail the methods of converting *YP-389*, *HMT Bedfordshire*, and *HMS Senateur Duhamel*, extensive research was necessary. The project incorporated a multifaceted approach, including a large historical research component, evaluation of theories of site formation and technological change, and archaeological site evaluations. Along with the assessment of these components, another aspect requiring the use of *Rhinoceros 5.0* (Rhino), a three dimensional (3D) modeling program, helped facilitate a visual representation of the progression of the distinct building and conversion stages, as well as archaeological remains of the selected vessels. These Rhino models were essential for final analysis. Ultimately, there are three main components for this study including historical, archaeological, and modeling phases, all of which are used to determine the manner of converting commercial craft for military use.

To make the project manageable, data collection and interpretation of the information were divided into multiple subject components. A large research component provided a broad base of information to evaluate many historical themes of this project. Theories of site formation and technological change were analyzed to help evaluate a large archaeological data set of the selected vessels' remains. Using both the historical and archaeological evidence, the appropriate information could be placed in the Rhino three dimensional modeling program to visually detail the methods of conversion. The Rhino model component was the third tool used in this process.

The Rhino models illustrate different stages in the life of each of the vessels. Model groups were created to show the different stages of the vessels, to include original design, the converted areas of each vessel based on historical documentation, features identified within the remaining archaeological site, and the reconstructed vessel detailing construction and

modification evidence from both the historical and archaeological record. Again, these models represent the various phases of the history of each vessel as is deciphered from the historical and archaeological evidence. Using historical and archaeological data to replicate the various stages of the life of each vessel ultimately provides for final analysis of converting commercial craft for military use.

In this chapter, each phase of study is chronicled in the order each was completed. Beginning with the historical research stage, a description of the resources used and the method in which they were applied for analysis is detailed. Following this section, sources for site formation theory and technological change, as well as archaeological evidence, are detailed. Aspects of the resources utilized are then examined as they were used to create the Rhino models. Combining both the historical and archeological information to create the Rhino models provided illustrations to be used for final analysis. To conclude, the manner for interpreting the Rhino model evidence and possible discrepancies are detailed, which are ultimately discussed in further chapters.

Historical Research

The historical research portion of this study encompassed many different themes with multiple objectives. It was easiest to first break down the needs of the overall historical research phase and compile a list of objectives. Focusing on this compiled list of objectives, primary and secondary documents would be used to fill the requirements for these objectives. Objectives fell into two broad categories: individual ship information and naval philosophy and strategy. Individual vessel information included the history of each vessel as well as information detailing both original construction and military conversion. Naval philosophy strategy information included a history of both pre-war and World War Two strategies and policies. Beginning with

broader themes and then working to acquire more specific information, secondary sources provided the base from which the study began. Following the completion of secondary source research, primary sources were then located to provide detailed and more specific information. The detailed information provided by primary documents corroborated the information presented by the secondary sources. The following describes the process of the historical research phase, beginning with a review of secondary resources.

Secondary Resources

Research began with the assistance of staff from East Carolina University's Joyner Library. Utilizing the resources available at Joyner Library, a list was compiled of sources detailing the history of the Battle of the Atlantic; inter-war year American and British naval policy; German, American, and British naval strategy during World War Two; and military vessels used during the war. Using the information provided in such works as, *U.S. Naval Logistics in the Second World War* (Ballantine 1949), *British and American Naval Power: Politics and Policy, 1900 – 1936* (O'Brien 1963), *Mr. Roosevelt's Navy: The Private War of the U.S. Atlantic Fleet, 1939 – 1942* (Abbazia 1975), *Torpedo Junction: U-boat War Off America's East Coast, 1942* (Hickam 1989), and *Churchill's Navy: The Ships, Men and Organisation 1939 – 1945* (Lavery 2006), a broad picture of these issues came into focus. Themes regarding war preparation, conflict losses, and vessel usage examined in this part of the research process provided a framework to then move into more specified research.

Using the information from these sources certain objectives were completed. An understanding of naval development following World War One was determined as policies were established collectively by countries, specifically the United States, United Kingdom, Japan, France, and Italy, dictating build up and development of each of their respective navies. These

agreements, such as the Washington Naval Treaty and later the Anglo-German agreement, played vital roles in determining the design and allocation of vessels for each navy. Specific restrictions, such as limiting the size and number of battleships in production as well as overall size of standing navies, were put in place that shifted resource allotment for certain vessel and technological developments. These restrictions greatly affected the design and allocation of resources designated by each navy during the inter-war years and up to the beginning of World War Two.

Along with developing a sense of pre-war naval policy, it was necessary to understand the course of the Battle of the Atlantic and the impacts of the U-boat war on the East Coast of the United States. Early Battle of the Atlantic descriptions of U-boat sinking of merchant shipping presented a context for the use of vessels at the outset of American involvement. The months following the 7 December 1941 attack on Pearl Harbor held unprecedented destruction of merchant shipping along the East Coast. Over time, the tactics, strategy, and available resources for the United States Navy would alter the effectiveness of the U-boat threat in the Atlantic. Piecing together the chronological order of the Battle of the Atlantic helped to display the changes made by the United States Navy. Combining multiple pieces of broad information, context was established to begin examining the selected vessels in a more focused light.

By understanding the course of the Battle of the Atlantic, information was then needed to determine the use of the selected vessels during the war. Each vessel came from a different background with prior commercial working experience. Determining when and where each vessel was used initially was supported through secondary sources. One of the sources included www.wreck site.eu, a website designed to present information compiled by individuals providing information regarding shipwreck sites from around the world. Information about each of the

selected vessels provided by wreck site.eu included brief descriptions of the wrecking event and basic ship profiles. In some cases, coordinates and images of the vessels were also provided. Information, such as where each vessel was built or armament features, would prove critical to further research requirements. Further ship information was compiled with the use of John Wagner's journal article entitled, "The Trawler *Cohasset* Goes Fishing for U-boats: A History of the Fishing Trawler That Would Defy a German Submarine" (Wagner 2012) about YP-389. Sources also included *Grimsby's Fighting Fleet: Trawlers and U-boats during the Second World War* (Hutson 1990), and *In Some Foreign Field* (Naisawald 1997), *British and Empire Warships of the Second World War* (Lenton 1998), *Royal Navy Trawlers Part Two: Requisitioned Vessels* (Toghill 2004), and *Atlantic Escorts: Ships, Weapons & Tactics in World War II* (Brown 2007) providing information about HMT *Bedfordshire* and HMS *Senateur Duhamel*. Chris Cartellone's master's thesis, "Trawlers to the Rescue: The Role of Minor War Vessels in Securing the Eastern Sea Frontier, 1942" (Cartellone 2003) provided a wealth of resources as well as excellent information about the British trawlers and their history of use along the East Coast. Information provided from these sources included original design and military conversion features, as well as an overall history of their use. Having located basic information regarding ship attributes, it would be necessary to move into the more detailed phase of historical research by locating primary documents.

Primary Sources

The second phase of historical research focused on retrieving more specific, detailed information, not necessarily provided within the historical texts previously mentioned. It was necessary to further expand upon the initial research process by locating and acquiring primary documents to corroborate the initial findings. This began with an extensive search process to

locate primary documents, resulting in a new set of goals. The main goals for this phase were to retrieve and be able to analyze vessel descriptions and builder's plans, company and government information of the ship building and conversion process, war diaries and action reports for the vessels selected, and specific vessel conversion orders. As with the initial phase of broader historical research, objectives were set outlining the necessary pieces of information needed for further development and progression of the overall project.

There were three main historical objectives to focus on for primary document acquisition to properly assess the conversion process of the selected vessels. The objectives included, first, obtaining specific war plan and strategic recommendations created by the United States Navy. Second, builder's plans of the selected vessels detailing original structure and dimensions were needed, and third, conversion orders for each of the vessels outlining modifications made to the original structure. By acquiring the information for each of the objectives, historical analysis of the selected vessels was completed which helped to provide an understanding of their role during the Battle of the Atlantic. Details of each of the objectives are expanded upon further.

The main source for locating many of the primary documents pertaining to war plans and strategic recommendations came from National Archives II in College Park, Maryland. Information regarding U-boat interaction with merchant vessels and Navy ships, as well as anti-submarine measures was located at these archives as well. The main focus for this objective was to locate information that would shed light on the procedures, recommendations, and allocated resources designated toward defense of the East Coast prior to and during the opening stages of United States involvement in World War Two. Research in this area concentrated on Record Group 38 (Records of the Office of the Chief of Naval Operations, 1875-2006) with a focus on the files of the 10th Fleet. Specific files pertaining to this research objective were found in the

10th Fleet Anti-Submarine Measures Files, 1941-1945. Further research involved utilizing files pertaining to the Easter Sea Frontier and all vessel movements, located in Record Group 38, Boxes 331 and 332. From these files, action reports and vessel movements described the increased activity along the East Coast as war preparations were made by Naval Command.

The second objective of locating specific builder's plans and vessel description prior to conversion proved to be a more expansive and difficult task. Locating information about pre-conversion attributes of each vessel first began with cataloging yearly rating details, found in *Lloyd's Register of Shipping*. For each year of operation information was tabulated on a Microsoft Excel spreadsheet, tracking details and any changes made to the character of each vessel. This information was made available by using the web database, www.plimsoll.org, as well as assistance from the Mariners Museum located in Newport News, Virginia. This information provided specific information such as size, weight, and propulsion, but it did not provide details regarding shape or design. This information would be located in individual ship builder's plans.

While there was individual information regarding *YP-389* located at National Archives II (which will be expanded upon further), research was unable to uncover specific builder's plans for any of the selected ships or any vessels of comparable nature. Research would extend to beyond National Archives II and encompass multiple museum and archival resources. Builder's and sheer plans for *HMT Bedfordshire* and *HMS Senateur Duhamel*, through extensive research, were located in two locations. With the assistance from the Curator of Maritime History at the Aberdeen Maritime Museum, Meredith Greiling, the sheer plans and builder's plans for *HMS Senateur Duhamel* were located. Physical copies of these original plans were scanned and sent from the museum in Scotland. Builder's plans for *HMT Bedfordshire* were located at the Royal

Museums Greenwich in London. With the assistance of Sonia Bacca and Jeremy Michell of the museum, research uncovered the builder's plans for both HMT *Bedfordshire* and another fishing trawler of similar design, *Cambridgeshire*.

As stated, exact builder's plans of *YP-389* were not located, however, similar vessel information was available to be used in this project. Limited original construction information on *YP-389* was located at the Massachusetts Institute of Technology Hart Nautical Library with the assistance of Kurt Hasselbalch. Located at the Hart Nautical Library is a collection of photographs taken of vessels built by the Bethlehem Steel Company during the early to mid-20th century. *YP-389*, originally *Cohasset*, was built at the Fore River Ship Yard in Quincy, Massachusetts, owned by the Bethlehem Steel Company. Production photographs were purchased detailing the construction of *Cohasset* as it was originally built. This information, although not direct builder's plans, was quite valuable in reconstructing the vessel.

The third objective was to acquire specific conversion orders for each of the selected vessels. The research process resulted, unfortunately, in a lack of available information. The only set of complete and detailed conversion orders that were located pertain to *YP-389*. Located at National Archives II in College Park, Maryland, an extensive, detailed listing of the conversion plans and costs were discovered in Record Group 19, Box 603, as part of the files entitled "Bu Ships Correspondence, 1940-1945." This listing describes the work done to adapt the fishing trawler for military use as well as and a detailed cost of these conversions. Other important information regarding *YP-389* was found in Record Group 125, Box 163, entitled "Court of Inquiry Proceedings; 1909 – 1971." This file grouping contained the official records of the circumstances leading to the loss of *YP-389*, with specific references to armament and protocol when encountering a German U-boat.

Information regarding conversion aspects for both HMT *Bedfordshire* and HMS *Senateur Duhamel* were limited, although, some primary documentation was discovered. Located at the Bedfordshire and Luton Archives in the United Kingdom, with assistance from Nigel Lutt, Kristy McGill, and Pamela Birch, are photographs of HMT *Bedfordshire* that were donated on 27 November 1996 by J.S. Munro. Included in this photograph set is detailed evidence of converted features. Acquiring copies of the photographs as well as a detailed listing of each of the aspects of each photograph helped to corroborate information provided within secondary sources.

With the help of information provided in Chris Cartellone's master's thesis, Mr. James Reedy, Jr. was able to be contacted and gave permission for use of his collection of unpublished correspondence with individuals working on the British trawlers. Cartellone used much of this correspondence, dating back as far as the late 1970s, in his research. The unpublished correspondences include detailed, firsthand accounts from sailors on board the British trawlers loaned to the United States in February, 1942. A description of the armament added to HMS *Senateur Duhamel* is part of this collection of unpublished correspondence. The specific letter from this correspondence group is from Mr. Norman Salmon of Ipswich, United Kingdom, dated 17 March 1994. Mr. Norman Salmon also provided copies of photographs to Mr. James Reedy Jr. of HMS *Senateur Duhamel*, helping to corroborate information uncovered in the historical record.

Overall, collection of data was not uniform for each vessel as there was certain information unable to be found for each vessel. The following table illustrates each of the objectives for data acquisition and the resulting ability to gather the available information (Table 4.1). The boxes marked with an "X" represent primary source information acquired.

These plans were vital for use in combination with available information for each vessel. It was necessary to utilize similar vessel information as this provided additional sources in which to draw parallels or better evaluate various aspects of the selected vessels.

The absence of available information is most likely due to loss of records over time or the records never existing, as multiple repositories and museums were contacted throughout the research process. Information requests to the Lincolnshire Archives and the North East Lincolnshire Archives, both of Lincolnshire, United Kingdom, the Royal Naval Patrol Service Association, the United States Coast Guard, the Smithsonian Institute, the Society of Naval Architects, the Museum of Dunkirk (France), the Association of Dunkirk Little Ships, the Imperial War Museum of the United Kingdom, and the Naval War College Museum located in Newport, Rhode Island, all were unable to locate or provide information on the selected vessels. Sources providing limited information, not previously mentioned, included the National Archives of New York located in New York City, the United States Navy Collections at the Washington Navy Yard, National Archives of the United Kingdom, Virginia Beach Life Saving Station of Virginia Beach, Virginia, and the National Museum of the Royal Navy in Portsmouth, United Kingdom. These source locations provided information in the form of secondary resources for the selected vessels. Although many of these locations were unable to provide primary source information, corresponding individuals were willing to offer other options and provide assistance when able.

Locating and analyzing all of the available historical information helped to create Rhino model designs of the selected vessels. Original builder's plans for HMT *Bedfordshire* and HMS *Senateur Duhamel* were used to create Rhino models of each vessel as originally built, illustrating ship designs prior to conversions being made. Using similarly built vessels and

photographs detailing the construction of *Cohasset*, a Rhino model was created to represent the original design of *YP-389*. Following the construction of this model grouping, a second set of Rhino models was created. Using the original plans, detailed modification records, and secondary source information, the converted designs of each of the selected vessels was modeled. This second model set emphasizes the conversion process of each ship from commercial to military use. Further description of creating these two model sets is detailed later in this chapter.

Archaeological Evidence

Following the acquisition of the historical evidence, the focus shifted on acquiring detailed archaeological data as well as information analyzing theories of site formation and models of technological change. The archaeological evidence comes directly from field work undertaken by NOAA's Office of National Marine Sanctuaries, Monitor National Marine Sanctuary, and the North Carolina Coastal Studies Institute starting in 2008 and continuing up through to present day. Information collected from these expeditions include high definition sonar images, multibeam imagery, ROV video, photographic imagery, as well as survey reports detailing site conditions and ship feature remains. Using this collection of data, remaining site features were analyzed by considering site conditions, methods of technological change, and the effects of c- and n-transforms. Coordinating the available information to input in the creation of three dimensional renderings of the archaeological remains ultimately helped with further analysis. Historical and archaeological evidence are combined with aspects of theories of site formation and methods of technological change for final analysis of converting commercial vessels to military use. First, it was necessary to better understand theories of site formation and models of technological change, prior to analyzing archaeological evidence.

Site Formation and Technological Change

In the previous chapter, theories of site formation and technological change were presented to provide a construct from which to determine methods of converting non-military vessels. It is not the purpose to repeat the information discussed previously, however, it is necessary to highlight important sources used for each section. Primary sources that were used which focused on site formation theories included *Maritime Archaeology* (Muckelroy 1978) and *Behavioral Archaeology* (Schiffer 1976). These sources provided the base from which future archaeological analysis took place and the foundation of analysis of this section of the previous chapter.

Theories of technological change offered a wider array of source material. The primary sources used to formulate discussion of the varied models of technological change included *Inventing the Ship* (Gilfillan 1935), *Technology's Storytellers: Reweaving the Human Fabric* (Staudenmaier 1985), *Does Technology Drive History? : The Dilemma of Technological Determinism* (Smith and Marx 1994), *How Invention Begins: Echoes of Old Voices in the Rise of New Machines* (Lienhard 2006) and *Re-inventing the Ship: Science, Technology and the Maritime World, 1800-1918* (Leggett and Dunn 2012). Again, these sources provided the framework from which analysis of technological change could be applied to the conversion methods of the selected vessels. Utilizing information from both theories of site formation and models of technological change, interpretation of the archaeological remains could take place. Having a framework in which to analyze the archaeological remains, the following is a description of the collection of the archaeological information.

Expedition Evidence

Starting in the summer of 2008 NOAA's Office of National Marine Sanctuaries and the *Monitor* National Marine Sanctuary (MNMS), collaborating with the agencies of Bureau of Ocean Energy Management (BOEM), North Carolina Coastal Studies Institute (CSI), and East Carolina University (ECU) began expeditions to locate and identify shipwreck targets thought to be part of the Battle of the Atlantic. The expeditions ran each summer for over a five year period and focused on an array of targets. During this first expedition season, surveys of *U-352* and *U-701* were done and provided information about the current state of each wreck site (NOAA 2008). The following year, a non-disturbance survey took place to analyze the remaining state of the archaeological remains of HMT *Bedfordshire*. In the same season, *YP-389* was discovered and an ROV was deployed to gather information about the archaeological remains (NOAA 2009). Video, photographs, and sonar images were collected and utilized from this expedition for interpretation and analysis for this project. Following these two expeditions, subsequent yearly expeditions provided large amounts of data and information about these and other wreck sites from the Battle of the Atlantic. Battle of the Atlantic expedition leader Joe Hoyt, from NOAA's MNMS, in cooperation with multiple agencies, catalogued the information collected from the research expeditions. It is with his assistance that the majority of expedition information regarding the selected vessels for this study was obtained.

Collection and use of sonar and multibeam imagery provided for primary evaluation of the archaeological remains. The sonar and multibeam images, as illustrated in Figure 4.2, provide parameters and context for analysis of the archaeological evidence. Deciphering these images allows for site integrity to be established as well as anticipating possible remaining

conversion evidence. Determining site integrity was necessary, especially to establish whether site conditions and remains are cohesive or disarticulated.

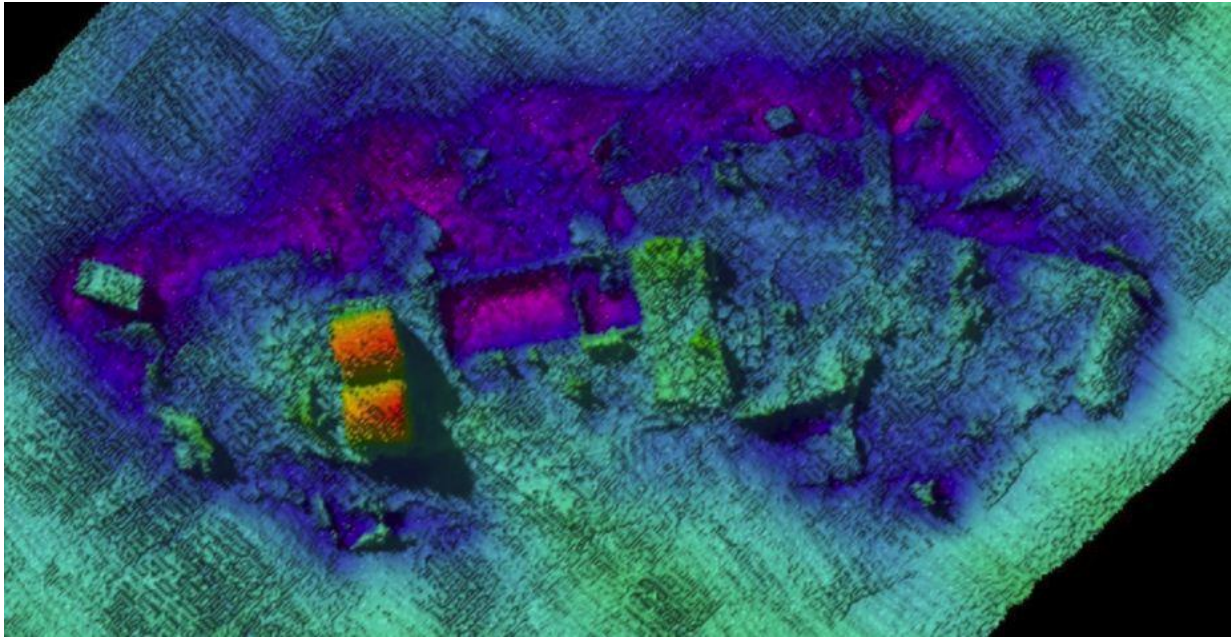


FIGURE 4.2. Multibeam imagery taken of HMS *Senateur Duhamel*, 2012. (Courtesy of NOAA Office of National Marine Sanctuaries, Silver Spring, MD.)

Ultimately, sonar and multibeam images only provide for a broad analysis of the archaeological remains, necessitating the use of other forms of imagery and archaeological tools. However, interpretation of these images still provides information regarding site extent, site relief, as well as possibly providing for a broad explanation of site formation processes, but lack the ability to accurately identify certain features. It would be necessary to utilize other tools to help identify the shapes that are presented in these images.

On site video and photography taken with use of an ROV and by divers provides excellent information regarding the integrity of the archaeological remains. Video and photographic imagery, as documented by NOAA during Battle of the Atlantic expeditions from 2008 through 2012, provide details to site conditions and features of each wreck site as it exists in its current state. This image of *YP-389* (Figure 4.3) is a mosaic created from multiple ROV

images, overlaid upon one another and stitched together to create a single, cohesive image of the remains.



FIGURE 4.3. ROV image of *YP-389*, 2009. (Courtesy of NOAA Office of National Marine Sanctuaries, Silver Spring, MD.)

In the event certain photographs were not available, other images of archaeological remains were pulled directly from video footage to verify remaining structure and integrity of the archaeological evidence. These images were then cataloged and organized to be matched with the corresponding modifications listed in the historical record. This effort would prove

invaluable to the overall analysis of the conversion process of the selected vessels. The video and photographic evidence also helped in the creation of the Rhino models, which will be discussed further.

Survey and site plan reports provide a third aspect of the available archaeological evidence. Reports from dive teams and the corresponding inked site plan provide detailed accounts and analysis of the remaining archaeological evidence. Site plans, such as the one presented in Figure 4.4, illustrate archaeological remains as currently presented on the ocean floor.

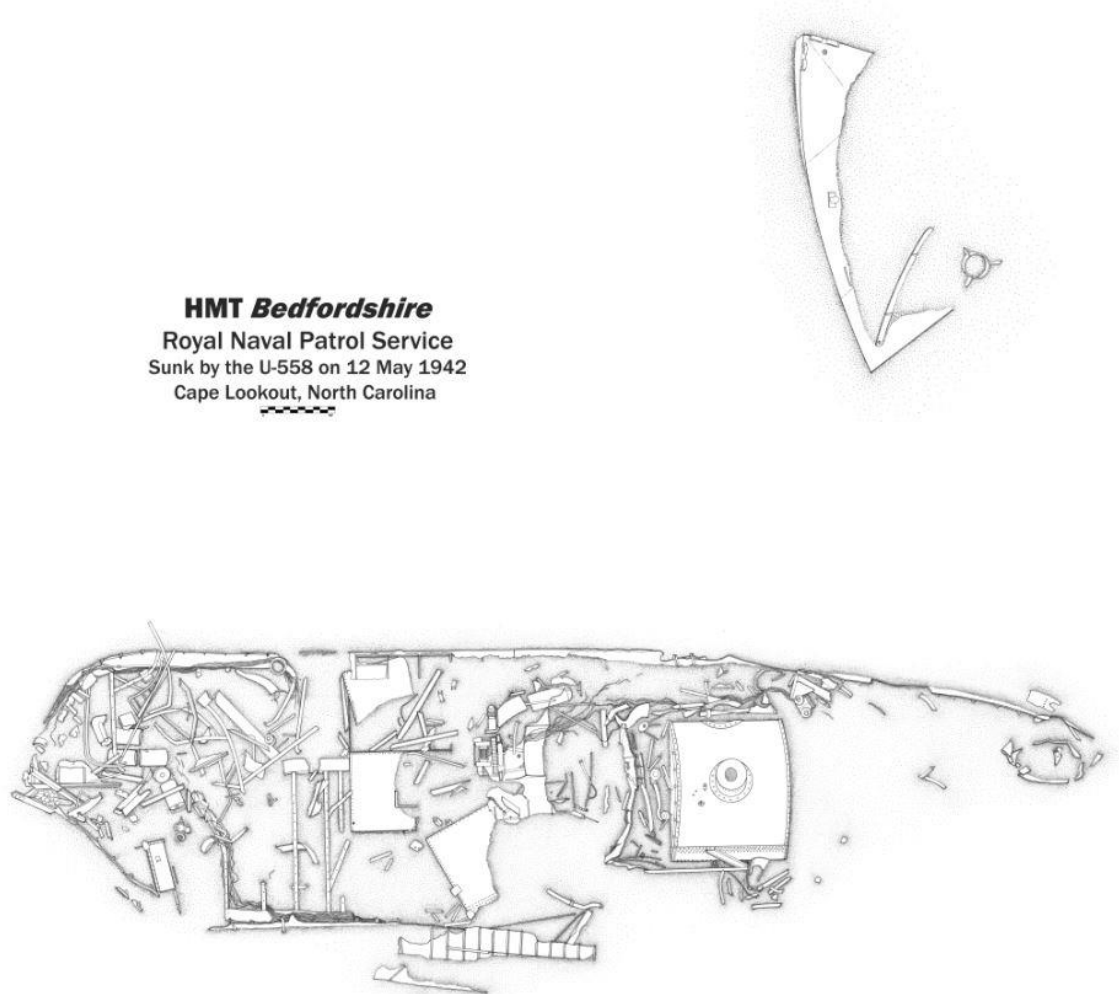


FIGURE 4.4. HMT *Bedfordshire* Site Plan, created 2010. (Courtesy of NOAA Office of National Marine Sanctuaries, Silver Spring, MD.)

Along with these inked drawings detailing the remains, individual features of ship design were identified. These features are important for final analysis, as the ability to identify them allows for determinations to be made regarding modification and conversions to each vessel.

Similar to the historical data, a second table (Table 4.2) was created to organize the available archaeological information. Information was collected and organized to maximize the use of all available information. Again, organizing data collection by objectives for each vessel helped to streamline the process. Below is a table representing the available archaeological information collected for each vessel.

Objective	Vessel		
	<u>YP-389</u>	<u>HMT <i>Bedfordshire</i></u>	<u>HMS <i>Senator Duhamel</i></u>
Sonar Imagery	X	X	X
Video/ Photographic Imagery	X	X	X
Complete Site Plans		X	

TABLE 4.2. Graph representing available archaeological information of selected vessels. (Created by author.)

Ultimately there are gaps in the available information for each vessel and acknowledgements are made for missing information and will be discussed further. However, using a combination of data available from sonar and multibeam imagery, video, photographs, and site plans, the next phase of analysis was attempted. Using this information to create three dimensional models was the next stage in determining the method for converting the selected vessels.

Analysis

Analysis of the conversion process of the selected vessels utilized a combination of historical and archaeological evidence. Further analysis was enhanced by including theories of site formation and models of technological change. To best represent this evaluation and to establish a formal order for analysis, a series of progressive images comparing the different

stages of the converted vessels was created. As mentioned previously, the Rhino models that were created focus on four aspects: original builder's design of each vessel, modifications and conversions made utilizing the historical record, vessel condition as dictated by the archaeological record, and a reconstruction of the vessel upon sinking as it relates to the archaeological and historical record. By interpreting the evidence represented in each of these models, final analysis for a model for technological change as it pertains to converting commercial craft for military use has been established. The results of this analysis are discussed in a later chapter. To reach these results, the method for creating each model for each vessel first must be discussed.

Rhinoceros 5.0 Models

The *Rhinoceros 5.0* program allows for very accurate three dimensional renderings of objects to be created. Prior to creating any model for the selected vessels, it was necessary to become familiar with aspects of the program. Multiple examples of various objects were created prior to fully embarking on creating each model. Once familiar with the modeling process, division of each model set, or grouping, and the method for creating each vessel design was outlined. As previously mentioned, there were four sets of model designs created for each vessel. Broken into four Groups, A through D, each group represented the use of different information and resulting analysis. Each grouping and the method for their creation is discussed here. It must be stated that the creation of these models was to help with the interpretation of all the information provided and each model is constructed as accurately as possible. However, there must be an understanding every detail was not available and general interpretation of specifics such as certain feature length, height, or location were made.

The first set of models, Group A, were created to represent the information provided within the historical analysis. Builder's plans, deck plans, photographs, and information pulled from ship registries were compiled to create a model of each of the selected vessels as they were originally purposed built. Group A represents the intended use function of each of the vessels. Each vessel had unique features attributed to its original plans, representative of the fishing environment and intended use and function. In many instances, the exact builder's lines were followed to recreate the outline and shape of the ship. As stated, some information was lacking for individual vessels, specifically *YP-389*, however, other resources were collected which allowed for the use of similarly built vessels to be exemplified for interpretation. The following is a description of the method used to create models for the vessels as originally built.

Prior to a feature being created for any of the vessels, it was necessary to start by building the hull structure. To create the hull design of the selected ships, builder's plans and, specifically in the instance of *HMS Senateur Duhamel*, sheer plans, were traced to create the curvature of the hull. Each line was then manipulated to fit within the design specifications, to include overall length, breadth, and depth of each vessel, as specified in the builder's plans or *Lloyd's Register of Shipping*. These lines represented the outer hull features and when completed, provide a skeleton like outline. These lines were then "lofted" to create a cohesive, singular structure. This process is represented in the figures below, displaying the curved lines (Figure 4.5) and the resulting "lofted" lines (Figure 4.6) that represent the outer hull structure.

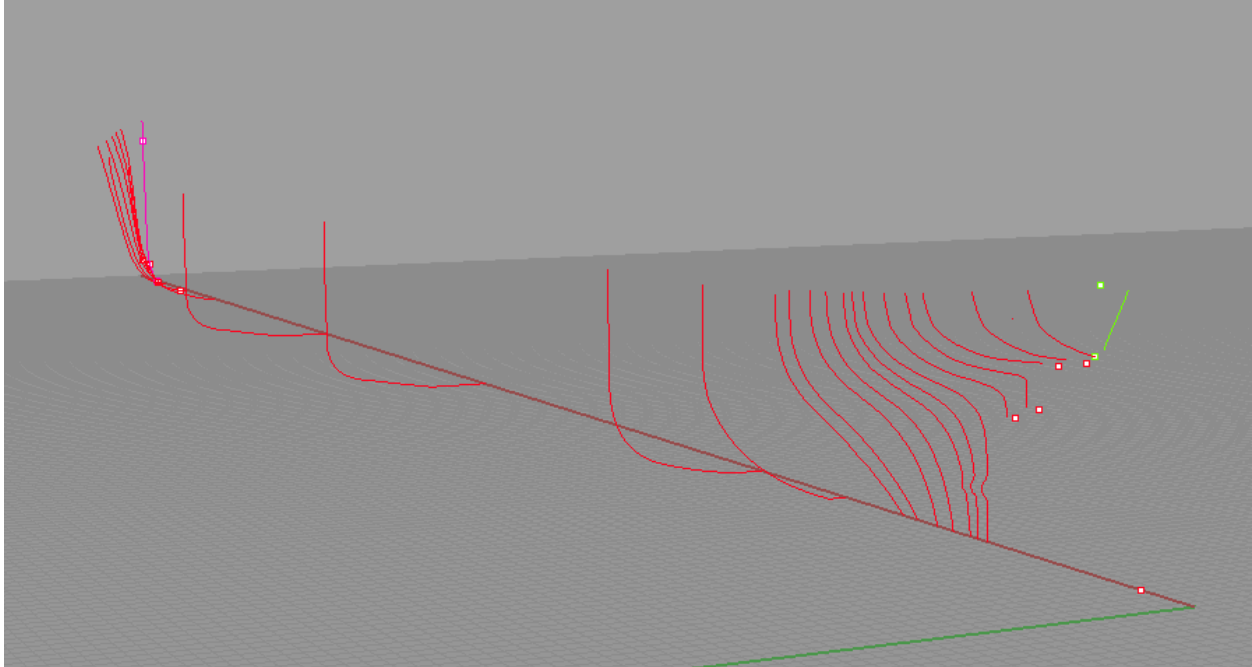


FIGURE 4.5. Outer Hull, Port side lines created for HMS *Senateur Duhamel* model. (Created by author, 2014.)

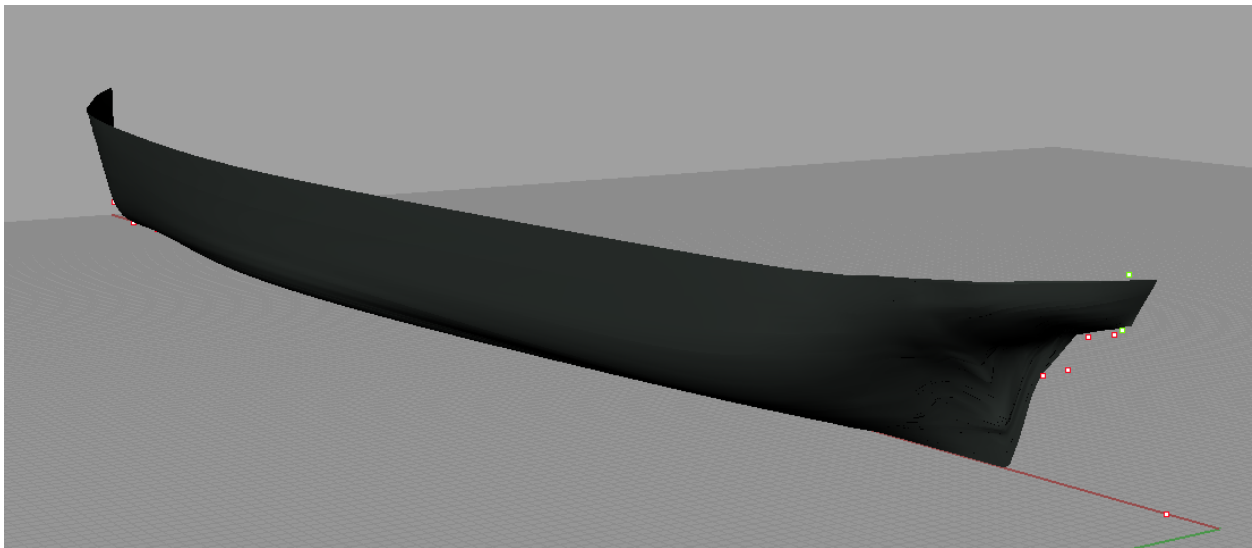


FIGURE 4.6. Outer Hull, Port side lines “lofted” for HMS *Senateur Duhamel* model. (Created by author, 2014.)

This was replicated for both port and starboard sides, ultimately creating the outer hull structure for each of the vessels.

As stated previously, information regarding the hull construction of *YP-389* and ship features was unavailable. For *YP-389*, similarly built fishing trawler plans from the time period

were used for assistance to create a representation of *Cohasset*, to reflect what it would have most likely looked like as it was originally built. Using the sheer plans and lines created from the HMS *Senateur Duhamel* model provided a base to scale the lines to the size and specifications of *Cohasset*. The lines were fit to the length and shape of *Cohasset*, as represented in the construction photos. Two of these photos used with interpreting hull and feature design are included here (Figures 4.7 and 4.8). Overall, the goal was to get the best representation of the hull design of the originally built *Cohasset*.



FIGURE 4.7. Construction of *Cohasset*, later YP-389, at Fore River Yard, Quincy, MA, 1941. (Courtesy of Hart Library.)



FIGURE 4.8. Construction of *Cohasset*, later *YP-389*, at Fore River Yard, Quincy, MA, 1941. (Courtesy of Hart Library.)

Following hull completion, main deck structures were the next features to be added to each of the models. During the conversion process, the most obvious features added to each vessel were various forms of armaments, so it was very important to make sure original features were best noted on this level of each vessel. Using archival pictures and deck plans to provide the proper information, deck features were added to the Rhino models. An example of the information used to create deck and structure features is the general arrangement plan of HMT *Bedfordshire* (Figure 4.9). Finishing the creation of Group A, stylized features were added to create identifying characteristics for each model.

The second set of Rhino models represents the modifications made according to the historical record and described as Group B. Group B models use the same hull structures and design as Group A models, as hull structures were not modified. Conversions and adaptations, specifically armament features, are highlighted in this second set of models.

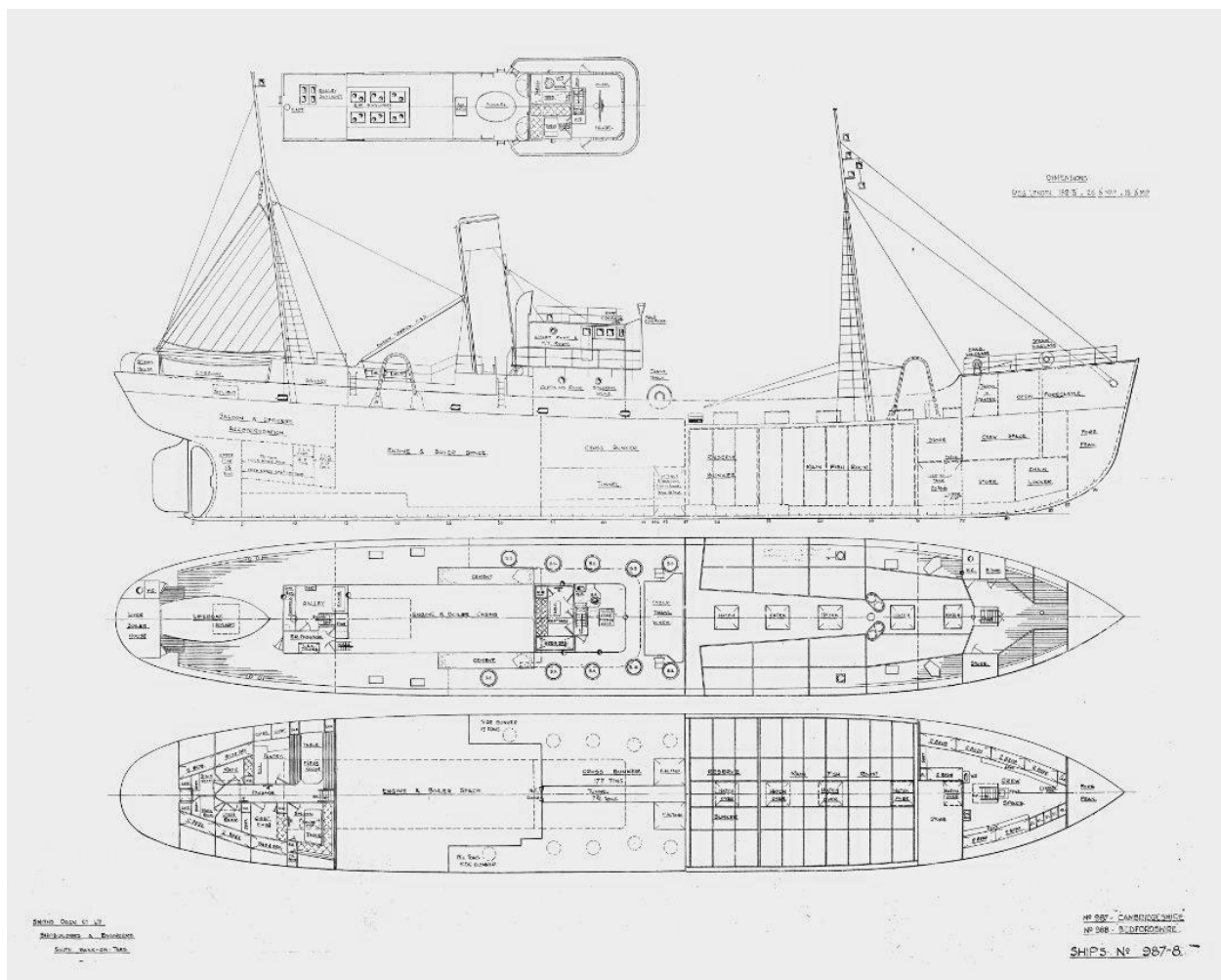


FIGURE 4.9. *Bedfordshire* deck arrangement plans, date unknown. (Courtesy of Royal Museums, Greenwich, United Kingdom.)

Conversion orders were pieced together through movement reports, dates of acquisition by the Royal Navy, listed dates when overhauls took place and the orders undertaken, and a description of armament features. Evidence located in the conversion reports as well as other historical documents detail the modifications made to each of the vessels. When primary information was not directly available, sufficient material was able to be gathered through secondary sources.

Conversion orders for *Cohasset*, for example, to become *Amc-202* prior to being re-designated as *YP-389*, provide details of exact conversion features. For HMT *Bedfordshire* and HMS *Senateur Duhamel*, however, this information was provided in secondary sources and

photographs. As an example, to determine the location of the Vickers machine guns on HMT *Bedfordshire*, the following photograph was used (Figure 4.10).



FIGURE 4.10. Vickers gun emplacement on HMT *Bedfordshire*. “Dated Oct. ’41. Gunner Storey and Featherstone on twin Vickers 0/5” M.G. Fitted in place of Lewis gun. (Courtesy of Bedfordshire Archives, United Kingdom.)

Gun emplacements, depth charge racks, depth charge throwers, and other forms of armament were developed and added to each vessel where approximately located, as specific placement was often difficult to discern. A table of adaptations was created for each vessel to manage addition or subtraction of features to the converted vessels. Internal conversion modifications were also made, as compared to Group A, and were noted in Group B models. More internal structure evidence was presented with the information for Group C however, and this would ultimately allow for more additions to be made to both Group A and Group B models.

The third set of models, identified as Group C, displays the archaeological sites as represented through sonar and multibeam imagery, photographs and video, and site plans. Converting this information into a Rhino model was more difficult than the previous model sets, however, the process in Rhino remained the same. The goal of the creation of Group C was to get a visual representation of the remains as evidenced more than sixty years after the wrecking events, as opposed to models in Group A and B. Model Group C for the vessels include site integrity as well as probable identification of feature remains. Again, evidence necessary to produce a representation of the archaeological remains was different for each vessel so the manner of replicating each site also differed.

For HMT *Bedfordshire*, there was a site plan created during the NOAA Battle of Atlantic expedition of 2010, as seen previously in Figure 4.4. Using this as a guide as well as photos pulled from video created during the same expedition, certain features could be identified and an archaeological site created. With *YP-389*, video and photo mosaics were the most important pieces of information to recreate a representation of the archaeological remains. There was not a site plan created for *YP-389*, however, video imagery provided for a great many features to be identified. Video stills, such as in Figure 4.11, helped to uncover more information about construction features of *YP-389* and could then be represented in the original, Group A, and converted, Group B, models. Features such as frames, boilers, engines, coal bunkers, and tunnels were all discovered within the archaeological remains and were then represented in the other model groups. It was necessary to continue working on all models throughout the process, as information uncovered for one model would need to be represented in others.



FIGURE 4.11. Starboard side displaying frames and double frames at turn of the bilge, 2009. (Courtesy of NOAA.)

Creating the models for Group C followed a similar process as Group A and Group B. Features were added based on best interpretations of the available information. Group C models do not include, for the most part, extraneous debris features that were unable to be identified. It is not a complete representation of the entire site plan, as in the case of HMT *Bedfordshire*, or representative of all the features photographed of each vessel. The main obstacle with recreating each model was many of the photos provided little context to the location of features on the site. For HMS *Senateur Duhamel*, interpreting the photographs and the location of objects proved to be very difficult as there was very limited evidence to determine where exactly on the site these images were taken. Again, as a result, the models of Group C are based on best interpretations of the available information.

The final set of models, Group D, are models created to identify the culmination of the previous three model groups. The focus of this model grouping was to reconstruct the vessel showing the original design and the modification evidence as it is reflected in the archaeological record. The models in Group D are presented in a manner that demonstrates the different features of each of the previous model groupings. Each model grouping for each vessel is utilized within this final Rhino model. By creating this last set of models, interpretation and analysis of the modification process and technological change could be completed.

Comparing the evidence produced following the creation of each model grouping was the necessary next step for the evaluation of conversion and modification processes of the selected vessels. As stated, model Group D represents the results of all three previous phases in the life of each vessel. Comparing the evidence from Group A, B, and C within model D, an interpretation of the process of conversion methods and technological change is identified. Following a description of each model group, the table below (Table 4.3) illustrates the representations of each model group design.

	Description	Intention	Sources
Group A	Original Design	Illustrate original purpose of vessel, as originally built.	Builder's plans, sheer plans, construction photographs.
Group B	Converted Design	Illustrate adaptations made for military use.	Conversion orders, descriptions, photographs.
Group C	Archaeological Remains	Illustrate the remaining archaeological remains of the vessels.	Site plans, multibeam, sonar, ROV, and video images
Group D	Life Process of Vessel	Comparing the three stages of the life of the vessels; original build, conversion, and archaeological remains.	Model Groups A - C

TABLE 4.3. Graph representing describing each model group, as well as the intention of the model and the sources used to complete the model for each vessel. (Created by author.)

In association with theoretical precepts, comparing differences between each group and ultimately within Group D, final analysis of conversion methods could be determined. The

differences observed in the archaeological data compared with the historical data are critical to analysis. The evidence could represent an alternative to the prescribed conversion plan or demonstrate changes made due to other human behaviors. This discussion is outlined in the final analysis chapter.

Conclusion

Using a broad range of historical and archaeological information and synthesizing the data into the creation of Rhino model groups allowed for methods for technological change to be evaluated. Connecting previous examples of historic conversion processes helped to build an understanding of possible conversion methods for World War Two era fishing trawlers. Theories of site formation assisted in the interpretation of the data evidenced in the archaeological record of the selected vessels. Evidence and information available, and equally unavailable, is noted throughout the research process, as a missing feature in the archaeological record of a vessel does not necessarily mean it was never there. This aspect must be evaluated as a possible result of some human interaction or decision.

Recommendations for the evidence of human interactions and behavior are offered following these evaluations. This study offers a guideline for evaluating converted ships used for military use and the process in which modifications took place. By following a structured methodology, a determination regarding human behavior and methods for technological change is concluded. Addressed in the following chapters are the results and analysis of historical and archaeological evidence that ultimately allow for final determination of human behavior and interaction pertaining to conversion methods and models of technological change.

CHAPTER FIVE: CASE STUDIES IN ADAPTATION AND TRANSFORMATION

Introduction

The adaptation of various vessels for military use throughout history has been discussed in Chapter Two. The adaptation and conversion of commercial craft for military use was indeed quite prevalent prior to and during World War Two. Vessels of all shapes and design were adapted and repurposed to aid in this war effort, especially during the early stages of the war when industry had yet to be fully developed and the necessary fighting craft were unavailable. Case studies of certain vessels were created in order to better understand the decision process for converting commercial ships. The following three vessels, HMS *Senateur Duhamel*, HMT *Bedfordshire*, and YP-389, were all commercial fishing trawlers prior to World War Two. At various stages during the war, each vessel would undergo a conversion process which altered their purpose and function. This chapter details evidence of three distinct phases in the life of the selected vessels. This information includes original ship design and function as commercial vessels, the conversion process and new military purpose, and the archaeological remains following the wrecking event. Analyzing the conversion process of each vessel requires insight into each stage in the life of each vessel. Complementing the analysis of each vessel, Rhinoceros 5.0 (Rhino) three dimensional (3D) models provide visual representations of original design, conversion aspects, and interpretations of archaeological remains. Arranged chronologically by year of build, and beginning with the oldest, HMS *Senateur Duhamel*, the life of each vessel is illustrated, detailing the original design and purpose, conversion and adaptation process, and the archaeological remains.

HMS *Senateur Duhamel*

Senateur Duhamel was built in 1927 by Hall Russell and Company in Aberdeen, Scotland, and is the oldest and largest of the selected vessels. Sold to a French fishing company, Les Pecheries de Fecamp, the first listing of *Senateur Duhamel* in *Lloyd's Register of Shipping* is from 1928 – 1929, a year after it was launched. *Senateur Duhamel* was listed with an overall length of 192.3 feet, a breadth of 31.1 feet, depth of 16.1 feet, and molded depth of 17.4 feet. Grossing 913 tons, it was one of the larger trawlers to be used commercially. The picture below (Figure 5.1) is of *Senateur Duhamel* at work and provides an example of the original design and purpose.

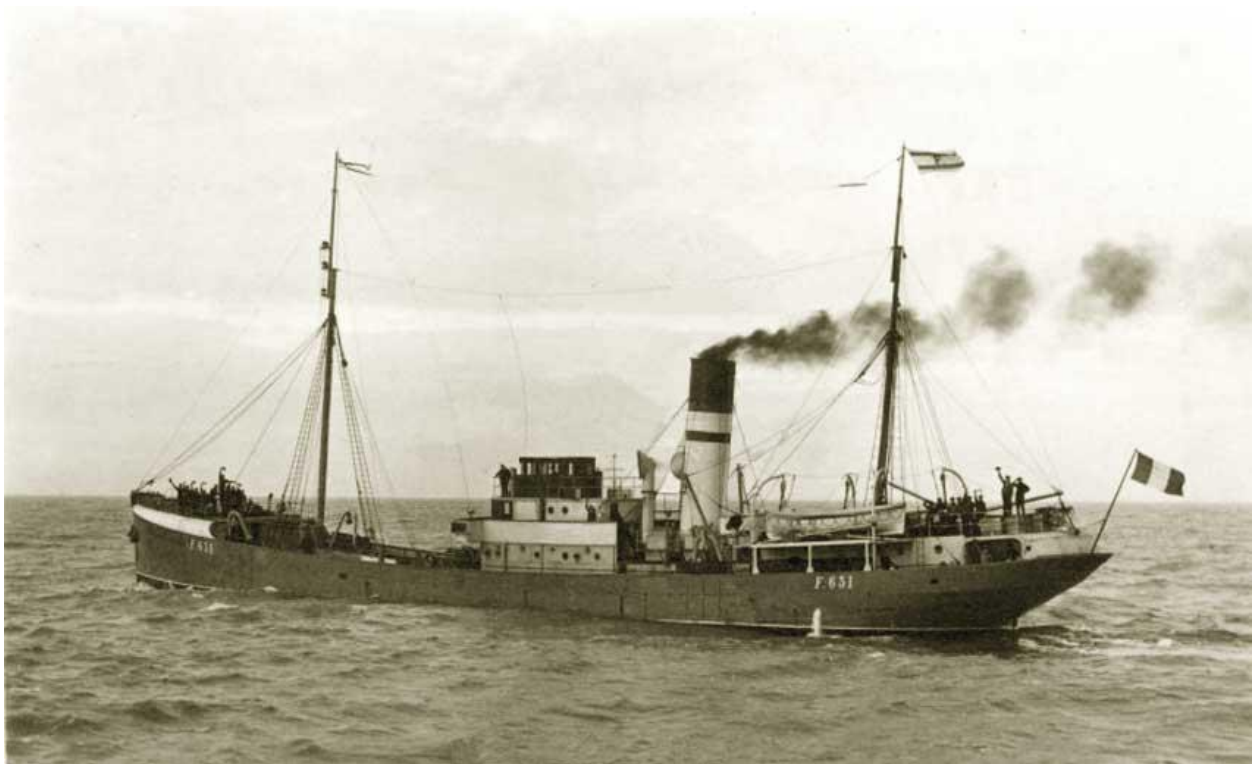


FIGURE 5.1. *Senateur Duhamel* and crew at work, date unknown. (Courtesy of wrecksite.eu.)

A triple expansion coal fired engine, with two boilers, provided 149 nominal horse power (Lloyd's Register of Shipping 1928/1929; Aberdeen Built Ships 2014). The picture below

(Figure 5.2) is the general deck arrangement of *Senateur Duhamel*, illustrating certain features and their locations on the vessel in relation to one another.

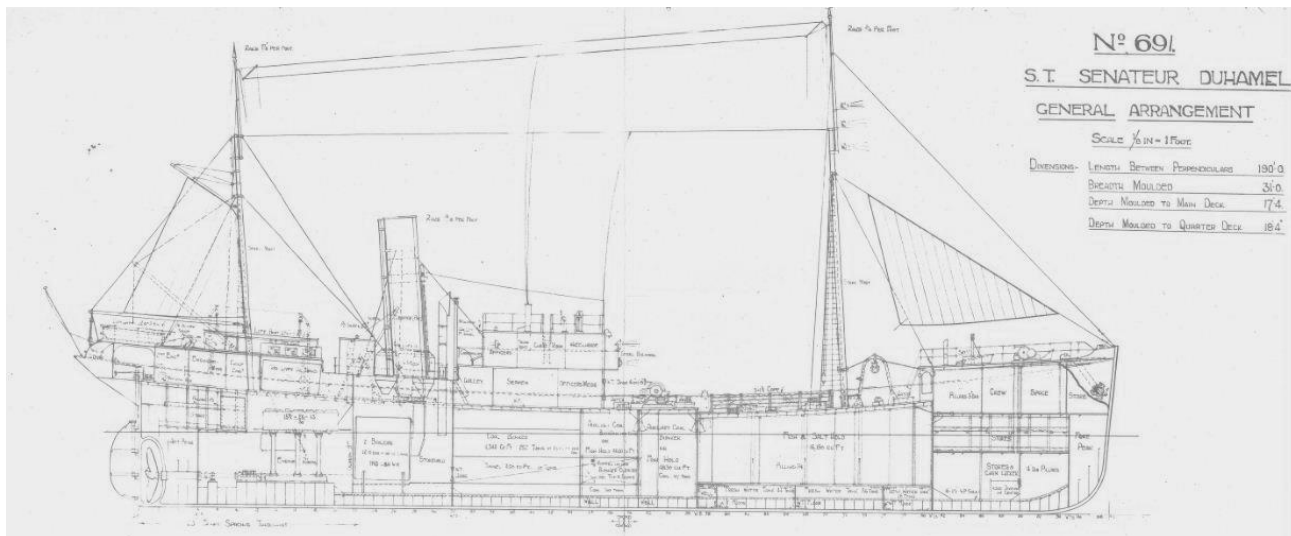


FIGURE 5.2. Deck arrangement of *Senateur Duhamel*, date unknown. (Courtesy of Aberdeen Maritime Museum.)

Further information regarding the design of *Senateur Duhamel* is provided within the boat deck, upper deck and, lower deck arrangement drawings (Figure 5.3), exhibiting both exterior and interior design features for *Senateur Duhamel* as it was originally built.

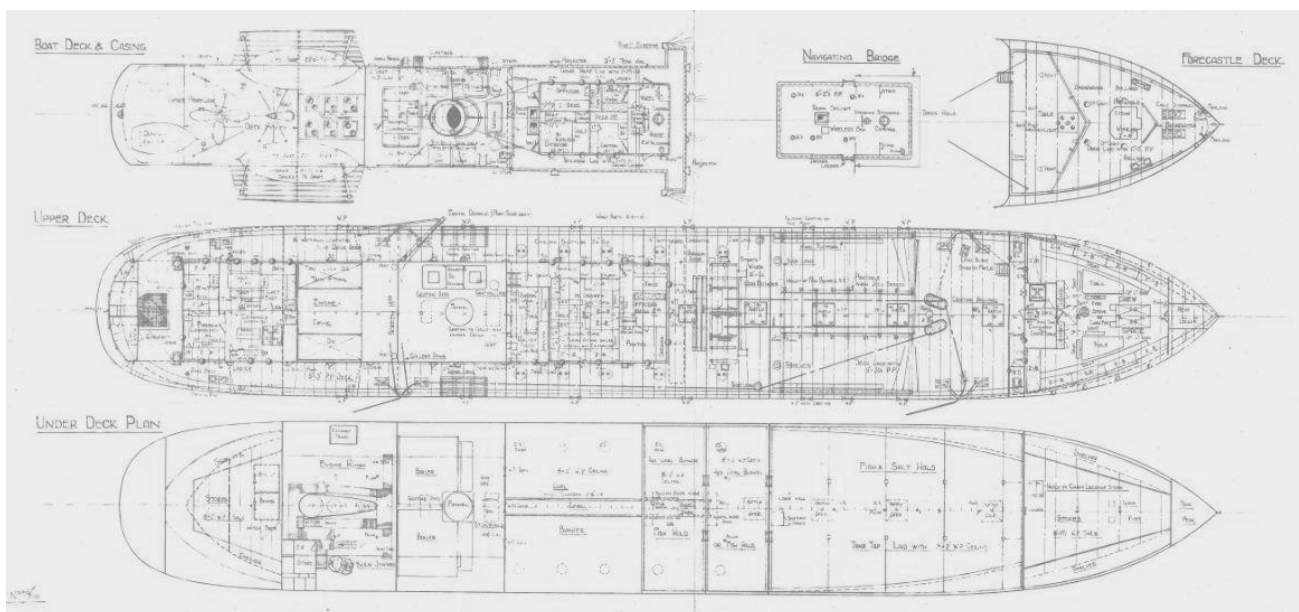


FIGURE 5.3. Lower deck arrangement of *Senateur Duhamel*, date unknown. (Courtesy of Aberdeen Maritime Museum.)

It is important to understand the location of certain features as they pertain to the original design, as these features are also represented in the converted vessel as well as in the archaeological evidence.

Using this photo along with deck arrangement images and *Lloyd's Register of Shipping* information, an original Rhino model could be created. Model Group A models represents original design features as interpreted using this information. The following pictures (Figures 5.4 through 5.6) illustrate the recreation of the original design of *Senateur Duhamel*. They are representative of the original design and are as accurately recreated with the available information. Each image offers a different view of *Senateur Duhamel* displaying features as it was originally purpose built. A note to all created model images, rigging features are not displayed because of inconsistent available information.

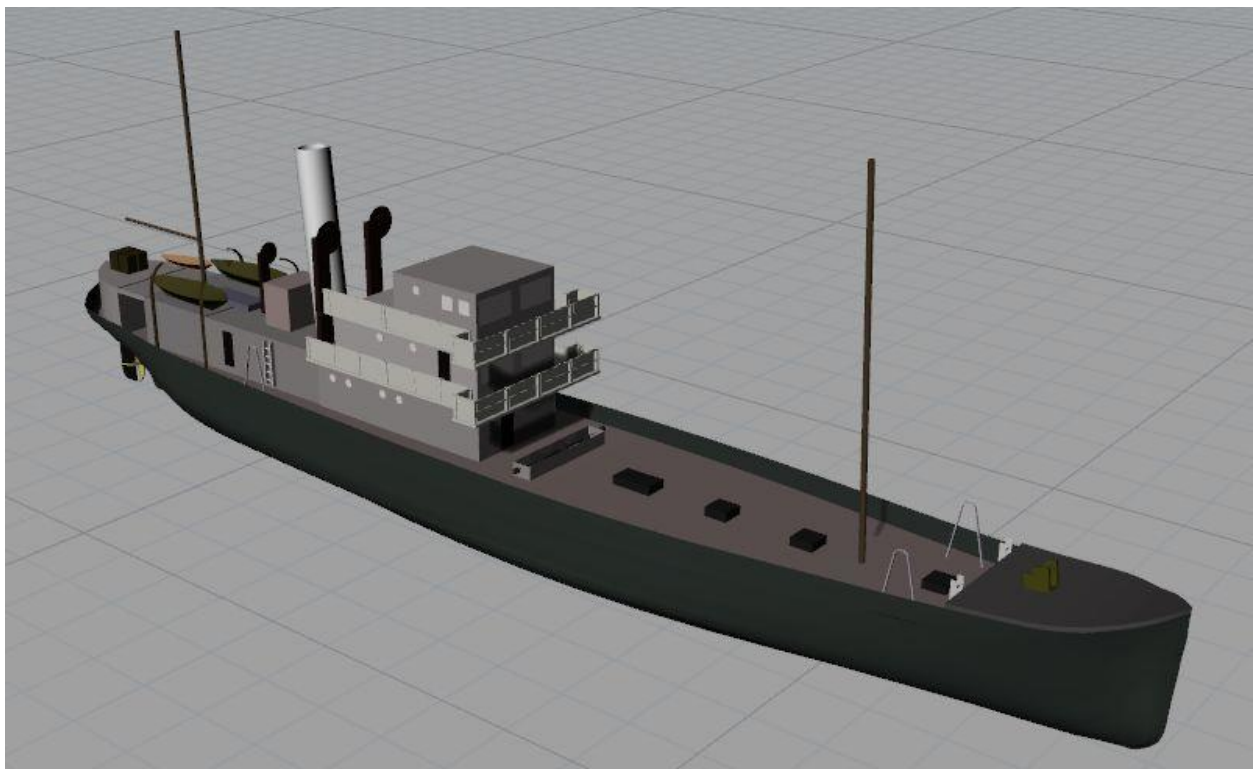


FIGURE 5.4. Model Group A of *Senateur Duhamel*, aerial view from starboard side. (Created by author, 2014.)

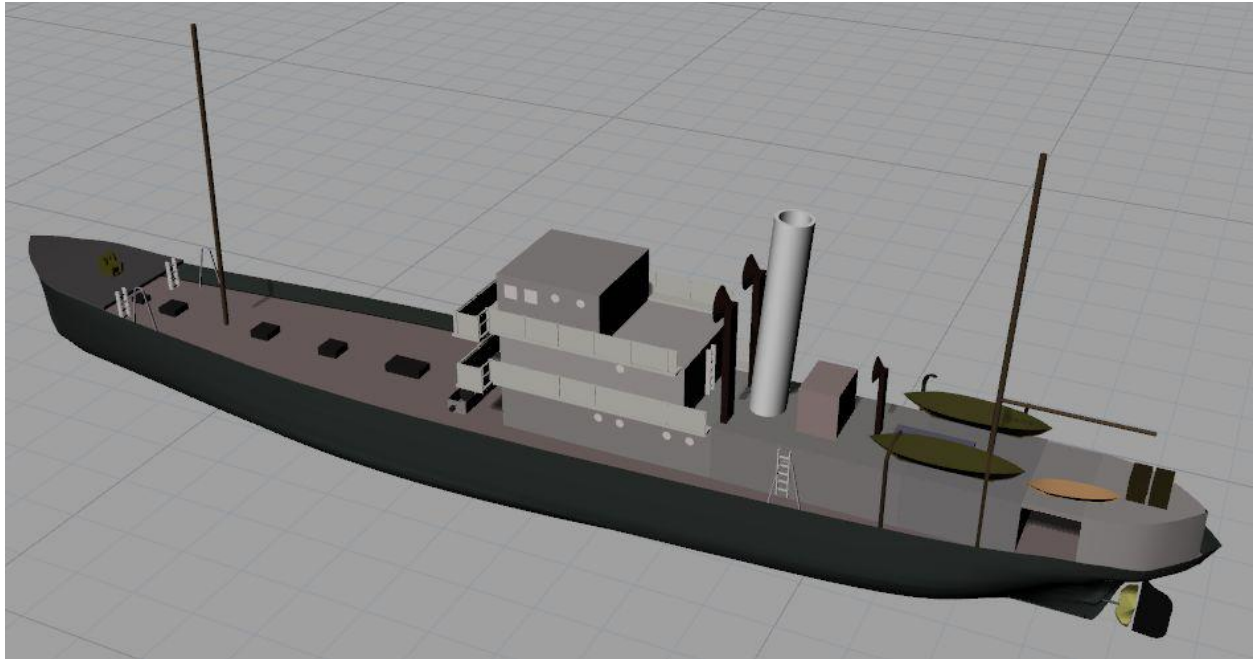


FIGURE 5.5. Model Group A of *Senator Duhamel*, aerial view from port side. (Created by author, 2014.)

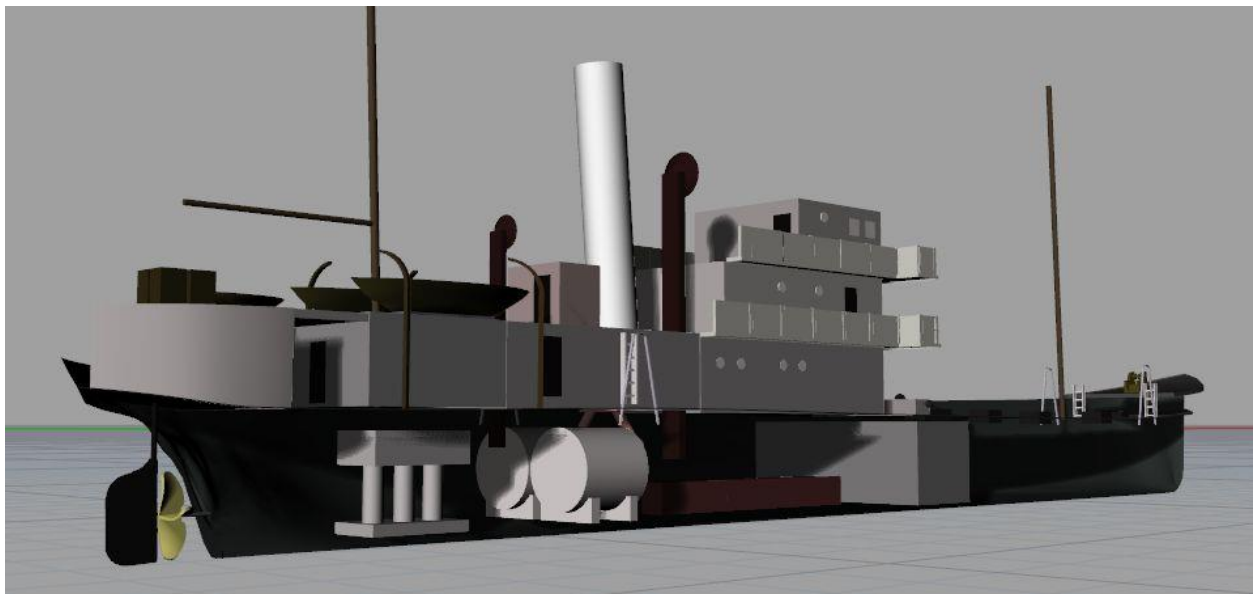


FIGURE 5.6. Model Group A of *Senator Duhamel*, starboard hull removed to expose engine and boilers. (Created by author, 2014.)

In this last illustration of the Rhino model, the engine, boilers, as well as tunnel and reserve coal bunker are seen, starting aft and moving forward. These features will ultimately be represented in other models as there is evidence of their existence.

The working life of *Senateur Duhamel* is not well documented. Through *Lloyd's Register of Shipping* yearly documentation to 1940, the vessel remained in the possession of Les Pecheries de Fecamp as a commercial fishing vessel. Based in Fecamp, France, *Senateur Duhamel* received yearly rating inspections but with no change to construction or engine facilities. This would change by the end of 1940. Still used at the time as a fishing vessel, *Senateur Duhamel* was seized by the Royal Navy and converted for anti-submarine patrol on 28 December 1940 (Toghill 2004:434). *Senateur Duhamel's* sister ship, *Joseph Duhamel*, was also seized about the same time, 26 December 1940, as both were operating out of the same area in France (Lenton 1998:396). Exact details as to the acquisition of both of these vessels are not known but it would be within the next few months that *Senateur Duhamel* would undergo a conversion process to change from commercial to military use.

Conversion orders are not specified, nor exactly where the conversions were made. However, *Senateur Duhamel* would be commissioned as HMS *Senateur Duhamel* and would fly the pennant number FY 327. According to the "Port Movement Summary" (Figure 5.7), acquired from the National Museum of the Royal Navy, the locations of HMS *Senateur Duhamel's* main movements were documented. Making Belfast, Northern Ireland, the main operational base by December, 1941, HMS *Senateur Duhamel* would ultimately see little action until being transferred to American waters in February, 1942, along with other British converted trawlers.

The conversions made to HMS *Senateur Duhamel* are pieced together through numerous sources. According to the unpublished correspondence of Mr. Norman Salmon to Mr. James R.

Reedy, Jr., dated 17 March 1994, HMS *Senateur Duhamel* was outfitted with,

60 odd depth charges with two throwers, one port one starboard near the stern, two rails with depth charges to drop over the stern, a four-inch gun, Hotchkiss machine guns each side of the bridge, two aircraft parachutes with 400 feet of wire attached from two containers on top of bridge housing, and last but not least a piece of equipment that can only be described as archaic, a “Holman Projector” that was mounted on a platform rather like a small boxing ring just aft of the funnel (Salmon 1994).

Corroborating the statement of Mr. Norman Salmon, are pictures he provided to Mr. James R.

Reedy, Jr. showing two views of HMS *Senateur Duhamel* as a converted vessel. The two pictures (Figures 5.8 and 5.9) below are from Mr. Norman Salmon and were included in the same unpublished correspondence.



FIGURE 5.8. HMS *Senateur Duhamel* displaying post conversion armament, date unknown. (Courtesy of James Reedy, Jr.)



FIGURE 5.9. Starboard view of HMS *Senateur Duhamel* post conversion, date unknown. (Courtesy of James Reedy, Jr.)

These pictures clearly show evidence of the deck gun as well as the depth charge rails located at the stern. These photographs, corroborating the deck gun installation and depth charges, are referenced in other sources (Gentile 1992:172; Toghil 2004:434; Tony 2011). Using the information provided, the Rhino model for Group B, representing the conversion process, could be created for HMS *Senateur Duhamel*.

The following pictures were created from the Rhino model to detail the converted aspects of HMS *Senateur Duhamel*. These are part of model Group B and specifically of the military conversions made to HMS *Senateur Duhamel*. Beginning with the first image (Figure 5.10) the conversions are seen from the starboard vantage point. Specific conversion features are identified

in the second image (Figure 5.11), detailing the armament added to HMS *Senateur Duhamel* as part of the conversion process.

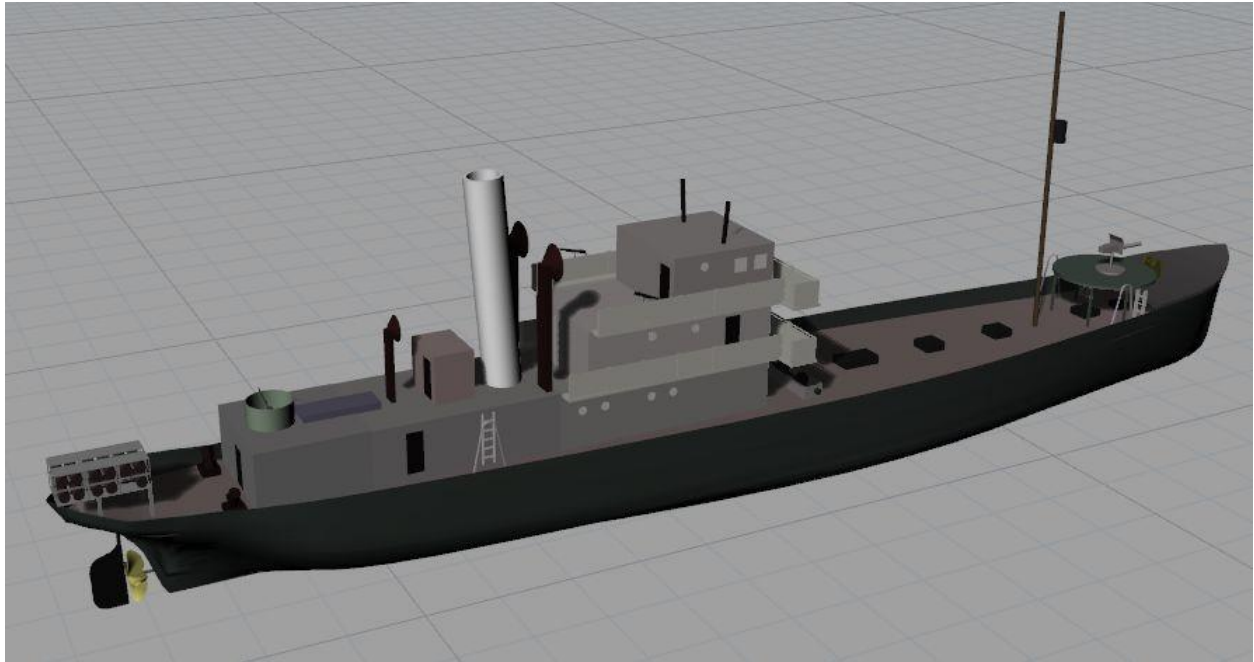


FIGURE 5.10. Starboard view of HMS *Senateur Duhamel* and the converted features. (Created by author, 2014.)

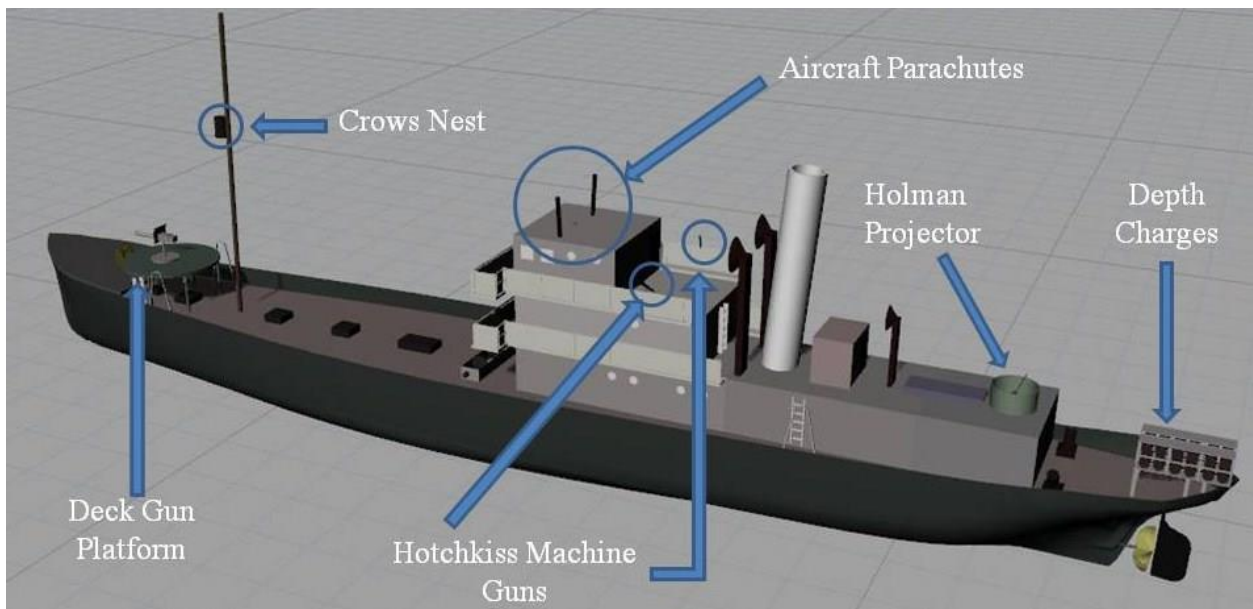


FIGURE 5.11. Port side view of HMS *Senateur Duhamel* displaying converted features. (Created by author, 2014.)

The most evident of the converted military adaptations were at the bow and at the stern. The deck gun is on a raised platform at the bow (Figure 5.12) can easily be identified in the photographic evidence.

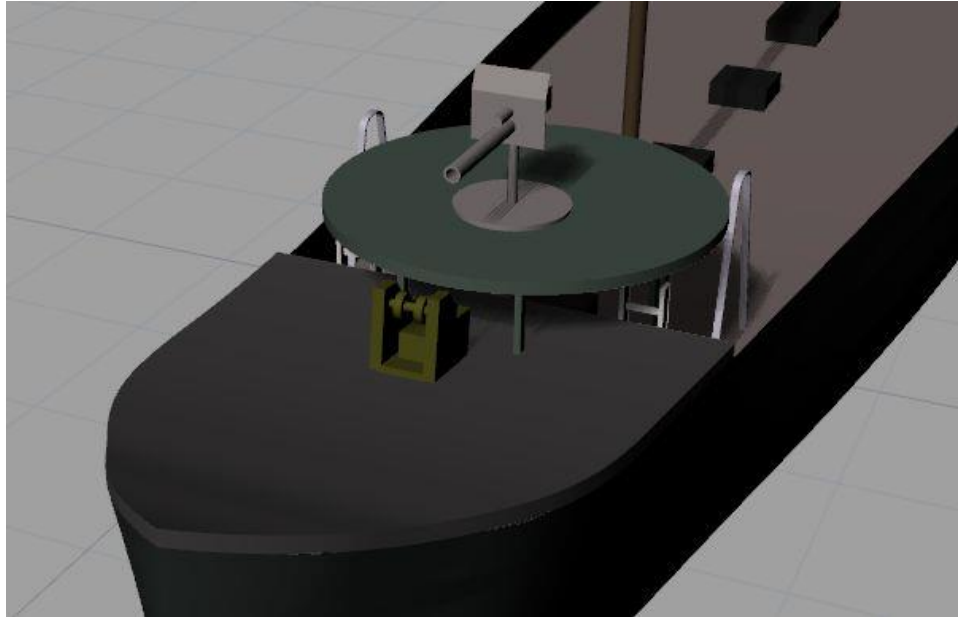


FIGURE 5.12. Bow of HMS *Senateur Duhamel* displaying the raised forecastle, deck gun, deck gun platform as well as a windlass. (Created by author, 2014.)

At the stern, two depth charge rails and the two depth charge throwers, one on both the port and starboard sides, are placed according to the photographic evidence as well as Mr. Norman Salmon's correspondence. In Figure 5.13, these features are identified as well as the Holman projector, with its location above the engine casing.

The location and placement of these features, specifically the depth charge throwers and Holman projector, are based on evidence from different sources. The Holman projector was placed, according to Mr. Norman Salmon, toward the stern, as well as according to the general ship plans of converted trawler-class types as detailed in Figure 4.1. The Holman projector and aircraft parachutes were two forms of anti-aircraft technology. The Holman projector was essentially a grenade launcher and the aircraft parachutes shot cable out in an effort to bring down aircraft. The success of these adaptations is not known.

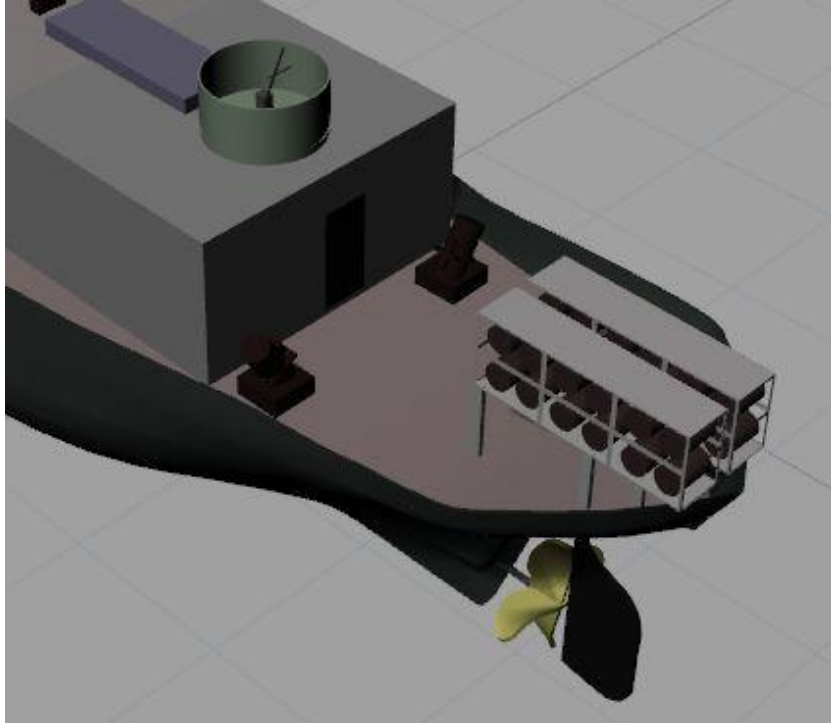


FIGURE 5.13. Stern section of HMS *Senateur Duhamel* showing two depth charge rails, two depth charge throwers, and the Holman projector. (Created by author, 2014.)

The depth charge throwers, as described by Mr. Norman Salmon, were also located on HMT *Bedfordshire* and with photographic evidence from this, a similar location was used for their placement. Information about HMT *Bedfordshire* will be discussed later in this chapter.

With the placement of the military equipment, there was a need for a removal of features to accommodate this space. Without a specific record of the conversion process, it is difficult to determine exact features that were removed, replaced, or altered, as a result of the addition of military equipment. However, there is a capacity, by using the Rhino model, to determine features that were altered due to the placement of these new features. For example, with the placement of the Holman projector, the mizzen mast was removed to make space. Another example of transformation includes a boom added to the foremast, previously not part of the original design. This is evident through photographic evidence as well as determined through the modeling process.

Other features were altered as part of the conversion process. With the addition of the depth charge rails and depth charge throwers, alterations were made to the stern section of the vessel. As best can be discerned through the modeling process, the Engineer's or Fireman's quarters, as illustrated in Figure 5.2, were altered due to the need for space. The awning that went between this space and the Engine Casing also was removed to make space for the depth charge rails and throwers. Information regarding the alteration of these spaces to make space for the military equipment, as well as making for accommodations for the previous space usage, is not available. The life boats and dinghy also were either removed entirely or moved to a different section of the vessel, to make space for the depth charge rails, depth charge throwers, and especially the Holman projector. The original locations of the dinghy and life boats were placed exactly in this area but upon transformation, were either removed or placed in an area that could not be determined. As a result of the inability to locate a place for them, they have been removed from the Rhino model.

At the bow of the vessel is the addition of the four- inch deck gun and platform. Specifications are not detailed as to the construction or the installation of this vital military addition, but it is evident from the photographic evidence (Figures 5.8 and 5.9) that the gun was placed on a raised platform. In Figure 5.2 there is structural design of original space usage under the forecastle, designed for crew space. This space could also be used for the same purpose following construction of the deck gun platform and the gun itself. Further examination of this aspect, as well as other transformations, will be presented in the next chapter.

Other evidence of the conversion process is difficult to determine using the available information. According to Mr. Norman Salmon, the addition of two Hotchkiss machine guns and the aircraft parachutes to the armament of HMS *Senateur Duhamel* was completed, however,

their exact location is not precisely determined. Also, with their addition, it is not understood if other features were removed or replaced. With no precise record, it is difficult to determine the exact manner in which these objects were added to the converted vessel. Further discussion of the overall conversion process will be presented in the next chapter.

HMS *Senateur Duhamel* would finish 1941 working for the Royal Navy in anti-submarine patrol duty. In February, 1942, HMS *Senateur Duhamel* would be part of a contingent to include 23 other converted fishing trawlers to assist the United States Navy along the east coast of the United States as German U-boats began to ramp up operations there. Following its transfer to American waters and a time of refitting in New York City, it would operate out of Morehead City, North Carolina with HMT *Bedfordshire* and help perform convoy duties. On 14 April 1942, HMS *Senateur Duhamel* was ordered to help tow in and support the recently torpedoed *Harry F. Sinclair, Jr.* The tanker had been torpedoed four days earlier and had lost a significant amount of its crew, but still managed to make it to Morehead City, North Carolina and eventually up to Baltimore, Maryland (Hickam 1989:162; Tony 2011). HMS *Senateur Duhamel* would return to anti-submarine patrol duty after leaving *Harry F. Sinclair, Jr.* at the operations base in Morehead City. It would continue to patrol its section of water, on the lookout for German U-boats.

The sinking of HMS *Senateur Duhamel* was a result of human error. A few weeks following the attack on *Harry F. Sinclair, Jr.*, on 6 May 1942, HMS *Senateur Duhamel* was on patrol near Beaufort Inlet, North Carolina, amidst a slight fog. In the haze the crew spotted another ship, USS *Semmes*, about a mile away and flashed the message “what ship?” The light temporarily blinded the crew of USS *Semmes* and before a reply was sent, the bow of the ship smashed into HMS *Senateur Duhamel*. After the collision, USS *Semmes* backed away and USS

Roper, a destroyer, was called in for assistance (Hickam 1989:201; Tony 2011). With the two ships apart, HMS *Senateur Duhamel* started to sink and was eventually lost entirely. However, the entire crew survived, uninjured (Eastern Sea Frontier 1942a). Unfortunately, which side of the ship HMS *Senateur Duhamel* was struck on was not recorded. HMS *Senateur Duhamel* sunk in only 65 feet of water, allowing for part of its mast to stick out of the water (Gentile 1992:174). This last aspect would influence future integrity of the wreck site.

Official study of the remains of HMS *Senateur Duhamel* would not take place until the National Oceanic and Atmospheric Association (NOAA) Office of National Marine Sanctuaries and *Monitor* National Marine Sanctuary (MNMS) collaborated with the Bureau of Ocean Energy Management (BOEM), North Carolina Coastal Studies Institute (CSI), and East Carolina University (ECU) to survey and photograph the wreck site. During the 2012 Battle of the Atlantic Expedition, multibeam survey data was collected along with photographs from a single dive, helping to piece together information to determine remaining features. In the summer of 2012, the first piece of information was made available following a successful multibeam survey. In the multibeam image (Figure 4.2) site integrity could be broadly determined following analysis of this data. Site extents and relief could be concluded from this imagery, however, individual shape features and structures were difficult to positively identify. Large features, such as the boilers, could be determined, with the ability to locate them on the site but providing little information about their integrity or the surrounding features. It would be necessary to utilize images taken from the dive to help identify certain remaining features.

The dive took place on 29 July 2012, with individuals from ECU, CSI, and MNMS to a depth of 65 feet. Diving conditions were less than ideal, as are reflected in the quality of the photographs, but certain features were able to be identified. Figures 5.14 through 5.18 show

individual features able to be identified throughout the dive. These features include boilers, the tunnel, a possible deck gun mount, the stem post, and what could either be a winch or windlass.



FIGURE 5.14. One of the boilers from HMS *Senateur Duhamel*, 29 July 2012. (Courtesy of John McCord, CSI.)



FIGURE 5.15. Tunnel remains of HMS *Senateur Duhamel*, 29 July 2012. (Courtesy of John McCord, CSI.)

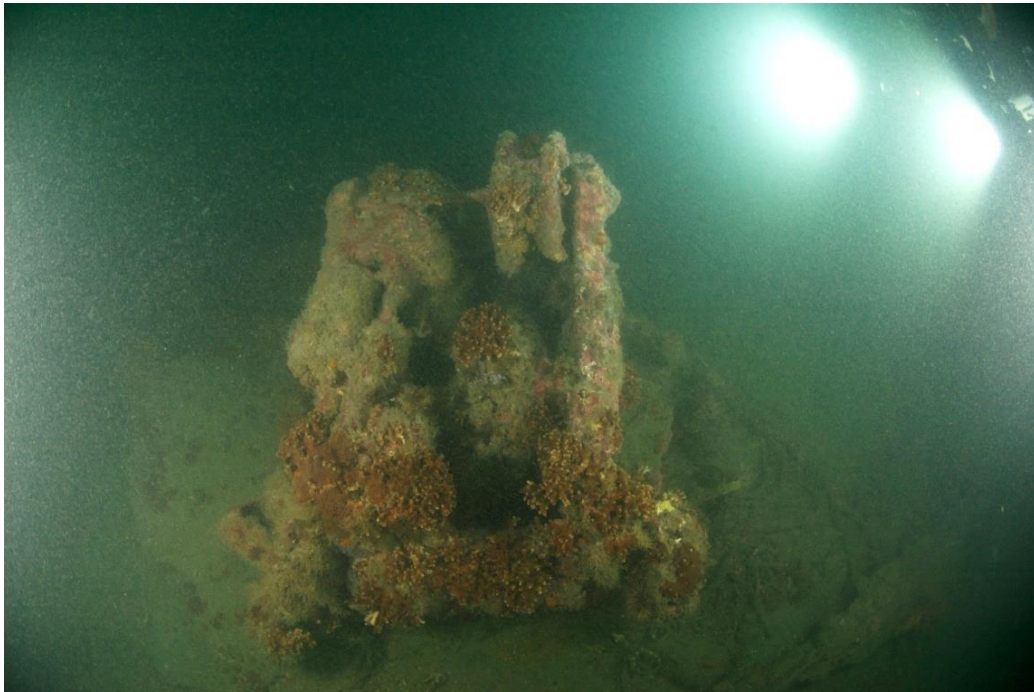


FIGURE 5.16. Windlass or winch of HMS *Senateur Duhamel*, 29 July 2012. (Courtesy of John McCord, CSI.)



FIGURE 5.17. Stem post of HMS *Senateur Duhamel*, 29 July 2012. (Courtesy of John McCord, CSI.)



FIGURE 5.18. Possible deck gun feature on HMS *Senateur Duhamel*, 29 July 2012. (Courtesy of John McCord, CSI.)

Unfortunately, the collection of photographs looked at individually do not provide context to the larger wreck site remains. The direction and course of the dive could be discerned using the time signature of each photograph and by positively identifying objects. Photographs of the boiler relatively early in the course of the dive suggest it began around the stern and then worked forward, turning around at the stem post later in the dive. In Figure 5.19 features of the site, using the multibeam data as a base for overall site reference, are identified using the photographs taken from the dive on 29 July 2012. By determining the direction of the dive, features could be identified in the multibeam data that could match with the photographs taken by Joe Hoyt. With the ability to put together information regarding features of the remaining archaeological site, the third Rhino model could be created.

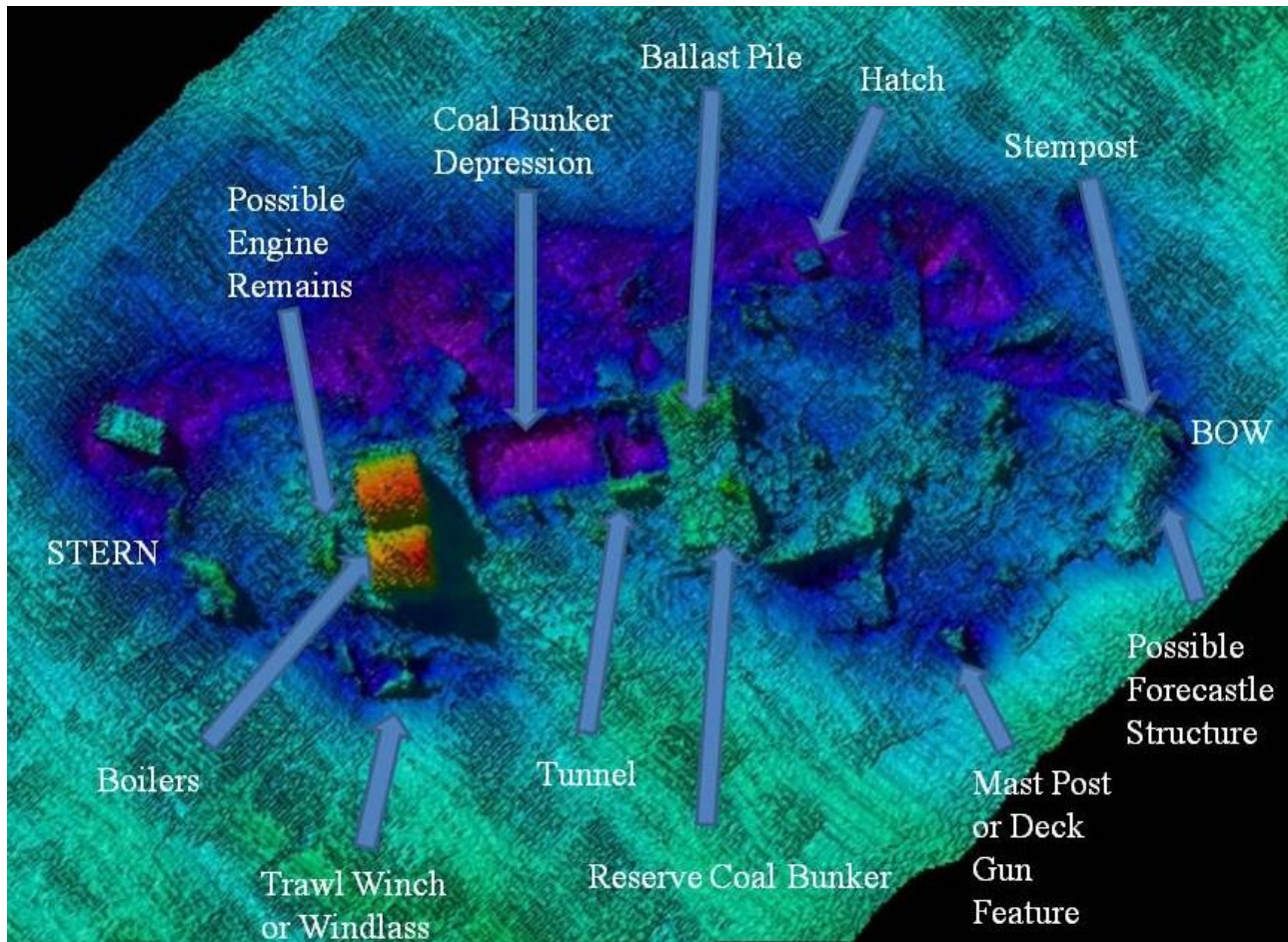


FIGURE 5.19. Multibeam data combined with dive photography for site identification of HMS *Senateur Duhamel*. (Created by author, 2014.)

The third Rhino model, Group C, represents the remaining features within the archaeological record of HMS *Senateur Duhamel*. The creation of this Rhino model focused on main features that could be identified. There is an abundance of material remains that could not be positively identified and as a result was not included in the Rhino model. Figure 5.20 illustrates the site remains as looking from stern forward. Identified features are then described using the same image, corresponding with information from the multibeam image (Figure 5.21).

Further detail of the site is seen with a closer examination of the boiler and amidships area as detailed in Figure 5.22.

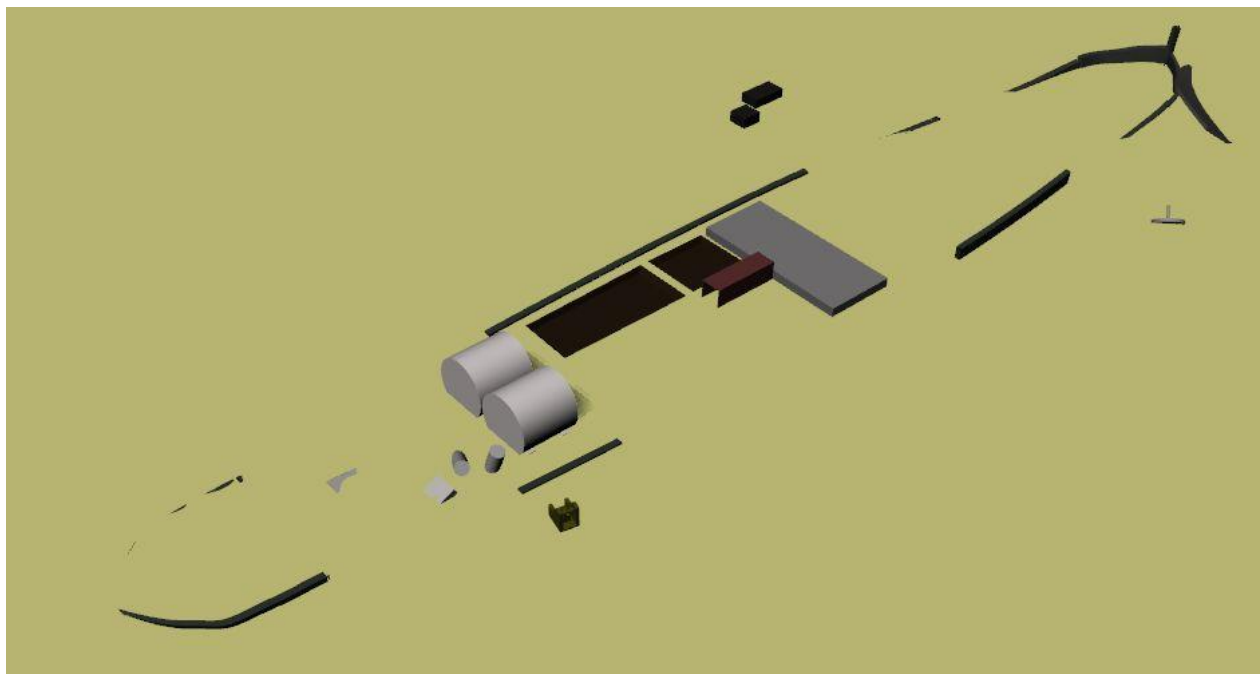


FIGURE 5.20. Site remains of HMS *Senator Duhamel*. (Created by author, 2014.)

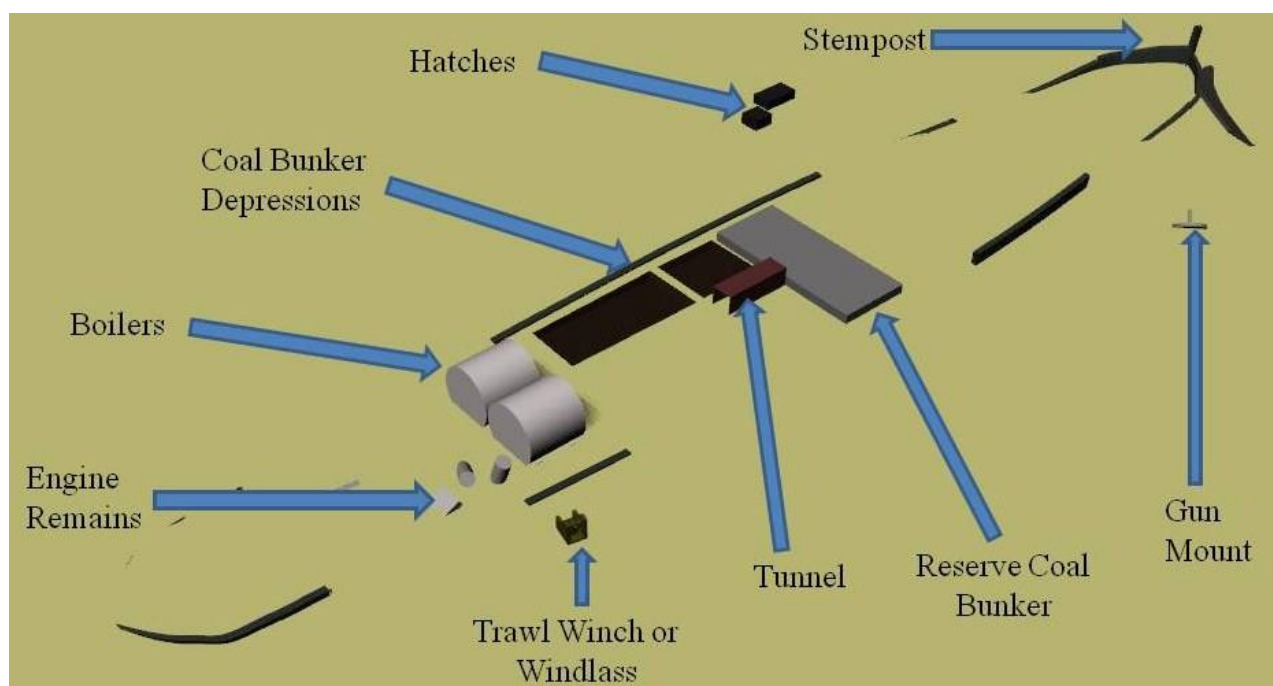


FIGURE 5.21. Identified features within the site remains of HMS *Senator Duhamel*. (Created by author, 2014.)

Further detail of the site is seen with a closer examination of the boiler and amidships area as detailed in Figure 5.22.

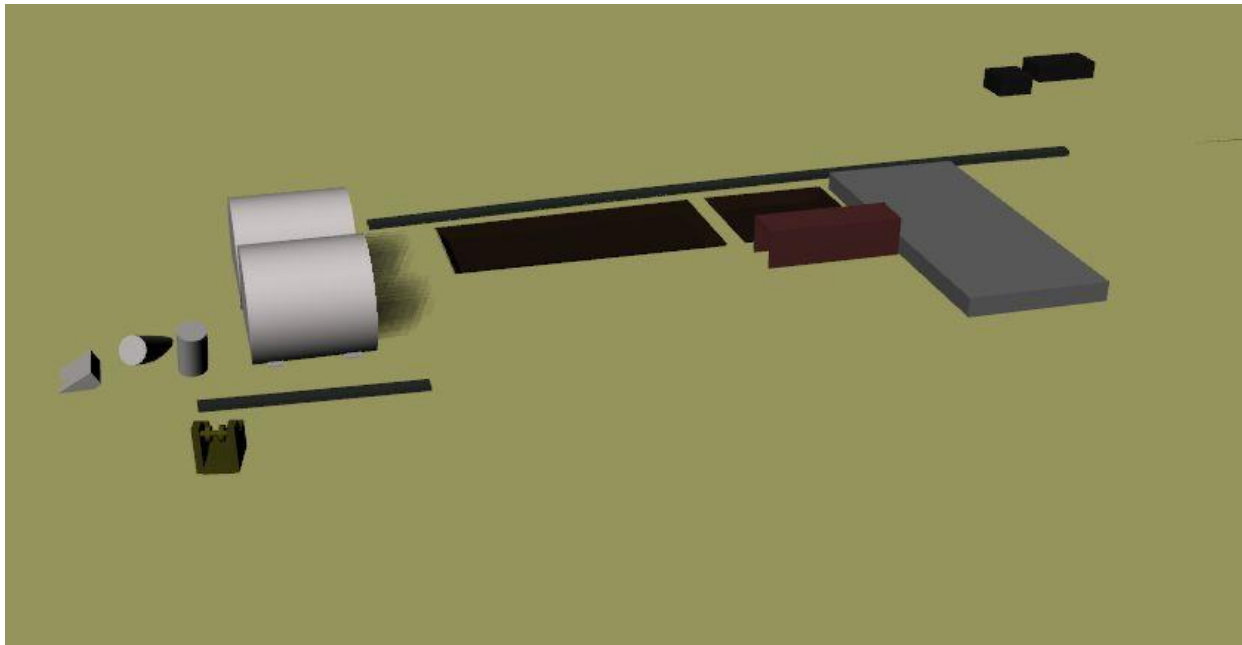


FIGURE 5.22. Boiler, possible engine remains, tunnel, and possible hull structure remains of HMS *Senateur Duhamel*. (Created by author, 2014.)

Model C for HMS *Senateur Duhamel* is an interpretation of the multibeam imagery and the photographs from a single dive. Anecdotal information from local Beaufort and Morehead City, North Carolina dive shops, attribute site degradation to blasting of the site by the U.S. Coast Guard Cutter *Vigilant* in 1944. Due to the mast of HMS *Senateur Duhamel* sticking out of the water, it was considered a navigational hazard. As stated on the HMS *Senateur Duhamel* dive description webpage, “in 1944, the Coast Guard Cutter *Vigilant* blasted (HMS) *Senateur Duhamel* with 2 tons of dynamite because it was a navigational hazard. They also wire-dragged (HMS) *Senateur Duhamel* to remove any remaining high spots” (Discovery Diving 2014). Subsequent research into the activities of USCG *Vigilant* was unable to produce any records after 1942, as World War II diary entries cease (United States Coast Guard 2014). Regardless, it is evident that the majority of ship features are missing, but further interpretation of the remaining site, as it relates to site formation and technological change, will be examined in the next chapter.

HMT *Bedfordshire*

Bedfordshire was built in 1935 at the Smith's Dock Company, Limited, in South Bank, Middlesbrough, England. Amassing 443 gross tons and displacing 900 tons, it was a smaller deep sea fishing vessel, certainly smaller than *Senateur Duhamel*. When completed in 1935, it measured 162.3 feet long, by 26.7 feet at breadth, with a 14.4 foot draft (Lloyd's Register of Shipping 1935/36). Designed specifically for arctic trawling, it was built for Bedfordshire Steam Fishing Company of Grimsby, which "was part of a larger organization, Shire Trawlers, known locally, as most trawler owning companies were, by the family name, 'Markham-Cooks' (Hutson 1990:45). With a triple expansion, three cylinder coal fired engine *Bedfordshire* could reach a max speed twelve knots (Farb 1985:112). This would ultimately be considerably slower than the surface speeds of U-boats, but for its designed purpose, it was adequate for fishing duties.

Bedfordshire was one of sixteen trawlers built in 1935 at the Smith's Dock Company (Shipbuilding on the River Tees 2013). Completed in early August, *Bedfordshire* was launched by Mr. Harry Markham-Cook and skippered by Albert Elletson. The maiden voyage to Iceland was significant because *Bedfordshire* was equipped with the new design feature of a refrigerated fish locker, used to help keep the catch fresh (Hutson 1990:45). Although this was a new feature, *Bedfordshire*'s coal fired boilers necessitated constant filling providing for a difficult task for those stoking the fires. The original design of *Bedfordshire*, as illustrated in Figure 4.9, displays deck arrangements and specific features of the vessel. Unavailable were original design photographs of *Bedfordshire*, such as in its working state. However, the deck arrangement diagram as well as vessel descriptions provided in *Lloyd's Register of Shipping*, allowed for the creation of a Rhino model. Figures 5.23 and 5.24 illustrate starboard and port side views of *Bedfordshire* as it would have originally looked, operating as a fishing vessel.

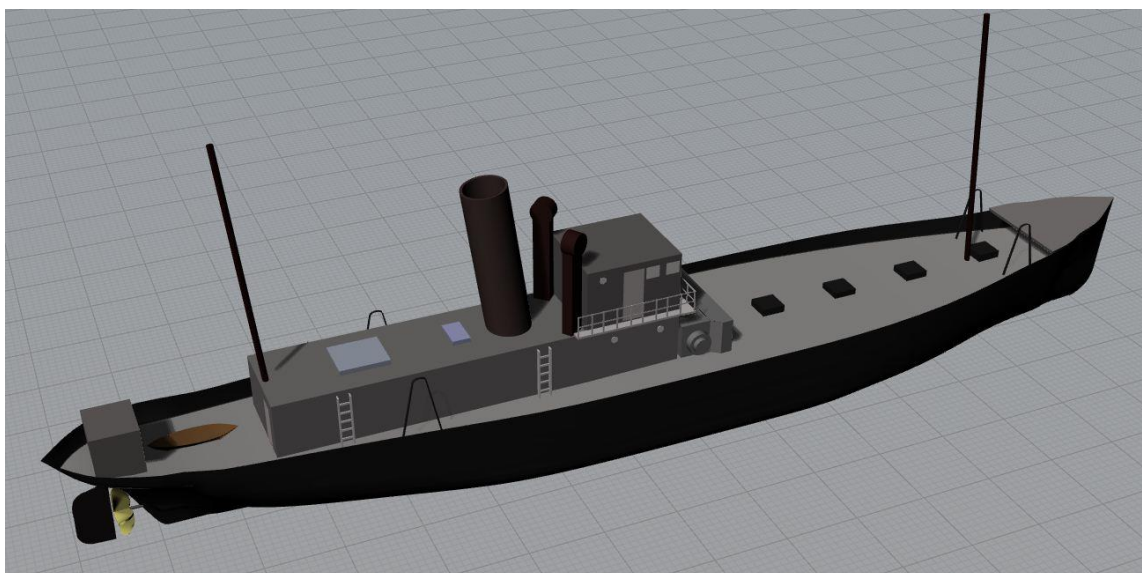


FIGURE 5.23. View of *Bedfordshire*, starboard side. (Created by author, 2014.)

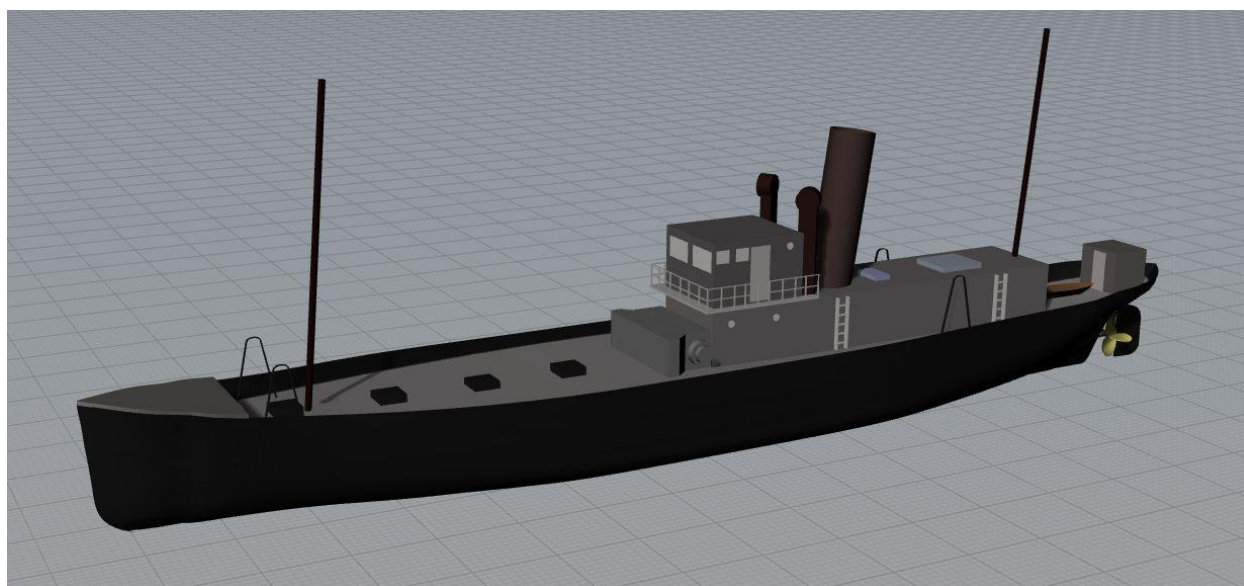


FIGURE 5.24. View of *Bedfordshire*, port side. (Created by author, 2014.)

It was important to make good use of all available space on a trawler of this type. To maximize the amount of space used,

pre-war distant trawlers carried coal in the after fish-room, usually at least enough for the proposed voyage to the fishing grounds. In order to get the coal from this fish-room through the full main bunker to the stokehold, the vessel's bunkers had been constructed in a special way. A square tunnel, about three to four feet high, ran from the stokehold to the after fish-room, right through the bottom of the main bunker with a heavy watertight steel door at each end (Hutson 1990:45).

Removing the starboard side hull (Figure 5.25) reveals the engine, boiler, and this special feature, the tunnel.

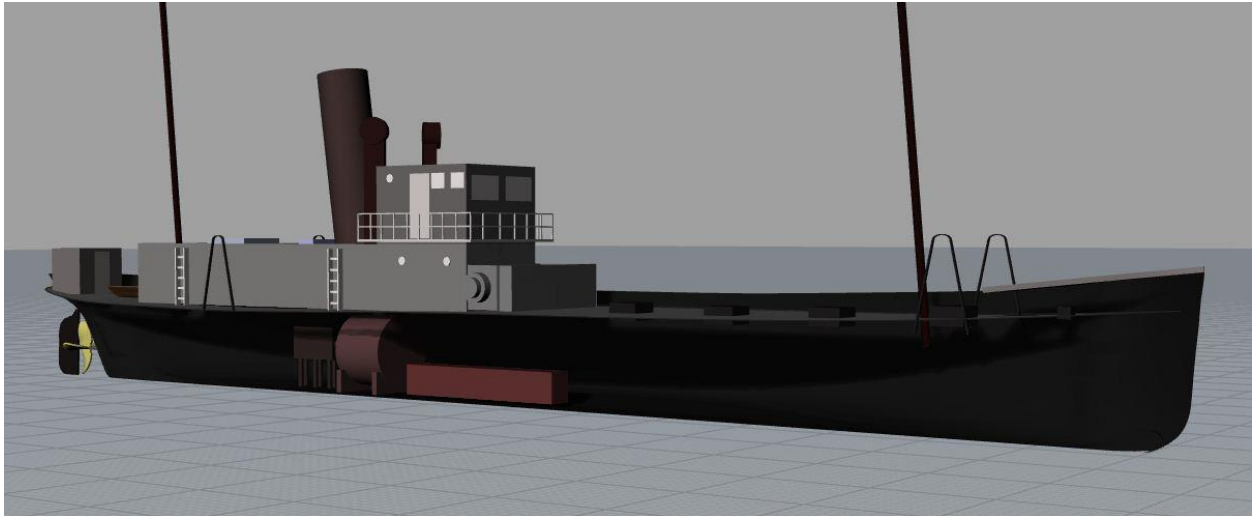


FIGURE 5.25. Starboard hull removed to illustrate engine, boiler, and the tunnel of *Bedfordshire*. (Created by author, 2014.)

Bedfordshire would operate in Arctic waters up until the beginning of World War Two. As war began, many trawlers would then be requisitioned by the Royal Navy and used for military operations. But for four years, *Bedfordshire* had sailed from the port of Grimsby, operating as a deep sea fishing trawler providing fish for the surrounding community.

Prior to Germany invading Poland on 1 September 1939, fishing trawlers and other boats of British Royal Navy interest were gathering near a town called Lowestoft, in a place called the “Sparrow’s Nest.” Lowestoft would soon be transformed into a transit depot for the Royal Navy Patrol Service as “trawlermen” [sic] and members of the Royal Navy Reserve would make their way there under the looming clouds of war (Lund and Ludlam 1971:19). With the German invasion of Poland, England and France soon joined the fight, declaring war on Germany on 3 September 1939. Although little involvement militarily occurred immediately following this declaration, the Royal Navy made full scale war preparations. Soon, the “Sparrow’s Nest” would

be busy with trawlers of all types, ready to work in concert with the bigger ships of the Royal Navy. These vessels,

had to be fast in order to operate with the Fleet, and their officers and crews were highly trained. Others were just ordinary trawlers purchased from civilian owners, armed and refitted at naval dockyards. But whether they were commissioned to the Navy or the Reserve, all were essentially the same craft as those used for deep-sea fishing and they were largely officered and manned by men with practical fishing experience (Walmsley 1941:67).

Bedfordshire would be the latter of the two cases, soon bought by the Royal Navy and added to the many other trawlers requisitioned for military service.

In October of 1939 *Bedfordshire* was sold to the Royal Navy for conversion and given the designation HMT *Bedfordshire* (Hutson 1990:46). The conversion process for HMT *Bedfordshire* took place at Redheads, South Shields, and included outfitting the vessel with military equipment as well as adapting the fish hold to accommodate a larger crew. Like many other converted fishing trawlers at this time, higher priority ships received better equipment. However, the Royal Navy utilizing all that it could,

hurriedly renovated a number of fishing vessels, replacing fishing gear with minesweeping equipment and ASDIC (an early and not-too-reliable detecting device that relied on sound impulses off submerged objects) submarine-hunting equipment. Fish holds were converted into wardrooms and sleeping space. Usually a single large caliber- but often antiquated- deck gun was installed along with the old World War 1 machine guns for defense of the boat from air attack (Naisawald 1997:20).

HMT *Bedfordshire* would first be outfitted with older World War One type equipment. A four-inch, quick fire deck gun was mounted at the bow, located on an elevated platform that was designed specifically to use this gun. HMT *Bedfordshire* would initially receive a second, World War One era, Lewis .303 caliber machine gun, located abaft of the funnel on a platform at the end of the engine room, to be used for anti-aircraft defense (Hickam 1989:200; Naisawald 1997:20; Jan 2013). According to unpublished movement reports donated to the Bedfordshire

Archives by a Mr. J.S. Munro, in December of 1940, a set of .50 caliber machine guns also were installed, along with a grenade-throwing device called a Holman Projector. The presence of the Lewis gun is corroborated by a photograph, also donated by J.S. Munro, seen below in Figure 5.26.



FIGURE 5.26. “The Lewis gun abaft of the funnel, 1941.” (Courtesy of Bedfordshire Archives, United Kingdom.)

These armaments would help to provide protection against enemy aircraft, and additional equipment would be updated periodically throughout its service. According to J.S. Munro, the Lewis machine gun would be replaced by a set of twin Vickers machine guns during an overhaul at Davenport, United Kingdom, during December, 1941 (Munro 1996). Evidence of this adaptation is seen in Figure 4.10.

HMT *Bedfordshire* was also equipped with depth charge rails and launchers at the stern of the ship. Photographic evidence of at least one depth charge thrower is seen in an image donated by Mr. J.S. Munro, seen in Figure 5.27 below.



FIGURE 5.27. “This was taken almost directly No. 4. The stb. Depth charge thrower, unloaded, is in the foreground. The door behind King leads to the galley and down to the engine room.” Date unknown. (Courtesy of Bedfordshire Archives, United Kingdom.)

Two depth charge rails and two throwers, on both the port and starboard sides, would be included in the total armament of HMT *Bedfordshire*. In Figure 5.28, the port side depth charge rack is seen.



FIGURE 5.28. “Ord. Tel. G. Featherstone. Aug. 1941. At sea. He is sitting on the port depth charge rack.” (Courtesy of the Bedfordshire Archives, United Kingdom.)

Also included as part of the equipment used to convert *Bedfordshire* to a military vessel was the addition of parachute rockets. These were added, in Figure 5.29, as part of the defense against enemy aircraft.



FIGURE 5.29. “Dated Nov. ’41. The two near vertical tubes on top of the bridge are parachute rockets that trailed a wire to bring down attacking planes.” (Courtesy of Bedfordshire Archives, United Kingdom.)

In recreating the converted aspect of HMT *Bedfordshire* for the Rhino, Group B, model, the information from the photographs and movement summary provided invaluable details. Further historical imagery came from the only known profile picture of HMT *Bedfordshire* at sea, seen in Figure 5.30.



FIGURE 5.30. Profile view, port side, of HMT *Bedfordshire*, date unknown. (Courtesy of Bedfordshire Archives, United Kingdom.)

Explicitly observed in these photographs are conversion aspects depicting military adaptation. Utilizing the information from the photographs and descriptions of armament additions, the converted HMT *Bedfordshire* Rhino model, Group B, was created, reflecting the transformation process. In Figure 5.31 below, a view of the port side is created, which can be compared with Figure 5.30.



FIGURE 5.31. Port side view of Rhino model, Group B, HMT *Bedfordshire*. (Created by author, 2014.)

In Figures 5.32 and 5.33, further details regarding the conversion process are illustrated. Figure 5.32 identifies certain features and Figure 5.33 displays the four inch deck gun and the platform at the bow of HMT *Bedfordshire*.

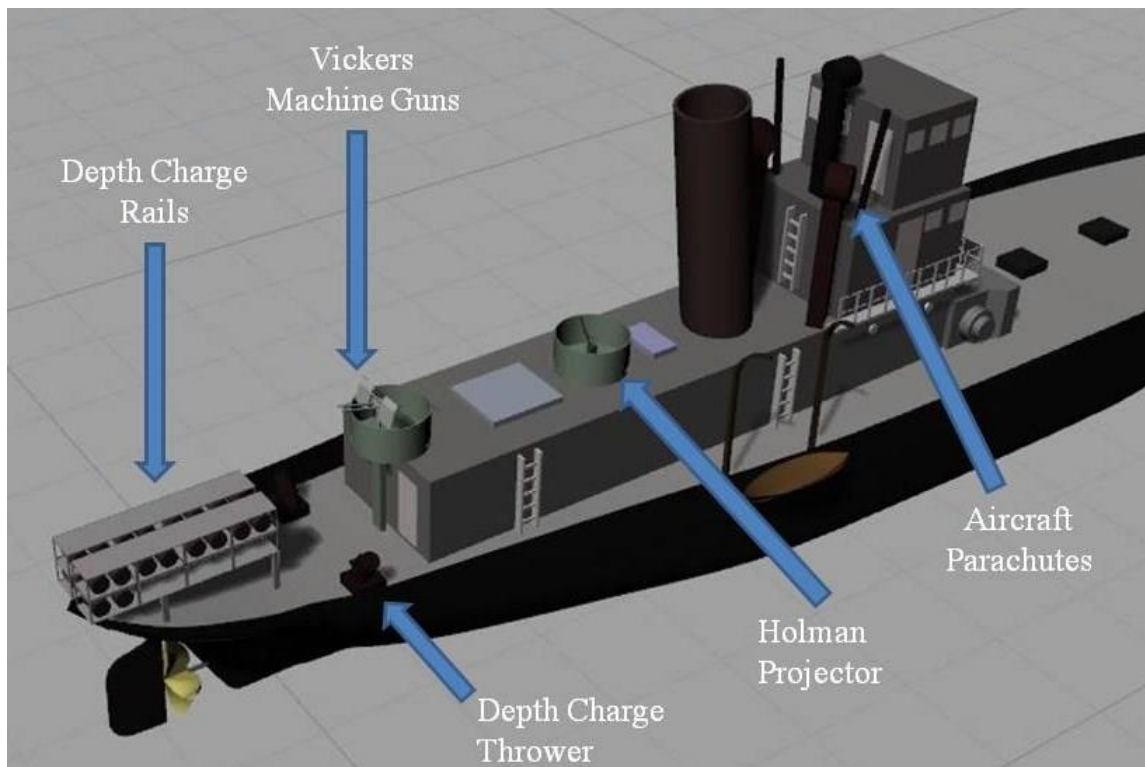


FIGURE 5.32. Identified armament features added to HMT *Bedfordshire*. (Created by author, 2014.)

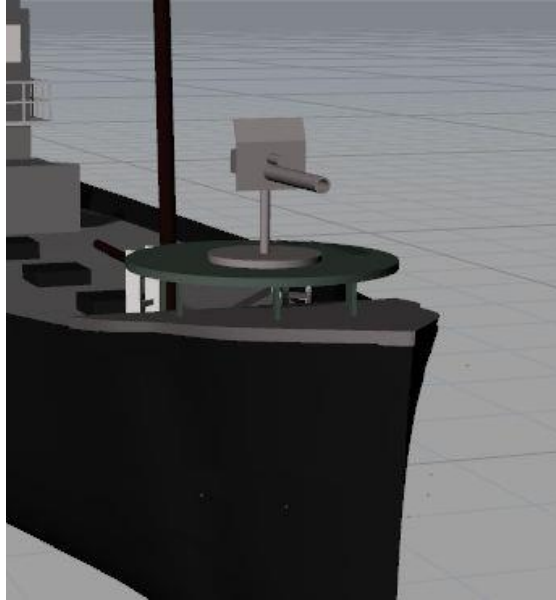


FIGURE 5.33. Deck gun and platform at bow of HMT *Bedfordshire*. (Created by author, 2014.)

As with HMS *Senateur Duhamel*, conversions and adaptations to HMT *Bedfordshire* include additions as well as subtractions. For instance, part of the conversion from fishing vessel to anti-submarine patrol included the removal of the tunnel (Hutson 1990:46). Other alternations were made as well. Life boat features were either removed or placed over the side of the vessel. As interpreted from photographs, it is possible the life boat and pulling system was placed amidships, on the starboard side. This is reflected in the Rhino Group B model. Using this model in a comparison with Model Group A will be discussed further in the next chapter. Other alterations due to military adaptations and conversions will also be discussed in the following chapter.

The military career of HMT *Bedfordshire* started by operating out of Plymouth, Devon, servicing the southwest coast of England as well as the Bristol Channel, providing convoy duty as an anti-submarine and anti-aircraft guard ship for the Bristol Channel lightship and cable ships. HMT *Bedfordshire*, while working in British waters from 1939 through the beginning of 1942 was attacked no less than five times by German aircraft as well as surviving a probable U-

boat encounter (Hutson 1990: 47; Naisawald 1997:22). In February, 1942, HMT *Bedfordshire* would be part of a contingent, to include HMS *Senateur Duhamel*, of 23 other converted fishing trawlers to assist the United States Navy along the east coast of the United States. Prior to making port in Nova Scotia, HMT *Bedfordshire* picked up survivors of the Norwegian merchant ship *Tyr*, previously torpedoed and sunk by *U-196* on 9 March 1942 (Naisawald 1997:28; Cartellone 2003:94). Able to unload the survivors in Nova Scotia two days later, HMT *Bedfordshire* continued with the convoy of trawlers toward New York for refitting and repairs (Hutson 1990:51). HMT *Bedfordshire* would be given orders to operate out of Morehead City, North Carolina, for patrol and escort duty.

On 7 May 1942 HMT *Bedfordshire* made its last refill stop in Morehead City, North Carolina. The vessel would head back out on patrol on 10 May 1942 and rendezvous with another British escort, *St. Zeno*, off of Cape Lookout to support a small convoy of merchant vessels making way toward Hatteras. HMT *Bedfordshire* met up with *St. Zeno* and the convoy at 3:00 PM that afternoon and made way toward Hatteras. It would be later that evening the two escorts and the convoy successfully made it to Hatteras. After, HMT *Bedfordshire* decided to begin patrols again, working a southwesterly route toward Morehead City and Cape Lookout, between Buoys 14 and 4 (Naisawald 1997:47-48). The vessel would continue to work in this fashion through the next day.

At about 10:07 PM on the evening of 11 May 1942, the crew of *U-558*, operating in the same area, spotted a silhouette of a ship patrolling, HMT *Bedfordshire*. *U-558* would follow the boat closely for the next hour, eager to attack. By 11:40 PM, following two unsuccessful torpedo launches at HMT *Bedfordshire*, a third torpedo was let loose by *U-558*. There would be a huge explosion as the trawler turned at the last moment and the torpedo caught it directly amidships,

along the port side (Hickam 1989:205; Naisawald 1997:52). The explosion was so violent that the stern of HMT *Bedfordshire* was thrown up in the air before sinking bow first, almost instantly. The sinking of HMT *Bedfordshire* was so sudden, no distress call was ever made and the vessel took with it the entire 37 man crew. In fact, the last signal sent by HMT *Bedfordshire* had been made earlier that afternoon, only as a routine message of patrol activities (Eastern Sea Frontier 1942a; Hickam 1989:205). It would be three days until any indication of the loss of HMT *Bedfordshire* was realized as evidence of the wrecking turned up on the beaches.

In 2009 NOAA, in cooperation with MNSM, BOEM, CSI, and ECU, began the second year of Battle of the Atlantic research expeditions. Beginning in early August, the expedition was divided into two phases, with the focus of the second phase on diving and recording the site remains of HMT *Bedfordshire*. Site remains lay at around 105 feet deep, so diving operations would necessitate shorter bottom time (NOAA 2009). During the course of the expedition, evidence was collected that included sector sonar imagery, video and photography, and the creation of a full site recording. The evidence provided by the sector sonar imagery as well as the video and photography all helped with the completion of the site plan.

An example of the sector sonar imagery, provided with the assistance of BOEM and NOAA, is seen in Figure 5.34. It is with this imagery that the extent of site remains could be established. The sector sonar imagery could be used to provide a broad sense of the site, and when combined with video and photography, individual features could be identified. Video of working dive teams as well as aspects of site features were very important to the expedition team with the overall goal of creating a final site plan.

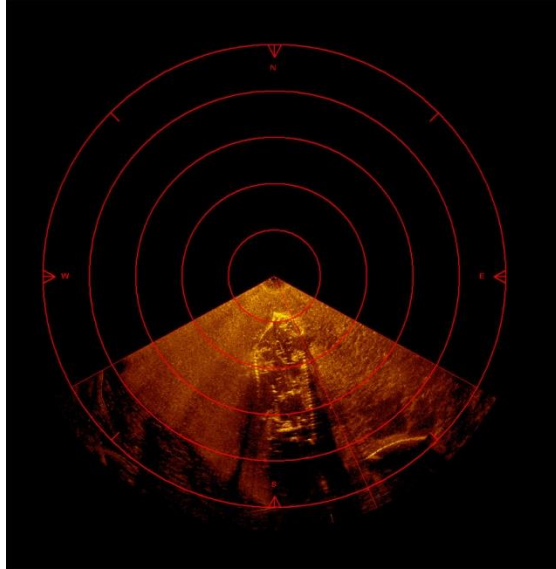


FIGURE 5.34. Sector sonar scan of HMT *Bedfordshire* detailing the stern section toward the middle of the image, 2009. (Courtesy of NOAA.)

Images were pulled from different videos made available by John McCord of CSI. Identifiable features, such as a depth charge in Figure 5.35, confirm the military conversions made to HMT *Bedfordshire*.



FIGURE 5.35. Remains of a depth charge, HMT *Bedfordshire*, 17 August 2009. (Courtesy of John McCord, CSI.)

Other conversion adaptations were also available for identification due to the video evidence. In Figure 5.36, evidence of the gun mount from the four inch deck gun is identified.

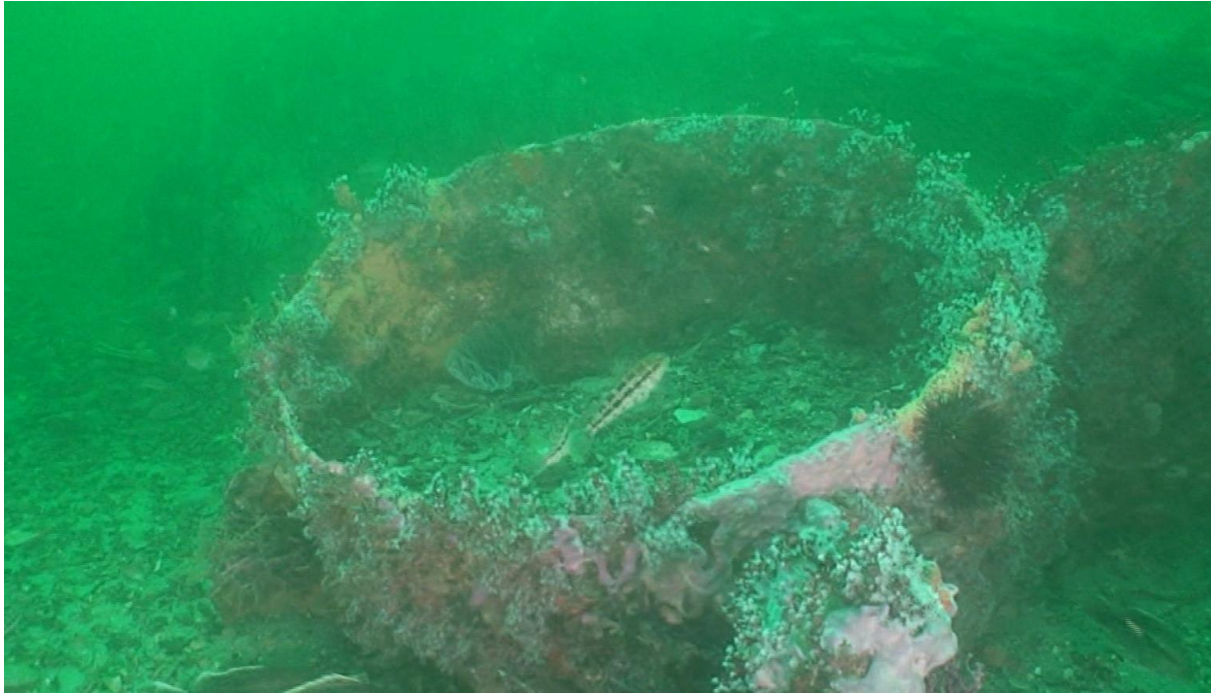


FIGURE 5.36. Deck gun mount remains, HMT *Bedfordshire*, 17 August 2009. (Courtesy of John McCord, CSI.)

The ability to review site remains through the use of video was helpful to determine individual features and possible aspects of site formation. This also allowed for small features to be recorded, but to get a full site plan, it was necessary to employ the use of multiple divers to record site remains through non-invasive techniques.

A complete, inked drawing of the site remains, as recorded by the dive teams, is also the culmination of the evidence provided by sector sonar and video information. The site plan for HMT *Bedfordshire*, as seen in Figure 4.4, illustrates the entire archaeological site remains of the wreck. Here, detailed aspects of the site have been recorded and provide an excellent source from which to continue analyzing aspects of site formation and the conversion process of the commercial vessel for military use.

Using the available information provided in the sector sonar, video, and complete site plan, the third Rhino model for HMT *Bedfordshire*, model Group C, representing archaeological remains could be created. The creation of this Rhino model focused on main features that could be identified as, again, there is an abundance of material that could not be identified. This information would not be included in the Rhino model representing the archaeological remains. The following two images, Figure 5.37 and Figure 5.38, illustrate the Rhino model representing the archaeological remains as best interpreted through the use of all available information.



FIGURE 5.37. Rhino model of site remains of HMT *Bedfordshire*, representing Group C. (Created by author, 2014.)

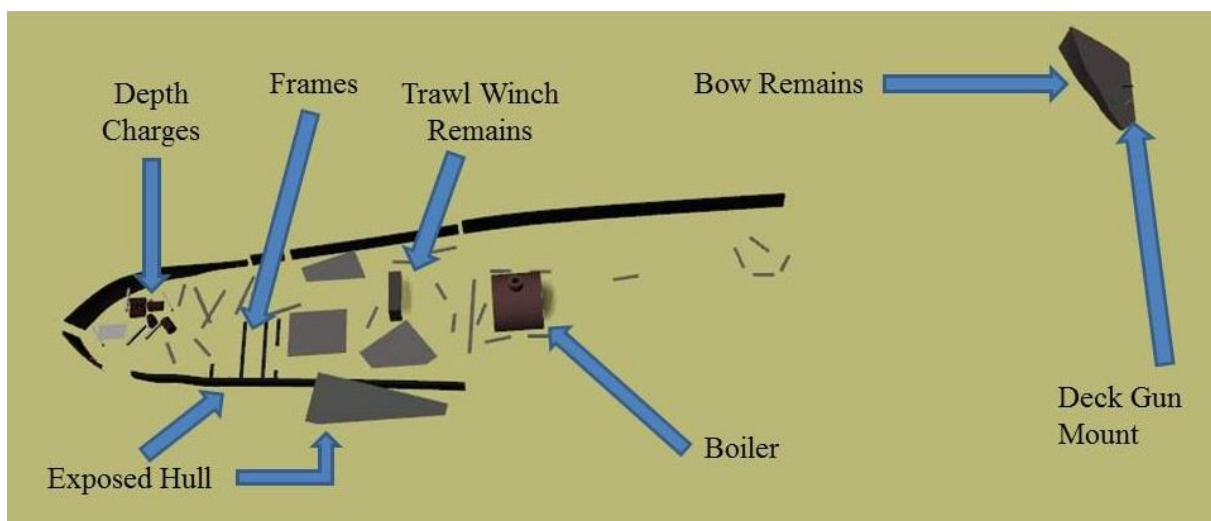


FIGURE 5.38. Possible identification of remaining features of HMT *Bedfordshire*. (Created by author, 2014.)

Corresponding with the photographic evidence seen previously, included in the Rhino model are depth charges, located at the stern (Figure 5.39) as well as a representation of the deck gun mount (Figure 5.40) that is located as part of a disarticulated piece of the bow structure.

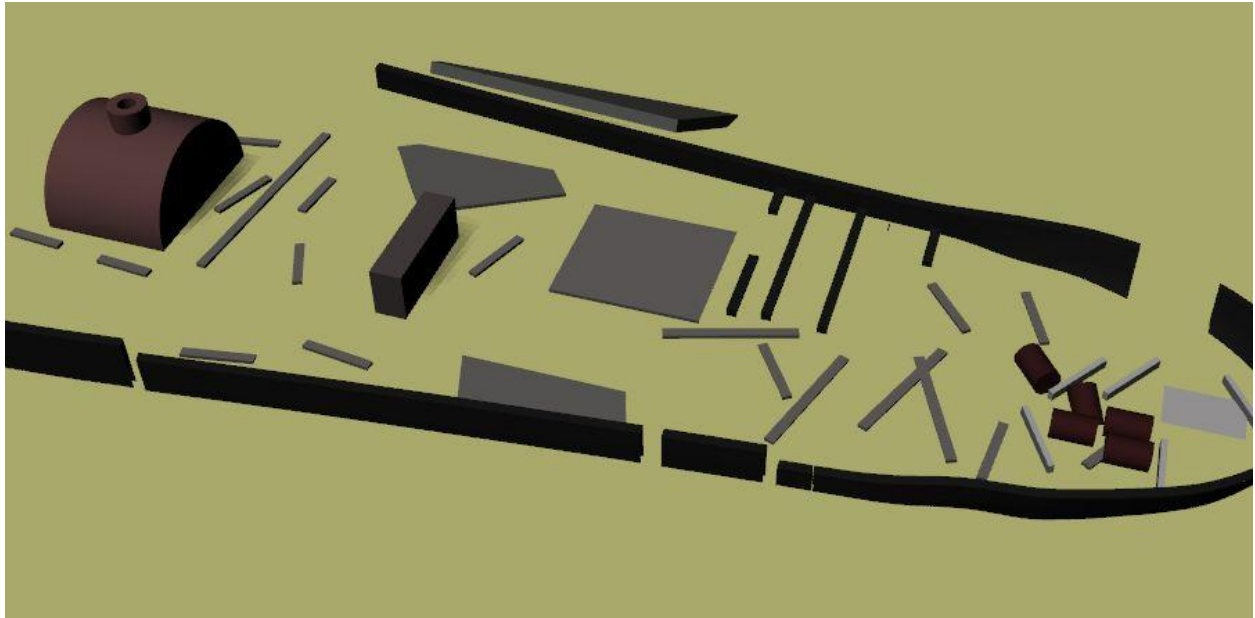


FIGURE 5.39. Boiler, as seen to the left toward amidships and a depth charge pile located toward the stern. Depth charge rail remains are scattered near the depth charges. (Created by author, 2014.)

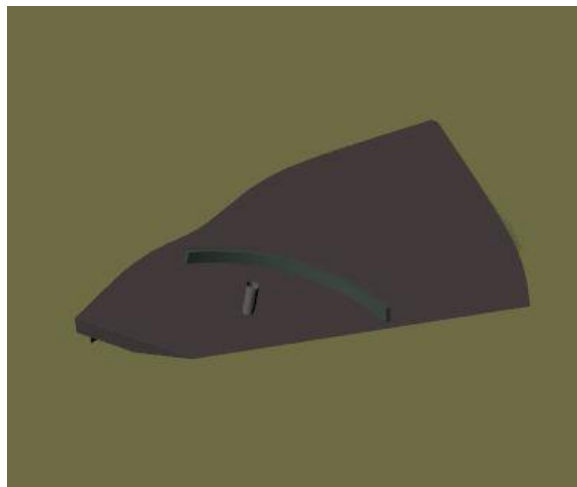


FIGURE 5.40. Deck gun mount remains, located apart from main site. (Created by author, 2014.)

The Rhino model of the archaeological remains for HMT *Bedfordshire*, Group C, is an interpretation of the evidence provided in the sector sonar information, available video, and the

complete site plan as recorded during the Battle of the Atlantic expedition in 2009. There is evidence of military conversions, especially with possibly live ordinance in the form of remaining depth charges. The deck gun mount is also evidence of the conversion process that took place to modify a commercial vessel for military use. Further interpretation of the archaeological remains as they pertain to models of technological change will be discussed in the next chapter.

YP-389

YP-389, originally named *Cohasset*, was the smallest and most recently built of the selected vessels in this study. *Cohasset* was one of four identically designed fishing trawlers to be built by Bethlehem Steel Company at the Fore River shipyard in Quincy, Massachusetts. Purchased by R. O'Brien & Company, *Cohasset* was delivered for commercial use in mid-October, 1941. The three sister ships to *Cohasset*, *Lynn*, *Weymouth*, and *Salem*, were delivered to R. O'Brien & Company following their completion the following few weeks. Each vessel was designed to be 110 feet long (Wagner 2012:4; Shipbuilding History 2014). In Figures 4.7 and 4.8 part of the construction process of *Cohasset* can be seen. However, *Cohasset*, upon completion, as seen in Figure 5.41, had an overall length of 102.5 feet, a breadth of 22.1 feet, and a draft of 10.6 feet, and grossing 170 tons. *Cohasset* was propelled by a 6-cylinder, 91 horsepower diesel engine (Lloyd's Register of Shipping 1940/41). The vessel was designed to carry a crew of four for its original designed purpose. It was constructed with, "few amenities: one head, no ventilation system, a tiny eating area with a small stove that hardly worked, and no fresh water showers" (Wagner 2012:5). It was designed for small coastal operations with a limited crew, as opposed to the other two selected vessels that operated much further from home waters and traveled longer distances.



FIGURE 5.41. The launching of *Cohasset*, date unknown. (Courtesy of Hart Nautical Library.)

Unfortunately, there were no deck arrangement or vessel plans available to better understand the construction process of *Cohasset*, or any of its sister ships. For a Rhino model to be created to represent the original design, model Group A, the use of photographs illustrating the construction phase as well as pre-conversion photographs (Figure 5.42), were used. Deck features and equipment used for commercial fishing as seen within these photographs were used to recreate similar features in the Rhino model.



FIGURE 5.42. *Cohasset* upon completion as viewed from its starboard side, date unknown. (Courtesy of Hart Nautical Library.)

The images below, Figures 5.43 through 5.45, illustrate the completion of the original design Rhino model, Group A, for *Cohasset* as best interpreted using the available information.

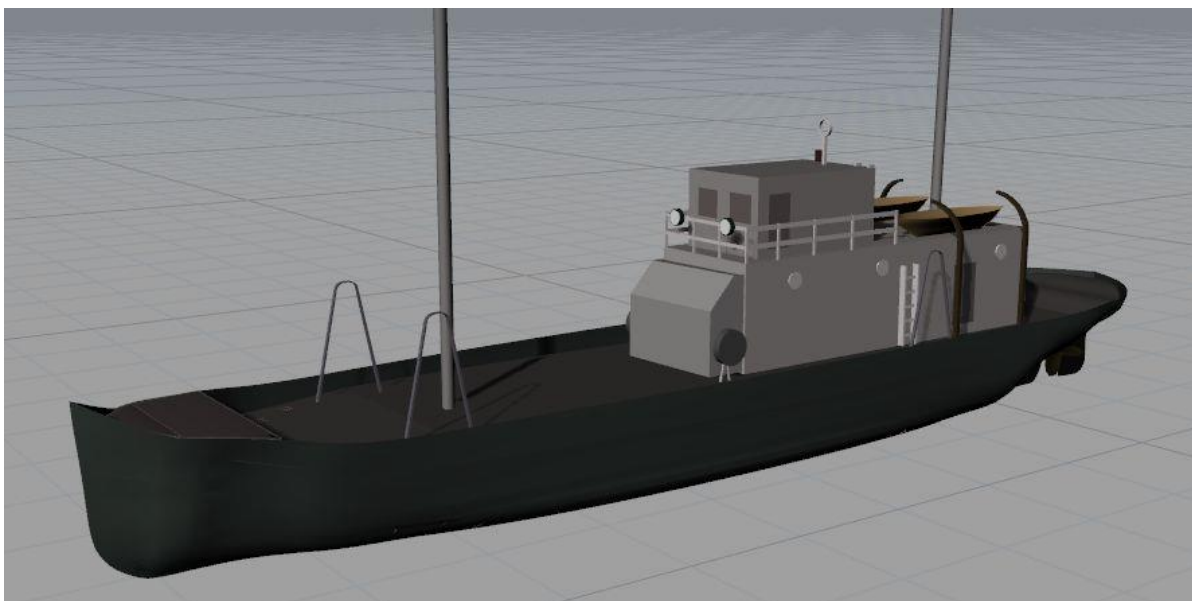


FIGURE 5.43. Model Group A image of *Cohasset*, as it was originally built. (Created by author, 2014.)

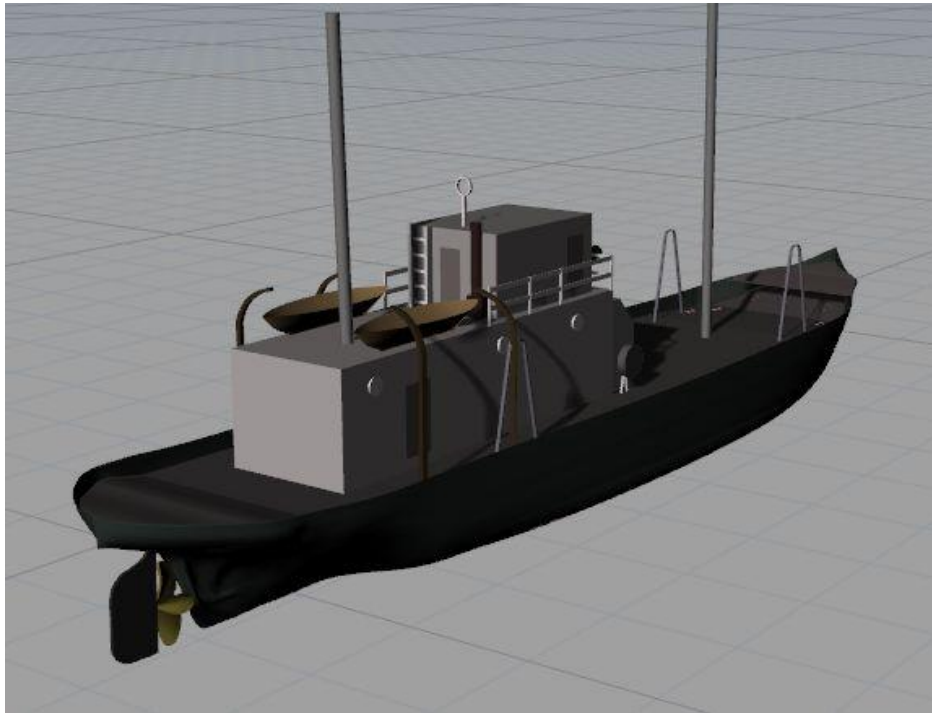


FIGURE 5.44. Stern view of *Cohasset*. (Created by author, 2014.)

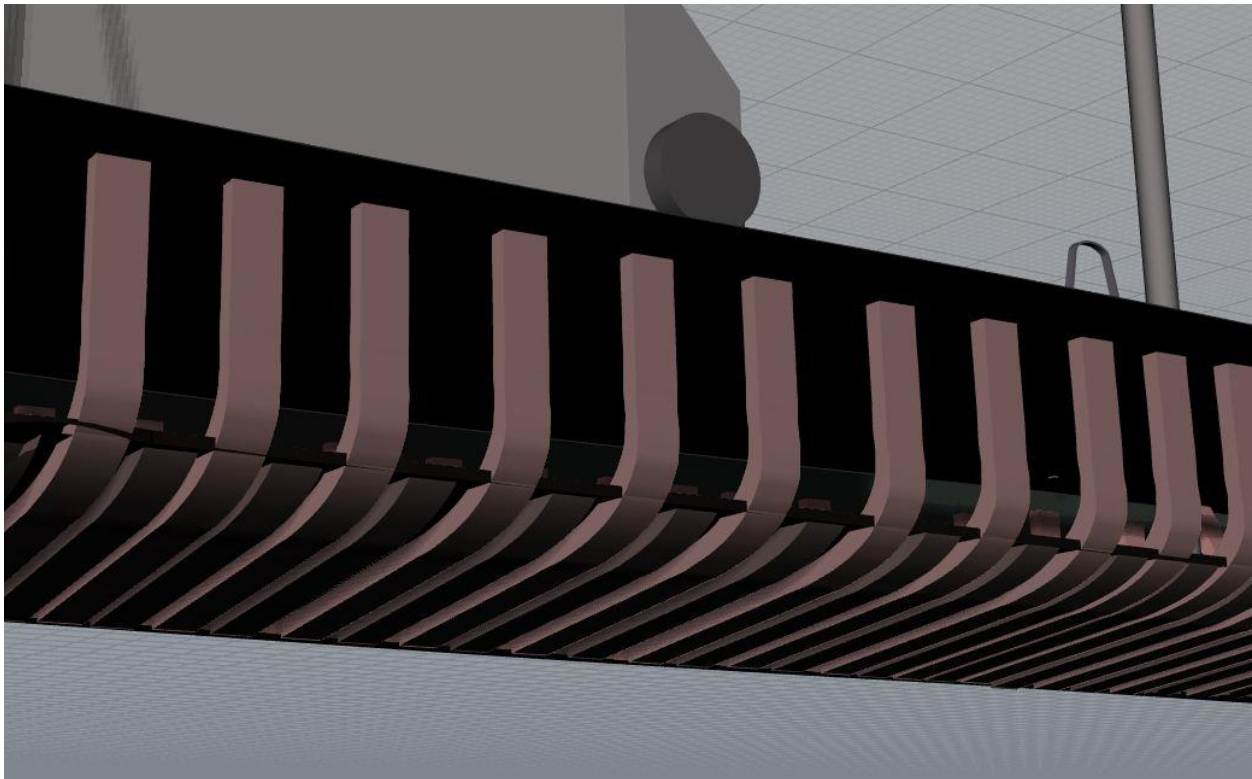


FIGURE 5.45. Starboard hull structure removed to reveal framing of *Cohasset*. (Created by author, 2014.)

The commercial career was very short lived for *Cohasset*, as well as for two of its sister ships, *Lynn* and *Salem*. It only operated in a commercial capacity for about four months. By February, 1942, the United States Navy was in desperate need for escort and patrol vessels to help defend the East Coast. On 6 February 1942, *Cohasset* and *Lynn* would be transferred into the United States Navy and become coastal minesweepers, designated *AMc-202* and *AMc-201* respectively (Wagner 2012:5). *Cohasset* would then be sent for conversions in New York.

Cohasset would arrive and undergo conversions at Marine Basin, Inc. off of Hubbard St. in Brooklyn, New York to become a minesweeper, receiving the new designation *AMc-202*. A complete listing of conversions and the corresponding costs for *Cohasset* were available in the “Bureau of Ships General Correspondence, 1940 – 1945,” files, within Record Group 19, Box 603, located in the National Archives II in College Park, Maryland. Conversions for *Cohasset* to become *AMc-202* included,

labor and material to fabricate and install foundations for 3” 23 cal. gun; labor and material to fabricate and install magazine and ammunition stowage complete, also sprinkling system and ventilation; provide labor and material to install two 30 cal. and one 3” 23 cal. guns as indicated on plan; and, labor and material to install two depth charge racks as indicated on plan (Commandant Third Naval District 1943).

A selection from the conversion orders is illustrated in Figure 5.46, below.

S74-1	A	f	Provide labor and material to install two 30 cal. and one 3" - 23 cal guns as indicated on plan.	154.	163.13	100
S76-1	A	f	Labor and material to install two depth charge racks as indicated on plan. Depth charge racks to be furnished by Navy Yard.	643.	511.90	100

FIGURE 5.46. Conversion orders from *Cohasset* to *AMc-202*, dated 15 March 1943. (Commandant Third Naval District 1943.)

This document outlines the military conversion orders for *Cohasset* to become *AMc-202*, however, the plans indicated in the orders, listed within the line “S76-1” of Figure 5.46, were

unavailable and never found. Within the same record file, it is evidenced *Cohasset* arrived at the Marine Basin Co. on 12 February 1942 and left on 21 February 1942, following completion of conversion to *AMc-202*. The complete conversion process of the vessel from commercial to military use took less than ten days.

Through movement records provided in the Eastern Sea Frontier War Diaries, *AMc-202* would operate in the Third Naval District, mostly in patrol operations and not working in minesweeping duties. This would occur for a few months, March through May. In the month of May, 1942, the specific date unknown, *AMc-202* would return to the shipyard for conversion again. *AMc-202* would take on the duties of a yard patrol boat, taking the new designation, *YP-389* (Wagner 2012:6). Coincidentally, *AMc-201*, originally *Lynn*, the sister ship to *Cohasset*, would also be redesignated as a yard patrol boat, *YP-388*. Specific conversion orders for *AMc-202* to become *YP-389* are not available. However, when compared with the “Court of Inquiry,” files following the loss of *YP-389* (which will be discussed further) the military equipment added during the first conversion process does not change from designation to designation.

The creation of the converted Rhino model, Group B, utilized the information provided in the conversion orders of *Cohasset* to *AMc-202*. Before discussing the wrecking event of *YP-389* in more detail, it is necessary to confirm the major military adapted features put in place at the time of its sinking. As stated previously, the “Court of Inquiry” procedure following the loss of *YP-389* confirms the military adaptations put in place. A statement entitled “Finding of Facts,” dated 8 August 1942, included within Record Group 125, Box 163 of the National Archives file “Court of Inquiry Proceedings; 1909 – 1971,” (Figure 5.47) validates the same equipment was put in place from the first conversion process.

FINDING OF FACTS

1. About 0215, June 19, 1942, the U.S. YP-389 was on patrol to eastward of the Navy Mine Field off Hatteras Inlet, North Carolina, between Diamond Shoal gas buoy and Buoy No. 4 of the mine field danger area, in approximate position Latitude 34 - 56 - 39 N, Longitude 75 - 25 - 36 W.

2. The officer-in-charge, Lieutenant Roderick J. Philips, U. S. Naval Reserve, was on duty on the bridge and the vessel was proceeding approximately on C 250°. The sea was smooth, weather clear but dark. Five enlisted men were on duty. No guns were manned.

3. The U.S. YP-389 was a steel vessel of approximately 110 feet in length, formerly a fishing vessel, and had been acquired and converted to a patrol vessel in February, 1942. She was of nine knots maximum speed and her armament consisted of one three-inch .23 calibre gun, mounted near the bow on a raised forecastle; one .30 calibre machine gun, mounted over the pilot house; and, one .30 calibre machine gun mounted on the superstructure deck, abaft the pilot house. There were two depth charge racks at the stern, each holding two 300-pound depth charges, with two spare depth charges secured on deck under the racks. The superstructure containing pilot house and living quarters was aft, a raised forecastle, with crew's living quarters forward, and between these was a well deck. No sound or listening equipment was installed. The personnel consisted of three officers and twenty-one enlisted men.

FIGURE 5.47. "Finding of Facts" information following the loss of YP-389, dated 8 August 1942. (Office of the Judge Advocate General 1943.)

Having the converted information confirmed, the Rhino model displaying converted features,

Group B, could be completed. In Figures 5.48 and 5.49, converted features are displayed and

identified. The adapted military features included a three-inch deck gun, two .30 caliber machine guns, along with a total of six depth charges, with two depth charge rails.

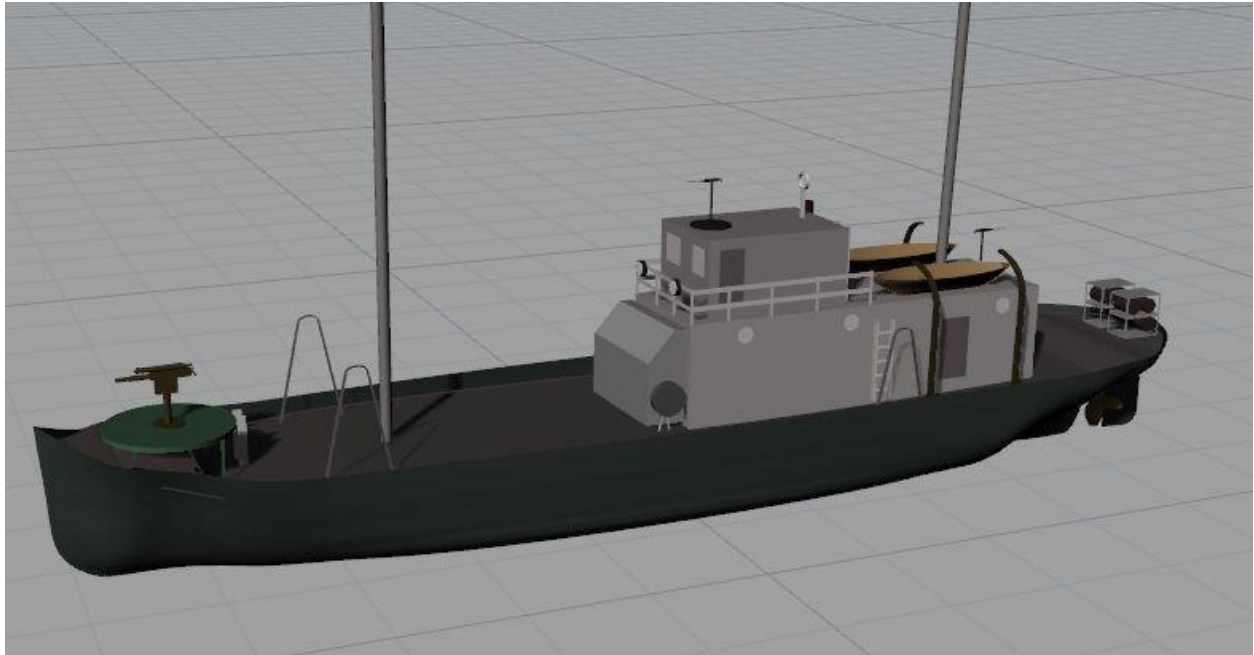


FIGURE 5.48. YP-389 with adapted features, seen from port side. (Created by author, 2014.)

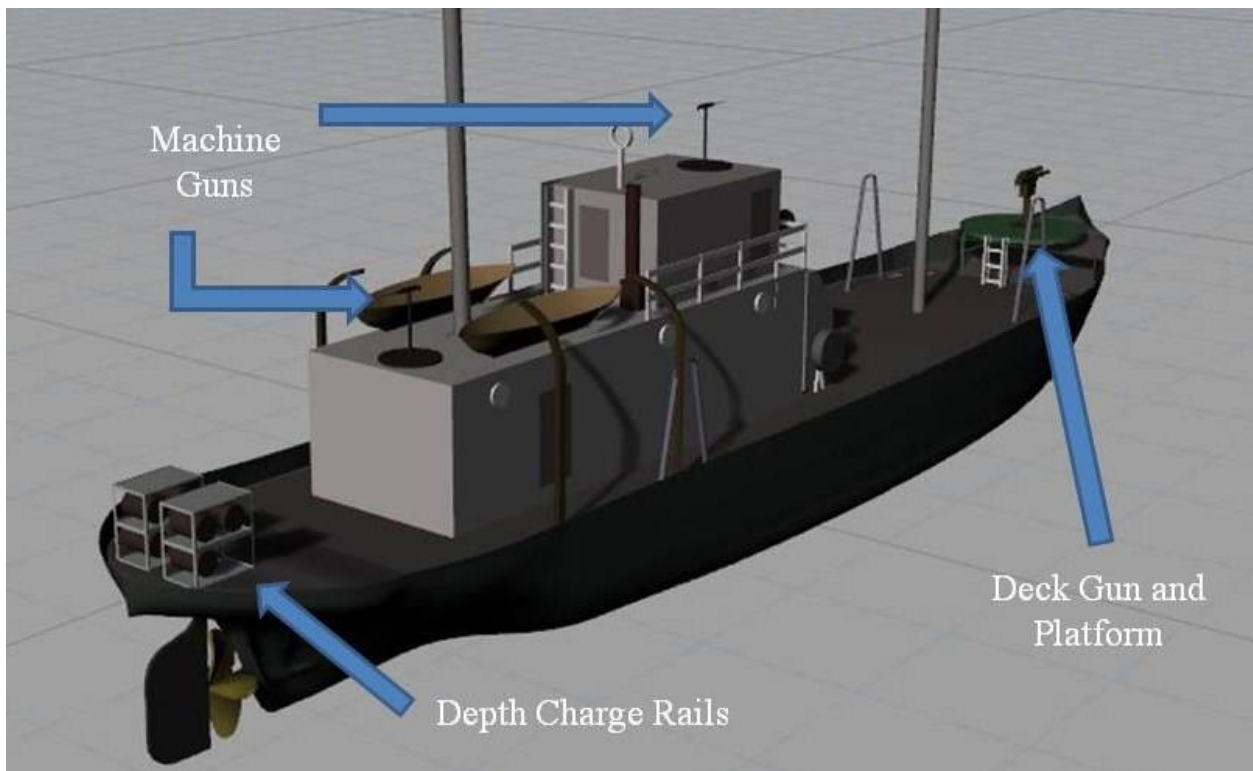


FIGURE 5.49. Identified adapted military features on YP-389. (Created by author, 2014.)

Also included in the conversion orders was a specific reference to, “labor and material to install forty (40) tons of ballast to insure that the vessel in the light condition will remain stable”

(Commandant Third Naval District 1943). This is the first reference to ballast arrangements following the conversion process of the selected vessels. Reference to exactly what was used as ballast, however, is not mentioned. This is an important aspect of the conversion process as the space used for holding fish and the weight it distributed would have to be compensated for upon its removal or alteration. This aspect will be discussed further in the next chapter.

Upon designation of *YP-389*, new operating orders followed. *YP-389* would operate within the Fifth Naval District of the Eastern Sea Frontier, tasked with safeguarding and patrolling areas near Cape Hatteras and the minefield near there (Eastern Sea Frontier 1942a; Wagner 2012:6). During this period, the three inch deck gun would malfunction for *YP-389* and a request for a replacement piece ultimately went unfulfilled, exhibiting a larger issue with equipment availability and vessel priority at this time. On 18 June 1942, *YP-389*, commanded by Lieutenant Roderick J. Phillips, was ordered to cruise back and forth between two marker buoys to warn merchant ships of the Cape Hatteras minefield it was guarding. At the same time, unbeknownst to *YP-389*, German U-boat *U-701* was operating in this area, with its commander frustrated not to have found any larger cargo ships to sink. Thinking *YP-389* had been tracking it, *U-701* decided to attack and sink the small ship. In a nighttime surface raid, *U-701* attacked *YP-389* with its deck and machine guns. *YP-389* returned fire with its machine guns, as well as dropping the few depth charges available, in a desperate attempt to disable the vastly superior U-boat (Eastern Sea Frontier 1942b; Wager 2012:10). Ultimately succumbing to the firepower advantage of *U-701*, *YP-389* sank with six crew members lost. Lieutenant Phillips and eighteen other crew members were able to abandon successfully and were ultimately rescued.

Upon review of the sinking event, Lt. Phillips was questioned about the loss of his crew, ship, and the faulty deck gun. As previously mentioned during the inquiry into the loss of six of

his crew, information about vessel details and the converted features were discussed. Ultimately, Lt. Phillips was not found derelict of duty. However, it was expected upon discovery of a U-boat, he was to make every attempt to ram and try and sink it, quite a lofty expectation for a vessel of this type (Office of the Judge Advocate General 1943).

In 2009 NOAA, in cooperation with MNSM, BOEM, CSI, ECU, started the second season of Battle of the Atlantic research expeditions. The expedition included two phases, the second phase which has been previously discussed with the work on HMT *Bedfordshire*, and the first phase utilizing a Remotely Operated Vehicle (ROV). ROV use would take place from 1 August 2009 through 9 August 2009 and would be used to locate and identify undiscovered deep water wreck sites. A video link to the ROV provided real time imagery to an operator working onboard the research vessel, *Nancy Foster* (NOAA 2009). Specific targets had been acquired through historical research and previous surveys. This multibeam data locating *YP-389* (Figure 5.50) provided a target area to then utilize ROV use, which provided for more in depth analysis of the site.

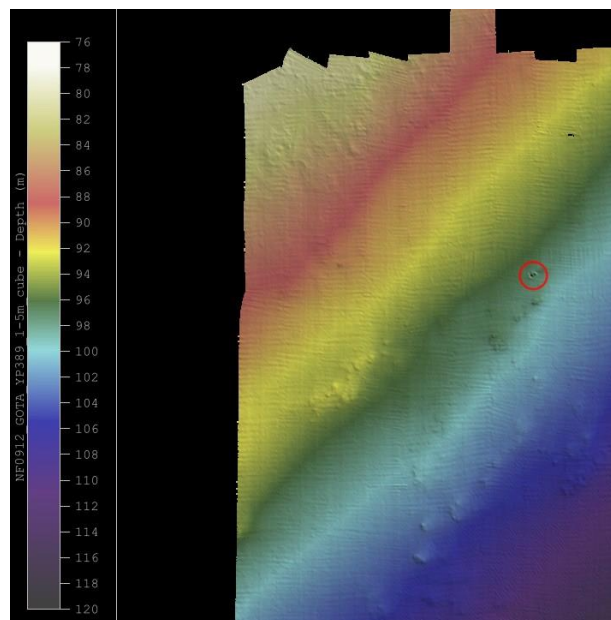


FIGURE 5.50. Red circle indicates the location of *YP-389*, 2009. (Courtesy of Joe Hoyt, NOAA.)

Identifying the target area of *YP-389* through the multibeam data indicated it was at about a depth of over 300 feet. This would prove difficult for any diver operations to take place, so it was advantageous to utilize the ROV.

ROV imagery of *YP-389* would prove to be quite detailed. ROV use on *YP-389* began on 7 August 2009. Conditions allowed for a great deal of detail to be recorded of the archaeological remains. Figures 5.51 through 5.55 illustrate features that were able to be identified using the ROV. In these images are features such as the deck gun, still identifiable at the bow, framing, and the intact propeller and rudder.



FIGURE 5.51. The three inch deck gun located at the bow, 7 August 2009. (Courtesy of NOAA.)



FIGURE 5.52. Starboard side of the bow of *YP-389*. Double framing could be identified at the turn of the bilge, 7 August 2009. (Courtesy of NOAA.)



FIGURE 5.53. Stern section of *YP-389*, 7 August 2009. (Courtesy of NOAA.)



FIGURE 5.54. Winch located on the deck of *YP-389*, 7 August 2009. (Courtesy of NOAA.)



FIGURE 5.55. *YP-389* propeller and rudder still intact, view from port side, 7 August 2009. (Courtesy of NOAA.)

Only one ROV video is available for the remains of *YP-389*. Given the size of the vessel, it is easier to establish context and identify certain features, as compared with video acquired for the other selected vessels during the Battle of the Atlantic expeditions. However, the video did not encompass the entire site and gaps are evident. This aspect will be discussed further. However, there was substantial evidence provided in the ROV footage to enable a recreation of the archaeological remains in a Rhino model.

Using information available about the remaining site features of *YP-389*, the third Rhino model, Group C, could be created. Utilizing the ROV footage as well as the photo mosaic image from Chapter Four (Figure 4.3), certain features were easily identified and replicated in the site plan. As seen in Figures 5.56 and 5.57, *YP-389* remains very much intact as a cohesive structure.



FIGURE 5.56. View of *YP-389* from bow, port side. (Created by author, 2014.)



FIGURE 5.57. Starboard side view, displaying remaining frames, winch, and trawl gallows. (Created by author, 2014.)

Features on the deck are identified in Figure 5.58 using evidence from the photomosaic (Figure 4.3) and within the ROV video. In Figure 5.59, bow features are better observed as well as stern features represented in Figure 5.60.

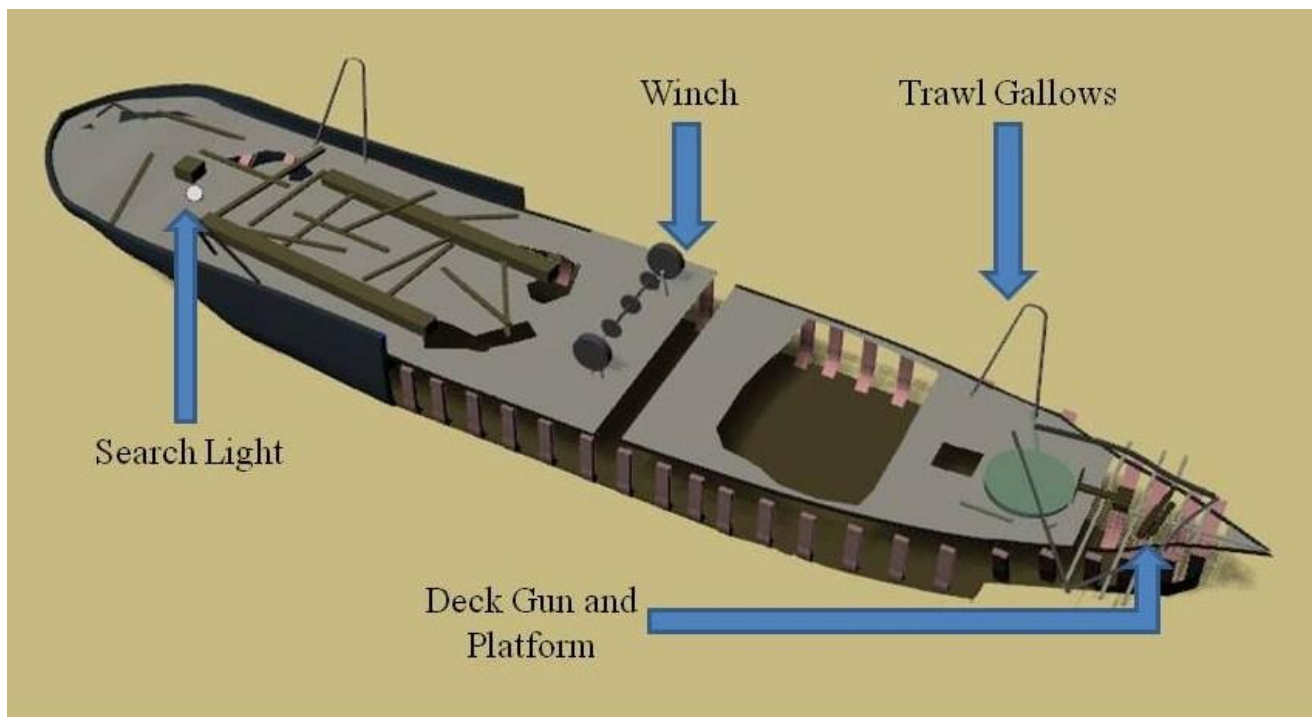


FIGURE 5.58. Identified features on the deck of YP-389. (Created by author, 2014.)

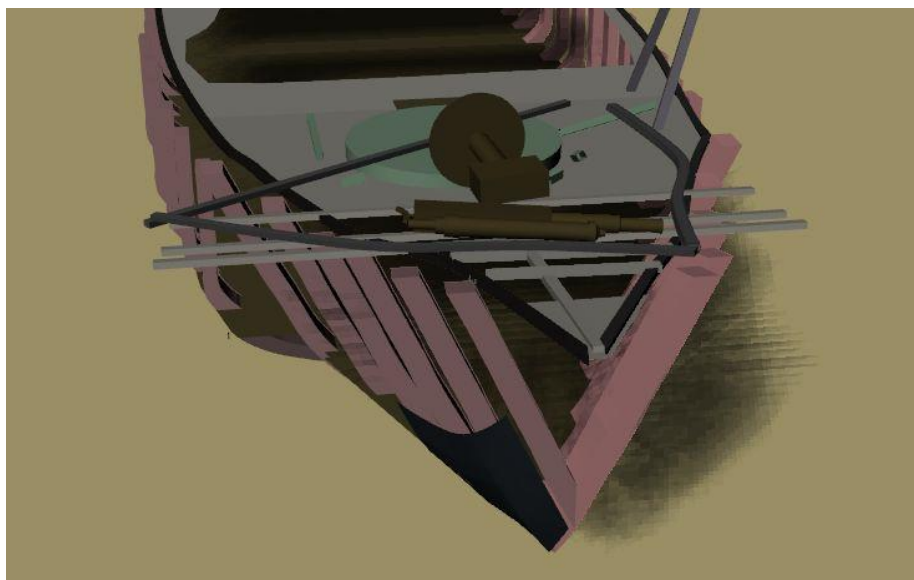


FIGURE 5.59. Bow features, including the deck gun and platform are observed. (Created by author, 2014.)

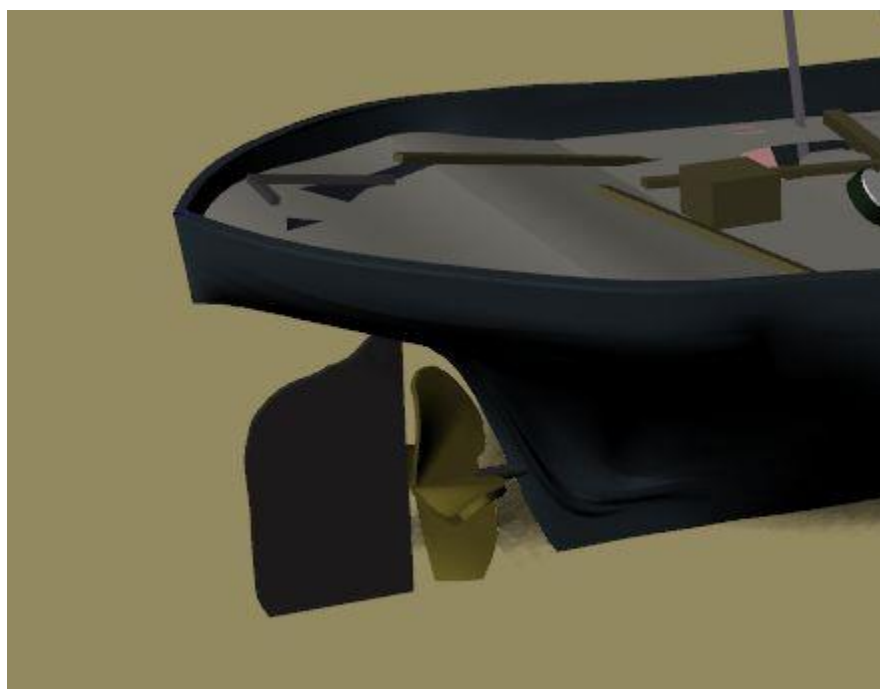


FIGURE 5.60. Rudder, propeller and stern features are still able to be identified. (Created by author, 2014.)

The Rhino model of the archaeological remains for *YP-389*, Group C, is an interpretation of the evidence provided in the multibeam image and the ROV video recorded during the Battle of the Atlantic expedition in 2009. There is evidence of military conversions, specifically with

the deck gun evident at the bow. Although depth charge evidence was not discovered, this is in part because video may not have been able to find the exact spot of the remaining charges. Regardless, site features were able to be identified corresponding with the evidence provided in the historical record. In the next chapter, further interpretation of the archaeological remains will be discussed as relating to site formation and methods of technological change.

Conclusion

Evidence has been collected to evaluate three phases in the life of each of the selected vessels. Rhino models were created to represent this information to be further evaluated to determine methods of technological change. Illustrating each phase, beginning with evidence of original use and purpose, to the converted phase and change to military use, to the remaining archaeological evidence, each vessel can be further analyzed to possibly better understand a method for converting a commercial vessel for military use. Each vessel went through a different process, transformed from a commercial vessel with a specific use and design, to sharing similar features and performing similar functions following a distinct conversion process. This process will be further analyzed in the next chapter to determine a method of technological change as commercial vessels are converted for military use.

CHAPTER SIX: ANALYSIS OF CASE STUDIES

Introduction

As world events of the late 1930s unfolded, changes to vessel use and function followed. Each of the selected vessels went through a distinct conversion process, changing the function and use from commercial to military. Determining methods for converting the vessels, especially if there were commonalities, might allow for a model, or models, of technological change to be attributed. Using the evidence presented in Chapter Five, it might be possible to determine the effectiveness of the transformations of each vessel, and the converted vessels collectively, to military vessels. Understanding the process of adaptation and the effectiveness of the converted vessels, it may be possible to determine the methods for how vessels are acquired and the determining factors that make each vessel appealing as a candidate for conversion.

The evidence presented in Chapter Five details the three distinct life phases of each vessel. Original design features, conversion orders, and the archaeological remains are all evidence of these life stages. The purpose of this chapter is to analyze and interpret the evidence as transitions were made within each life phase of the vessels. Utilizing models created with *Rhinoceros 5.0*, termed model Group D, visual interpretations of the evidence allowed for a determination of conversion processes as well as an interpretation of the archaeological remains. Site formation processes aid in this interpretation of what happened to the archaeological features as well as how features have possibly been altered. Following this examination of features for each vessel, models of technological change presented in Chapter Three will be evaluated as possible fits for the method of converting commercial craft for military use. Beginning with HMS *Senateur Duhamel*, an examination of the transformations from each stage, with the assistance of illustrations from model Groups A, B, and C, will ultimately lead to an

evaluation of the conversion process of commercial vessels for military use as a model of technological change.

HMS *Senateur Duhamel*

To analyze the conversion process of HMS *Senateur Duhamel*, it is necessary to determine what was either added or removed as a result of the change from commercial to military use. Due to a lack of specific conversion orders, it was necessary to use the information that was pieced together, as outlined in Chapter Five, to determine what features were added and removed. To illustrate this process, two model sets were created of HMS *Senateur Duhamel* to show original features and converted features. In Figures 6.1 and 6.2, the original design for commercial use is displayed for HMS *Senateur Duhamel*. The features from the original design and structure are colored in green.

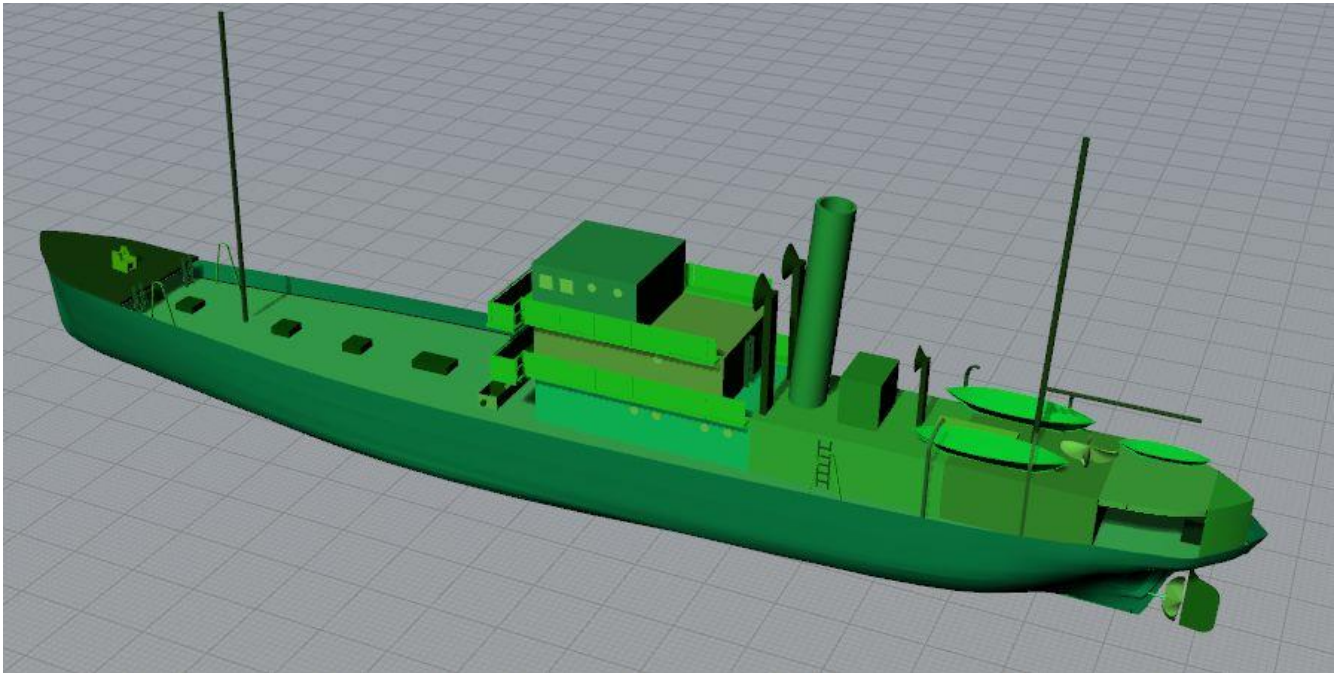


FIGURE 6.1. Port side view of original features, all in shades of green. (Created by author, 2014.)

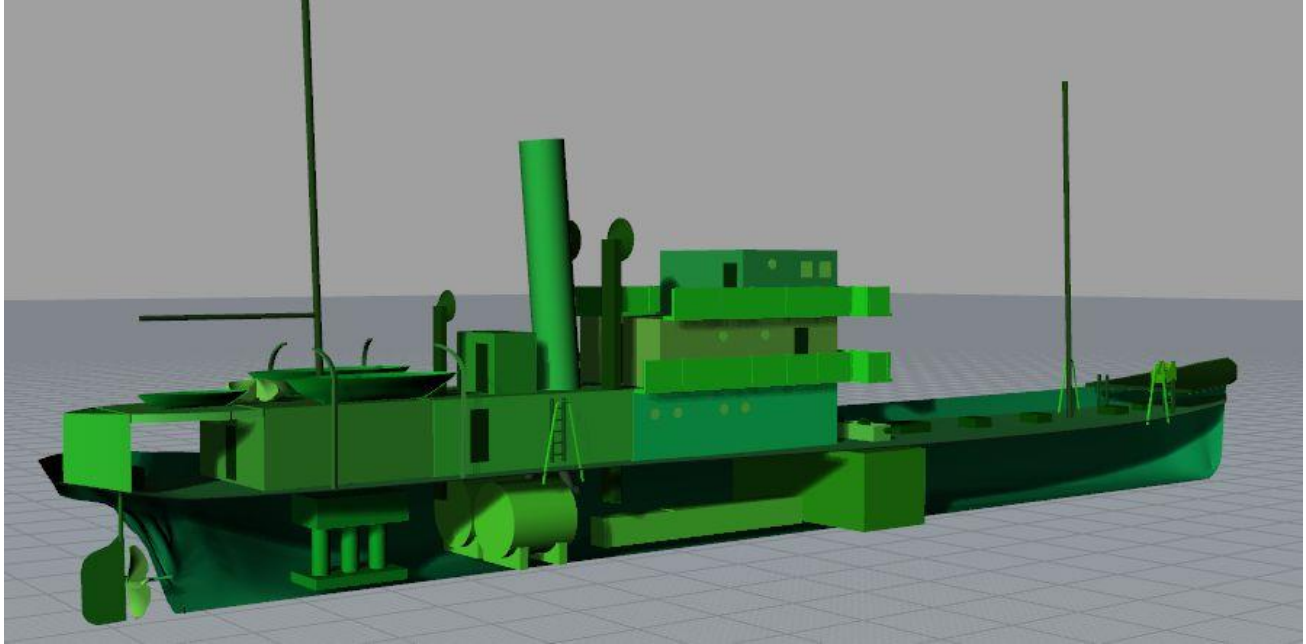


FIGURE 6.2. Starboard side view with hull removed to display internal features. (Created by author, 2014.)

Using the green shading as the base for original features, the following images show the converted features, shaded in red. These images (Figures 6.3 and 6.4) represent converted features as HMS *Senateur Duhamel* was adapted for military use. As is illustrated, certain features were added but there were also features removed.

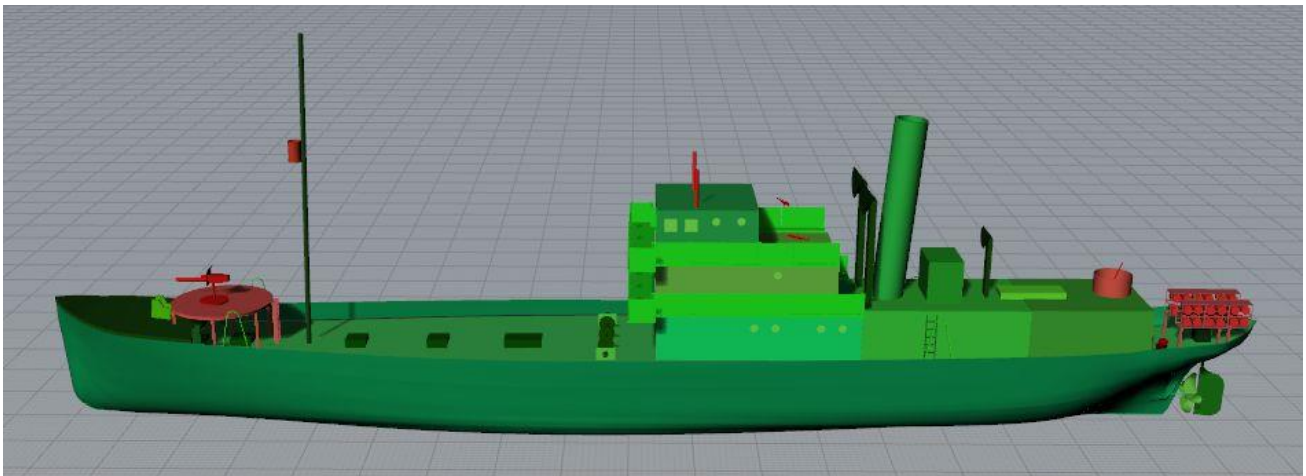


FIGURE 6.3. Port side view displaying converted features. (Created by author, 2014.)

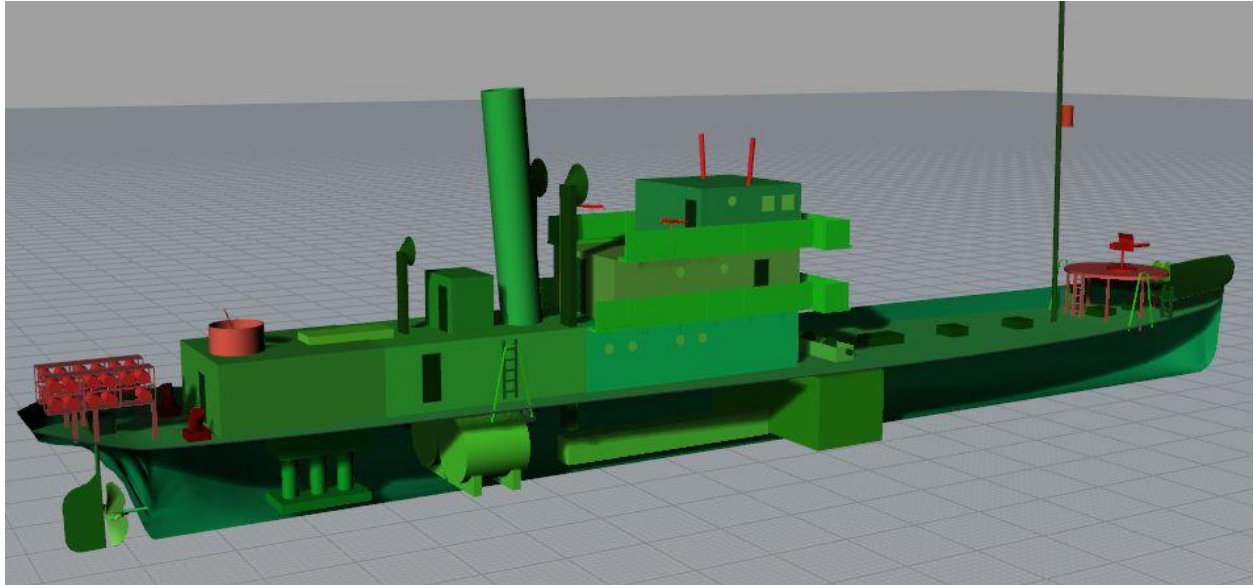


FIGURE 6.4. Starboard side view with hull removed to display internal features. (Created by author, 2014.)

The main features that can be identified, using the available information, in this conversion process are the addition of military equipment. Two main areas of the vessel were utilized for adaptations, the bow and the stern. At the bow, as seen in Figure 6.5, there was the addition of a deck gun, the deck gun platform, and an added ladder to access the deck gun. The deck gun platform, although no specific details are available regarding its size or dimensions, was a substantial modification to the bow of the vessel. It added supplemental coverage underneath the platform that may have provided a location for features that were removed to make space for armament at the stern.

The stern section of HMS *Senateur Duhamel* was the other significant area where modification was visible. As seen in Figure 6.6, the stern area has been converted with the addition of depth charge rails, depth charges, and depth charge throwers.

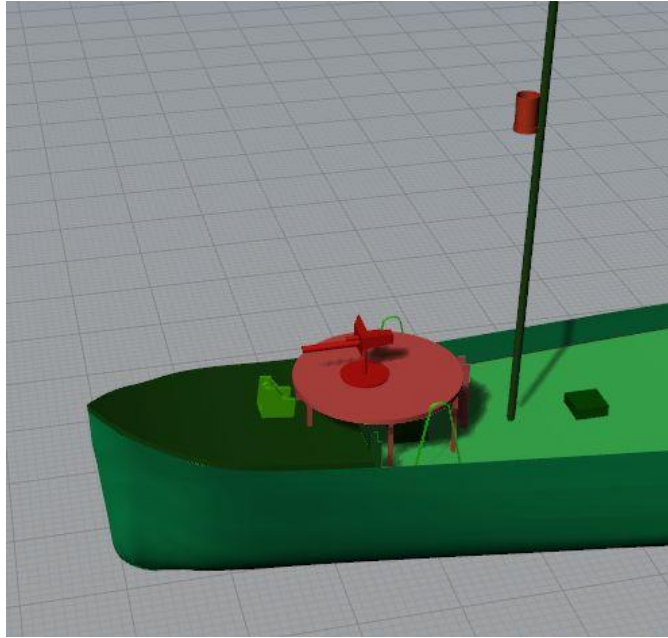


FIGURE 6.5. Deck gun and deck gun mount featured as well as a crow's nest has been added, all colored in red. (Created by author, 2014.)

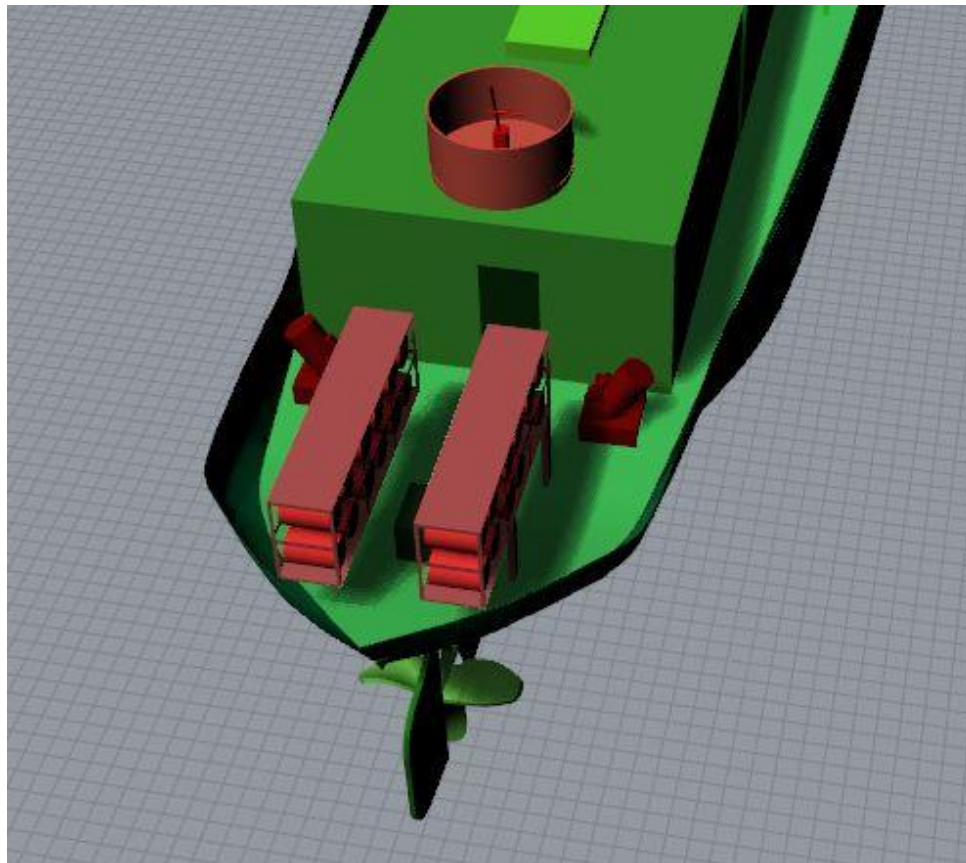


FIGURE 6.6. Depth charge rails, depth charges, depth charge throwers, and the Holman projector all at the stern colored in red. (Created by author, 2014.)

To make adjustments for the addition of the depth charge rails, depth charges, depth charge throwers, and the Holman projector, there was a need to modify the existing structure. As seen in Figure 6.7 there was a water closet located at the stern, along with two life boats and a dinghy.

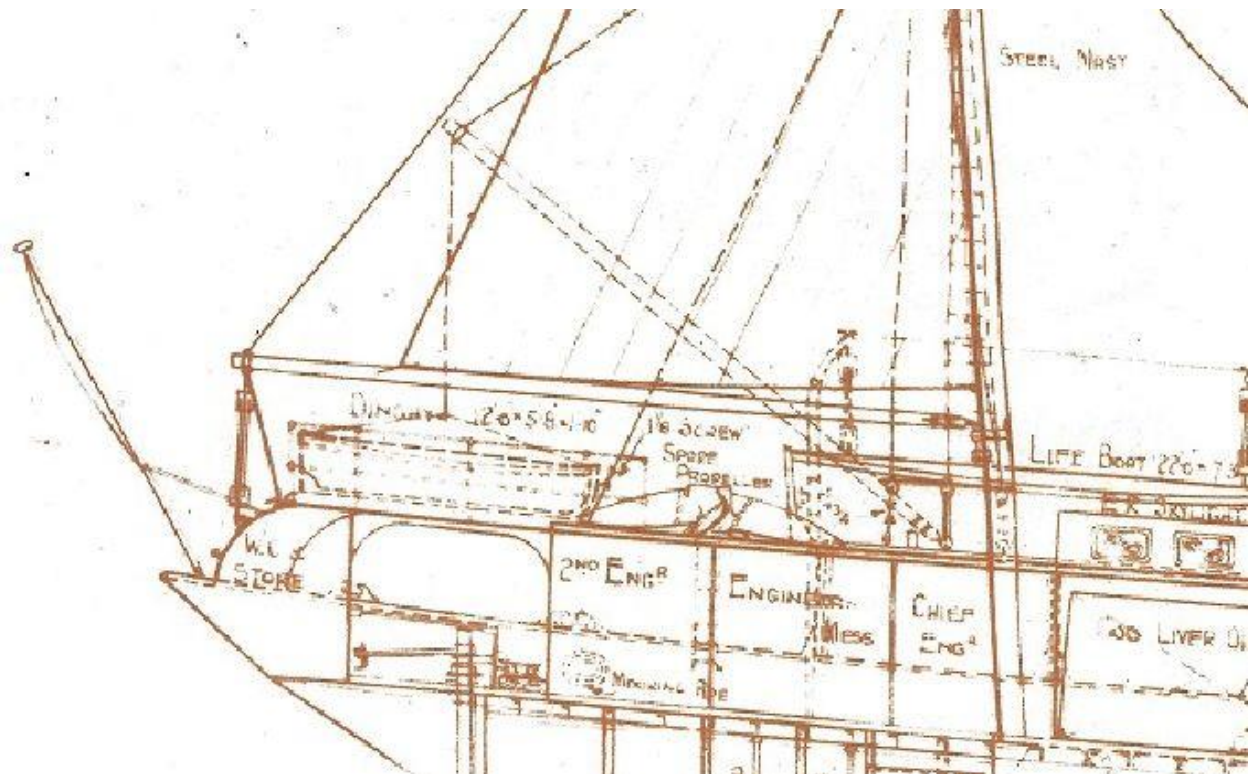


FIGURE 6.7. Original stern section of *Senateur Duhamel* according to builder's plans, displaying the water closet, store, awning, mast, life boats, spare propeller, and dinghy. Date unknown. (Courtesy of Aberdeen Ships.)

There was also a second mast and a spare propeller that were originally placed in the areas that would be adapted for the Holman projector. Without specific conversion records to state exactly what happened to these features, it is interpreted they were removed entirely. As seen in Figure 6.3, the second mast was removed, as well as all life boats and the propeller to make space for the Holman projector. As mentioned in Chapter Five, the water closet, store, and awning were also removed to accommodate the depth charge rails and depth charge projectors, which can be seen in Figure 6.8.



FIGURE 6.8. Converted stern section of HMS *Senateur Duhamel* highlighting depth charge rails, date unknown. (Courtesy of James Reedy, Jr.)

Unfortunately, it is not known exactly where a modified water closet, as well as the spare propeller, would have been moved as detailed conversion records are unavailable.

Additional armament features were added to the area around the wheel house. As seen in Figure 6.9, two Hotchkiss machine guns as well as two aircraft parachutes were added as part of the conversion process.

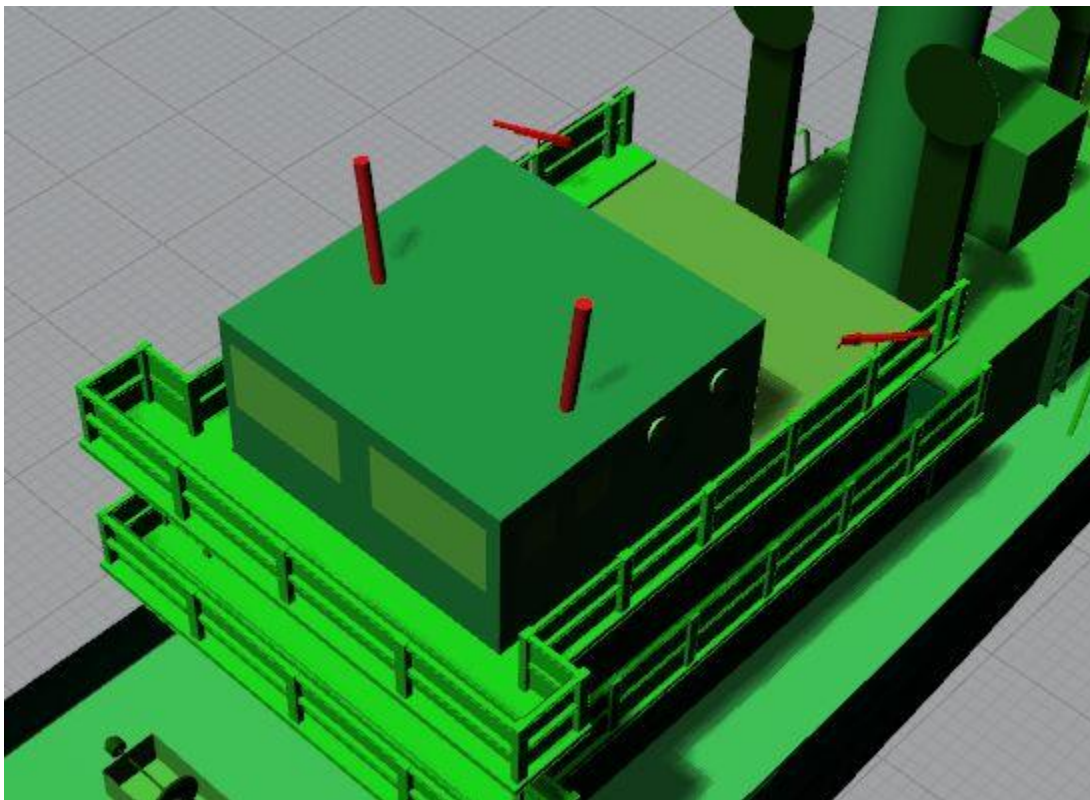


FIGURE 6.9. The two aircraft parachutes on top of the wheel house and the two Hotchkiss machine guns along the railing, all colored in red. (Created by author, 2014.)

All of these added features were for military use. The commercial aspects of the vessel, including the trawl gallows and trawl winch, appear to have remained following the conversion process. This could be emblematic of a decision to keep certain aspects of the original vessel intact, possibly as either being too expensive to remove or a desire to return the vessel to original purpose following military use.

The transformation of the commercial fishing vessel *Senateur Duhamel* to HMS *Senateur Duhamel*, the anti-submarine military vessel, is a form of reuse. As described previously in Chapter Three, understanding how an object was used is a result of analyzing the evidence. The transformation of the vessel from commercial to military use could be considered a form of secondary use. Alterations were made to the fishing vessel to change its purpose, creating a different form and function of the vessel. Considering modifications, as interpreted, did not drastically change the majority of aspects of the vessel, this aligns with Michael Schiffer's definition of secondary use. Schiffer stated, "objects often take on a new use without needing extensive modifications. This type of reuse process is termed secondary use" (Schiffer 1987:31). As interpreted, the modifications were not extensive enough to ultimately create a completely new vessel and even possibly allowed for a return to original use and function following the end of military operations. This process of converting *Senateur Duhamel* in such a manner could also be similar and reflected in the other selected vessels.

Further interpretation of the adaptation process for HMS *Senateur Duhamel* is limited due to the lack of specific conversion orders. It can be interpreted that modifications to the fish hold and compensating for the ballast were undertaken, but specifically how this was done is unknown. Other aspects including armament, such as ammunition stores, would have to be included somewhere within the vessel as well. Modifications to the fish hold could have

compensated for the ballast as well as held ammunition or other necessary stores, but this information cannot be confirmed using the evidence presented. It is possible some of these aspects could be interpreted within the archaeological evidence. An interpretation of original and converted features differentiated within the archaeological remains may account for these missing conversion details.

The archaeological remains, as interpreted using the presented information in Chapter Five, are illustrated using the same color coded system representing original and converted features. In Figures 6.10 and 6.11, different views of the wreck site are presented, highlighting original design features in green and converted features in red. This model set is representative of Group D. In Figure 6.11, site features, as best interpreted, have been identified.

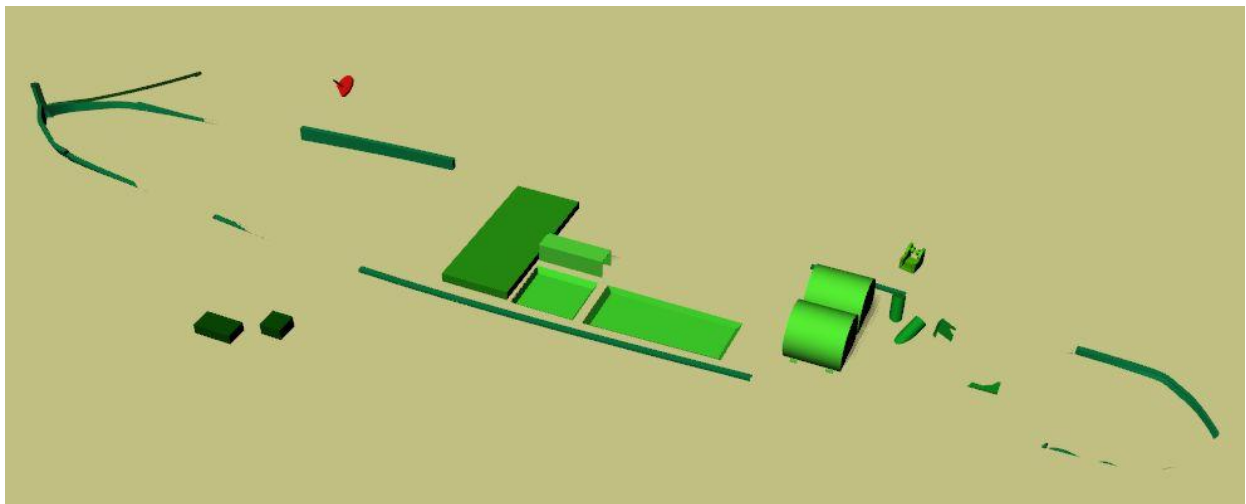


FIGURE 6.10. Port side view of archaeological remains, color coded in green and red. (Created by author, 2014.)

Model D for HMS *Senateur Duhamel* illustrates a large amount of remaining features to have come from the original structure of the vessel. Most features from the deck, including the wheel house, galley, and engine casing are all missing from the wreck site. The gun mount is the only identifiable feature remaining from the conversion process. The depth charge rails, depth charge throwers, and depth charges themselves were not able to be identified during the NOAA

dive in 2012 and were either destroyed, buried, or removed through some other means. With the wreck site being within recreational dive limits, at 65 feet, there is a great possibility of human interaction with this site.

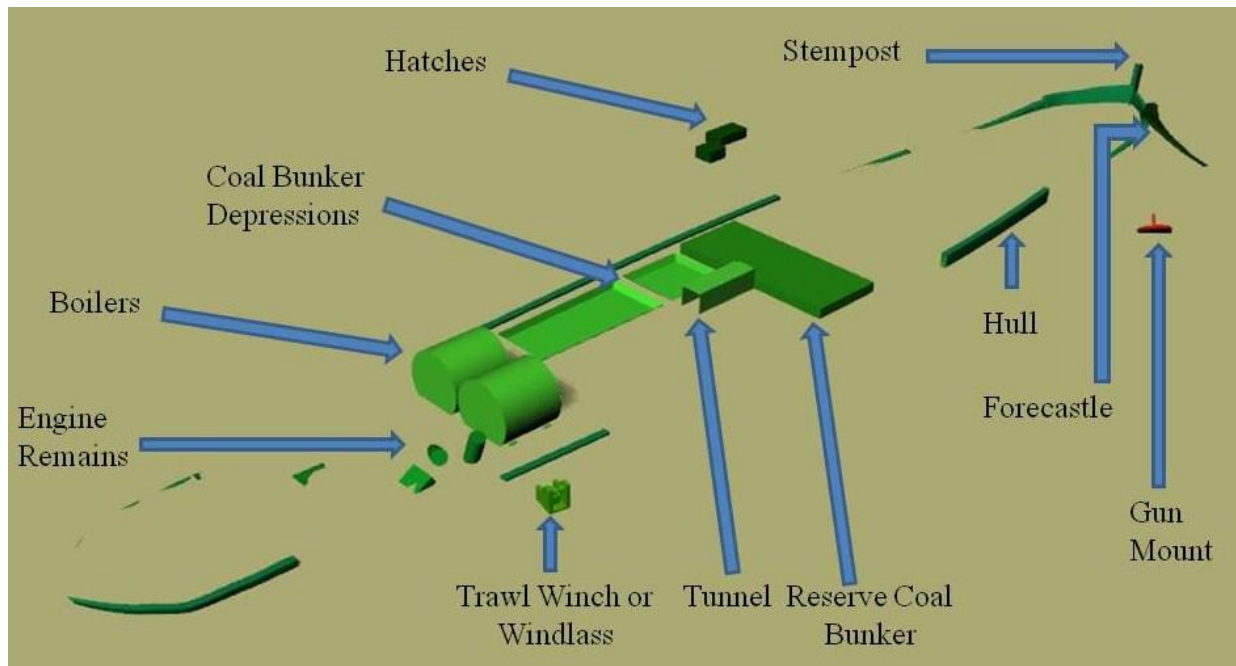


FIGURE 6.11. Feature identification of archaeological remains, color coded. (Created by author, 2014.)

There have been a number of human related behaviors, c-transforms, acting on the wreck site of HMS *Senateur Duhamel*. First, the wrecking event was a direct result of human error and the collision with USS *Semmes* caused a great deal of damage to both vessels. The structure of HMS *Senateur Duhamel* would have been impacted and it is possible aspects of the conversion process were affected, resulting in an inability to distinguish these features from original structure. Secondly, reports of blasting the wreck site by *Vigilant*, because HMS *Senateur Duhamel* was considered a navigational hazard, could greatly impact interpretation of the archaeological remains. Deck structure, masts, and features like the wheel house and galley, would be susceptible to dynamite blasts. Converted features such as the Hotchkiss machine guns, Holman projector, and aircraft parachutes all located on these structures, could have been

destroyed due to the blasting. This blasting is most likely the reason for many remains to be unidentifiable, as it was difficult to discern twisted metal structures, such as seen in Figure 6.12.



FIGURE 6.12. Unidentifiable metal structure on HMS *Senateur Duhamel*, 29 July 2012. (Courtesy of John McCord, CSI.)

A third aspect of human interaction on the wreck site is from recreational divers. As a navigational hazard, the location was well known and happens to be within recreational diving limits. At 65 feet deep it has been a frequented dive location for a long time. Many features could have been removed by recreational divers, seeking artifacts from a World War Two wreck.

Of the remaining archaeological evidence, few structures remain in place for identification. However, certain aspects can still be deciphered. Boilers and the tunnel used to move coal extending into the reserve coal bunker are still identifiable features of the wreck site. There are pieces of hull structure still evident, as well as what is considered the stem post. These aspects provide a context for the extents of the wreck site, but other structures important to determining conversion processes are missing. Aside from part of the deck gun mount, there are

no identifiable military features. Due to the large number of depth charges, numbering 60 (Salmon 1994), it is surprising during the NOAA dive of 2012 there was no evidence of them being located. As there was no reported use of the depth charges, it would seem as there would be a large number of them still visible. It is possible there are other factors that impact the remaining features of the wreck site as well.

Non-cultural processes, n-transforms, from the natural environment may have an impact on the visible archaeological remains. It is possible, due to the depth, that wave action or ocean current could move sediment around the wreck site, covering and obscuring smaller objects. Sediment movement could account for certain objects being visible while others are covered by the shifting bottom. In the following list, Table 6.1, a description of site formation processes is presented for HMS *Senateur Duhamel*. The table outlines processes that were identified (observed), not identified (not observed), as well as information that was unable to be ascertained. In the description table, transitions are mentioned as going from one model group to the next, such as model Group A to model Group B. This reflects the process of moving through one life phase to the next for the selected vessel. Unfortunately, the effects of natural causes are only able to be speculated upon, as a full understanding of site conditions are unknown at this time. The most plausible processes acting upon the site stem from human interactions and are taken into account when determining aspects of technological change.

Site Formation Processes	Description	Observed	Not Observed	Unknown
Recycling	Use function in transition from A - B		X	
Lateral Cycling	Use function in transition from A - B	X		
Secondary Cycling	Use function in transition from A - B	X		
Conservatory Processes	Use function in transition from A - B		X	
Wrecking Event	Scrambling Device and Extractive Filter, Transition B - C	X		
Salvage Operations - Recreational	Extractive Filter, Transition B - C	X		
Salvage Operations - Commercial/Military	Extractive Filter, Transition B - C	X		
Commercial Fishing	Extractive Filter, Transition B - C			X
Disintegration of Perishables	Extractive Filter, Transition B - C	Most Likely		
Tidal Currents/Wave Action	Scrambling Device, Transition B - C			X
Sediment Disturbance	Scrambling Device, Transition B - C			X
Corrosion	Scrambling Device, Transition B - C	X (not analyzed)		

TABLE 6.1. Site formation processes observed for HMS *Senateur Duhamel*. (Created by author.)

Considering the modification process for HMS *Senateur Duhamel* in terms of technological change, it may be difficult to place it within a single model given the available information. Using a color coded system to illustrate features, changes over time can be clearly identified on the vessel, definitively showing a conversion process. The transformation from original commercial use to military operations utilized specific modifications in a few key areas. These observable modifications to HMS *Senateur Duhamel*, following the wrecking event, were greatly obscured due to, most likely, human interaction with the site. The identification of only the deck gun mount, as seen in Figures 6.10 and 6.11, as an aspect of the conversion process confirms the vessel's military capabilities but also places higher priority on the historical record

to evaluate the transformation process. Using this available information, consideration for a technological model cannot be clearly established. However, as stated in Chapter Five, the available information for each vessel is different, and therefore, if using the information collectively, it may be possible to evaluate all three vessels to determine a model for technological change. An evaluation of technological change will be considered on a case by case basis. However, it will be most effective to consider all three vessels collectively.

HMT *Bedfordshire*

As with the analysis of HMS *Senateur Duhamel*, the conversion process of HMT *Bedfordshire* was evaluated by determining features that were either added or removed as a result of the change from commercial to military use. Due to a lack of specific conversion orders, it was necessary to use the information that was pieced together, as outlined in Chapter Five, to determine feature changes. To illustrate this modification process, two model sets were created of HMT *Bedfordshire* to show original features and converted features. In Figures 6.13 and 6.14, the original design for commercial use is displayed for HMT *Bedfordshire*. The features that are from the original design are colored in green.

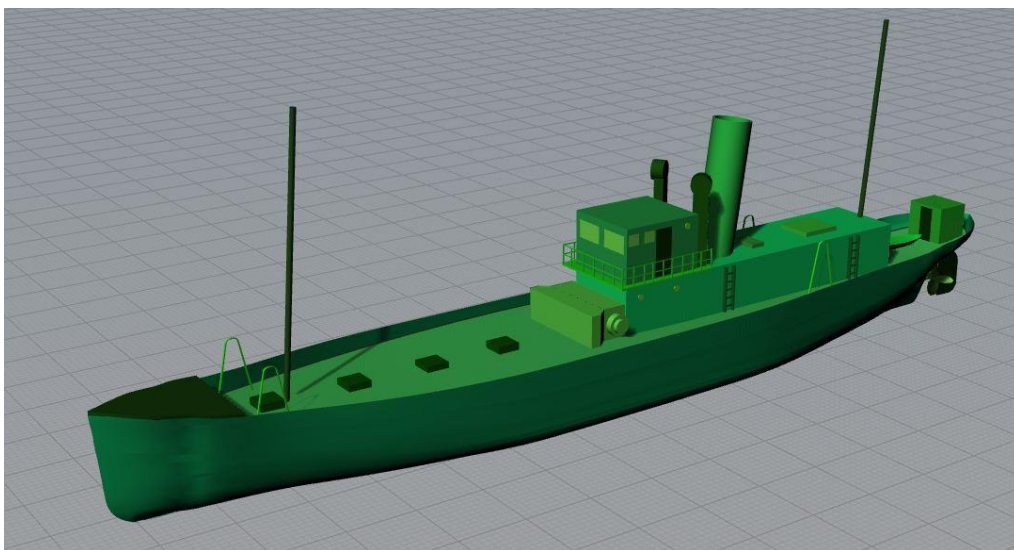


FIGURE 6.13. Port side view of original design of *Bedfordshire*. (Created by author, 2014.)

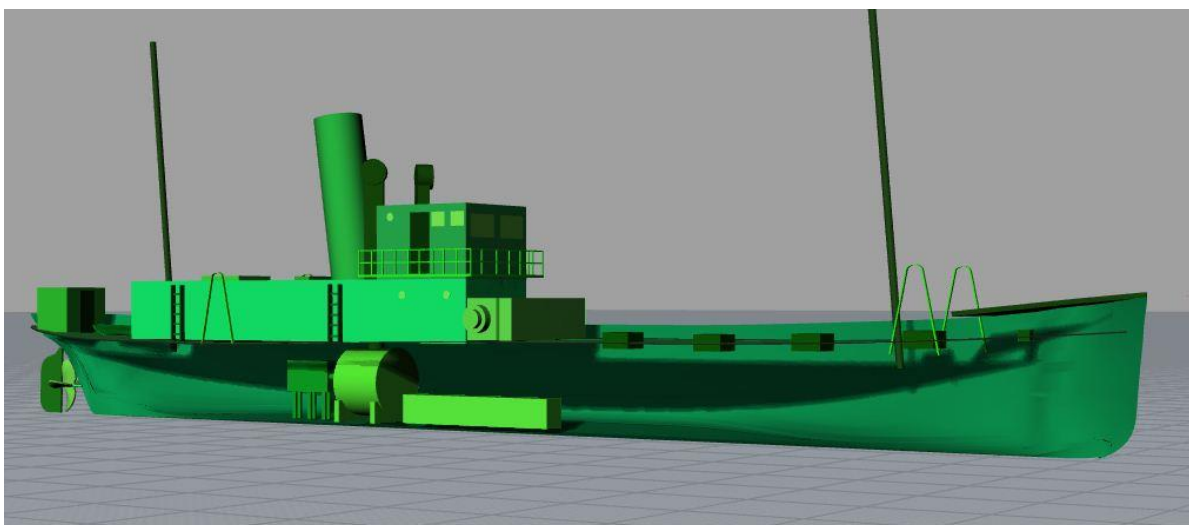


FIGURE 6.14. Starboard side view with hull removed to display original inner features of *Bedfordshire*. (Created by author, 2014.)

Using the green shading as the base for original features, the next set of images show the converted features, shaded in red. These images (Figures 6.15 and 6.16) represent converted features as it was adapted for military use. As is illustrated, certain features were added, but there were also features that were removed, which will be discussed further.

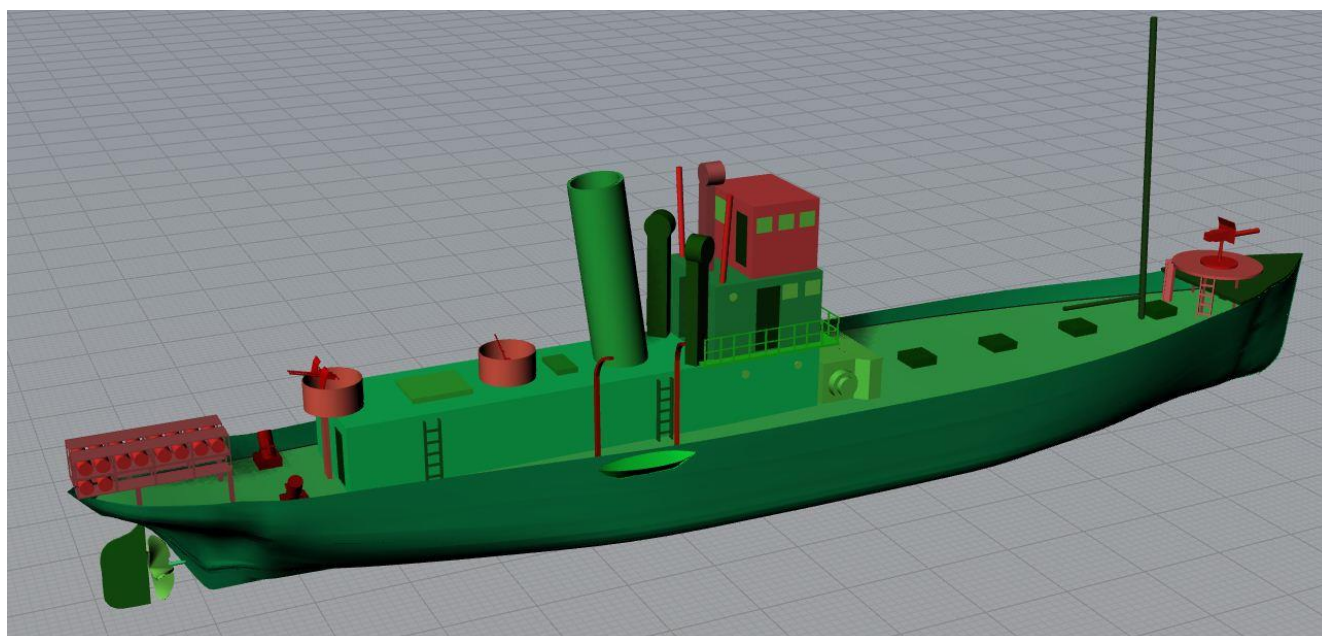


FIGURE 6.15. Converted features in red, starboard side view of HMT *Bedfordshire*. (Created by author, 2014.)

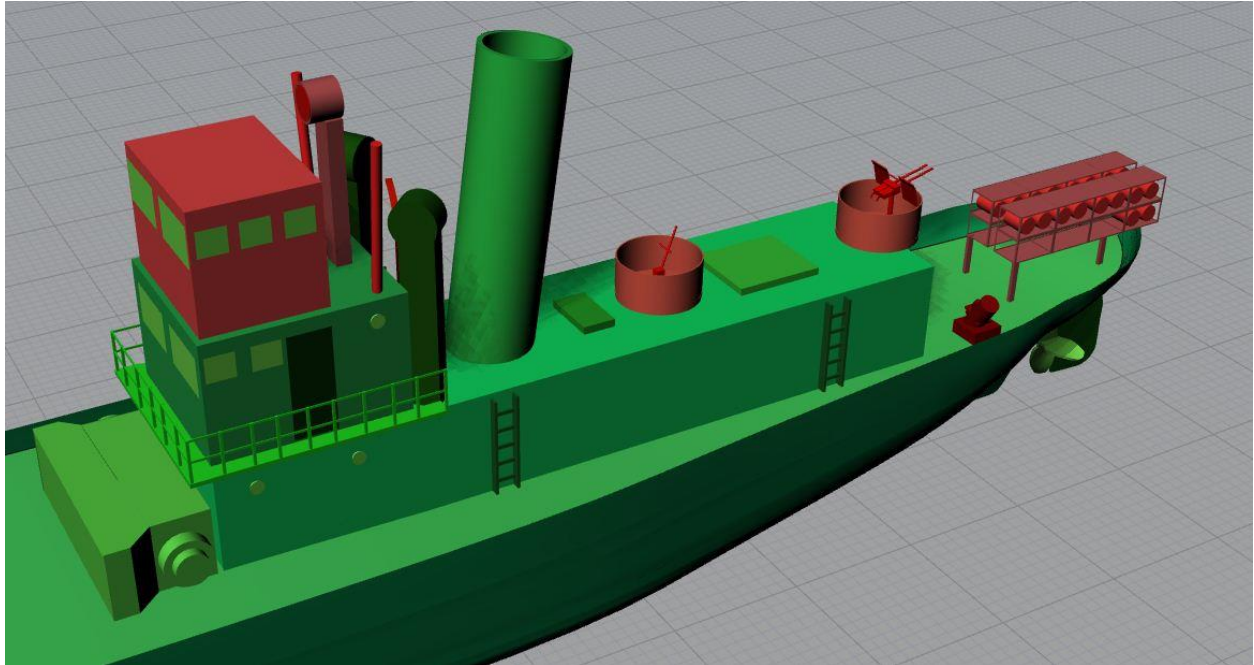


FIGURE 6.16. Converted features include built up compass house, Holman projector and depth charge rails. (Created by author, 2014.)

Using the available conversion information, as detailed in Chapter Five, there were numerous additions made to HMT *Bedfordshire*. As with HMS *Senateur Duhamel*, the majority of the converted features are military in nature. As seen in Figure 6.17, the addition of the deck gun and deck gun platform at the bow, prominently displayed military equipment.

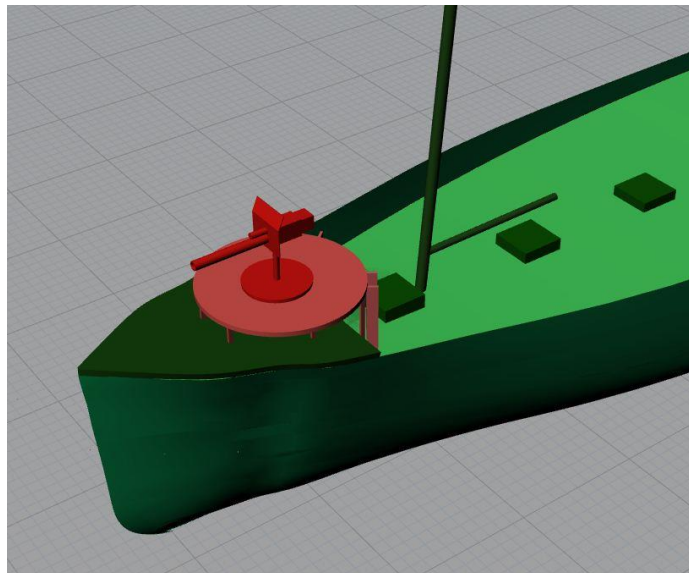


FIGURE 6.17. Deck gun and deck gun mount colored in red, located at the bow of HMT *Bedfordshire*. (Created by author, 2014.)

As with HMS *Senateur Duhamel*, the deck gun platform on HMT *Bedfordshire* provided additional coverage, possibly used as available space for features removed or altered through the conversion process. As seen in Figure 6.18, the deck gun platform provided coverage and space that could be utilized by the crew. Specific information about how this space was used is unfortunately unavailable.



FIGURE 6.18. Deck gun platform of HMT *Bedfordshire*, July 1941. (Courtesy of Bedfordshire Archives, United Kingdom.)

The bow area was a prominent section for conversion, but the stern section of the vessel contained numerous other alterations as well.

As is seen in all the vessels, depth charge rails were added, allowing for depth charges to be rolled directly off the stern. Similar to HMS *Senateur Duhamel*, HMT *Bedfordshire* also contained depth charge throwers, seen in Figure 6.19.

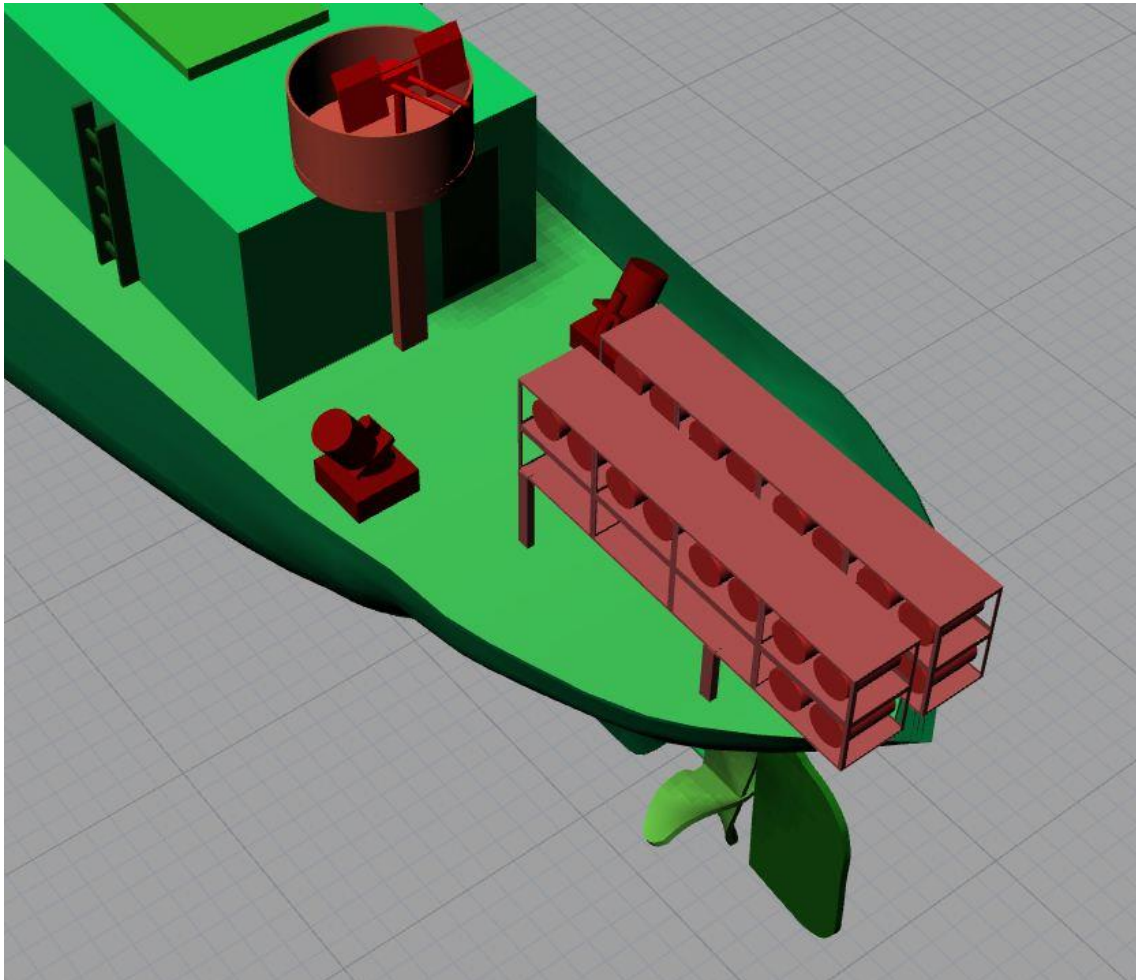


FIGURE 6.19. Stern section of HMT *Bedfordshire*, displaying Vickers machine guns, depth charge rails and depth charge throwers. (Created by author, 2014.)

To make the necessary adjustments of adding depth charge rails, depth charge throwers, and the Vickers machine guns, alterations and modifications were made to the existing structure. As seen in Figures 6.20 and 6.21, there was a water closet located within the stern house, also identified as boiler house, as well as a life boat and the second mast.

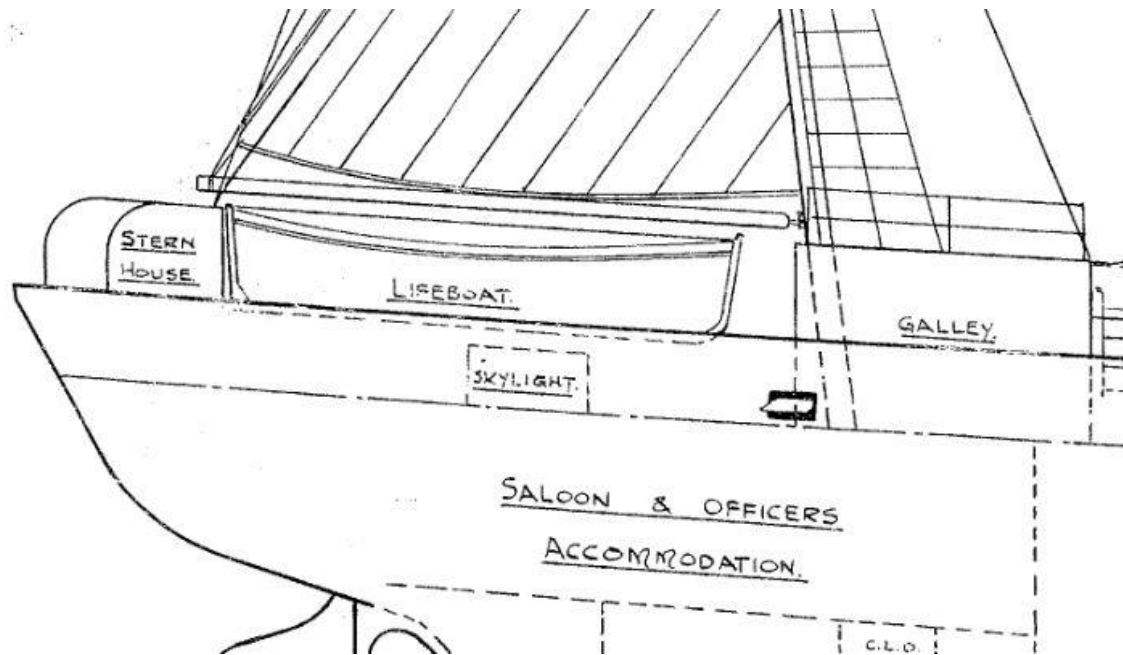


FIGURE 6.20. Stern section of *Bedfordshire* according to original builder's plans, displaying stern house, skylight, lifeboat, and the second mast extending from the galley. Date unknown. (Courtesy of National Maritime Museum, London, United Kingdom.)

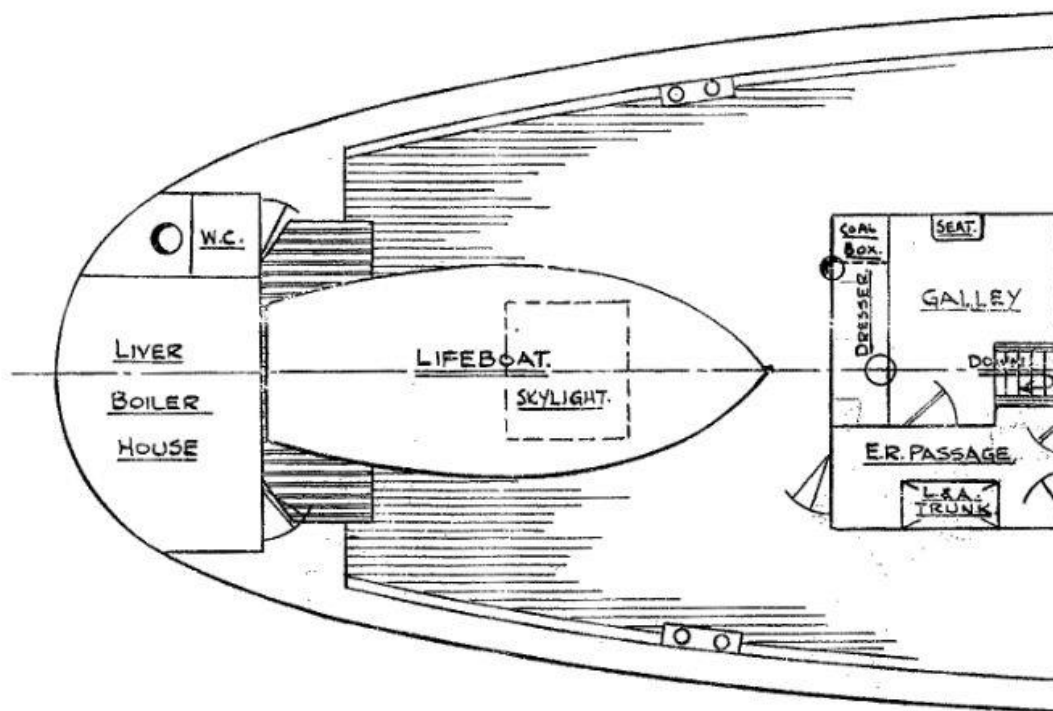


FIGURE 6.21. View of deck features for *Bedfordshire*, displaying original features such as the boiler house/stern house, lifeboat, and skylight, all of which would have been altered during the conversion process. Date unknown. (Courtesy of National Maritime Museum, London, United Kingdom.)

These structures, without having specific conversion orders, are interpreted as being removed entirely from the stern section of the vessel. The second mast was also removed to accommodate the Vickers gun platform, placed above the galley structure. The life boat is interpreted as being relocated and placed off the starboard side of the vessel. This interpretation is due to evidence of a pulley system, seen in Figure 5.29, which most likely would accommodate the life boat.

Also seen in the same image (Figure 5.29) are the vertical parachute rocket tubes, searchlight, and the compass house, which were all converted features, added to the existing structure. As seen in Figure 6.22, these same converted features are identified by the color red.

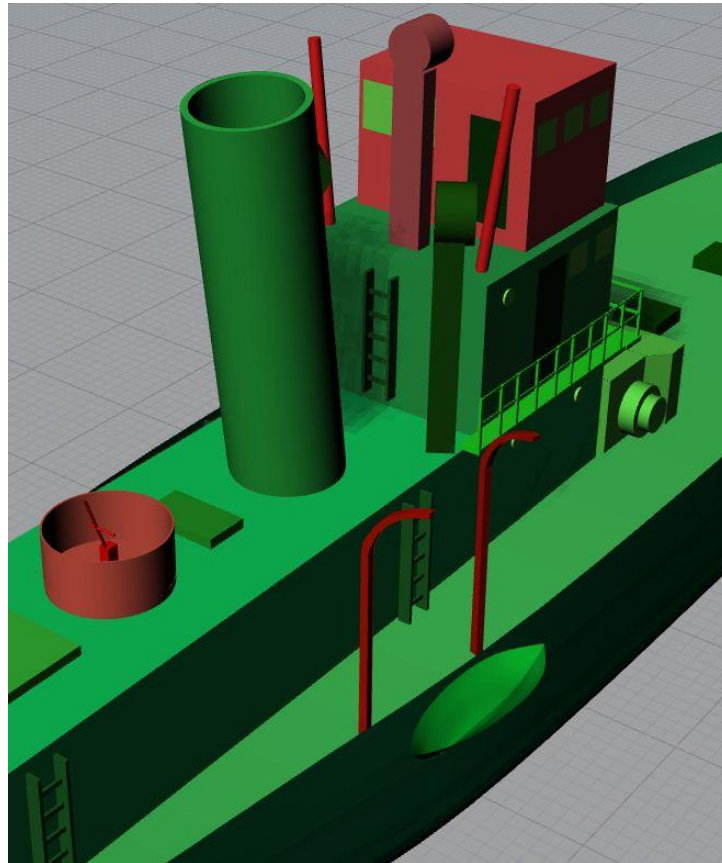


FIGURE 6.22. Mid-ship area displaying pulley system for the life boat, parachute rockets, compass house, and Holman projector. (Created by author, 2014.)

Using the available evidence, the converted features that were added are known. However, how these features were added or the decision process in placing them is not. All of these features

were added as part of the military conversion process for the purpose of military use, yet there were many remaining commercial features, such as the large trawl winch, left on the vessel. It is possible that, as with HMS *Senateur Duhamel*, the conversion process was meant to be temporary with the ability to return the vessel back to original use following military operations.

As with HMS *Senateur Duhamel*, the transformation of HMT *Bedfordshire* for military operations is a form of reuse. Similar to HMS *Senateur Duhamel*, secondary use as a form of reuse can be attributed to the conversion process for HMT *Bedfordshire*, as modifications were not extensive, but the role of the vessel did change. There is also a second form of reuse that can be attributed to this conversion process. Although alterations were made to each vessel, there are attributes of lateral cycling involved. Within the transfer of ownership from a private commercial firm to the Royal Navy, HMT *Bedfordshire* kept its designation as a trawler. Granted, operations as a commercial fishing trawler ceased, but the designation as trawler remained. Many commercial features were kept and the overall design of the original vessels remained intact. Each of the selected vessels in the study ultimately exhibited both forms of reuse resulting from human behavior.

Further interpretation of the adaptation and conversion process of HMT *Bedfordshire* is also limited due to the lack of specific conversion orders. Similar to HMS *Senateur Duhamel*, information regarding location of armament stores and ballast compensation cannot be interpreted given the available historical evidence; however, it may be possible to make determinations utilizing the archaeological evidence. An interpretation of original and converted features differentiated within the archaeological remains may account for missing conversion details. Model Group D for HMT *Bedfordshire* illustrates the original and converted features located with the archaeological remains.

Model Group D for HMT *Bedfordshire*, as seen in Figures 6.23 and 6.24, illustrate the vast amount of remaining features are from the original structure of the vessel.

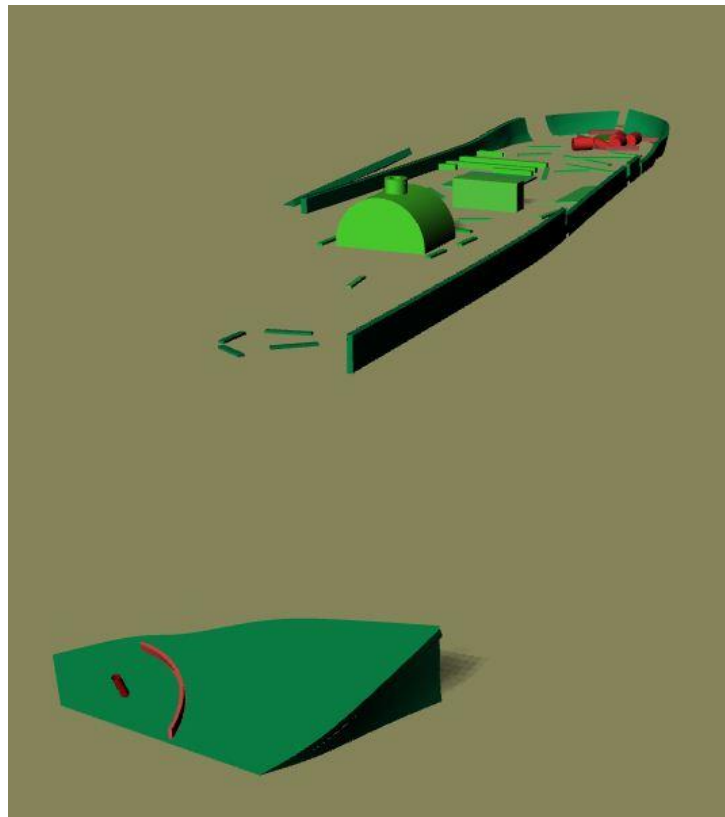


FIGURE 6.23. View of exposed bow and remaining site features, color coded. (Created by author, 2014.)

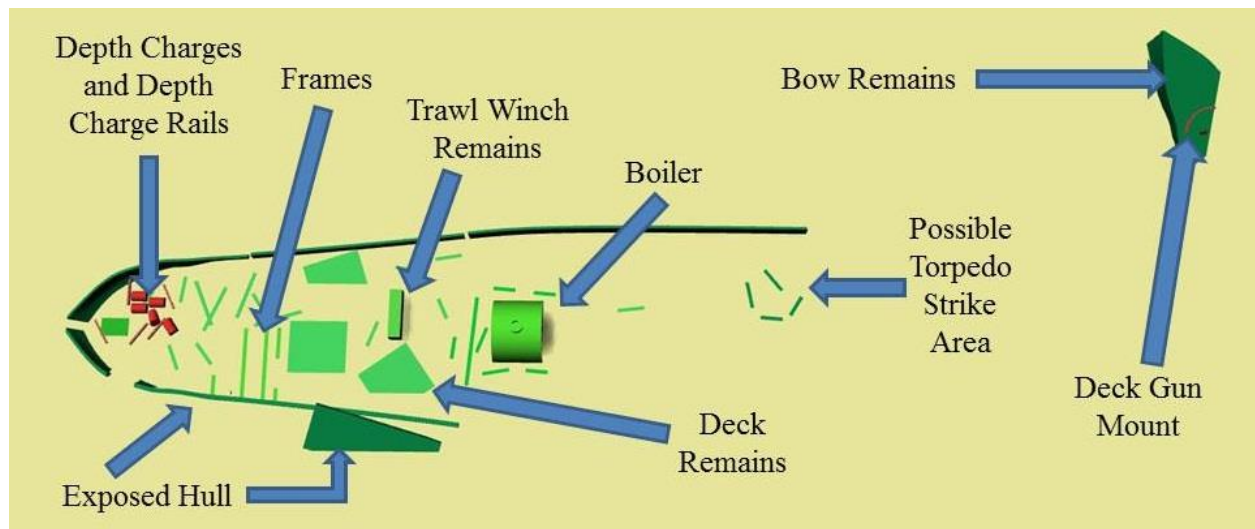


FIGURE 6.24. Feature identification of archaeological remains, color coded. (Created by author, 2014.)

Many features from the deck structure, including the galley, compass room, chart room, and depth charge throwers were unable to be seen or identified. There is disarticulated material that could not be positively identified, similar to the condition of the site remains of HMS *Senateur Duhamel*. Of the converted military features, only aspects of the depth charge rails, part of the deck gun mount, and a few depth charges are left exposed as identified during the NOAA expedition in 2009. The manner in which the vessel was sunk, both violently and quickly, could possibly account for the loss of many of the deck structures but there are also other influences affecting the remaining evidence. At a depth of 105 feet the wreck site is within recreational diving limits and the possibility of features removed by human intervention is great.

Human related behaviors, c-transforms, acting on the wreck site are similar to that of HMS *Senateur Duhamel*. First, the wrecking event was the result of an attack by U-558, using a torpedo that, most likely, separated part of the bow when it struck the ship. Evidence of the deck gun mount is all that remains from this section of the vessel, as the gun itself was unable to be located. Other military features are missing and could have been deposited further away from the wreck site as the vessel settled. It is also possible these same features could have been removed due to salvage operations by recreational divers. The NOAA expedition in 2009 completed a full site recording of the archaeological evidence and, as previously mentioned, only a few aspects of military conversion features remain. The smaller military features, such as the Vickers machine guns and Holman projector, are missing from the remains and it is possible these items could have been intentionally removed. Of the remaining non-military features that can be identified are hull and deck structures, part of the trawl winch, and the boiler, all of which are larger objects more difficult to remove. Considering the available archeological evidence, the influence of human behavior upon this evidence is great, however, there are other influences as well.

Non-cultural processes from the natural environment may have an impact on the visible archaeological remains. It is possible, due to the depth, ocean current could move sediment around the wreck site, covering and obscuring smaller objects. Sediment movement could account for certain objects being visible while others are covered by the shifting bottom. The following list, Table 6.2, describes site formation processes acting on the remains of HMT *Bedfordshire*. The table outlines processes that were able to be identified (observed), not identified (not observed), as well as information that was unable to be ascertained.

Site Formation Processes	Description	Observed	Not Observed	Unknown
Recycling	Use function in transition from A - B		X	
Lateral Cycling	Use function in transition from A - B	X		
Secondary Cycling	Use function in transition from A - B	X		
Conservatory Processes	Use function in transition from A - B		X	
Wrecking Event	Scrambling Device and Extractive Filter, Transition B - C	X		
Salvage Operations - Recreational	Extractive Filter, Transition B - C	Most Likely		
Salvage Operations - Commercial/Military	Extractive Filter, Transition B - C			X
Commercial Fishing	Extractive Filter, Transition B - C		X	
Disintegration of Perishables	Extractive Filter, Transition B - C	Most Likely		
Tidal Currents/Wave Action	Scrambling Device, Transition B - C			X
Sediment Disturbance	Scrambling Device, Transition B - C			X
Corrosion	Scrambling Device, Transition B - C	X (not analyzed)		

TABLE 6.2. Site formation processes observed for HMT *Bedfordshire*. (Created by author.)

As with HMS *Senateur Duhamel*, the effects of natural causes are only able to be speculated upon, as a full understanding of site conditions are unknown at this time. The most plausible

processes acting upon the site stem from human interactions and are taken into account when determining aspects of technological change.

Considering the modification process for HMT *Bedfordshire* in terms of technological change, it is difficult place it within a single model given the available information, similar to the situation with HMS *Senateur Duhamel*. The transformation from original commercial use to military operations utilized specific modifications in a few key areas. These observable modifications to HMT *Bedfordshire*, following the wrecking event, were likely greatly obscured due to human interaction with the site. The identification of the deck gun mount at the bow and depth charges, as seen in Figures 6.23 and 6.24, as aspects of the conversion process confirms the vessel's military capabilities but also places higher priority on the historical record to evaluate the transformation process. Although there is more photographic evidence in the historical record to evaluate the transformation, there still lacks definitive conversion orders explaining the process itself. Using the available information, consideration for a technological model cannot be clearly established exclusively for this case. However, a better understanding can be developed when combined with the evaluation of HMS *Senateur Duhamel*. Consideration for a model of technological change will utilize analyses of each of the vessels, combining the evaluations to make a final determination.

YP-389

As with the other selected vessels, analysis of the conversion process for *YP-389* begins with a determination of features both added and removed during the transformation from commercial to military use. Builder's plans were missing. However the existing images of the building process and those available prior to the conversion orders being completed, allowed for an original model of the vessel to be created. Conversion orders are available from when

Cohasset was first converted to *AMc-202*, but if there were any further modifications of non-military character made following the reclassification to *YP-389*, this information is unknown. To highlight the conversion process, the color coding system used for the previous two selected vessels was utilized. The features of the original *Cohasset* design are in green and seen below in Figures 6.25 and 6.26.

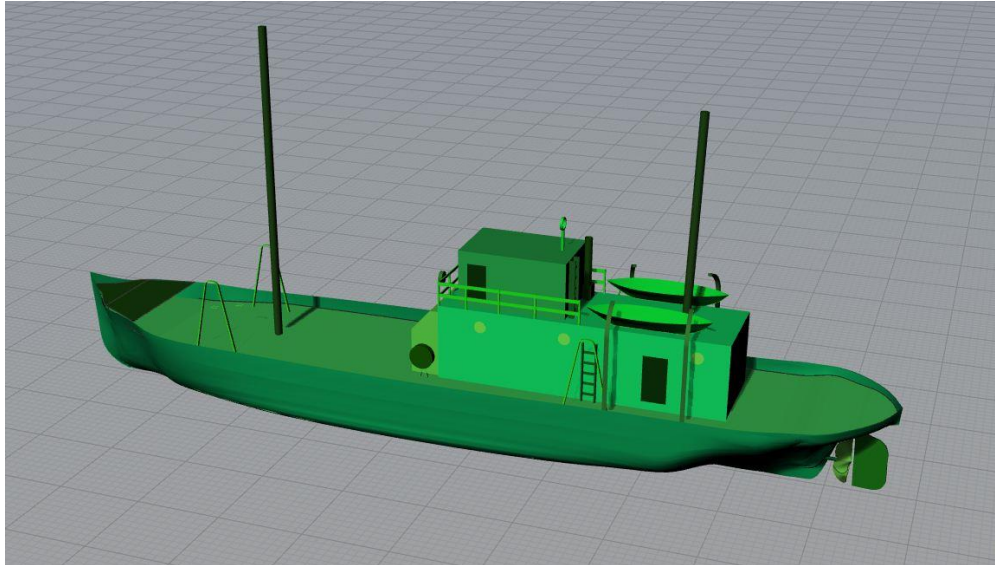


FIGURE 6.25. Port side view of original features for *Cohasset*. (Created by author, 2014.)

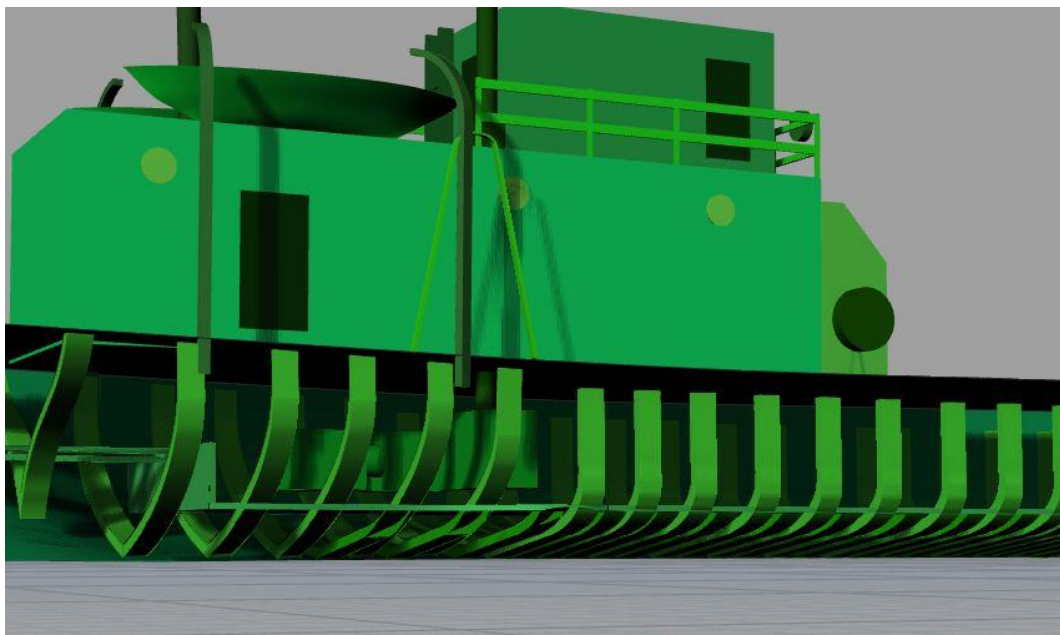


FIGURE 6.26. Starboard hull removed to display framing pattern of *Cohasset*. (Created by author, 2014.)

The converted features, as seen in Figures 6.27 and 6.28, are highlighted in red. Again, the converted features represent additional structure added for military operations. Other features were also altered and removed, which will be discussed further.

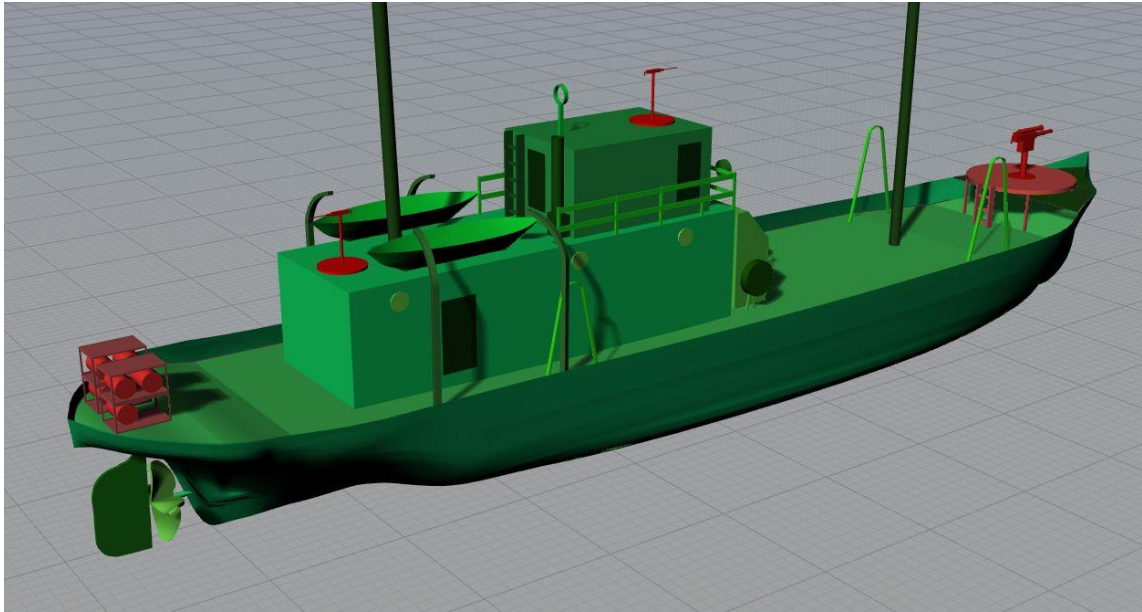


FIGURE 6.27. Starboard side view of YP-389 with converted features highlighted in red. (Created by author, 2014.)

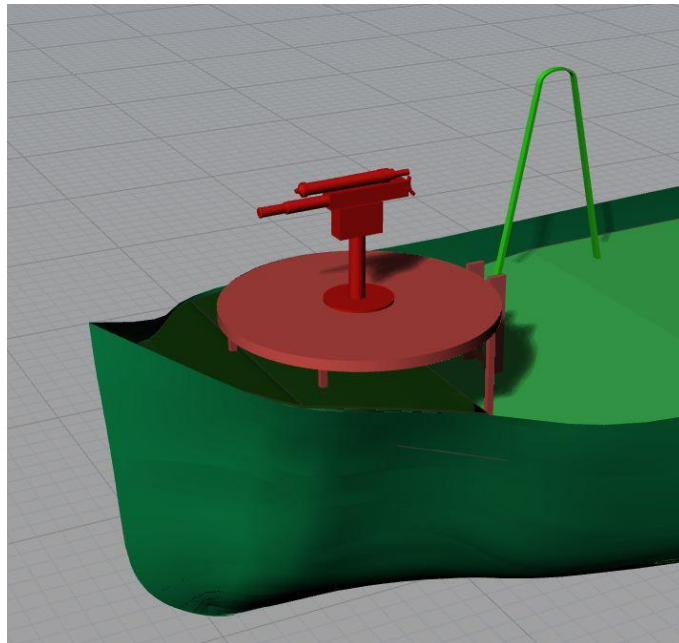


FIGURE 6.28. Bow of YP-389 displaying deck gun, highlighted in red. (Created by author, 2014.)

The main features added to the vessel as part of the conversion process are of military value. The deck gun, machine guns, and the depth charges were all added for military purposes. As part of the conversion orders, mentioned previously in Chapter Five and seen in Figure 5.46, installation of these armament pieces was completed by 21 February 1942. Included in these orders is reference to alterations made under the forecastle, stating, “labor and material to fabricate and install transverse bulkheads of wood complete with doors and fittings port and starboard in forepeak,” (Commandant Third Naval District 1943). This increase in space could have many uses, however, how it was exactly used is not known.

As discussed with the previous two vessels, the stern section of *YP-389* was adapted for placement of the depth charge rails. Little information is available as to how the depth charge rails were placed and if anything was removed to allow for their placement. As is seen in Figure 6.29, the stern section prior to conversion did not contain any specific feature, such as a water closet, and therefore minor alterations for the placement of the depth charge rails were expected.



FIGURE 6.29. Stern of *Cohasset*, prior to conversion in February 1942. (Courtesy of National Archives.)

The stern of *Cohasset* was modified to hold a total of six depth charges, four loaded on two racks, and two available as spares. This most likely did not require extensive work to be done, as is reflected in Figure 5.46 in Chapter Five, as the comparably low overall cost of \$511.90 was spent on this modification.

Along with the added military equipment and altered spaces on the deck, other alterations were made to the vessel. Reference to added ballast, as mentioned in Chapter Five, was necessary to account for the alteration of the fish hold to accommodate ammunition and a larger crew. It is unknown exactly how the added ballast was distributed, but this would also be apparent in the other two selected vessels as well. Another aspect of the conversion process is that these vessels were originally designed for a smaller crew. For *Cohasset*, the original design was intended for a very small crew with limited amenities, but following conversions, a full complement of twenty four crew members were aboard *YP-389* (Office of the Judge Advocate General 1943). Alterations to parts of the ship, as described within Figures 6.30 and 6.31, accounted for the increased living capacity needed for the converted vessel.

S33-1	A	c	Labor and material to rearrange lower berths for crew aft. providing doors and separate compartments under same.	235.	171.73	100
S33-2	A	c	Labor and material to make and install six (6) lockers forward. Lockers to be of wood similar to B-1 with three (3) compartments in each furnished with locks on each compartment door.	487.	874.04	100
S33-3	A	c	Provide labor and material to remove six (6) berths on starboard side of crew's quarters forward and provide and install nine (9) berths.	471.	144.80	100

FIGURE 6.30. Description of alterations to existing berths on *Cohasset*, dated 15 March 1943. (Commandant Third Naval District 1943.)

S33-4	A	o	Labor and material to install chart table and shelves in Captain's cabin, also rearrange C.P.O's room and install two (2) berths and lockers.	565.	211.34	100
S36-1	A	o	Provide labor and material to install one (1) Burke water system Model A5C42 or equal, complete with piping to connect to present sanitary system, provide and install flush toilet and wash basin in forward oil-skin locker. Toilet and basin to be piped to new salt water system.	1150.	1070.41	100

FIGURE 6.31. Toilet installation and berth alterations done to *Cohasset*, dated 15 March 1943. (Commandant Third Naval District 1943.)

The original design for *Cohasset* did not allow for the necessary naval crew to operate in its original state and, therefore, alterations were necessary. The increase in crew members would also be necessary on the other two selected vessels, however, the specific information regarding how this was accomplished is unavailable. The addition of armament was not the only feature of military conversion, as there was a need to make accommodations for a larger crew.

Unfortunately, these alterations were unable to be included in any of the model designs as specific details are unavailable.

Many features of commercial use remained, as mention of removal of the trawl winch or trawl gallows was not located or listed in the conversion orders. As with the other two vessels, the decision to keep certain features of original use intact is emblematic of a larger method of conversion and modification. The transformation process of *Cohasset* to YP-389, commercial fishing vessel to a military vessel, is the result of human decisions, c-transforms, and is a form of reuse. The transformation process for YP-389, as has been discussed with HMS *Senateur Duhamel* and HMT *Bedfordshire*, exhibited both aspects of lateral cycling and secondary use. A common aspect of the conversion process with all the selected vessels, regardless of nationality,

is that the modifications were designed to be temporary and allow for a vessel to return to original commercial use following cessation of military operations. Further interpretation of original and converted features remaining in the archaeological record of *YP-389* may confirm this aspect of the conversion process.

The archaeological remains of *YP-389*, as interpreted using the presented information in Chapter Five, are illustrated using the same color coded system representing original and converted features. In Figures 6.32 through 6.34 representative of model Group D, different views of the wreck site are presented, highlighting original design features in green and converted features in red.

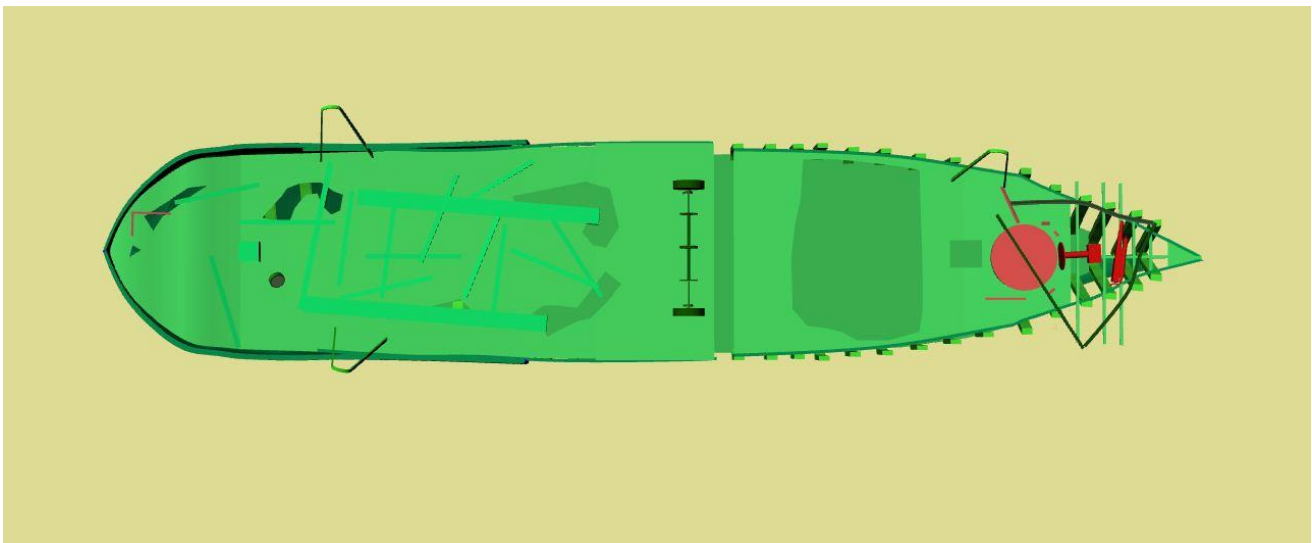


FIGURE 6.32. Plan view of *YP-389*, displaying view of entire wreck site. (Created by author, 2014.)

The majority of features positively identified within the archaeological remains are from original design and structure. The two most prominent of converted structures identified are the deck gun and deck gun mount. Although there is possible evidence of the depth charge rails, none of the six depth charges have been identified. Many of them were used during the battle with *U-701* and most likely exploded or are located much further away from the wreck site.

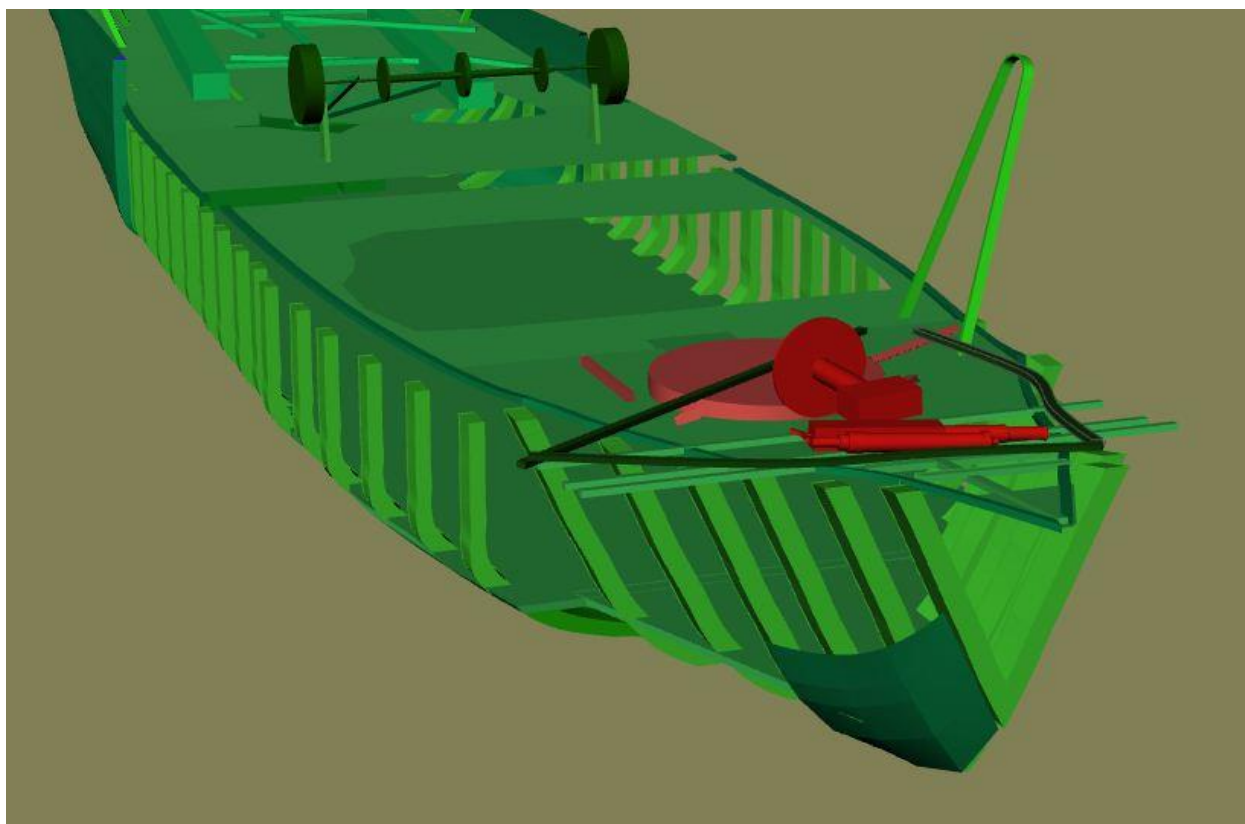


FIGURE 6.33. Bow structure with deck gun and gun mount still visible. (Created by author, 2014.)

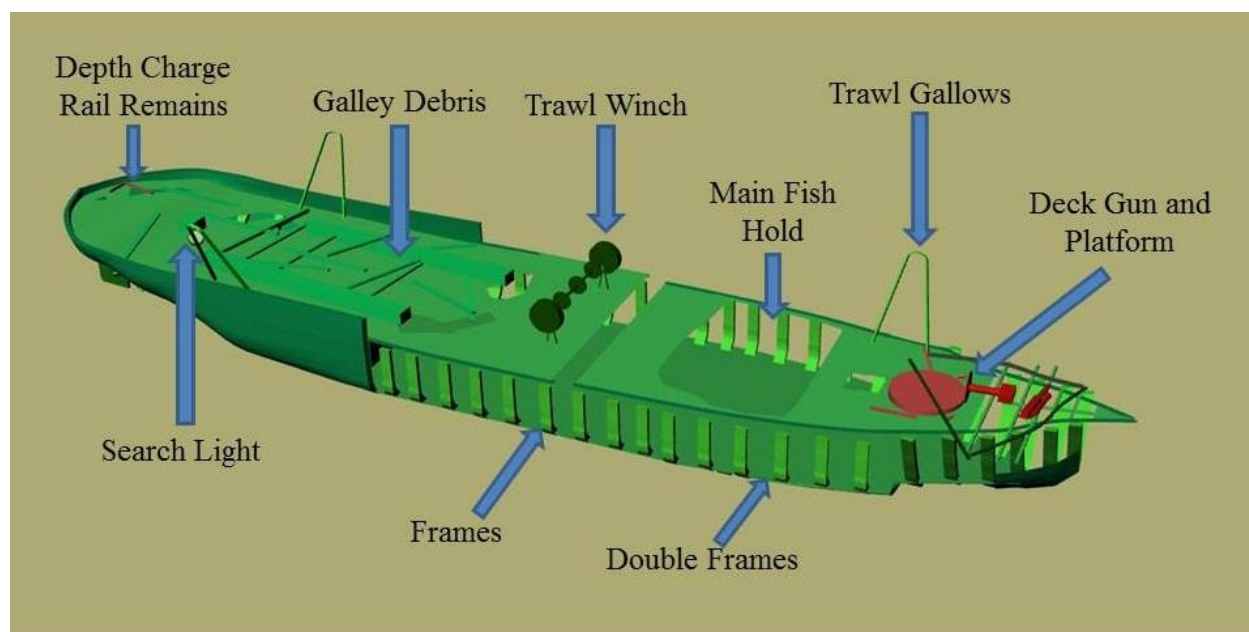


FIGURE 6.34. Feature identification of archaeological remains, color coded. (Created by author, 2014.)

As was presented in Chapter Five, much of the hull, framing, and deck itself remain. Missing features within the available video footage do create gaps in the interpretation of the wreck site. Using photo-mosaic images created from the NOAA ROV video, such as Figure 4.3, there is the ability to discern other aspects, such as the disarticulated galley, within the structure of the remains.

Human interaction with the archaeological evidence is considered minimal. The wrecking event itself, following a lengthy gun battle with *U-701*, could provide for an explanation for the lack of full deck structure, and features remaining intact on this level. Upon sinking, features could be disseminated over a large area. Compared with the other two selected vessels, the wreck site location is also an inhibitor of human interaction. Located at a depth of over 300 feet, the possibility of recreational salvage operations taking place is very remote.

Perishable goods, including the wooden structure under the forepeak, were most likely lost due to natural causes. Non-cultural processes, n-transforms, may have the most impact on the visible archaeological remains. Ocean current, at this depth, could move sediment around the wreck site, covering and obscuring smaller objects. Sediment movement could account for certain objects being visible and while others are covered by the shifting bottom. In Table 6.3, a description of site formation processes is presented for *YP-389*. The table outlines processes that identified (observed), not identified (not observed), as well as information unable to be ascertained. Corrosion seems to play the most significant role in the degradation of the wreck site. Corrosive properties could account for certain areas of the vessel to be observed and remaining, however, a study of the corrosive properties of the archaeological remains is well outside the scope of this study.

Site Formation Processes	Description	Observed	Not Observed	Unknown
Recycling	Use function in transition from A - B		X	
Lateral Cycling	Use function in transition from A - B	X		
Secondary Cycling	Use function in transition from A - B	X		
Conservatory Processes	Use function in transition from A - B		X	
Wrecking Event	Scrambling Device and Extractive Filter, Transition B - C	X		
Salvage Operations - Recreational	Extractive Filter, Transition B - C		X	
Salvage Operations - Commercial/Military	Extractive Filter, Transition B - C		X	
Commercial Fishing	Extractive Filter, Transition B - C			X
Disintegration of Perishables	Extractive Filter, Transition B - C	Most Likely		
Tidal Currents/Wave Action	Scrambling Device, Transition B - C			X
Sediment Disturbance	Scrambling Device, Transition B - C			X
Corrosion	Scrambling Device, Transition B - C	X (not analyzed)		

TABLE 6.3. Site formation processes observed for *YP-389*. (Created by author.)

The effects of natural causes can only be speculated upon, as a full understanding of site conditions are unknown at this time. However, it seems the most plausible processes acting upon the site stem from natural causes.

The transformation process of *YP-389* is difficult to attribute to a singular model of technological change. There was a definitive conversion process, with reference to a plan (Figure 5.46), most likely a builder's plan, illustrating the conversion process and the areas to be adapted for the vessel. The conversion orders greatly helped to provide detailed aspects of adapted features. However, looking at the conversion process as a singular case might be misleading and a model of technological change may be misinterpreted. By using information for all three of the

selected vessels collectively, a determination of processes for technological change is more probable.

Models of Technological Change

To evaluate the conversion process of the adapted vessels and to comment on the effectiveness of the modifications, a determination of a model of technological change is necessary. On a singular, case by case basis, each selected vessel did not necessarily fit into an exact model of technological change. However, when combining the available information, a clearer representation is available. Collectively, each vessel went through a very similar conversion process. In all three instances, adaptations were made to both the bow and stern areas of the vessels. Each vessel was armed with a deck gun, mounted at the bow, and depth charge rails located at the stern. Additionally, several secondary armament pieces, such as machine guns, were mounted at various points throughout each ship. These additions could be considered hallmarks of the military conversion process. To accommodate all these armament features certain modifications were made, albeit different for each vessel, but necessary to convert each commercial vessel for military use.

Other components of the modification process were accounting for the increase in crew as well as modifying the fish holds. Modifications were necessary to increase the number of berths as well as accounting for the change of ballast. Ammunition storage may have accounted for some of the ballast difference. How this was administered and the location of stores is not known. These modifications are not necessarily purely military in nature, but they are to accommodate military operations. Overall, the modifications were made to be reversible in nature as a return to original, commercial, use was expected.

Understanding these modification components allows for the ability to assign a model of technological change to the conversion process of these vessels. The most efficient way to analyze a specific model fit, meaning how aspects of the conversion process best matches the technological model, is to determine if the available evidence for each vessel is reflected in the technological change model descriptions. A breakdown of each technological model with a brief definition and available level of vessel evidence is outlined in Table 6.4.

Model and Description	Vessel		
	<u>YP-389</u>	<u>HMT <i>Bedfordshire</i></u>	<u>HMS <i>Senateur Duhamel</i></u>
<i>Heroic Inventor</i> : Single individual making leaps in innovation apart from others.	No Evidence	No Evidence	No Evidence
<i>Technological Evolution</i> : Progressive movement incorporating larger set of actors as opposed to single inventor.	Some Evidence Available	Some Evidence Available	Some Evidence Available
<i>Technological Determinism</i> : Advancements are predetermined, systematic, and formulaic.	No Evidence	No Evidence	No Evidence
<i>Technological Momentum</i> : Affected by social influences as well as effecting social change.	Evidence Available	Evidence Available	Evidence Available

TABLE 6.4. Models of technological change and evidence available in the selected vessels. (Created by author.)

What was characteristic in the available information was evidence of a singular individual promoting or emphasizing the conversion process could not be identified. It was not possible, given the available information, to identify a singular individual responsible for making the decision to convert trawlers or how specific conversion modifications should be administered. This eliminated the heroic inventor model as acceptable for the modification process. Similar to analyzing the heroic inventor model, technological determinism is not acceptable either. The

conversion process was not emblematic of a predetermined technological end. The conversion process, rather, reduced the ability for any technological advancement in commercial fishing, as the military operations did not coincide with this activity. This meant technological determination would also be eliminated as a model for considering this conversion process.

There is some suggestion of technological evolution reflected within the available evidence. As counter to the heroic inventor model, technological evolution represented work accomplished by a larger group of individuals. Military conversions were undertaken by many individuals, working to achieve a common goal. The design process, although specific information is unavailable, was most likely the result of multiple people working together, utilizing available resources and working within an administrative hierarchy with various attitudes and ideas, focusing on achieving a specific end. It is not known exactly who had the final say in what was added or removed from the converted vessels, but it is most likely the result of a process inclusive of multiple ideas and available resources. It is this basic idea, that technological change evolved as a result of multiple individuals, that the available information for the selected vessels are somewhat reflected in the technological evolution model. But it is not the most prominent of the models in which the available evidence fits.

The available evidence for the conversion process fits more in line with the technological momentum model. At the central core, the conversion process was sparked due to military necessity. This aspect has been repeated time and time again, as evidenced in other historical adaptations referenced in Chapter Two, when social influences bring about change. An essential part of the technological momentum model is that social events influence and affect change, and in this instance war created a need for military craft that were previously unavailable for immediate use. The German U-boat effectiveness created a need for both the United States Navy

and the British Royal Navy to create a rapid response to their activity. The conversion process of using requisitioned commercial vessels to adapt for military use came from the need to respond to the lack of available vessels necessary to take on the German U-boats.

Using available resources, such as World War One era weaponry, and combining it with sturdy commercial vessels, an effective response was created for much needed convoy and patrol duties. This is understood when examining a larger number of fully adapted vessels operating throughout the war. However, consideration to the effectiveness of the conversion process must be given to the fact that ultimately two of the selected vessels were lost due to interaction with German U-boats. Captain E.J. Estess, the commanding officer at the section base in Morehead City, NC, where *YP-389* operated from, had different feelings about the conversions. He stated during the inquiry hearing for Lieutenant Roderick Philips, “I believe the ships should have had a more thorough conversion before they were put in active service” (Office of the Judge Advocate General 1943). Without providing an alternative example as to how these vessels, particularly *YP-389*, could have been better converted, it was easy to comment in this manner with proper hindsight. Still, the number of converted vessels utilized during the war provided a cost effective opportunity to counter the German U-boat threat. With the onset of war, especially for the United States, an immediate need for something to counter the German U-boats was needed, and converting commercial vessels provided one answer. It was this social influence, specifically the act of war, which created a need for necessary technological change, beginning the process of converting commercial vessels for military use.

Conclusion

In the case of these three selected vessels, there are aspects of two models of technological change exhibited; one being more prominent. Although imperfect, placing

technological momentum as the most likely model for technological change is fitting because the converted vessels would never have gone through the modification process had there not been a social factor involved. The need for rapid development of vessels was established because of war necessities. It is possible this model could be attributed to not only the three converted commercial vessels in this study, but to all converted vessels used during World War Two. Essentially, converted and adapted commercial vessels used for military purposes were developed as a result of this social, human influence, and the needs that arose from this behavior. Technological momentum as a model for technological change best encapsulates the reasoning for the development of the converted commercial craft for military use.

The ability to ascertain the model of technological change allows for further analysis of the conversion process. As was discovered within evidence of the military conversion processes, many of the armament features were from a previous generation and not necessarily of the newer variety. The main influencing factor on the conversion process itself was the availability of resources, in that, whatever was available in good working order could be utilized in the adaptation of the selected vessels. The latest armament was designated for the newer vessels being built for military operations and not necessarily destined for the older vessels going through a transformation that ultimately could be reversed following the war's end. The conversion process was set forth to maximize the available resources and adapt the vessels as quickly as possible for military operations, even if at times the alterations were considered inappropriate by some individuals.

The adaptations to the selected vessels followed a process that was determined to be most effective given the available resources and design of existing vessels. Through a process most likely involving many individuals, a determination of the most important aspects of combating

German U-boats was established, as well as concluding what resources were available in the shortest amount of time. This combination ultimately delivered adapted bow and stern attributes, featuring deck guns and depth charge rails, outfitted upon ocean-going fishing vessels. These sturdy vessels were not fast, nor were they needed to be, for their designed roles. Among other tasks, their main duties included the protection of convoys as well as patrol for U-boats.

Identifying the need and using resources available, a cost effective tool was created to combat the German U-boat threat. Although the success rates of the converted vessels varied, their use ultimately altered the effectiveness of the U-boats themselves. In this manner, the process of adapting commercial vessels for military use could be considered quite effective.

CHAPTER SEVEN: CONCLUSION

The selected vessels of this study are just a few of the thousands of vessels that were requisitioned during World War Two. They were taken into service because of a few major factors. Most importantly, they were seaworthy and readily available. At naval yards on both sides of the Atlantic, vessels of these types were acquired and quickly outfitted in an effort to cost effectively counter the German U-boat threat. By analyzing both the historical and archeological record for HMS *Senateur Duhamel*, HMT *Bedfordshire*, and YP-389, an understanding of how the conversion process was completed and how alterations fit within a model of technological change, for not only these three vessels but for many others, was established.

The potential of these vessels, ranging in age, was observed in operations needing not necessarily the most heavily armed or fastest ships. A need developed as a result of the lack of naval vessels available to fill the role of patrol and convoy duties. Observing the available commercial fleet as a potential source for military use greatly helped leaders organize operational resources to best deal with the circumstances and social issues of this time period. In Chapter Two, other forms of converted vessels throughout history were illustrated, each occurring as a result of a different influence. Along with those converted vessels, HMS *Senateur Duhamel*, HMT *Bedfordshire*, and YP-389 are the results of innovative ideas to help in the war effort and were part of a larger history of converting craft for military use.

Within Chapter Three, theories of site formation processes were identified to be able to interpret the remaining archaeological evidence. Contrary to Muckelroy's statement that the study of modern vessels was unnecessary, it was absolutely imperative to analyze these modern era wreck sites for the purpose of determining models of technological change within the

conversion process of commercial vessels. The correlation between the historical and archaeological evidence, as best interpreted, was the same and the corresponding historical evidence matched with the archaeological remains. With the available information, there was no discernable difference between the two records. By confirming this aspect, a technological change model, as presented in Chapter Three, was best supported with evidence in the final analysis. Without the certain pieces of evidence reflected in the archaeological evidence of the selected vessels, analysis of conversion processes would be unable to be confirmed. In this regard, it was absolutely necessary to study the wreck sites of these modern era vessels.

Understanding the conversion process of the selected vessels necessitated a large data set of evidence from both the historical and archaeological record. Chapter Four covers the process of acquiring and synthesizing this evidence. Using both sets, historical and archaeological, of information to compare aspects of the conversion process and whether or not there were glaring differences between the two was crucial to final analysis. As has been referenced, there were many gaps in the necessary information that would have proven helpful if available. Ideally, a full set of builder's plans for each vessel, as well as a detailed set of conversion orders, would have allowed for a cohesive, uniform methodological structure. Despite this, using the available information a determination was established for a method of conversion and a model of technological change.

Individual vessel information was presented and analyzed in Chapters Five and Six. The historical and archaeological information was deciphered and interpreted, and with the assistance of *Rhinoceros 5.0*, three dimensional (3D) models of each life phase of the selected vessels were illustrated. Using these models, assigned into four distinct groupings, analysis of the converted features truly came into focus. The removal and addition of certain features became more

defined when using the models as tools for analysis. Available photographic and historical evidence contributed to the modeling process that was then utilized to demonstrate, as best interpreted, the modified vessel design. Using the different Rhino models as a guide, analysis of the conversion process could then establish a model of technological change. As has been stated, the adaptation and modification process of the converted vessels falls in line with a model of technological change.

Any future study of vessels converted for military use might be able to attribute technological momentum as a model for the technological change. As this study set to establish a model for technological change for converting commercial vessels for military use, there is reason to believe this identified model is not the only way of evaluating such a transformation. The scope of this study has the potential to be expanded as other models for technological change may develop or have gone unmentioned. Other converted vessels, possibly from the same conflict and time period, could exhibit different properties of the technological change models. This study could be replicated to analyze other vessels, either from this or another era, to determine if the technological change model remains the same.

Ultimately, social and economic factors prompted military leaders in World War Two to find solutions to a specific problem, which is a similar process exhibited throughout previous conflicts. Using the technological momentum model as a guide, future conversion processes can be developed in advance to utilize existing equipment in a manner for use outside of original designed purpose. The multiple conversions detailed in this study resulted from acknowledgment of a threat and utilizing available resources to counter or alleviate such a problem. It might be possible to perceive future threats and create methods for rapid conversion of materials if the

need arises by examining current resources and planning for the next conflict, something which is most likely already being done.

Ultimately, the study of HMS *Senateur Duhamel*, HMT *Bedfordshire*, and *YP-389*, is a look into one of many wartime related modification processes. Throughout this period, rapid change in military equipment evolved battlefield strategy, forever altering the manner in which war is fought. The contributions to the war effort of these selected vessels should not be understated, as many others like them were utilized and greatly altered German U-boat effectiveness. The Battle of the Atlantic was won because of vessels like HMS *Senateur Duhamel*, HMT *Bedfordshire*, and *YP-389*, and the service of those working and gave their lives during this period should be forever remembered.

REFERENCES CITED

Abbazia, Patrick

1975 *Mr. Roosevelt's Navy: The Private War of the U.S. Atlantic Fleet, 1939 – 1942*. United States Naval Institute, Annapolis, MD.

Aberdeen Built Ships

2014 "Senateur Duhamel." Aberdeen Built Ships. <<http://http://www.aberdeenships.com/single.asp?searchFor=duhamel&index=101428>>. Accessed 18 September 2014.

Aberdeen Maritime Museum

1927a "*Senateur Duhamel* - General Arrangement Drawing No. 691." Drawing, File number ABDMS005450, Aberdeen Maritime Museum, Aberdeen, Scotland.

1927b "*Senateur Duhamel* (691) – Body Plan." Plan, File number ABDMS047034.3, Aberdeen Maritime Museum, Aberdeen, Scotland.

1927c "*Senateur Duhamel* (691) – Deadweight scale." Plan, File number ABDMS047034.1, Aberdeen Maritime Museum, Aberdeen, Scotland.

1927d "*Senateur Duhamel* (691) – Lines Plan." Plan, File number ABDMS047034.2, Aberdeen Maritime Museum, Aberdeen, Scotland.

1927e "*Senateur Duhamel* (691) – Hydrostatic Curves." Plan, File number ABDMS047034.4, Aberdeen Maritime Museum, Aberdeen, Scotland.

Ballantine, Duncan S.

1949 *U.S. Naval Logistics in the Second World War*. Princeton University Press, Princeton, NJ.

Bedfordshire and Luton Archives

1996a "Activity Report relating to the history of HMT *Bedfordshire*." Part of file Z940, donated by J.S. Munro 27 November, Bedfordshire and Luton Archives, Bedfordshire, United Kingdom.

1996b Photograph file Z940/1 – 22, relating to HMT *Bedfordshire*. Black and white photographs, donated by J.S. Munro on 27 November, Bedfordshire, United Kingdom.

Benn, Carl

2002 *Essential Histories: The War of 1812*. Routledge Publishing, New York, NY.

Bimber, Bruce

1994 Three Faces of Technological Determinism. In *Does Technology Drive History? The Dilemma of Technological Determinism*, Merritt Roe Smith and Leo Marx, editors, pp. 79-100. The M.I.T. Press, Cambridge, MA.

Birnbaum, Karl E.

1970 *Peace Moves and U-Boat Warfare: A Study of Imperial Germany's Policy Towards the United States April 18, 1916 – January 9, 1917*. Archon Books, Hamden, CT.

Black, Jeremy

2011 *The Great War and the Making of the Modern World*. Continuum International Publishing Group, New York, NY.

Bridgland, Tony

1999 *Sea Killers in Disguise: The Story of the Q-Ships and Decoy Ships in the First World War*. Naval Institute Press, Annapolis, MD.

Brown, D.K.

2006 *Nelson to Vanguard: Warship Design and Development, 1923-1945*. Naval Institute Press, Annapolis, MD.

2007 *Atlantic Escorts: Ships, Weapons & Tactics in World War II*. Naval Institute Press, Annapolis, MD.

Buchanan, Angus R.

2002 *Brunel: The Life and Times of Isambard Kingdom Brunel*. Hambledon and London, London, United Kingdom.

Cartellone, Chris

2003 *Trawlers to the Rescue: the Role of "Minor War Vessels" in Securing the Eastern Sea Frontier, 1942*. Master's Thesis, Department of History, East Carolina University, Greenville, NC.

Chatterton, E Keble

1972 *Q-Ships and Their Story*. Naval Institute Press, Annapolis, MD.

Cheatham, James T.

1995 *The Atlantic Turkey Shoot*. Wentworth Printing Corporation, West Columbia, SC.

Churchill, Winston S.

1950 *The Second World War*. Vol. 4, *The Hinge of Fate*. Houghton Mifflin Company, Boston, MA.

Coletta, Paolo E.

1996 *Allied and American Naval Operations in the European Theater: World War I*. Edwin Mellen Press, Lewiston, NY.

Commandant Third Naval District

1943 USS *AMc-202* Report of Complete Actual Costs. Bu Ships Correspondence, 1940 – 1945, Records of the Office of the Chief of the Naval Operations, File Tenth Fleet, Box 603, Record Group 19, National Archives at College Park, College Park, MD.

Daly, R.W.

1957 *How the Merrimac Won: The Strategic Story of the C.S.S. Virginia*. Thomas Y. Crowell Company, New York, NY.

Daughan, George C.

2011 *1812: The Navy's War*. Basic Books, New York, NY.

Discovery Diving

2014 "Wreck Desc Senateur Duhamel."
<http://www.discoverydiving.com/index.php?option=com_content&view=article&id=237&Itemid=158>. Accessed 25 October 2014.

Diveley, Brian D.

2008 Naval Development and the Diffusion Nineteenth-Century Maritime Innovation: An Archaeological and Historical Investigation of the *Sassacus*-Class Double-Ender, USS *Otsego*. Master's Thesis, Department of History, East Carolina University, Greenville, NC.

Eastern Sea Frontier (ESF)

1942a War Diary Eastern Sea Frontier, May. Records Relating to Naval Activity During World War II, World War II War Diaries, East Sea Fron Dec 41 to May 42, Records of the Office of the Chief of the Naval Operations, File Tenth Fleet, box 331, Record Group 38, National Archives at College Park, College Park, MD.

1942b War Diary Eastern Sea Frontier, June. Records Relating to Naval Activity During World War II, World War II War Diaries, East Sea Fron Jun 42 to Aug 42, Records of the Office of the Chief of the Naval Operations, File Tenth Fleet, box 332, Record Group 38, National Archives at College Park, College Park, MD.

Engle, Eloise and Arnold S. Lott

1975 *America's Maritime Heritage*. Naval Institute Press, Annapolis, MD.

Farb, Roderick M.

1985 *Shipwrecks: Diving the Graveyard of the Atlantic*. Menasha Ridge Press, Hillsborough, NC.

Foley, Brendan

2007 "Impact of Fishing on Shipwrecks." Woods Hole Oceanographic Institute.
<<http://www.whoi.edu/sbl/liteSite.do?litesiteid=2740&articleId=4965>>. Accessed 25 March 2014.

Forester, C.S.

1956 *The Age of Fighting Sail: The Story of the Naval War of 1812*. Doubleday & Company, Inc., Garden City, NY.

Gardiner, Robert (editor)

1998 *The Naval War of 1812*. Naval Institute Press, Annapolis, MD.

Gentile, Gary

1992 *Shipwrecks of North Carolina, From Hatteras Inlet South*. Gary Gentile Productions: Philadelphia, PA.

Gibbs, Martin

2003 "The Archaeology of Crisis: Shipwreck Survivor Camps in Australasia," *Historical Archaeology*, Vol. 37, No. 1, Recent Work in Historical Archaeology in Australia and New Zealand, pp. 128-145.

Gilfillan, S.C.

1935 *Inventing the Ship*. Follett Publishing Company, Chicago, IL.

1970 *The Sociology of Invention*. The M.I.T. Press, Cambridge, MA.

Good, Timothy (editor)

2012 *American Privateers in the War of 1812: The Vessels and Their Prizes as Recorded in Nile's Weekly Register*. McFarland and Company, Inc., Jefferson, NC.

Hadley, Michael L.

1995 *Count Not the Dead: The Popular Image of the German Submarine*. McGill-Queen's University Press, Montreal, Canada.

Hart Nautical Collections

1941 Construction process photographs of *Cohasset*. Bethlehem Steel Company photograph collection of vessels built at Fore River Shipyard at Quincy, MA. Reference Number R2015.065. Hart Nautical Collections, Massachusetts Institute of Technology, Cambridge, MA.

Henning, G. R., and M. Henning

1990 "Technological Change from Sail to Steam: Export Lumber Shipments from the Pacific Northwest, 1898–1913." *International Journal of Maritime History*, Vol. 2, No. 2, pp. 133–45.

Hickam, Homer H.

1989 *Torpedo Junction: U-boat War Off America's East Coast, 1942*. Naval Institute Press, Annapolis, MD.

Hone, Thomas C. and Trent Hone

2006 *Battle Line: The United States Navy 1919–1939*. United States Naval Institute, Annapolis, MD.

Hough, Richard

1983 *The Great War at Sea*. Oxford University Press, Oxford, United Kingdom.

Howarth, Stephen

1990 *To Shining Sea*. Stephen Howarth Associates, New York, NY.

Hughes, Thomas P.

1994 Technological Momentum. In *Does Technology Drive History? The Dilemma of Technological Determinism*, Merritt Roe Smith and Leo Marx, editors, pp. 101-114. The M.I.T. Press, Cambridge, MA.

Hutson, Harry C.

1990 *Grimsby's Fighting Fleet: Trawlers and U-boats during the Second World War*. Hutton Press, North Humberside, England.

Imperial War Museum

2014 "Q-Ships." Imperial War Museum.
<<http://www.iwm.org.uk/collections/search?query=q-ships>>. Accessed 7 November 2014.

Ireland, Bernard

2003 *Battle of the Atlantic*. Naval Institute Press, Annapolis, MD.

Jan, Lettens (editor)

2013 "HMT Bedfordshire." Wrecksite.eu. <<http://www.wrecksite.eu/wreck.aspx?15498>>. Accessed 25 October 2014.

Jones, Noah

1967 *Journals of Two Cruises Aboard the American Privateer Yankee*. The Macmillan Company, New York, NY.

Kasper, Wolfgang

1980 "Technological Change and Economic Growth." In *Technological Change in Australia*. Vol. 4, *Selected Papers on Technological Change, Committee of Inquiry into Technological Change in Australia*, pp. 237–60. Government Publishing Service, Canberra, Australia.

King, Ernest J.

1946 *U.S. Navy At War: 1941-1945*. United States Navy Department, Washington, DC.

Leggett, Don, and Richard Dunn

2012 Introduction: Re-inventing the Ship in the Long Nineteenth Century. In *Re-inventing the Ship: Science, Technology and the Maritime World, 1800-1918*, Don Leggett and Richard Dunn, editors, pp. 1-7. Ashgate Publishers, Surrey, United Kingdom.

Lenton, H.T.

1998 *British and Empire Warships of the Second World War*. Naval Institute Press, Annapolis, MD.

Lienhard, John H.

2006 *How Invention Begins: Echoes of Old Voices in the Rise of New Machines*. Oxford University Press, New York, NY.

Lloyd's Register of Shipping

1928/29 *Steamers & Motorships Under 300 Tons, Trawlers, &c.* Lloyds Register of Shipping. Register Book. Register of Ships 1928/29.
<<http://www.plimsollshipdata.org/index.php>>.

1929/30 *Steamers & Motorships Under 300 Tons, Trawlers, &c.* Lloyds Register of Shipping. Register Book. Register of Ships 1929/30.
<<http://www.plimsollshipdata.org/index.php>>.

1930/31 *Steamers & Motorships Under 300 Tons, Trawlers, &c.* Lloyds Register of Shipping. Register Book. Register of Ships 1930/31.
<<http://www.plimsollshipdata.org/index.php>>.

1931/32 *Steamers & Motorships Under 300 Tons, Trawlers, &c.* Lloyds Register of Shipping. Register Book. Register of Ships 1931/32.
<<http://www.plimsollshipdata.org/index.php>>.

1932/33 *Steamers & Motorships Under 300 Tons, Trawlers, &c.* Lloyds Register of Shipping. Register Book. Register of Ships 1932/33.
<<http://www.plimsollshipdata.org/index.php>>.

1933/34 *Steamers & Motorships Under 300 Tons, Trawlers, &c.* Lloyds Register of Shipping. Register Book. Register of Ships 1933/34.
<<http://www.plimsollshipdata.org/index.php>>.

1934/35 *Steamers & Motorships Under 300 Tons, Trawlers, &c.* Lloyds Register of Shipping. Register Book. Register of Ships 1934/35.
<<http://www.plimsollshipdata.org/index.php>>.

1935/36 *Steamers & Motorships Under 300 Tons, Trawlers, &c.* Lloyds Register of Shipping. Register Book. Register of Ships 1935/36.
<<http://www.plimsollshipdata.org/index.php>>.

1936/37 *Steamers & Motorships Under 300 Tons, Trawlers, &c.* Lloyds Register of Shipping. Register Book. Register of Ships 1936/37.
<<http://www.plimsollshipdata.org/index.php>>.

1937/38 *Steamers & Motorships Under 300 Tons, Trawlers, &c.* Lloyds Register of Shipping. Register Book. Register of Ships 1937/38.
<<http://www.plimsollshipdata.org/index.php>>.

1938/39 *Steamers & Motorships Under 300 Tons, Trawlers, &c.* Lloyds Register of Shipping. Register Book. Register of Ships 1938/39.
<<http://www.plimsollshipdata.org/index.php>>.

1939/40 *Steamers & Motorships Under 300 Tons, Trawlers, &c.* Lloyds Register of Shipping. Register Book. Register of Ships 1939/40.
<<http://www.plimsollshipdata.org/index.php>>.

1940/41 *Steamers & Motorships Under 300 Tons, Trawlers, &c.* Lloyds Register of Shipping. Register Book. Register of Ships 1940/41.
<<http://www.plimsollshipdata.org/index.php>>.

1941/42 *Steamers & Motorships Under 300 Tons, Trawlers, &c.* Lloyds Register of Shipping. Register Book. Register of Ships 1941/42.
<<http://www.plimsollshipdata.org/index.php>>.

1942/43 *Steamers & Motorships Under 300 Tons, Trawlers, &c.* Lloyds Register of Shipping. Register Book. Register of Ships 1942/43.
<<http://www.plimsollshipdata.org/index.php>>.

1943/44 *Steamers & Motorships Under 300 Tons, Trawlers, &c.* Lloyds Register of Shipping. Register Book. Register of Ships 1943/44.
<<http://www.plimsollshipdata.org/index.php>>.

Lund, Paul and Harry Ludlam

1971 *Trawlers Go To War: The Story of 'Harry Tate's Navy'.* W. Foulsham & Company, Inc. New York, NY.

MacLeod, Christine

2007 *Heroes of Invention: Technology, Liberalism and British Identity, 1750-1914.* Cambridge University Press, Cambridge, United Kingdom.

- Mahon, John K.
1972 *The War of 1812*. University of Florida Press, Gainesville, FL.
- Manson, Janet M.
1990 *Diplomatic Ramifications of Unrestricted Warfare, 1939 – 1941*. Greenwood Press, New York, NY.
- Marrin, Albert
1985 *1812: The War Nobody Won*. McClelland & Stewart, Ltd., Baltimore, MD.
- Marolda, Edward J. (editor)
1998 *FDR and the U.S. Navy*. St. Martin's Press, New York, NY.
- Marsden, Ben and Crosbie Smith
2005 *Engineering Empires: A Cultural History of Technology in Nineteenth-Century Britain*. Palgrave Macmillan, New York, NY.
- Morison, Samuel E.
1947 *The Battle of the Atlantic: September 1939 – May 1943*. Little, Brown and Company, Boston, MA.
- Muckelroy, Keith
1978 *Maritime Archaeology*. Cambridge University Press, Cambridge, United Kingdom.
- 1980 *Archaeology Under Water: An Atlas of the World's Submerged Sites*. McGraw-Hill Book Company, New York, NY.
- Naisawald, L. VanLoan
1997 *In Some Foreign Field: Four British Graves and Submarine Warfare on the North Carolina Outer Banks*. North Carolina Division of Archives and History, Raleigh, NC.
- National Maritime Museum
1935 *Bedfordshire* General Arrangement Profile and Decks Plan. Plan. Object ID LLDB0001, File BF14/129, Box Collection "Ship Plans," National Maritime Museum, Greenwich, United Kingdom.
- National Museum of the Royal Navy
1942 "HMS *Senateur Duhamel* Port Movement Summaries, 1939 – 1946. Sheet 1, Year 1942 - 1942, Royal Navy, National Museum of the Royal Navy, Portsmouth, United Kingdom.
- National Oceanic and Atmospheric Administration (NOAA)
2008 Battle of the Atlantic Expedition. National Oceanic and Atmospheric Administration's National Marine Sanctuaries. <<http://sanctuaries.noaa.gov/missions/battleoftheatlantic/>>. Accessed 16 July 2013.

- 2009 Battle of the Atlantic Expedition. National Oceanic and Atmospheric Administration's National Marine Sanctuaries
<<http://sanctuaries.noaa.gov/missions/battleoftheatlantic2/welcome.html>>. Accessed 16 July 2013.
- 2010 Battle of the Atlantic Expedition. National Oceanic and Atmospheric Administration's National Marine Sanctuaries.
<<http://sanctuaries.noaa.gov/missions/2010battleoftheatlantic/welcome.html>>. Accessed 16 July 2013.
- 2010 "HMT Bedfordshire." National Oceanic & Atmospheric Administration, National Marine Sanctuaries.
<<http://sanctuaries.noaa.gov/missions/battleoftheatlantic2/bedfordshire.html>>. Accessed 1 July 2013.
- Office of the Judge Advocate General
- 1943 [Case Number 43306] Circumstances Attending the Attack on YP-389, June 1942, Court of Inquiry Proceedings; 1909 – 1971, Records of the Office of the Chief of the Naval Operations, File Tenth Fleet, box 163, Record Group 125, National Archives at College Park, College Park, MD.
- Ojala, Jari
- 1997 "Productivity and Technological Change in Eighteenth and Nineteenth Century Sea Transport: A Case Study of Sailing Ship Efficiency in Kokkola, Finland, 1721–1913." *International Journal of Maritime History*, Vol. 9, No. 1, pp. 93–123.
- Park, Carl D.
- 2007 *Ironclad Down: The USS Merrimack - CSS Virginia From Construction To Destruction*. Naval Institute Press, Annapolis, MD.
- Parkes, Oscar
- 1990 *British Battleships*. United States Naval Institute, Annapolis, MD.
- Perret, Geoffrey
- 1991 *There's a War to Be Won: The United States Army in World War II*. Random House, New York, NY.
- Quarstein, John V.
- 2012 *The CSS Virginia: Sink Before Surrender*. History Press, Charleston, SC.
- Renfrew, Colin and Paul Bahn
- 2000 *Archaeology: Theories, Methods and Practice*. Thames & Hudson Ltd., London, United Kingdom.

Richards, Nathan

2008 *Ship's graveyards: Abandoned Watercraft and the Archaeological Site Formation Process*. University Press of Florida, Gainesville, FL.

Rolt, L.T.C.

1959 *Isambard Kingdom Brunel: A Biography*. St. Martin's Press, New York, NY.

Rosen, Stephen P.

1991 *Winning the Next War: Innovation and the Modern Military*. Cornell University Press, Ithaca, NY.

Sadkovich, James J.

1990 *Reevaluating Major Naval Combatants of World War II*. Greenwood Press, New York, NY.

Salmon, Norman

1994 Letter to James R. Reedy, Jr., 17 March. Transcript and photographs in the hand of James R. Reedy, Jr., Morehead City, NC.

Scheina, Robert L.

1982 *U.S. Coast Guard Cutters & Craft of World War II*. United States Naval Institute, Annapolis, MD.

Schiffer, Michael B.

1976 *Behavioral Archaeology*. Academic Press, University of Michigan, Ann Arbor, MI.

1983 "Toward the Identification of Formation Processes," *American Antiquity*, Vol. 48, No. 4 (Oct., 1983), pp. 675-706. Published by: Society for American Archaeology.

1995 *Behavioral Archaeology: First Principles*. Salt Lake City, UT: University of Utah Press.

1996 *Formation Processes of the Archaeological Record*. University of Utah Press, Salt Lake City, UT.

Schiffer, Michael B. and James Skibo

1987 "Theory and Experiment in the Study of Technological Change," *Current Anthropology*, Vol. 28, No. 5 (Dec.), pp. 595-622.

Shipbuilding History

2014 "Bethlehem Steel Company, Quincy MA." Shipbuilding History.
<<http://www.shipbuildinghistory.com/history/shipyards/2large/inactive/bethquincy.htm>>.
Accessed 15 August 2014.

Shipbuilding On The River Tees

2013 "Yard List for Vessels Completed Between 1930 and 1944." Shipbuilding On The River Tees, Smith's Dock Company.

<<http://www.teesbuiltships.co.uk/smiths/19301944/aalist19301944.htm>>. Accessed 29 October 2013.

Showell, Jak.P. Mallmann

1987 *U-Boats Under the Swastika*. Naval Institute Press, Annapolis, MD.

Simpson, Michael (editor)

1991 *Anglo-American Naval Relations: 1917-1919*. The Navy Records Society, Greenwich, London.

Simpson III, Michael

1989 *Admiral Harold R. Stark: Architect of Victory, 1939 – 1945*. University of South Carolina Press, Columbia, SC.

Skibo, James M. and Michael B. Schiffer

2008 *People and Things: A Behavioral Approach to Material Culture*. Springer Science and Business Media, New York, NY.

Smith, Merritt Roe and Leo Marx (editors)

1994 *Does Technology Drive History? : The Dilemma of Technological Determinism*, The M.I.T. Press, Cambridge, MA.

Staudenmaier, John M.

1985 *Technology's Storytellers: Reweaving the Human Fabric*. The M.I.T. Press, Cambridge, MA.

Stern, Robert C.

1991 *Type VII U-Boats*. Naval Institute Press, Annapolis, MD.

Still, William N., Jr.

1971 *Iron Afloat: The Story of the Confederate Armorclads*. Vanderbilt University Press, Nashville, TN.

Toghill, Gerald

2004 *Royal Navy Trawlers: Requisitioned Vessels, Part 2*. Maritime Books, United Kingdom.

Tony, Allen (editor)

2011 "HMT Senateur Duhamel." Wrecksite.eu.

<<http://www.wrecksite.eu/wreck.aspx?22364>>. Accessed 25 October 2014.

Trexler, Harrison A.

1938 *The Confederate Ironclad "Virginia" ("Merrimac")*. The University of Chicago Press, Chicago, IL.

Trigger, Bruce G.

2006 *A History of Archaeological Thought*. Cambridge University Press, New York, NY.

United States Coast Guard

2014 "Vigilant, 1927." United States Coast Guard.
<<http://www.uscg.mil/history/webcutters/Vigilant1927.asp>>. Accessed 25 October 2014.

United States Naval Historical Center

2014 "CSS *Virginia*." U.S. Naval Historical Center. <<http://www.history.navy.mil/photos/sh-us-cs/csa-sh/csash-sz/virg-d.htm>>. Accessed 8 January 2014.

Vaughn, Adrian

1991 *Isambard Kingdom Brunel: Engineering Knight – Errant*. John Murray Publishers Ltd., London, United Kingdom.

Van der Vat, Dan

1988 *The Atlantic Campaign: World War II's Great Struggle at Sea*. Harper & Row Publishers, New York, NY.

Wagner, John

2012 "The Trawler *Cohasset* Goes Fishing for U-boats: A History of the Fishing Trawler That Would Defy a German Submarine," *Nautical Research Journal*, Vol. 57, No. 1, Spring 2012.

Walmsley, Leo

1941 *Fishermen At War*. Doubleday, Doran and Company, Inc., Garden City, NY.

Warwick History

2013 "James deWolf." Warwick History.
<http://www.warwickhistory.com/index.php?option=com_content&view=article&id=263:james-dewolf-continued&catid=56:rogues-and-knaves&Itemid=125>. Accessed 9 December 2013.

Woodfield, Andrew

1976 *Teleology*. Cambridge University Press, London, United Kingdom.

Wrecksite

2014 "U-580." Wrecksite.eu. <<http://www.wrecksite.eu/wreck.aspx?14282>>. Accessed 9 November 2014.

Wright, Larry

1976 *Teleological Explanations: An Etiological Analysis of Goals and Functions*. University of California Press, Berkeley, CA.

Yarnell, Paul R. (editor)

1996 "YP-389" Navsource Naval History.
<<http://www.navsource.org/archives/11/03202.htm>>. Accessed 18 November 2013.