REASSESSING THE CAPE HATTERAS MINEFIELD:

AN EXAMINATION OF NORTH CAROLINA COASTAL DEFENSES DURING THE SECOND WORLD WAR

by

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In response to the German U-boat attacks on Allied Atlantic merchant shipping during the Second World War, Ernest King, the Commander-in-Chief of the Atlantic Fleet, approved construction of a defensive wall of naval mines in an area off Cape Hatteras, North Carolina. This configuration of mines was intended to provide a safe harbor opportunity for convoys moving along the coast.

The currently accepted narrative of Cape Hatteras Minefield is that it was a failure. This assessment is due to recent scholarship which cites the loss of three Allied ships that sunk after striking mines intended for Axis watercraft. As opposed to studies of the effectiveness of offensive or defensive weapons on mobile platforms (ships, aircraft, and terrestrial vehicles) or land-based defensive structures (e.g. forts and gun emplacements), this study will seek to understand the ways in which researchers can assess the success or failure of a different kind of defensive measure – a naval minefield. In-depth historical research will be undertaken in order to better understand the social, economic, and wartime effects of the minefield. Archaeological theories sourced from battlefield archaeology will also be applied to a virtually reconstructed minefield data set created with Geographic Information System (ESRI *ArcGIS*). The objectives

of this project are to reassess how minefields are contemplated in battlefield archaeology in a naval setting as well as to reconsider the narrative of Cape Hatteras minefield itself.

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LIST OF ABBREVIATIONS

B.d.U.or BdU- Befehlshaber der U-Boote (Commander of the Submarines)

CG- Coast Guard Patrol Vessel

CNO- Chief of Naval Operations

EEZ- Exclusive Economic Zone

ESF- Eastern Sea Frontier

ESSO-Exxon Mobile

EWT- Eastern War Time

GADM- Global Administrative Areas Boundaries

GIS- Geographic Information System

KOCOA- Key Terrain, Observations and Fields of Fire, Cover and Concealment, Obstacles, Avenues of Approach

KS- Convoy New York to Key West

METT-T- Mission, Enemy, Terrain, Troops Available, and Time

NAD 1983- North American Datum

NOAA- National Oceanic and Atmospheric Administration

NRHP- National Register of Historic Places

OCNO- Office of the Chief of Naval Operations

OPSEC- Operational Security

RG- Record Group

SOC- Standard Oil Company

TMA- German Moored Magnetic Sea Mine

USC&GS- United States Coast and Geodetic Survey

USS- United States Ship

YP- Yard Patrol Craft

CHAPTER ONE: INTRODUCTION

Following the outbreak of the Second World War and the aftermath of Japan's attack on Pearl Harbor, most the world's attention was held captive by the aggressive blitzkrieg perpetrated by the German *Heer* (Army) and *Luftwaffe* (Air Force). Meanwhile, in the cold, dark depths of the Atlantic, a silent and ruthless war was taking place. This fight was not exclusively between the German *Ubootwaffe* (U-boat) Corps and Allied warships but featured Allied noncombatant merchant shipping as the focal entity and more often, principal victim. Over the course of the Battle of the Atlantic, approximately 36,000 merchant sailors owing allegiance to Allied nationalities would perish (Hughes 1977:303; White 2008:2). This carnage would reach as far as the North American Eastern Seaboard, into the Gulf of Mexico and South America with the German implementation of Operation Drumbeat in 1942, which pitted a starkly supplied Allied homeland defense against battle-hardened U-boat crews. As the United States had stretched its East Coast assets thin due to the Lend-Lease program, the American coast and shipping were sluggish in implementing basic homeland wartime strategies, such as coastal blackouts, convoy structure, and other naval defenses, such as naval minefields (Dönitz 1959:200).

In May of 1942 after mobilizing necessary resources the American naval seacoast defense efforts came online. Fleet Admiral Ernest King ordered the construction of several minefields along the eastern seaboard as well as other coastal defenses, such as antisubmarine nets, the Naval Section Base at Ocracoke, and patrols by ships and planes to offer safe ports of harbor for the newly instituted convoys (Blair 1996:456). However, the coast of North Carolina was a perfect hunting ground for the German U-boats for a host of reasons. Initially, there were no major defensive military installments along the coast of North Carolina to monitor the coast.

Concurrently, the U-boats took advantage of the protrusion of Cape Hatteras' portion of the continental shelf that is less than 30 miles wide between shore and open ocean. Convoys who were hugging to shallower waters in order to take advantage of air support were crammed into a bottleneck, one on side the extent of air support and on the other small North Carolina inlets such as the Ocracoke Inlet or the Hatteras Inlet that the large merchant vessels could not enter, offering the U-boats advantage of easy access to open water (Blair 1996:439).

These factors gave birth to Cape Hatteras Minefield, over 2,650 Mark VI contact mines placed in an overlapping half-moon arrangement around Cape Hatteras with the intention of creating a "safe" harbor (Figures 1 and 2). The Mark VI mine was a surplus, featuring "horns" that when in contact with a metal hull ship would create an electric connection detonating the mine. This technological advancement made the Mark VI mine relatively more stable and appropriate for homeland defense (Bureau of Naval Ordinance 1955:376).

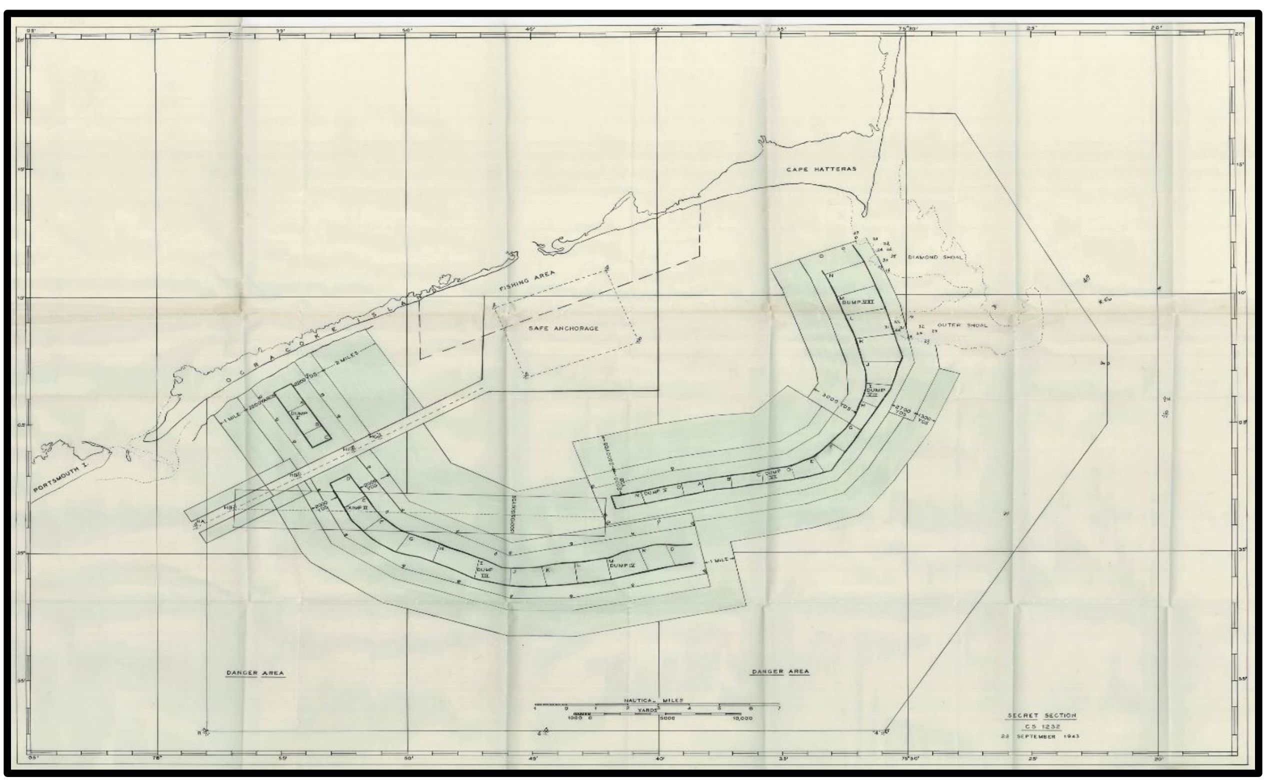


FIGURE 1. Confidential Section of USC&GS Chart 1232 showing the location and configuration of the Hatteras minefield (Source: National Archives).

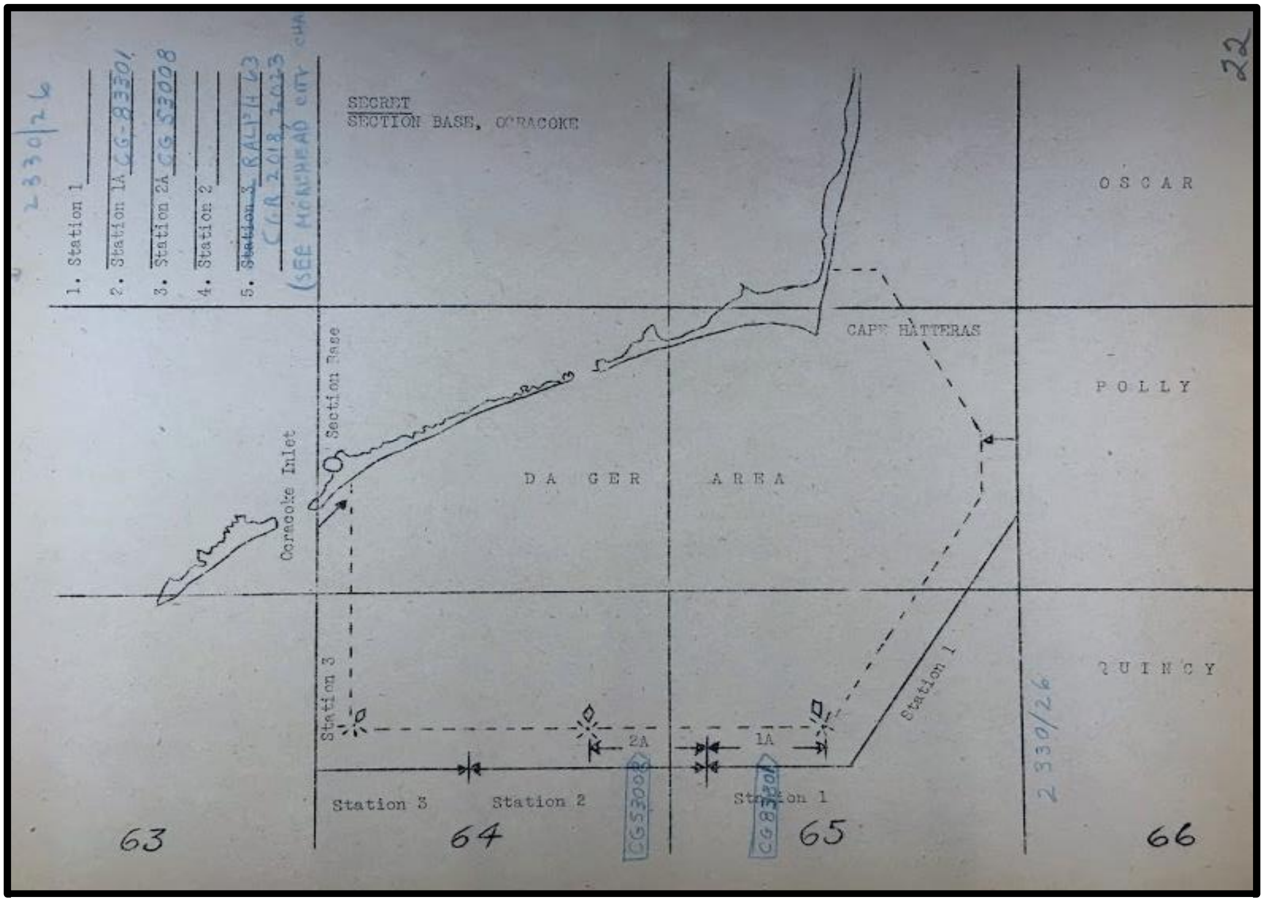


FIGURE 2. U.S. Navy chart showing the location and configuration of the Hatteras minefield, including how the sectors were divided (Source: National Archives).

Previous Research and Importance

Before this thesis, there has been no attempt at a dedicated work centered around Cape Hatteras Minefield. Much of the data collection had to be taken from either primary sources or small sections in secondary works. The largest composites of information pertaining to Cape Hatteras Minefield are contained within two other Battle of the Atlantic theses. These belong to John Wagner (2010), "Waves of Carnage: A Historical, Archaeological and Geographical Study of the Battle of the Atlantic in North Carolina Waters" and John Bright (2012) "The Last Ambush: An Adapted Battlefield Analysis of the *U-576* Attack upon Allied Convoy KS-520 off Cape Hatteras During the Second World War". These two works were instrumental in accumulating base information and made researching Cape Hatteras Minefield much easier. However, both maintain the idea that Cape Hatteras Minefield was a failure as did the primary sources that provided this opinion (to be discussed). Their sections on Cape Hatteras Minefield were purely the retelling of history and lacked any archaeological analysis, as the minefield was only a small portion of their wider scope. In turn, Cape Hatteras Minefield has often been passed over, and its traditional failure narrative has never been truly examined. Therefore, the importance of this thesis lies in the ability to flesh out an often passed over, uncharacteristic patterned defensive structure, while serving as a dedicated source of information. Additionally, it allows Cape Hatteras Minefield and its negative connotations to be examined through archaeological study. Further, it serves to fill in another small piece of the work that NOAA is performing during their Battle of the Atlantic surveys (2008-present).

Objectives

The dominant narrative of the minefield is that it was a failure. Between 15 June and 19, July 1942 merchant ships *F.W. Abrams*, *Chilore*, and *Keshena* [another vessel hit a mine but did not sink] all struck mines and were lost while there were no German U-boat casualties due to mines. There were other attacks directly associated with the minefield as well, most notably, the U.S. Navy vessel USS *YP-389* that was patrolling the minefield when it was attacked by *U-701* (Hickam 1989:291). The United States Navy was responsible for marking the minefield only as a hazardous navigation area on charts, instead of divulging the true destructive nature of the minefield. This deception meant that for the duration of the minefield's existence, merchant shipping would have no knowledge of the hazardous navigation area's true nature. As with any military endeavor, collateral damage should not only be understood as possible but also expected and allowed for in planning. *Operational Security*, or OPSEC as it is known, has always been a dangerous dam regulating the natural ebb and flow of battlefield information. The United States Navy could ill afford to announce openly the location or even the existence of the minefield, least the element of surprise be destroyed. The divulgence of the site of Cape Hatteras Minefield would only serve to open a major opportunity for the German U-boats to find a route inside the areas of safe anchorage and wreak havoc on the merchant ships enjoying false amnesty from the raging Battle of the Atlantic (Lott 1959:44).

This research is an attempt to assess the effectiveness of this defense structure in detail and reassess this narrative. It will evaluate the Hatteras Minefield considering the assumption that the objective of a defensive structure is not to cause damage to an enemy force (no army builds a wall in hopes that it falls and crushes their enemy). Cape Hatteras Minefield is one of several examples of mines being used as a physical barrier on the American East Coast. This is in stark comparison to the German offensive mining that was done along the American East Coast (Caram 2011:28). Additionally, it will attempt to examine the many factors that precipitated the loss of merchant ships *F.W Abrams, Chilore,* and *Keshena*. Finally, this study intends to follow a process informed by battlefield archaeological theory in order to attempt to measure the effectiveness of the minefield. A series of research questions, outlined below, will be used to reevaluate the success or failure of the minefield, which will be used to either redefine or reinforce the narrative of failure. Potentially, the methods employed may be extrapolated to other minefields from the Second World War, such as the Key West Minefield. Also, a comparison highlighting the unique nature of Cape Hatteras Minefields may be made in contrast to the offensive mining by the German U-boats in the Chesapeake Bay shown in Figure 3 (Blair 1996:387).

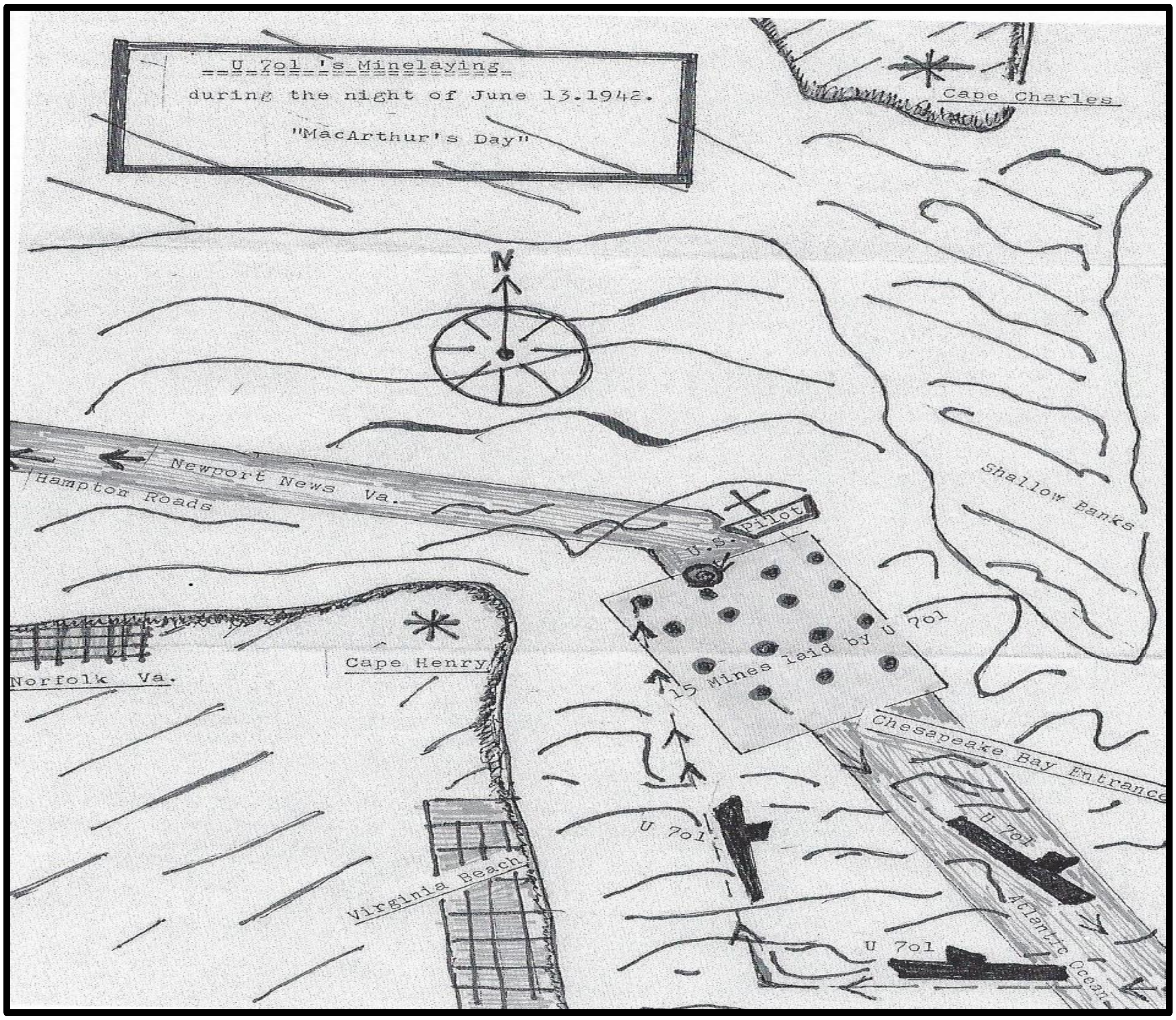


FIGURE 3. Hand-drawn map by KptLt. Horst Degen, Skipper of *U-701* depicting mines that he and his crew laid in Chesapeake Bay, Virginia on 13 June 1942 (Source: Caram 2011:28).

It is important to reconsider Cape Hatteras Minefield as it is an atypical defensive structure and tactic in America's history, in this case it serves to artificially create a navigational hazard into open ocean to protect a port. It is one thing to wall of the entrance to a port but Cape Hatteras Minefield was in one package an offensive weapon of destruction, a defensive weapon and a neutral navigational hazard. In the same way that the National Register of Historic Places qualifies sites in part if they are exemplary models "or that represent a significant and distinguishable entity" (NHRP Staff 1990:2). Another consideration, with the amount of work being undertaken by NOAA to document the Battle of the Atlantic, it is important that every aspect is accurately represented.

Research Questions

Research will focus on answering a primary research question by asking a series of secondary research questions. These questions will focus the research on quantifiable factors for determining the relative success, or failure, of the naval minefield.

Primary:

- What methods are suitable for the assessment of the success or failure of naval minefields, specifically Cape Hatteras Minefield, during the Second World War?

Secondary:

How can the success of a minefield be defined?

- Categorizing Minefields
  - Minefields are both passive and active depending on the situation; therefore, can they be assessed by a single set of standards?
- Survival and Safety
  - Can the safe passage of tonnage past Cape Hatteras whose goods were used to fuel the war effort be cited as the success of the minefield?

How can the failure of a minefield be ascertained?

- Economic losses
  - How many ships were lost?
  - How much gross tonnage was lost?

- Cost for the United States Navy to patrol and escort ships through the minefield.

Thesis Structure

This work is broken up into seven chapters. *Chapter One*: *Introduction*, focuses on introducing the work and includes a brief historical background, the objectives of this study, the research questions that framed the study and the structure breakdown. The introduction transitions into the second chapter, *History*. *Chapter Two: History* includes information regarding the climate in which the Battle of the Atlantic created, and therefore the need for coastal defenses to guard against the German U-boat's attacks on Allied merchant shipping. progresses into the process in which Cape Hatteras Minefield was proposed, accepted and implemented by the Fifth Naval District. The remainder of the chapter is dedicated to the narrative of the destructive events that surround the minefield, particularly that of *F.W. Abrams, Chilore,* and *Keshena.*

Chapter Three: Theory then focuses on the theoretical framework in which the archaeological components of the work were based upon. Foremost, the theory of historical archaeology is responsible for the ability to reconcile the historical data in the form of maps with the practice of archaeological analysis. In conjunction with historical archaeology, battlefield archaeology was the main structural thesis for the final analysis. Within the use of battlefield archaeology, methods for battlefield assessment created by the U.S. Army known as METT-T (Mission, Enemy, Terrain, Troops Available, and Time Available) and KOCOA (Key Terrain, Observation and Fields of Fire, Cover, and Concealment) were important for better understanding the battlefield landscape. Finally, because of the heavy use of Geographic

Information System (GIS) data a specific theoretical structure concerning the use of GIS was used.

Chapter Four: Methodology recounts the process by which historical research was performed throughout the data collection process for both primary and secondary sources. It also goes into the process by which the rubbersheeting and map creation were performed in some depth. This is important as the technology that drives GIS is ever-evolving. *Chapter Five: Results* consists of the results produced from GIS creation, as well as the various graphs and charts that resulted from historical research. This moves to *Chapter Six: Analysis* in which the archaeological meaning of the materials in *Chapter Five: Results* is ascertained. Finally, *Chapter Seven: Conclusion* wraps up the project and reiterates what was learned from the project. This is where the research questions are revisited, and a final statement is made to each of the questions.

CHAPTER TWO: History

Introduction

As the dust at Pearl Harbor, Hawaii settled and the year 1942 opened, the world saw the American war machine begin to plan its protracted offensives in European and Pacific theaters. While much of the American military focused on offensive operations, homeland defense was becoming a pressing issue. On 15 January 1942, a meeting was held in Washington DC by naval personnel to discuss implementing additional coastal defenses, with the intent to guard against opening hostilities by German U-boats which, would eventually evolve into Operation *Paukenschlag* (Operation Drumbeat), the German *Unterseeboot* (U-boat) offensive. Deliberated in this meeting was the proposal of laying more mines along the coast from Cape Cod, Massachusetts to Key West Florida. With this plan agreed upon, it initially saw frequent delays due to difficulty in acquiring proper ships to lay mines as well as foul weather. While it was completed and put into use, the life of Cape Hatteras Minefield would be short-lived. The unfortunate drawback of mines being non-discriminatory saw the sinking of *F.W.*

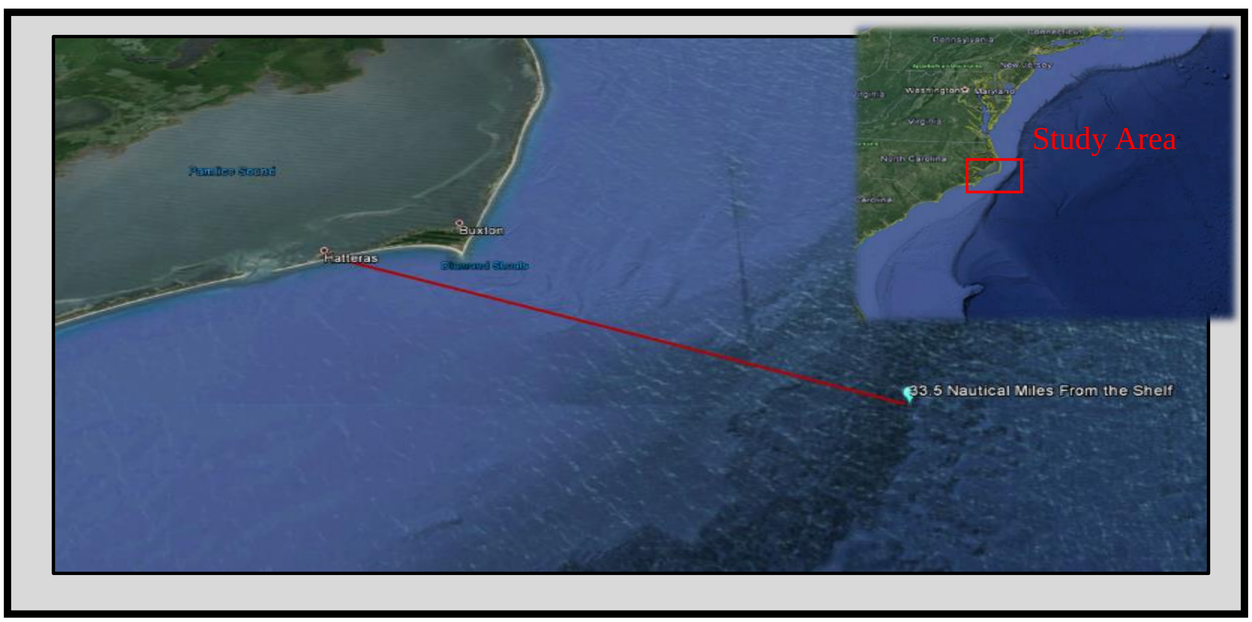


FIGURE 4. Map showing the rough distance the continental shelf extends out into open ocean from Cape Hatteras (Created on Google Earth by Mitchell Freitas, 2016).

Abrams, J.A. Mowinckel, and *Keshena*. Each Allied ship lost served as a metaphorical nail in the coffin, leading to the ultimate deactivation of the minefield in April of 1943 (ESF 1943:11-13,chap. 5; Wagner 2012:102).

Conception and Construction

The plan, initially proposed by Chief of Naval Operations (CNO) Admiral Earnest King, was met with reserve and disdain by Admiral Adolphus Andrews. Admiral Andrews believed that the mines would be of little concern to the German U-boats and would pose a significant danger to Allied merchant shipping that frequented the harbors proposed for mining. After several attempts to voice his growing concern over the relative danger of the mines, Admiral Andrews yielded to his superiors and proceeded with preparations. However, this passive behavior would not last for long. As the Cape Cod and Cape Ann minefields were unremittingly delayed, Admiral Andrews would once again vocalize his disapproval of the minefields, instead offering a plan of a swift offensive campaign against the Germans to clear them from American waters. Andrews also argued that "Minefields are a menace to friendly as well as enemy vessels. To require the Frontier to protect friendly vessels from its own weapons is a task that should be forced upon it by the enemy- not voluntarily adopted" (ESF 1942b; Andrews in Freeman 1987:61). Regrettably, for Andrews, the rampant success of the German U-boats was indeed forcing the U.S. Navy to consider adding additional minefields.

One of the major geographical advantages offered to German U-boats was the bathymetry of the North Carolina coast. The continental shelf is, at its narrowest, only roughly 33.5 nautical miles in width (Figure 4). This allowed U-boats to attack and quickly make it back to the safety of deep water (Blair 1996:439). These benefits were a factor in the U-boat captain's successes in the region and drawing the ire and attention of the U.S. Navy. In February of 1942, the leadership within the American Navy met once again to discussing mining options to defend against a fluid situation with the German U-boats. This time, however, instead of two small mined harbors, the Commander of the Inshore Patrol of the Fifth Naval District submitted that all coastlines susceptible to U-boat attack have a minefield constructed to make up for inadequate military surface and air vessels. This plan would be heavily debated over the next several months and would take until April 1942 for the submission of two distinct operational plans for consideration. The first would echo the proposal by the Commander of the Inshore Patrol of the Fifth Naval District and consist of a mined barrier stretching from Cape Hatteras to Cape Canaveral totaling 30,000 mines and over 600 miles of ocean (ESF 1942b; Eastern Sea Frontier 1943:3; Freeman 1987:192).

Ultimately, the sheer scale of this task would incur heavy costs, not only monetarily but in the constant upkeep that the plan would require. Minesweepers would have to patrol constantly for loose mines that had the possibility of drifting into the shipping channel, and the spread-out nature of mines made it impossible to discern if the mines could keep the U-boats at bay (ESF 1942b; Freeman 1987:191-193; Wagner 2012:85). The second plan of action consisted of laying a network of mined anchorages that would populate the East Coast and would provide merchant vessels safe haven during the night. The network would comprise six mined anchorages, beginning in New York and ending in Florida and would utilize less than half of the mines that the first option required, totaling only 14,000 total mines. The smaller fields would also require fewer patrol vessels, which were already at a premium. However, there were still drawbacks to this plan:

> The downsides of using mined anchorages included the fact that merchant ships would need to be routed further out to sea to get around the minefields, further exposing them to U-boats during the day and making it harder to provide them with coverage, and requiring them to plan their travel times around stopping at anchorages. This would ultimately increase the travel time required to complete a voyage and slow the transportation of supplies (Wagner 2012:86).

Due to the relative safety and lower cost of the smaller mined anchorages, the U.S. Navy ultimately decided to implement the second plan and poignantly directed Andrews, the biggest antagonist to the minefield system to oversee the installation of the mined anchorages. In response to the increased volume of attacks in North Carolina waters, Andrews suggested that Cape Hatteras and Cape Fear be the first anchorages mined (ESF 1942b; Freeman 1987:193). After the plan had been put into place, the Fifth Naval District became aware of the need for the establishment of a small naval outpost to support the day-to-day operations of the minefield (ESF 1943:4,5,12). The choice was made for Ocracoke Island to become the home for the outpost and Captain Henry Coyle of the Coast Guard was appointed Convoy Dispatcher, Hatteras, Lookout and Cape Fear Area (ESF 1943:5-6).

With the remainder of April being used to complete the planning stages of the project, 22 May 1942 was issued as a deadline for the completion of Cape Hatteras Minefield. Due to the inadequate number of minelaying vessels available, progress was halted in Hatteras until the completion of the Key West Minefield due to the availability of minelayers that were already operating in Florida. This shortage of vessels, however, did not stop preparations from taking place, and on 6 May 1942, a notice issued to commercial mariners warned that a “Danger Area” had been established around Cape Hatteras though the true destructive nature of why the area had become a danger zone was kept secret (ESF 1943:6; Wagner 2012:88).

Five days later (11 May 1942), the Fifth Naval District remarked that it was “Assembling materials for Hatteras anchorage” (ESF 1942a:13) and would continue over the next several days. At this point in the war, CNO Admiral Ernest King would be promoted to Commander in Chief of the United States Navy and would leave the completion of the minefield to the newly appointed Admiral Royal Ingersoll, Commander-in-Chief, Atlantic Fleet. It was left up to Admiral Ingersoll to corral enough resources for the completion of the project. On 20 May 1942, the minelaying package (Table 1) sailed from the Naval Mine Depot in Yorktown, Virginia and would begin work on the first leg of the minefield the following day (ESF 1942a:23; Miller 1942; Bright 2012:145). A notice issued on the same day by the Hydrographic Office stated that a “Danger Area” had been established and that:

> The only passage through the dangerous area to the anchorage is from Lighted bell Buoy HA, black and white vertically striped and showing a short- long flashing white light, located in lat. 35°00’59”N., lon. 75°58’19”W., through a channel 1000 yards wide in a 60° direction for a distance of approximately 11 miles. A lightship has been established in lat. 35°01’12”N., lon.75°59’06”W., near the entrance channel where pilots or specific instructions may be obtained (ESF 1942c:34).

TABLE 1.
MINELAYING PACKAGE FOR CAPE HATTERAS MINEFIELD

Ship Type	Ship Name
Minelayers	USS *Keokuk* (CM-8) USS *Miantonomah* (CMc-5) USS *Monadnock* (CMc-4) USS *Wassuc* (CMc-3)
Escorts	USS *Benson* (DD-421) USS *Cherokee* (AT-66) USS *Mayo* (DD-422)
Minesweepers	USS *Bluebird* (AM-72) USS *Flicker* (AM-70) USS *Linnet* (AM-76)

Note: List of vessels present at the construction of Cape Hatteras Minefield (Dictionary of American Naval Fighting Ships 1981:1.

Further preparations, made on 22 May 1942 included ordering Captain Coyle to establish 24-hour patrols to ensure that the minelaying process went smoothly and was not interrupted. To launch the “Hatteras minefield patrol” Coyle was only given a small group of five Coast Guard cutters that were supplemented by *YP-388* and *YP-389*, fishing trawlers that the navy seized and converted (ESF 1942b, 1943:7; Headquarters Fifth Naval District 1942:9; Freeman 1987:328,352; Wagner 2012:89). Only four days past the original deadline on 26 May 1942 the minefield was announced compete (Figure 5). Due to the relative stability of its payload, the task of homeland defense was left to the Naval Mark VI mine (Bureau of Naval Ordinance 1955:376; Campbell 1985:167; Friedman 1988:111; Bright 2012:143). There exists a slight discrepancy on the final number of Mark VI mines that constitute the double crescent-shaped field. One document in Record Group 38 states that there were 2,635 mines laid with a premature percentage of 3.1% or 82 premature detonations (ESF 1942d). This statistic would put the final number at 2,553 mines (Figure 6). A second document within the same record group shows the final number at 2,860 mines laid. Both documents agree on the first leg consisting of 1,440 mines, but the first source states that only 1,195 mines were laid on the second leg while the second shows 1,420. Each leg of the minefield stretched 17 miles long and overlapped for two miles in the center, spaced to create a 1.5-mile entrance. The first leg, Leg 1 (East) consisted of four rows of mines; each row spaced 500 yards apart. The second leg, however, Leg 2 (West) was only constructed with three rows of mines with the rows once again spaced 500 yards apart (ESF 1943:12; Wagner 2012:89,90). This difference in leg layers may explain why there was a discrepancy in the number of mines in Leg 2 and favors the first document's number of 1,195 mines.

Regardless, after the completion of the minefield, a series of several "Notices To Mariners," namely "Restricted Notice to Mariners No. 9 and No. 12" were issued on 7 May and 13 May 1942 respectively, to warn against the hazardous area that Cape Hatteras Minefield now occupied. These notices were kept intentionally vague in order to preserve operational security but detailed the procedures of how to safely enter the area with a naval escort and the navigational aids now associated with the minefield (Freeman 1987:415; Bright 2012:110).

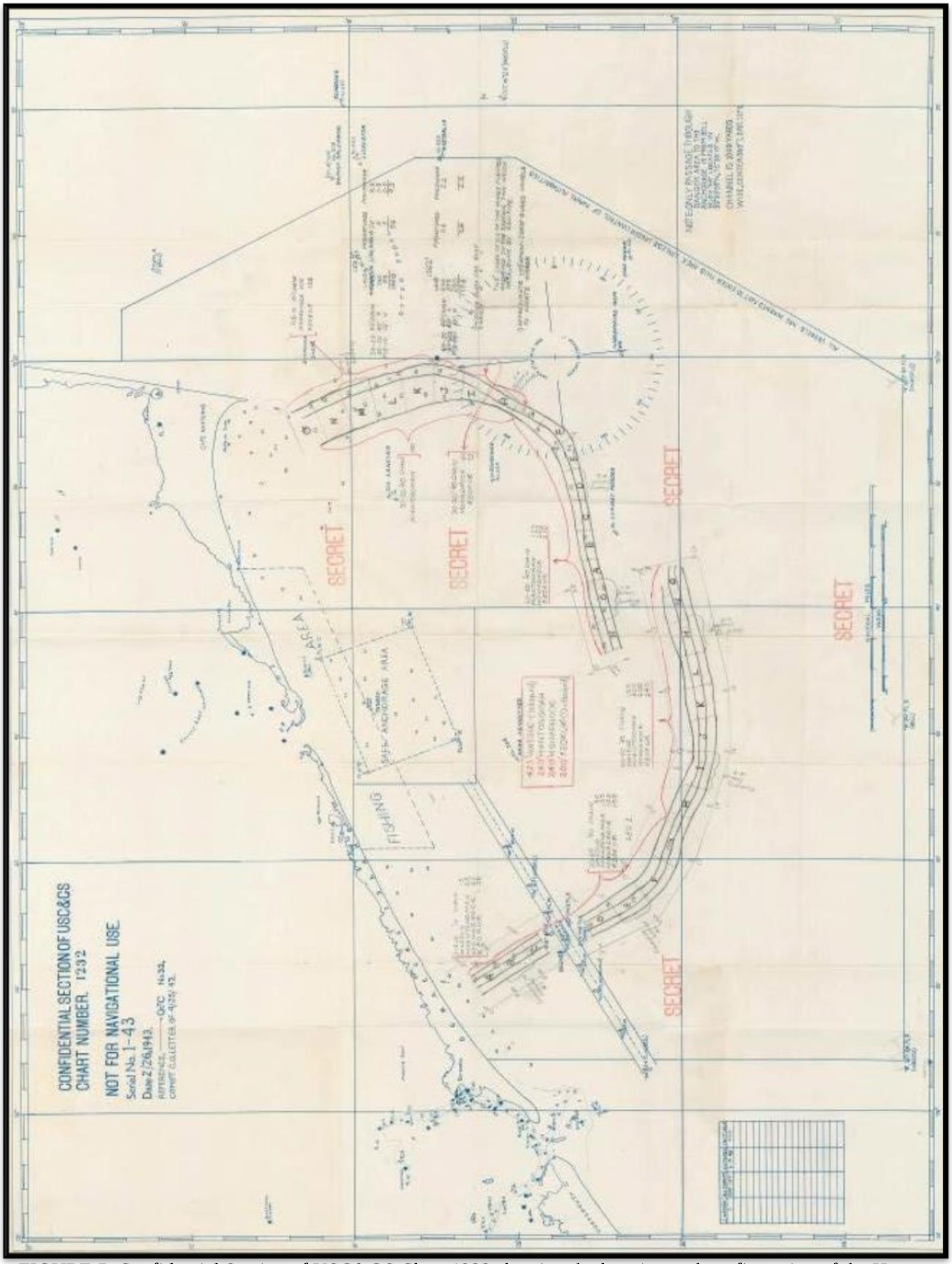
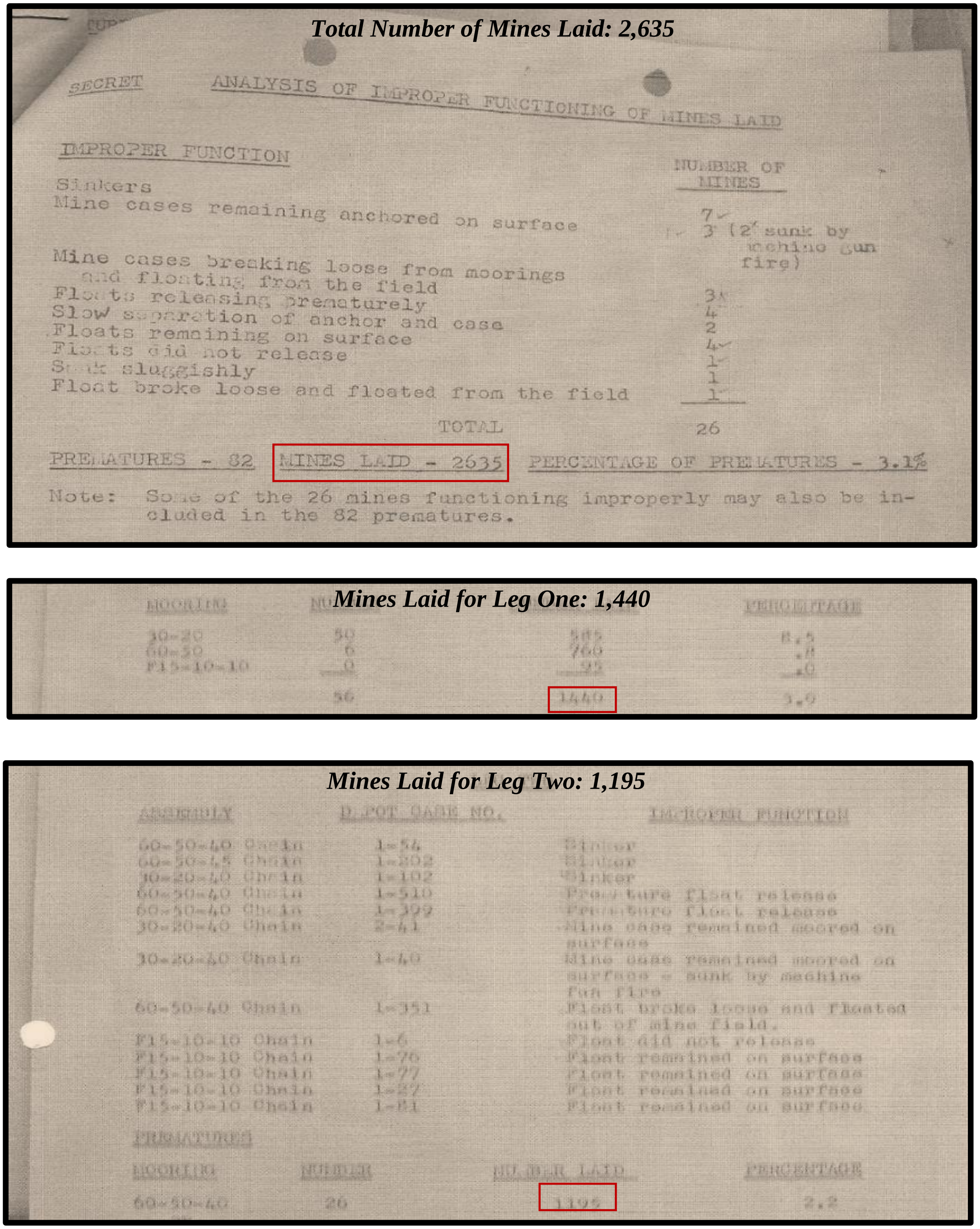


FIGURE 5. Confidential Section of USC&GS Chart 1232 showing the location and configuration of the Hatteras minefield, and the retrieval of mines post-conflict (National Archives).



IMPROPER FUNCTION	NUMBER OF MINES
Sinkers	7
Mine cases remaining anchored on surface	3 (2 sunk by machine gun fire)
Mine cases breaking loose from moorings and floating from the field	3
Floats releasing prematurely	4
Slow separation of anchor and case	2
Floats remaining on surface	4
Floats did not release	1
Sank sluggishly	1
Float broke loose and floated from the field	1
TOTAL	26

PREMATURES - 82 MINES LAID - 2635 PERCENTAGE OF PREMATURES - 3.1%

Note: Some of the 26 mines functioning improperly may also be included in the 82 prematures.

MOORING	NU[illegible]	[illegible]	PERCENTAGE
30-20	50	585	8.5
60-50	6	760	.8
F15-10-10	0	95	.0
	56	1440	3.9

ASSEMBLY	D.POT CASE NO.	IMPROPER FUNCTION
60-50-40 Chain	1-54	Sinker
60-50-45 Chain	1-202	Sinker
30-20-40 Chain	1-102	Sinker
60-50-40 Chain	1-510	Premature float release
60-50-40 Chain	1-399	Premature float release
30-20-40 Chain	2-41	Mine case remained moored on surface
30-20-40 Chain	1-40	Mine case remained moored on surface - sunk by machine gun fire
60-50-40 Chain	1-351	Float broke loose and floated out of mine field.
F15-10-10 Chain	1-6	Float did not release
F15-10-10 Chain	1-76	Float remained on surface
F15-10-10 Chain	1-77	Float remained on surface
F15-10-10 Chain	1-27	Float remained on surface
F15-10-10 Chain	1-81	Float remained on surface

PREMATURES

MOORING	NUMBER	NUMBER LAID	PERCENTAGE
60-50-40	26	1195	2.2

FIGURE 6. Document from Record Group 38 showing the final number of mines laid at Cape Hatteras as 2,635 (National Archives).

The First Nail: F.W. Abrams

Unfortunately, Cape Hatteras Minefield would force Admiral Andrews' fear of damage to merchant shipping to manifest quickly in the loss of the oil tanker *F.W. Abrams* (Figure 7). Beginning its voyage in early May from Aruba to New York with 90,000 barrels of oil under the command of Captain Anthony Coumelis along with a crew of 35, the instructions issued by the British to *F.W. Abrams* contained no mention of the newly implemented minefield (Williamson 2006:134). This ignorance, however, was by design; only naval personnel were aware of the true nature of the "Danger Area." The crew of *F.W. Abrams* was already in violation of Admiral Andrews' orders that tankers were not to sail the coast without a convoy. This lack of respect for naval directions was not an isolated event; some merchant captains chose to sail alone, against the orders to convoy as they did not trust the navy to protect them (Geroux 2016:94).

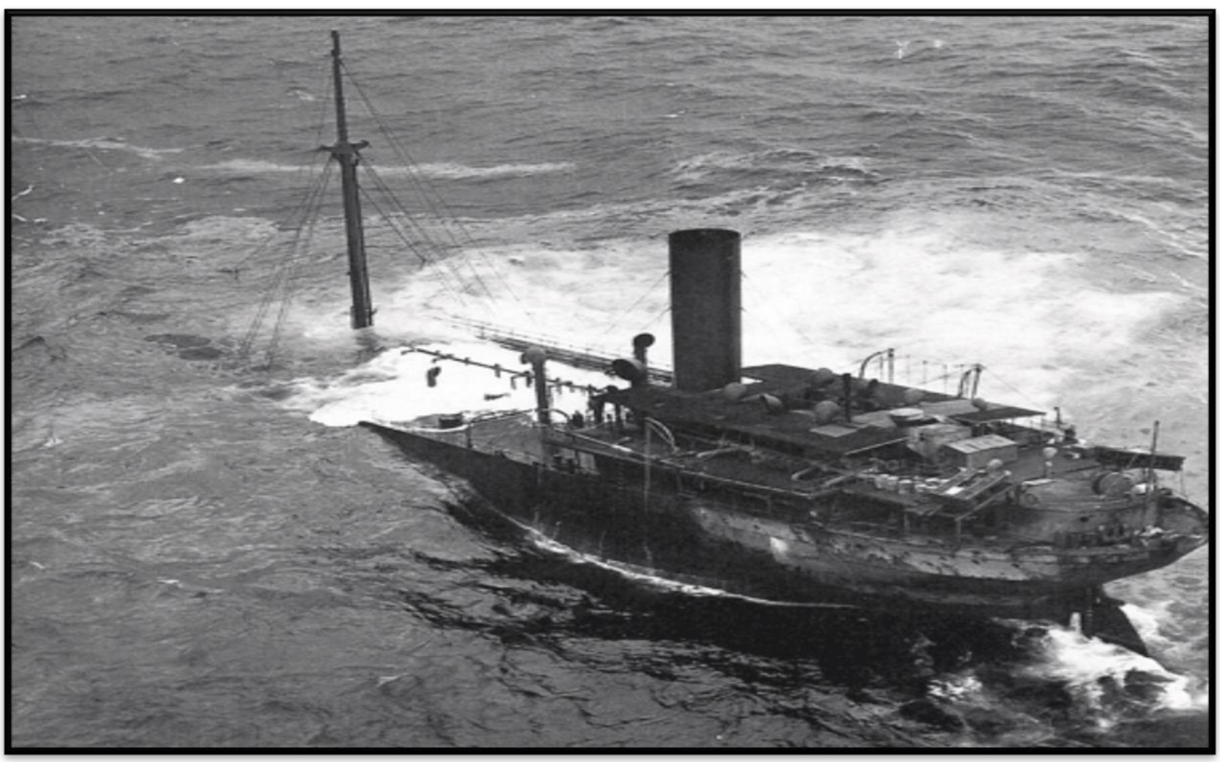


FIGURE 7. Photograph showing *F.W. Abrams* after striking mines in Cape Hatteras Minefield (http://www.divehatteras.com/fwabrams.html).

Regardless of Captain Coumelis' feelings, this decision would cost the crew as *F.W. Abrams'* journey progressed (Hickam 1996:275). On 10 June 1942, *F.W. Abrams* passed into North Carolina waters and was quickly hailed by the escort ship *CG-484*, one of the vessels making up the Hatteras minefield patrol. After anchoring the night within the protective enclosure of the minefield, *F.W. Abrams* the crew was set to continue their voyage the next morning. However, the weather on 11 June 1942 would make that difficult. Beset by downpours and heavy fog, *F.W. Abrams* quickly lost sight of *CG-484* and, being ignorant of the threat of friendly naval mines; the choice was made to push out to open sea of their own accord (Freeman 1987:345; Wagner 2010:91; Bright 2012:110).

At 0650 Eastern War Time (EWT), the first explosion shook *F.W. Abrams.* The captain, realizing the tanker was not in the danger of immediately sinking, decided to drop anchor and radio for help, this was an incredibly risky choice to carry out in water where known U-boats were patrolling. However, due to a jammed anchor chain, *F.W. Abrams* was left to drift helplessly in an area ripe with naval mines and German U-boats. Not even 40 minutes later at 0717 EWT, a second explosion ripped through the starboard side of *F.W. Abrams.* Still afloat by 0737 EWT, a third mine would devastate the bow. Finally defeated, *F.W. Abrams* began to sink, which forced the crew to abandon it to the depths. The official report from the ESF War Diary states "SS *ABRAMS* en route from Ocracoke anchorage in foggy weather encountered Navy Mine Field while apparently steering the improper course, struck mines and sank in 34/59/24 – 75/48/18" (ESF 1942a:13). While the cause of sinking was straightforward, blame for the incident became quickly convoluted. As Captain Coyle began investigating the breakdown in communication between *CG-484* and *F.W. Abrams* a number of different after action reports began coming forward. The Coast Guard crew claimed that *F.W. Abrams* ignored orders and failed to respond to several instructions, this then evolved into claims of torpedo wakes, seemingly anything to avoid taking responsibility for the incident. This event, regardless where the blame falls, marks only the beginning of the tainted history of Cape Hatteras minefield (ESF 194344:7,8; Freeman 1987:345-346; Wagner 2012:92).

The Second Nail: The Battle of YP-389 and U-701

Due to the overwhelming need for combat vessels for overseas operations as well as for the protection of major ports, Cape Hatteras Minefield was outfitted with *YP-388* and *YP-389* (Figure 8). While designated "Yard Patrol" (YP), these vessels were converted fishing trawlers ill-prepared for wartime purposes. After conversion, at Naval Submarine Base New London, Connecticut, the vessels were given orders to make their way down the coast as convoy escorts until they reached their destination at Cape Hatteras (ESF 1942b; Freeman 1987:352; Hickam1989:285-286; Wagner 2012:6).

FIGURE 8. Photograph showing *Cohasset*, before the military conversion to *YP-398* (Source: National Archives).

These vessels, specifically *YP-389*, could only handle a maximum speed of 9 knots and could, on an exceedingly favorable day, make 10 knots. It is understandable why then the vessel failed as a convoy escort; the convoy's speed at 8.5 knots put a massive strain on the vessel and forced frequent stops for repairs (ESF 1942b, 1943:8; Headquarters Fifth Naval District 1942:3-6,9-10; Freeman 1987:352; Wagner 2012:93).

After reaching Cape Hatteras already in rough condition, the two vessels were to begin their roles with insignificant armament. Both vessels were outfitted only with two .30 caliber machine guns, one 3-inch gun as well as four racked depth charges and two spares (Figure 9). This armament was entirely insufficient for warding off U-boat attacks, and *YP-389* would pay dearly for the lack of warfighting tools the U.S. Navy had bestowed upon the vessel. Slotted for their first 5-day patrol from 11 June to 16 June, *YP-389* befell more mechanical issues, this time; it was the 3-inch gun that refused to fire (Headquarters Fifth Naval District 1942:3-6, 9, 10; ESF 1943:8,chap. 5; Freeman 1987:352,353; Wagner 2012:93).

FIGURE 9. YP class vessel, notice the depth charge barrels mounted to the stern (National Archives).

Upon returning to Section Base Ocracoke, it was determined that the weapon's firing spring was broken, and the replacement part would have to be provisioned through Operations at Morehead City. Put back out to patrol on 18 June the crew of *YP-389* had no idea what was awaiting them or how woefully unprepared they were 7 (ESF 1942b, 1943:8; Headquarters Fifth Naval District 1942:3-6, 9, 10; Freeman 1987:352,353; Wagner 2012:93).

Under the command of Kapitänleutenant Horst Degen, *U-701* was a type VIIC commissioned 16 July 1941. Capable of 17 knots on the surface, 7 knots submerged, *U-701* carried 14 torpedoes, 26 TMA magnetic sea mines, and was crewed by anywhere between 44-52 men (Stern 1991:38-47). Sailing from Lorient, *U-701* began its journey on 20 May 1942, hoping to gain the same success and fame as other U-boats had done during Operation Drumbeat. This honor, however, would not come to fruition. The crew missed several opportunities on its voyage across the Atlantic, one being the Swedish *Drottningholm*, which was carrying Axis diplomats and therefore was allowed to go on its way, and the other being a British ocean liner that was out of range and moving too fast for *U-701* to catch. These failures had a significant effect on the crew, and tensions began to rise. After narrowly escaping an Allied aircraft on 12 June, *U-701* began its given mission of mining the entrance to the Chesapeake Bay. Unknown to the crew, this minelaying operation would wreak major havoc on the Allies, ultimately sinking two ships and damaging two more. On 16 June, the crew would be consumed with frustration, missing an 8,000-ton freighter with two torpedoes (B.d.U.1942b:78-79,117; OCNO 1942:10-12; Hickam Jr. 1989:267-261,281; Wagner 2012:95).

With tempers extremely high, and the fear of having to return failures weighing on the crew, an unsuspecting *YP-389* would serve to reduce the crew's stress. At 0245 on 19 June, the two vessels made contact, and immediately the crew of *YP-389* realized how helpless they were.

With only two .30 caliber machine guns online, they would only serve to give away the patrol vessel’s position. While attempting evasive maneuvers being constantly bombarded by 3-inch shells, *YP-389* could do nothing more but attempt to maintain course back to shore. Eventually, a 3-inch round from *U-701* found its way into *YP-389*’s chart room, setting the vessel on fire. At this point, there was nothing the crew could do to save the vessel and furthermore there was no way for the crew to deploy life rafts as two had been shot away and the equipped lifeboats were too exposed to *U-701*’s constant fire to lower. With the only choice left to the crew being to abandon ship, Lieutenant R.J. Phillips ordered his men directly into the water with only life vests to maintain their buoyancy (Hickman 1989:291).

After four hours afloat, watching their vessel sink (Figure 10), the crew was finally picked up by Coast Guard cutters at 0800 EWT (ESF 1942b; Freeman 1987:354; Hoyt 2008:8; NOAA 2016). It is here that the minefield is traditionally credited with its second victim (ESF 1942b, 1943:8; Freeman 1987: 355; Wagner 2012:96). While *YP-389* did not strike a mine, the minefield’s existence was the reason the vessel was near *U-701*. The lack of proper equipment due to the strain on resources led to the loss of six Allied lives. This loss was enough for the Eastern Sea Frontier to place a hold on the future construction of the remaining minefield

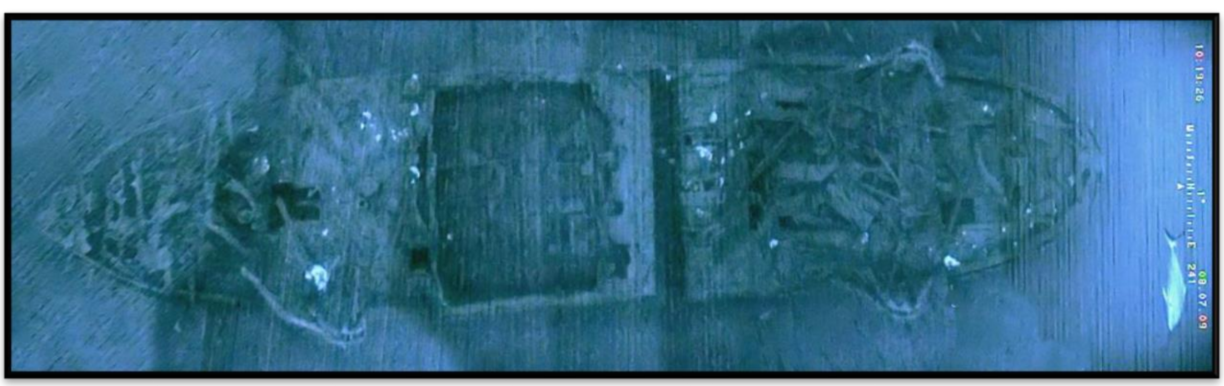
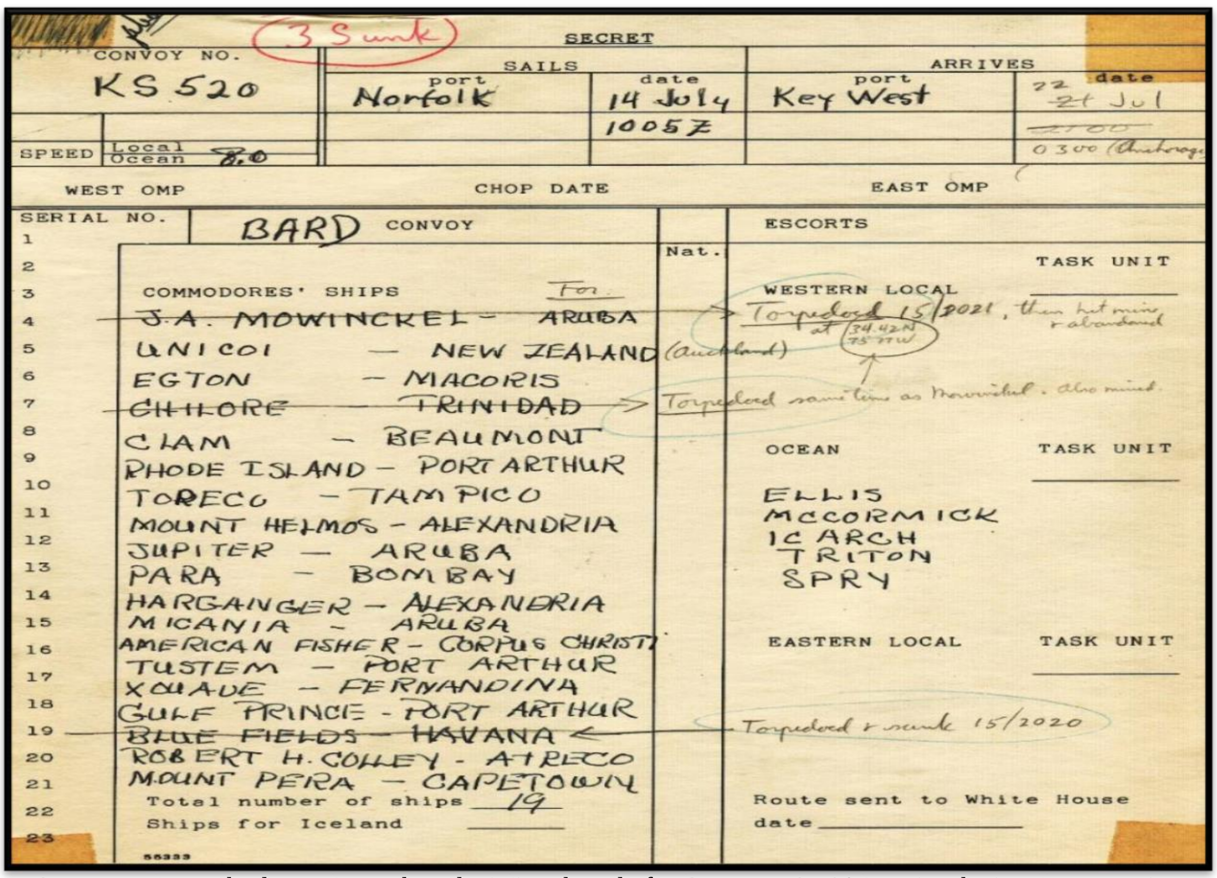


FIGURE 10. Photomosaic documenting the final resting place of *YP-389*, the vessel is located in 300 feet of water (NOAA).

anchorages and instead wait until they could be adequately furnished with patrols (ESF 1943:8,chap. 5; Freeman 1987: 355; Wagner 2012:96).

The Final Nail: Convoy KS-520

Soon after the incident with *F.W. Abrams,* the effectiveness of the mined anchorage plan was once again called into question. On 14 July 1942, convoy KS-520 left port at Lynnhaven Road, Virginia and would be the minefield's ultimate undoing. After leaving Virginia at 0430 EWT, the convoy reached Cape Hatteras at around 0700 EWT 15 July without incident. The convoy consisted of 19 merchant vessels (Figure 11) organized into seven columns escorted by two Coast Guard cutters, two destroyers, one corvette, two PCs (Coastal Patrol Vessels) and was covered in the air by two allied aircraft (ESF 1942b; Freeman 1987:411).



3 Sunk

SECRET

CONVOY NO. KS 520

SAILS — port: Norfolk — date: 14 July 1005Z

ARRIVES — port: Key West — date: 22 ~~21~~ Jul ~~2100~~ 0300 (Anchorage)

SPEED Local / Ocean 8.0

WEST OMP — CHOP DATE — EAST OMP

SERIAL NO. — BARD CONVOY — Nat. — ESCORTS

COMMODORES' SHIPS — For.

SERIAL NO.		
1		
2		
3		
4	~~J.A. MOWINCKEL — ARUBA~~	Torpedoed 15/2021, then hit mine & abandoned at 34.42N 75.?W
5	UNICOI — NEW ZEALAND (Auckland)	
6	EGTON — MACORIS	
7	~~CHILORE — TRINIDAD~~	Torpedoed same time as Mowinckel. also mined.
8	CLAM — BEAUMONT	
9	RHODE ISLAND — PORT ARTHUR	
10	TORECO — TAMPICO	
11	MOUNT HELMOS — ALEXANDRIA	
12	JUPITER — ARUBA	
13	PARA — BOMBAY	
14	HARGANGER — ALEXANDRIA	
15	MICANIA — ARUBA	
16	AMERICAN FISHER — CORPUS CHRISTI	
17	TUSTEM — PORT ARTHUR	
18	XCUADE — FERNANDINA	
19	GULF PRINCE — PORT ARTHUR	
20	~~BLUE FIELDS — HAVANA~~	Torpedoed & sunk 15/2020
21	ROBERT H. COLLEY — ATRECO	
22	MOUNT PERA — CAPETOWN	
23		

Total number of ships 19

Ships for Iceland

ESCORTS

WESTERN LOCAL — TASK UNIT

OCEAN — TASK UNIT: ELLIS, MCCORMICK, IC ARCH, TRITON, SPRY

EASTERN LOCAL — TASK UNIT

Route sent to White House date

55333

FIGURE 11. A Tenth Fleet convey chart depicting the role for Convoy KS-520. Notice the incorrect notation at the top of the page asserting that three vessels were sunk, in reality, only two were lost (Tenth Fleet Convoy and Routing Files Box 78, National Archives).

At 1600 EWT about 20 miles away from Ocracoke Inlet the convoy made first contact with *U-576* and after two unsuccessful attacks contact was broken. While the entire convoy was now on alert, though it would not be enough for the convoy to escape unscathed. At 1625 EWT, *Chilore* (Figure 12) was struck for the first time by a torpedo from *U-576* on the vessel's port bow and was still afloat when *Chilore* was then hit by a second torpedo this time on the port beam. The Convoy Commodore, Captain N.L. Nichols (retired) witnessed the attack from the vessel *J.A. Mowinckel,* but before he had time to react and give evasive orders, *J.A. Mowinckel's* stern was struck by another of *U-576*'s torpedoes leaving a 20 by 20ft hole and damaging steering machinery (ESF 1942b; Freeman 1987:412). The attack on *J.A. Mowinckel* claimed two lives and injured 20 more, adding to the panic onboard. Given time to react, the remainder of the convoy began to scatter as *Chilore*, and *J.A. Mowinckel* fell out of line, but *U-576* had already chosen its next victim. Only two minutes had passed since *J.A. Mowinckel* was hit before *Bluefields* was struck amidships (ESF 1942b; Freeman 1987:412).

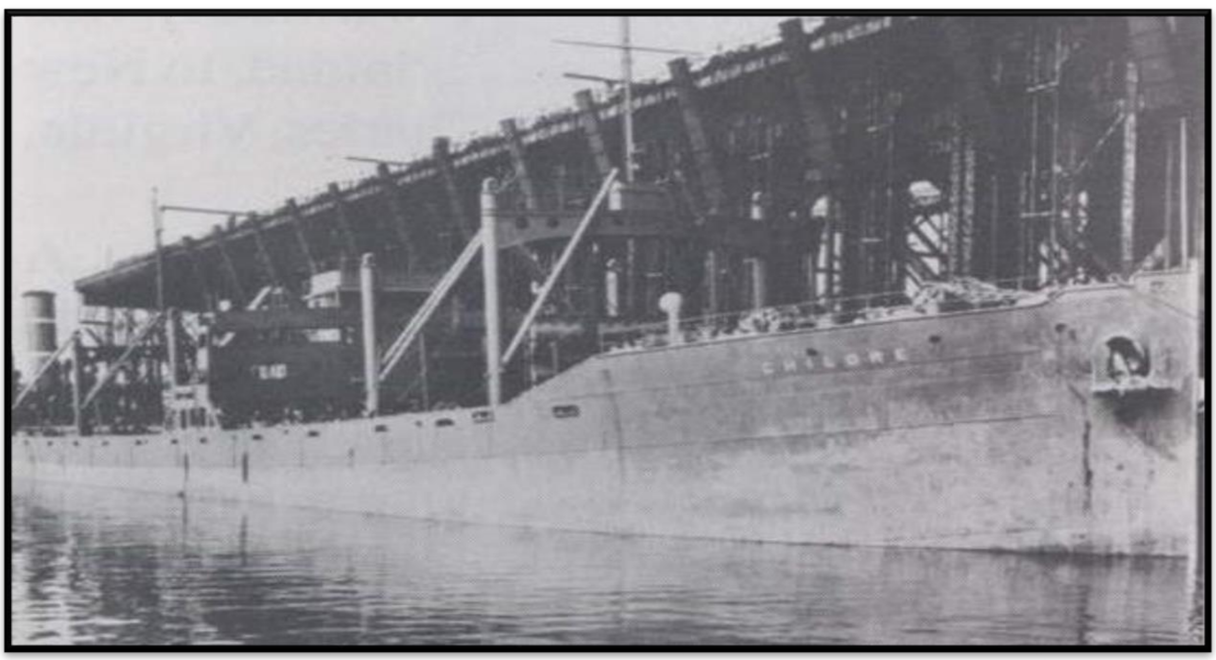


FIGURE 12. Image showing *Chilore* at dock (Norfolk Public Library).

Over the next 40 minutes, the convoy escorts frantically searched for the U-boat with no results while Nichols realized that *J.A. Mowinckel* (Figure 13) with 20 men in need of medical attention and *Chilore,* who had been hit twice needed to find their way to safety. What was not known at the time is that *U-576* was sank within 15 to 20 minutes of sinking *Bluefields* (NOAA 2008). *Bluefields* did not hold much concern for Nichols because it had sunk completely by 1700 EWT while its crew had been picked up by the escort ship *Spry.* After a doctor transferred from *McCormick* to *J.A. Mowinckel* and *Spry* had been given orders to escort the two injured vessels to the nearest port. With *Spry* leading and *J.A. Mowinckel* steering by only its engines, the vessels began their 20- mile journey towards Cape Hatteras. The course the small convoy plotted would ultimately be its downfall, set for 315 degrees true would lead the vessels directly into Hatteras Inlet slightly below the danger area of the minefield (ESF 1942b, 1943:10; Freeman 1987:413-415; Wagner 2012:98).

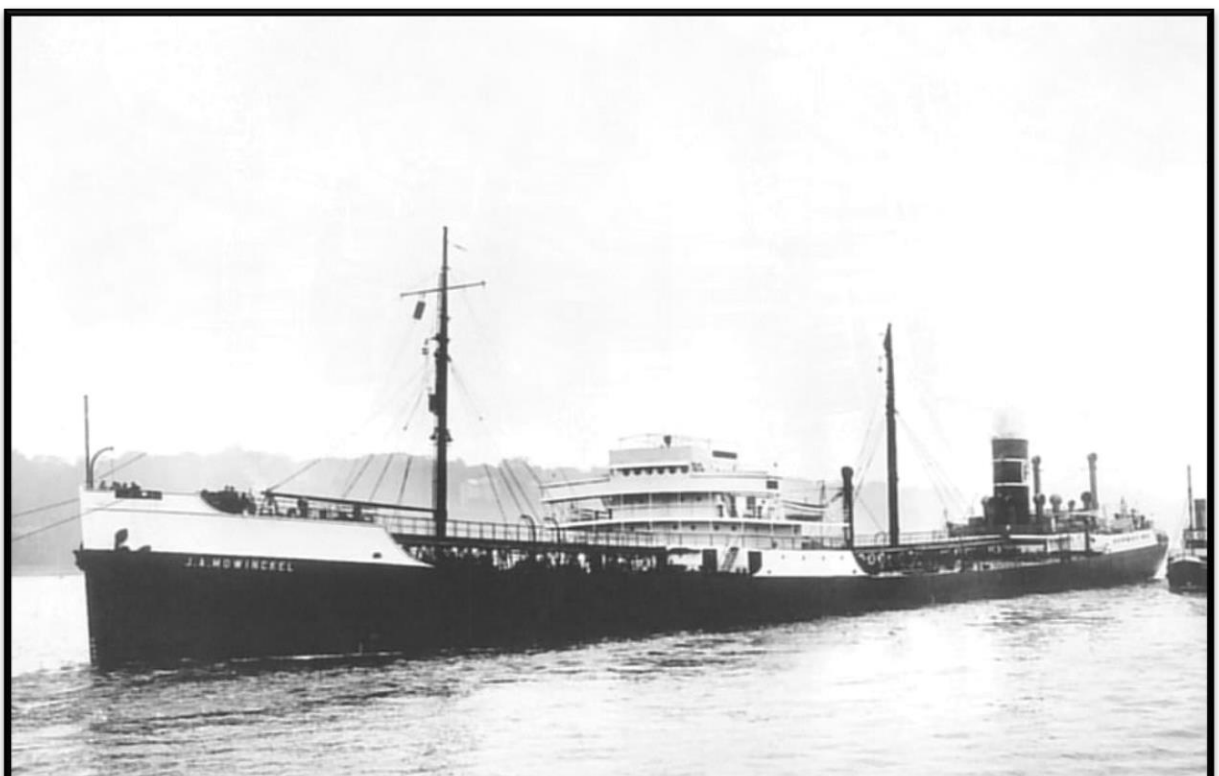


FIGURE 13. Photo of *J.A. Mowinckel* while still in service of the ESSO Petroleum Company (Uboat.net).

Several issues contributed to the overall failure of the next several hours. Lieutenant Commander (LtCdr) Maxim Firth, commanding officer of *Spry*, knew of the minefield due to Conhydrolant (Confidential Hydrographic Office Report) Notice 32 but was incorrect on his dead reckoning and was 60 miles further south than he realized (ESF 1942a). This was a normal occurrence for escort ships to only have a dead reckoning level of navigation as they were often dispatched away from the convoy to hunt threats (Freeman 1987:414). Nichols, however, knew exactly where the vessels were but would later claim that he had never seen Notice to Mariners 175 and, therefore, had no knowledge of the danger area surround Hatteras. Before the ships began under weigh to safety, Nichols appointed the Vice Commodore in control of the convoy effectively making himself simply a passenger aboard *J.A. Mowinckel* with no operational control. However, the master of *J.A. Mowinckel* agreed to allow Nichols a degree of control due to his vast experience as a retired U.S. Navy Captain (ESF 1942b; Freeman 1987:415).

As the three vessels progressed and communication began to flow between Lieutenant Commander Firth aboard *Spry* (Figure 14) and Nichols aboard *J.A. Mowinckel,* it was soon realized by LtCdr. Firth that the current course was taking them directly into the minefield. To attempt to remedy this, LtCdr. Firth radioed "You should head for a position 15 miles 227 true from Hatteras Inlet according to latest information" (ESF 1942b; Freeman 1987:416). This course would have put the vessels at the opening to the minefield. However, there was no response from Nichols or any onboard *J.A. Mowinckel.* Instead of reissuing the course change, the LtCdr. was afraid of questioning the Commodore a second time due to his prior service as a Captain. With the warning unheeded, it would be up to the patrol vessels to perform their duty of

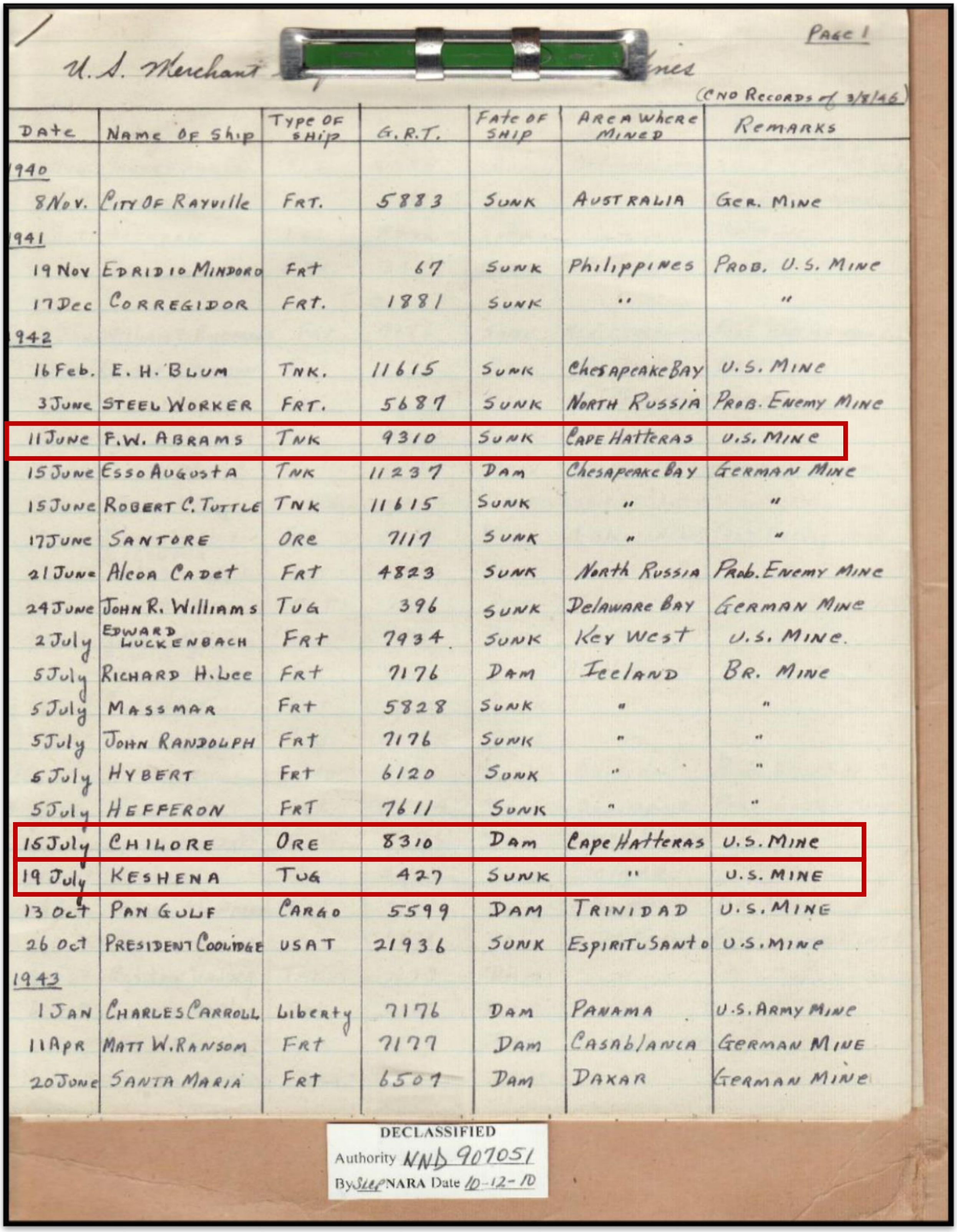
FIGURE 14. Image showing *USS Spry* (PG-64), formally *HMS Hibiscus*. The vessel was a flower-class corvette that the United States acquired for homeland defense (National Archives).

preventing vessels from inadvertently wandering into the minefield. Thus, another opportunity for a breakdown in protocol (ESF 1942b; Freeman 1987:416).

The minefield was directed to have three 400 class Coast Guard patrol vessels. These Coast Guard vessels were 83 feet in length and could reach a top speed of 20 knots. The 400 class was intended to be used not only in the capacity of hunting U-boats but to handle search and rescue missions as well as mundane patrol tasks (Flynn 2014:18). On 15 July, only one of the three was on patrol. *CG-463* (Call Sign NLUO) had been detached to aid the hunt of the U-boat, and *CG-462* (Call Sign NLUN) was ferrying gasoline to one of the YP vessels attached to the minefield, leaving *CG-480* (Call Sign NLVH) alone to patrol the entire minefield. The crew aboard *CG-463* witnessed the three vessels move past, but due to the presence of *Spry*, a naval vessel, the commanding officer of *CG-463* saw no reason to contact the vessels. Shortly after *CG-463* failed to make contact, a naval blimp spotted the vessels and dropped smoke bombs ahead of their position. These signals were incorrectly taken by Commodore Nichols as a warning for U-boats in the area while the blimp had been attempting to warn of the danger of the vessel's current course.

At 1930 EWT, the three vessels were spotted by *CG-462*, who was returning from its supply run. The crew attempted to catch up with the injured vessels to warn them off their current heading, going as far to signal with their blinkers and fire their guns. The sound of a loud explosion at 2000 EWT ended *CG-462*'s efforts. The uproar, caused by *Chilore* and *J.A. Mowinckel* was the result by both striking mines. The crew, fearing they were under attack once again by German U-boats, filed into lifeboats and made it safely ashore. Once *CG-462* had the time to catch up to the vessels and make contact with *Spry* did LtCdr. Firth understand the amount of danger facing his crew. Without the ability to do anything for the severely injured but still afloat merchant vessels, *Spry* was led to safety by *CG-462* and was able to reestablish contact with KS-520 (ESF 1942b, 1943:8; Freeman 1987:418; Wagner 2012:100).

While the events surrounding the attack of KS-520 were chaotic, as far as *Chilore* and *J.A. Mowinckel* were concerned they were not over. As both vessels were still afloat, two tugboats were detached to tow the two merchant vessels to safety on 19 July. While a secure channel was swept for this towing operation, at around 1630 EWT the tug, *Keshena* ventured out of the security zone, striking a mine and sinking quickly. The other tug, *J.A Martin* managed to pull both merchant vessels out of harm's way (Standard Oil Company 1946:36; Bright 2012:151). While *J.A. Mowinckel* was able to be ultimately repaired and be put back into service, *Chilore* capsized near the Chesapeake Bay, Virginia on 24 July (SOC 1946:370-371; Bright 2012:152). The traditional narrative attributes *Chilore*'s ultimate demise as the fault of the minefield (Figure 15). After the culmination of the events of KS-520, many within the Fifth Naval District began to push hard for the removal of the minefield.



/ U. S. Merchant [illegible] nes

PAGE 1

(CNO RECORDS of 3/8/46)

DATE	NAME OF SHIP	TYPE OF SHIP	G.R.T.	FATE OF SHIP	AREA WHERE MINED	REMARKS
1940						
8 NOV.	CITY OF RAYVILLE	FRT.	5883	SUNK	AUSTRALIA	GER. MINE
1941						
19 NOV	EDRIDIO MINDORO	FRT	67	SUNK	Philippines	PROB. U.S. MINE
17 DEC	CORREGIDOR	FRT.	1881	SUNK	"	"
1942						
16 Feb.	E. H. BLUM	TNK.	11615	SUNK	Chesapeake Bay	U.S. MINE
3 JUNE	STEEL WORKER	FRT.	5687	SUNK	NORTH RUSSIA	PROB. ENEMY MINE
11 JUNE	F.W. ABRAMS	TNK	9310	SUNK	CAPE HATTERAS	U.S. MINE
15 JUNE	ESSO AUGUSTA	TNK	11237	DAM	Chesapeake Bay	GERMAN MINE
15 JUNE	ROBERT C. TUTTLE	TNK	11615	SUNK	"	"
17 JUNE	SANTORE	ORE	7117	SUNK	"	"
21 JUNE	Alcoa Cadet	FRT	4823	SUNK	North Russia	Prob. ENEMY MINE
24 JUNE	JOHN R. Williams	TUG	396	SUNK	Delaware Bay	GERMAN MINE
2 July	EDWARD LUCKENBACH	FRT	7934	SUNK	Key West	U.S. MINE.
5 July	RICHARD H. Lee	FRT	7176	DAM	Iceland	BR. MINE
5 July	MASSMAR	FRT	5828	SUNK	"	"
5 July	JOHN RANDOLPH	FRT	7176	SUNK	"	"
5 July	HYBERT	FRT	6120	SUNK	"	"
5 July	HEFFERON	FRT	7611	SUNK	"	"
15 July	CHILORE	ORE	8310	DAM	Cape Hatteras	U.S. MINE
19 July	KESHENA	TUG	427	SUNK	"	U.S. MINE
13 Oct	PAN GULF	CARGO	5599	DAM	TRINIDAD	U.S. MINE
26 Oct	PRESIDENT COOLIDGE	USAT	21936	SUNK	Espiritu Santo	U.S. MINE
1943						
1 JAN	CHARLES CARROLL	Liberty	7176	DAM	PANAMA	U.S. ARMY MINE
11 APR	MATT W. RANSOM	FRT	7177	DAM	CASABLANCA	GERMAN MINE
20 JUNE	SANTA MARIA	FRT	6507	DAM	DAKAR	GERMAN MINE

DECLASSIFIED
Authority NND 907051
By SLP NARA Date 10-12-10

FIGURE 15. Handwritten chart showing the fates of vessels lost or damaged during the Battle of the Atlantic from 8 March 1946. Notice the notation of *Chilore* as damaged, not sunk by U.S. Mine (Record Group 38 National Archives).

Closing Moves

On 21 July 1942, Admiral Andrews finally vindicated in his opposition to the minefield, petitioned King to replace the hazardous minefield with anti-torpedo netting. Andrews not only cited the events surrounding *Abrams*, *Chilore,* and *Keshena* as evidence for the removal of the minefield but also suggested that since the convoy system had been put online, the safety of merchant shipping had risen above the need for the minefields protection (ESF 1942b, 1943:8; Freeman 1987:415-419; Wagner 2012:100). Andrews also asserted that the failure to warn mariners of the actual nature of the danger area had contributed to the minefield's failure due to the mariner's confusion and apathy. Two weeks later, on 4 August 1942 King issued his response to Andrews, once again denying him the ability to remove the minefield. King believed that the geography of Cape Hatteras was such that anti-torpedo nets were not capable of ensuring the safety of merchant shipping. King did cede the fact that the confusion created by labeling the field as a "Danger Area" needed to be rectified and mariners alerted to the destructive nature of the minefield. At this point, the need to keep the knowledge of the minefield away from nonmilitary personnel was moot, enough of the merchant mariners had been alerted to the mines that operational security had been dissolved (ESF 1943:8-11; Wagner 2012:101).

As the Fifth Naval District and the men stationed at Ocracoke continued to maintain what was seen as a derelict defense system, their sparse resources and munitions began to dwindle. The patrol vessels were required to guard the minefield regardless if merchant vessels were utilizing it and the regular routine began to take the toll on the ill-suited vessels. Moreover, only one ship had sought the safety of the anchorage in three months. On 6 November 1942 Admiral Andrews once again pleaded with Admiral King, suggesting that the mines be removed, but the area still be treated as a danger zone. Admiral King, seemingly growing tired of Admiral

Andrews' requests, simply stated that no minesweepers were available for use by the Fifth Naval District and that none would be free until the following year around springtime, and that Andrews should wait until then to once again approach the issue (ESF 1943:11; Wagner 2012:101).

Admiral Andrews would wait until April 1943, this time, throwing every shred of evidence he had to support the removal of the minefield. In this brief, Andrews noted the lack of merchant vessel attacks since 15 July 1942 as well as the effect on local fishing which was "based on the Department of the Interior's Deputy Coordinator of Fisheries stating that restrictions on fisherman in the area had already decreased the catch by a staggering 80,000,000 pounds" (ESF 1943:11; Andrews in Wagner 2012:101). Finally, on 21 April 1943, Admiral King allowed the deconstruction of Cape Hatteras Minefield. However, this was left entirely to the Fifth Naval District, who while battling mechanical malfunctions and heavy weather only recovered 1,303 of the 2,500 mines. The danger of the remaining mines is why today the area is still labeled as a "Danger Area" (Figure 16).

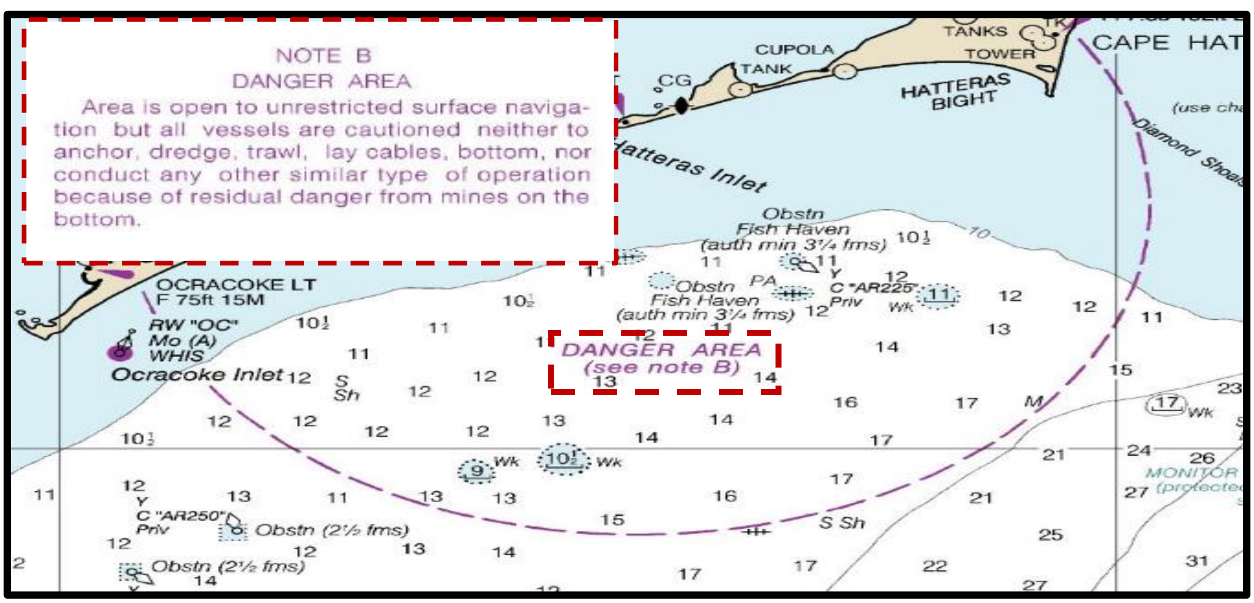


FIGURE 16. Modern day chart, showing that the area is still considered dangerous due to "residual danger from mines" (NOAA Chart 12200).

Conclusion

Even with the job incomplete, the Fifth Naval District considered the removal a success, and the Navy moved on from Cape Hatteras. The event of historic ordnance washing on shore is not an uncommon phenomenon and is an issue that is always swiftly handled by military Explosive Ordnance Disposal technicians (R.G. Sprigg et al. 2001:A2). Therefore, it is impossible to say in this work if there have been any mines from Cape Hatteras Minefield wash up on shore as the access to operational records is restricted and further historical/archival material is unknown. Similarly, to date, there have been no reports of any ships entering the marked danger area and striking any of the mines. Now that the historical context has been set, the next chapter, theory, will discuss the theoretical framework of the project. This marks the move from an historical lens to an archaeological view.

CHAPTER THREE: Theory

Introduction

This chapter discusses several theories sourced from battlefield and historical archaeology that are used throughout this study. Battlefield archaeology is a component of the larger field of historical archaeology. Historical archaeology approaches not only helped to populate the data sets and maps that were used for the analysis but also served as a backdrop for the information that was provided by archaeological survey. While considered a weapons system, the minefield is also at its core a *battlefield*; therefore, this designation justifies the use of the structures of both battlefield archaeology in conjunction with the METT-T (Mission, Enemy, Terrain, Troops Available and Time) and KOCOA (Key Terrain, Observation and Fields of Fire, Cover and Concealment, Obstacles and Avenues of Approach) approaches that will be used throughout the study (and expanded below). Finally, theory pertaining to the use of Geographical Information Systems in archaeological research will be discussed in order to guide the creation of geospatially-rectified maps. This will help ensure that the maps created are compatible and aid the analysis of Cape Hatteras Minefield.

Historical Archaeology

The use of historical archaeology was central to the completion of this project, as historical sources will take precedence over the sparsely available archaeological datasets. It served as an overarching framework, incorporating battlefield archaeology and two battlefield archaeological approaches: METT-T and KOCOA. In line with historical archaeology, in addition to archaeological evidence, historical documents viewed as artifacts are interpreted to "allow a more accurate and thus more useful drawing of testable hypotheses to better organize the collection and analysis of new data” (Babits 1981:11). Effectively, this allows for a melding of the disciplines of history and archaeology in the way that helps answer the research questions and enables archival information found in libraries and archives using traditional historical research methods to be reconciled with the sparse archaeological data.

Battlefield Archaeology

Battlefield archaeology endeavors to bridge the gap between traditional military history and the social science of archaeology (Pollard et al. 2005:v). This bridge can be built “where the archaeological record is viewed as an independent dataset that can be compared to historical documents, participant accounts, maps, and other sources to build a more complete and accurate picture of an event” (Scott et al. 2009:429). As Phillip Freeman lays out in his work, “History, Archaeology and the Battle of Balaclava,” there are three distinct ways that an archaeologist can approach the analysis of a battlefield. The first uses “archaeology to embellish the accepted story of events,” where “archaeology is used to clarify details or add to the historical framework” (Freeman 2007:149). The second, employs archaeological work to “reconcile the problematic aspects of an engagement, or to correct conventional interpretations” (Freeman 2007:149). The third and final way views archaeological data as a tool used to bolster the historical account when available sources do not exist. These three basic tenants of battlefield archaeology mean well, but as Nathan Richards (et al. 2011:25; Richards in Bright 2012:31) point out, “without an explicit theoretical framework, study of battlefields seem to trend along the lines of antiquarianism or historical particularism.” Utilizing an approach like antiquarianism or historical particularism tends to lead the user to fetishize artifacts while reinforcing the dominant historical narrative or it simply will describe a battlefield while lacking analysis. Over time, and thanks to contributions by Dean Snow (1981), Douglas Scott et al. (1989), Richard Fox and Scott (1991) and Carl Drexler (2009), methodical frameworks have been constructed, therefore allowing the user to venture beyond a simple description of a battle and make educated assumptions as to why and how these events took place.

The implementation of a battlefield archaeology framework can have a major impact on the narrative of a historic site in that "the conception of a particular battlefield can be greatly enhanced and perhaps even altered in the light of material evidence" (Bright 2012:7). Such a framework also emphasizes that warfare, being a human social activity, are not random occurrences, but come with a set of socially constructed rules. Therefore the "actions of military units on a battlefield are based on the tactics of the prevailing military wisdom of the day" (Potter et al. 2000:13).

Battlefield archaeological approaches usually share a belief in the underlying cultural constant, that "combatants fight as they are trained under the rules of that culture's perception of warfare behavior. Opposing combatant positions, movement, armament, and methods of warfare should be discernible" (Scott et al. 2009:433). However, they also allow researchers to consider vast differences in military culture from the macro (country) to the micro (unit) level. These sentiments are crucial for understanding the strategic and tactical decisions of the United States Navy when implementing a naval minefield at Cape Hatteras.

The analysis of the American warfighter outlined in this thesis seeks to follow the precedent set in the introduction of the book *Fields of Conflict,* which is to uncover and compare the behavioral tendencies and choices of Allied and Axis combatants operating along the North Carolina coast (Scott et al. 2009:1). This patterning of a combatant's decision-making process asserted by Scott et al.'s analysis is echoed in John Keegan's (1976) theory of inherent military probability in which,

> By assuming soldiers performed on the battlefield in a manner consistent with their training, military historians could critically review battle accounts by visiting the battlefield and determining what course of action a trained soldier would have taken given the lay of the land (Keegan 1976:34; Keegan in Bright 2012:26).

Maritime scholars may also extrapolate this understanding to naval battlefield landscapes through a modified version of the U.S. Army's METT-T Theory (which will be discussed later in this chapter). The patterning of shipwrecks, especially those that result from naval engagements offers a unique form of analysis. The idea of shipwreck distribution as a reflection of human behavior is a common idea in maritime archaeology. For example, Keith Muckelroy (1978:4) defined maritime archaeology as "the scientific study of the material remains of man [sic] and his activities on the sea […] for the insight they give into the people who made or use them," and Richard Gould (1983c:105) has written that shipwrecks "provide the signatures of particular kinds of behaviors associated with such conflict if one is willing to examine the relationships that exist between behavior and material residues." Augmented by research such as John Broadwater's work on the Battle of Yorktown, present-day researchers can see how essential understanding the relationship between the naval battlefield elements, such as mine placement and land formation choices (such as the area off Cape Hatteras) contributes to judging whether ports were safe during wartime. As Broadwater asserts,

> Analyzing naval engagements within the broad natural and cultural landscapes across which they took place and with respect to the historical

> events that define them, imparts additional significance and meaning to the events and the natural contexts in which they occurred (Broadwater 2010:177).

Only by understanding the natural marine environment and the way organizations such as the U.S. Navy analyzed the natural landscape can researchers analyze the wartime effectiveness of places such as Cape Hatteras Minefield.

A major flaw of using Battlefield Archaeological Theory in this thesis is the lack of ability to personally ground-truth the locations that were used in the analysis of Cape Hatteras Minefield. Though information from other works were consulted such as Hoyt et al 2017. This would be closer to the particularistic approach of George F. Bass (1983:91-104; Bass in Bright 2012:14), of which a specific, comprehensive study would be performed at each site with the focus being on the artifacts themselves. In the case of this thesis, a particularistic approach was just not monetarily feasible at this time. To compound the issue, the monetary funding, staff, and time needed to study two large freight vessels and a tugboat at such a great length are outside the scope of this project. The next step in the logical framework is to then take a generalist approach. This approach, while not as site specific, as Larry Murphy (1983:67) claims, lends more to the analysis of human behavior which is more in line with this project's goals.

Another issue that may arise is that while historical records list the routes of the various convoy paths and the locations of sinking events, these cannot necessarily be verified through any archaeological survey performed by the author in the context of this study. This is in part due to the nature of the ocean itself. In the instance of terrestrial archaeology, heavily traveled routes can often still be observed in the terrain and the density of artifact scatter can be used to determine the locations of encampments, troop movements, and battlefields (Babits 1998:12). The flow of ships does not leave these long-lasting pieces of evidence. Moreover, the final resting places of sunken vessels do not reflect the same geographical locations as their sinking events. As observed by Muckelroy (1998:267) and Robert L. Gearhart (1998:291), this is due to the natural tendency of vessels and artifacts to drift and move as they sink, as opposed to sinking straight down. For the GIS created for this thesis, both the historic wrecking event coordinates and the current resting locations of *Chilore*, *Keshena,* and *F.W. Abrams* will be interpolated to show the differences in location.

An important distinction that needs to be drawn is that unlike traditional terrestrial battlefield archaeology projects where the battlefield represents the geographic location where two groups of combatants fought, this thesis is examining the geographic location of an area where armed combatants (German U-boats) attacked non-combatant merchants (Allied shipping). Under normal circumstances, the comparison would be difficult. German U-boats would be expected to follow a set doctrine of movement while the Allied merchants would have more freedom when they traveled. However, this may be a null point in this case. Wartime restrictions on sea travel and the mobilization and activation of the American Merchant Marine would suggest that the Allied shipping lanes would be highly regulated and follow a very similar doctrine to that of the American Navy (Blair 1996:446). Of course, it may also be that the cultural differences between the U.S. Navy and the merchant marine created a mistrusting and therefore insubordinate environment. Moreover, it was not uncommon for retired and active duty naval officers to be present on the merchant shipping convoys (Freeman 1987:415).

To fully decode defensive choices of the United States, offensive trends of German U-boats, and the utilization of the North Carolina Coast as the field of battle, the METT-T system will be utilized (Table 1). METT-T as an interpretive framework aids in the identification of the mission of Cape Hatteras minefield; and helps delineate the purpose of the minefield in the greater context of the Battle of the Atlantic. The time portion will also work to emphasize the dichotomy between the long static nature of the minefield and the ever-fluid environment of naval warfare. Time available is often defined as "time-based on the tentative plan and any changes to the situation" (United States Army 1992: 2.8-2.9).

This is an important consideration because the time often dictates what the truly available options are to a commander. For instance, the German U-boats had already begun creating havoc on Allied merchant shipping before the United States entered the war. This forced the United States to make quicker decisions. While the use of KOCOA will fulfill the 'Terrain' portion of METT-T, this framework allows the battlefield itself to be viewed through a theoretical lens and aid the construction of a new combat narrative (Table 2). During wartime, naval escorts led convoys; this will allow their actions to be viewed through the lens of METT-T. Also as a military installation, Cape Hatteras Minefield was operated and patrolled by U.S. Navy vessels such as *YP-389* and, therefore, merchant mariners' movements within the minefield are also viewable through the lens of METT-T and KOCOA. This is due to the fact that at the time those in command of the naval escorts *should* have been adhering to the same naval doctrine.

TABLE 2.
METT-T BREAKDOWN

Battlefield Consideration	Definition	Examples
Mission	Objective of combat and the actions necessary to the task	The mission of the minefield being solely to serve as a safe haven in the instance U-boats would knowingly or unknowingly of the minefield penetrate the harbor.
Enemy	Opposing force as well as the danger posed by those forces	German U-boats with the proclivity for devastating sudden attacks against merchant vessels. The enemy had the advantage of maneuverability and armament.
Terrain	Largely continued within KOCOA (see Table 2)	The protrusion of Cape Hatteras farther out on the Continental Shelf offered a bottlenecking situation ideal for the U-boats to attack, cut and run back to deeper water. KOCOA will be used for a more in-depth analysis.
Troops Available	Available, friendly forces	After the initial set up of the minefield, the troops available were relatively scarce; needing converted commercial vessels to serve as escorts and mine inspectors. Local air support was present but not particularly strong. With these given resources, one could argue the benefit of a minefield over that of something like a blockade that would require more troops.
Time Available	Time available for logistical elements to come together and accomplish the task	Unlike other naval weapons, mines like the model used for the Cape Hatteras Minefield were intended to be stationary and long lasting. This creates an interesting dichotomy between static mines and the remaining majority of fluid naval warfare.

Note. Prototypical use of METT-T within the theoretical framework. (Source: Bright 2012: 282-290; Created by Mitchell Freitas).

TABLE 3.
KOCOA BREAKDOWN

Battlefield Element	Definition	Examples
Key Terrain	A portion of the battlefield, possession of which gives an advantage to the possessor.	Currents, water depth, temperature, weather conditions, visibility.
Observation and Fields of Fire	Any point on the landscape that allows observation of the movements, deployments, and activity of the enemy that is not necessarily key terrain, offers the opportunity to see over an area and acquire targets and allows flat-trajectory weapons to be brought to bear on the enemy.	Line of sight, elevation, orientation of vessel.
Cover and Concealment	Landforms or landscape elements that provide protection from fire and hide troop positions from observation.	Storms
Obstacles	Landscape elements that hinder movement and affect the ultimate course of battle.	Hazards to navigation both natural and manmade.
Avenues of Approach	Corridors used to transfer troops between the core battle area and outer logistical areas.	Natural aids to navigation along prescribed route.

Note. Definitions within the KOCOA Battlefield Evaluation System (Source: Bright 2010:295; Mastone et al. 2011:50; Created by Mitchell Freitas).

Geographical Information Systems and Theory

This thesis uses Geographic Information Systems data in the form of ESRI ArcMap to create georectified maps that show the locations of the various convoy routing lines, sites of U-boat attacks, the location of Cape Hatteras Minefield, and define the locations of the archaeological sites of *Chilore, F.W. Abrams,* and *Keshena* (and areas with potentially remnant mines). Utilizing GIS is suited to creating visual representations of the amount of shipping that took place along the North Carolina coast during the Second World War, but also, allows for data to be subjected to geospatial analyses. For this study, GIS will also facilitate a more detailed interpretation of the patterns of movement of Allied convoys and German U-boats relative to the static structure of the minefield. Each of these features will be created as separate maps and then overlaid on a single geospatial representation. As Wagner (2010) points out, "[b]y creating multiple GIS layers, a researcher can present the attributes of the particular item being added to the dataset. GIS software thus […] digitally links locations and their attributes so that they can be displayed in maps and analyzed" (Wagner 2010:16). What sets GIS apart from other databases is this ability to reconcile two distinct events spatially; this allows a researcher to contextualize archaeological sites spatially. Therefore, the archaeologist can analyze the spatial patterns of archaeological locations and events (Conolly and Lake 2006:3; Wagner 2010:16).

The use of GIS comes with its own theoretical framework. For instance, with space, there is a difference in what James Conolly and Mark Lake (2006) describe as the *Absolute Concept* and the *Relative Concept*. These terms are defined as,

> The Absolute Concept: "views space as a container of all material objects, which exists independently of any objects that might fill it" (Conolly and Lake 2006:3).

> The Relative Concept: “views space as a positional quality of the world of material objects or events, from which it follows that, unlike in the absolute concept, it is impossible to envisage space in the absence of things” (Conolly and Lake 2006:3).

Thus the absolute concept and the relative concepts are theories of how to conceptualize space. It is the process by which a researcher takes a theory of space and transforms it into visual representations that create spatial distinctions. For example, if a map of the minefield was drawn with no scale, in the relative concept, the minefield’s legs would appear close to each other but without any spatial data taken into account. They simply would exist relative to each other without consideration to space itself as a third factor. If drawn using the absolute concept, the legs of the minefield would be drawn with respect to the spatial data separating them, effectively drawing the map to scale. These are then projected into two widely used forms of how to view space known as Topology and Euclidean Geometry. Conolly and Lake (2006) mark the differences between the two as,

> Topology distinguishes spatial objects that should be considered different on account of the way in which they relate to their neighbors and, for that reason, it has a close affinity with the relative model of space. For example, suppose an excavation plan were drawn on a rubber sheet, then topology is concerned with those aspects of the recorded features that remain invariant when the sheet is stretched or knotted, but not cut or folded. These include stratigraphic relations

> such as ‘contains’ and ‘abuts’, but not the areas covered by different deposits (Conolly and Lake 2006:4).

> Euclidean Geometry is the geometry that most of us are taught at school. Devised by Euclid around 300 BC, it is an example of a metric geometric, that is one which includes the concept of distance between points such that the distance from point A to point B is the same as that from B to A. Euclidean geometry has long been associated with the absolute concept of space…Returning to the example of an excavation plan, Euclidean geometry allows one to measure the areas covered by different deposits as well as to state the stratigraphic relations between those deposits (Conolly and Lake 2006:4).

Of these two, this thesis will use Euclidean Geometry as the ability to analyze the spatial relation between two distinct features is the crux of the analysis of this thesis. Euclidean Geometry is closely linked to the absolute concept of space as that it takes into account the spatial data between two objects and, like the aforementioned map drawn with the absolute concept will be more accurate and scaled in order for patterns to emerge. As Conolly and Lake (2006) point out, Euclidean Geometry regarding GIS is more specific and therefore more accurate. Conversely, Topology is closely linked with the relative concept of space and therefore would be akin to drawing an unscaled map. In general, archaeology is very concerned with the use of the most accurate forms of data, to better inform the analytical process. Thus it is clear that the use of Euclidean Geometry in conjunction with the absolute concept of space is the best choice for archaeological study.

Conclusion

These theoretical frameworks of historical archaeology, battlefield archaeology, and GIS permeate the proceeding chapters. As a work of historical archaeology, this thesis will heavily rely on historical data to assist in the analysis of the minefield. Battlefield archaeology approaches (specifically the METT-T and KOCOA frameworks) will help to analyze the choice in the battlefield and therefore the decision to place the minefield in Cape Hatteras. Finally, GIS theory will serve as a guide for creating maps in order to display and analyze archaeological and historical datasets. In the next chapter, Methodology, GIS methodologies will take precedence as the use of ArcGIS and the processes of map creation will stand alongside historical archaeology and the practice of historical research.

CHAPTER FOUR: Methodology

Introduction

The methodology of this project lies in the amalgamation of both historical research and geospatial datasets to analyze the overall effectiveness of the minefield as a defensive structure. Both historical primary and secondary sources were consulted to understand the thoughts, actions, motives, and perception of the United States Navy and the German sailors involved in the conflict surrounding the minefield. The intended goal of the work done from the geospatial standpoint was to take the historical information and past archaeological datasets like the ones used by John Bright and John Wagner and create a georectified examination of the minefield. This method took into account the strategic and tactical considerations within the Battle of the Atlantic off North Carolina's coast during the Second World War. As mentioned in the chapter on theory, a generalist approach was taken and, therefore, the need for historical and GIS data was high. As Conlin and Russell (2011:41) point out,

> Unlike terrestrial battlefields, remains from naval battlefields will not typically consist of individual artifacts distributed across a landscape. However, multi-scalar analysis of individual site components and the site as a whole can illuminate the progress of the battle and be used to evaluate overall patterns.

Therefore, several goals in researching this project needed to be met before analysis would be possible. These include:

- Research and collection of historical data in order to establish a static timeline of Cape Hatteras Minefield and incidents that created its historically negative narrative.
- Research and collection of historical data about the Battle of the Atlantic as a whole to contextually understand Cape Hatteras Minefield's place within the prolonged engagement.
- Collection of spatial data to (or "intending to") determine historic attack locations as well as final resting places of *Chilore, F.W. Abrams,* and *Keshena,* as well as the extent of the minefield itself.
- Collection of spatial data to determine the total amount of merchant shipping taking place during the time Cape Hatteras Minefield was operational.
- Use of ArcGIS to input collected data points and create maps to serve as visual representations of data described above, allowing the battlefield patterning to become apparent.

Historical Research

While there are numerous works on the Battle of the Atlantic very few of them, actually contain any mention of the minefield. A great deal of the preliminary work was spent scouring these works for any mention of the minefield and subsequently the best primary sources to use as support. Many of these works gave excellent background sources for the Battle of the Atlantic as a whole. However, the three most comprehensive works that provided direction for primary source research were Robert Freeman's *The War Offshore 1942* (1987) which was an annotated reprint of the ESF War Diary, John Wagner's "Waves of Carnage" (2010) and John Bright's "The Last Ambush" (2012). These three sources each contained a dedicated section on the minefield with accompanying primary source material. A benefit of "Waves of Carnage" (Wagner 2010) and "The Last Ambush" (Bright 2012), was that both were East Carolina University theses. This meant that there was access to the source materials they collected, these source collections have been curated by Dr. Nathan Richards who made them easily accessible. The main goals of historical research in this study included:

- Collection of historical data pertaining to the operational timeline of Cape Hatteras Minefield.
- Collection of historical data relating to the Battle of the Atlantic as a whole to contextually understand Cape Hatteras Minefield's place within the continued engagement.
- Collection of historical data pertaining to the wrecking events and descriptions of KS-520, *Chilore, F.W. Abrams,* and *Keshena.*
- Collection of historical maps to determine the spatial extent of the minefield.

Secondary Sources

While primary sources are the gold standard for research, to contextually understand the Battle of the Atlantic secondary sources were initially consulted to fill in gaps. There are a plethora of secondary sources that have compiled the historical narrative of the Battle of the Atlantic. Thankfully having access to the East Carolina University Joyner Library was extremely beneficial as they possess a significant number of the secondary sources needed. Approaching secondary sources first accomplished two things. First, it identified the utter lack of dedicated sources on Cape Hatteras Minefield. The most comprehensive secondary sources that were found were the subsections in Wager (2010) and Bright (2012). Second, the secondary sources provided a direction in which to take the research of primary sources. For example, Bright (2012:48) included this chart "Listing of NARA Records Accessed during Historical Data Collection Phase" (Figure 17), which was one of the first indications that a trip to the National Archives Records Administration (NARA) was necessary.

Record Group	Subject	Location	Description
RG 24	Records of the Bureau of Naval Personnel	Archives II Text Records College Park, MD	Deck Logs of USS *Ellis* (DD-154), USS *McCormick* (DD-223), and USS *Spry* (PG-64)
RG 26	Records of the United States Coast Guard	Archives I Text Records Washington D.C.	Logbooks of Coast Guard Cutters *Icarus*(WPC-110) and *Triton* (WPC-116)
RG 38	Records of the Office of the Chief of Naval Operations	Archives II Text Records College Park, MD	Tenth Fleet Convoy & Routing Files: KS-520 Mine Warfare Section: Hatteras Minefield. ASW Analysis and Statistics Sections, 1942-1945: Incident 1255
RG 80	General Records of the Department of the Navy, 1798-1947	Archives II Photographic Branch College Park, MD	Photographs of USS *McCormick*, USS *Ellis*, USS *Spry*, USCGC *Triton*. Photographs of various merchant vessels damaged after U-boat attack.
RG 181	Records of Naval Districts and Shore Establishments	National Archives at Philadelphia	Fifth Naval District Port Director's Activities

FIGURE 17. Table listing the NARA Records that were accessed during the writing of "The Last Ambush" (Source: Bright 2012:48)

There was an expansive amount of scholarship dedicated to the study of the Battle of the Atlantic that was used to research this thesis (Bekker 1974; Middlebrook 1976; Hughes 1977; Hoyt 1978, 1984; Gentile 1989, 2005; Hickam 1989; Cheatham 1990, 1994; Gannon 1990, 2010; Rust 1991; Syrett 1994; Blair 1996, 1998; Groove 1997; Rayner 1999; Hauge 2000; Williams 2003; White 2006; Brown 2007; Levine 2012). While the number of sources that offered information about the Battle of the Atlantic off the coast of North Carolina in great detail were much fewer (Hickam 1989; Gannon 1990; O'Neal 2001). These works were instrumental in setting up the contextual information that was used in the history chapter.

In order to better understand the German U-boats and therefore their wartime strategies, several works were used (Wolfgang 1955; Cremer 1982; Hoyt 1987; Edwards 1999; Werner 2002; Williamson 2006; Wiggins 2010). Unfortunately, throughout the course of research for this project, there were no dedicated sources pertaining to Cape Hatteras Minefield itself. Instead, information regarding the minefield was taken from the small sections from works mentioned in this chapter but was mainly pieced together from primary sources. Fortunately, John Wagner's "Waves of Carnage: A Historical, Archaeological, and Geographical Study of the Battle of the Atlantic in North Carolina Waters" (2010) and John Bright's "The Final Ambush: An Adapted Battlefield Analysis of the U-576 Attack upon Allied Convoy KS-520 off Cape Hatteras during the Second World War" (2012) focus directly on the Battle of the Atlantic in North Carolina waters.

To understand both the way in which the U.S. Mark VI mine worked and the theory behind the construction of the minefield, this thesis examined several sources (Bureau of Navy Personnel 1955; Cook and Stevenson 1978; Friedman 1982; Melia 1987; Levie 1992; Koburger 1994; Busuttil 1998; House 2001; Naval Studies Board 2001; Conlin and Russell 2006). Several studies were essential to understanding different theories that are being utilized. For battlefield archaeology, there were a number of main sources that were used (Freeman and Pollard 2011; Carret et al. 2002; Sutherland and Holst 2005; Conlin and Russell 2006). For the theory supporting Geographic Information System use in archaeology and history, *Past Time, Past Place: GIS for History* (Knowles 2002) and *Geographic Information Systems in Archaeology* (Conolly and Lake 2006) were heavily used for the way in which ArcGIS was integrated into this thesis. To better understand the application of *ArcGIS* specifically for the purpose of modeling battlefield landscapes and Cape Hatteras Minefield, Stephen Sanchagrin's "A View Through the Periscope: Advanced and Geospatial Visualization of Naval Battlefields" (2013) was used as a guiding example. For both a mix of battlefield and historic archaeology, *Method and Topic in the Historical Archaeology of Military Sites* (2010) compiled by Dr. Clarence Geier, Dr. Lawrence Babits, Dr. Douglas Scott and Dr. David Orr, was consulted, as well as some of Dr. Babits' sole-authored works (Babits 1981, 2001a, 2001b, 2010a, 2010b). Information for the use of METT-T and KOCOA was beneficial to understand the way these guidelines can be deployed in a maritime battlefield as maritime battlefields are a great deal more ephemeral than terrestrial sites (Potter 2000; Scott et al. 2009; Babits 2010; Bright 2012).

A majority of this project depended on the reconstruction of the narrative surrounding the minefield, which was accomplished through the analysis of primary and secondary historical documents. Many of the secondary source information was available through East Carolina University's Joyner Library as well as through Interlibrary Loan. The focus was principally on primary source documents, such as United States Navy and Coast Guard reports, local and state economic records, merchant shipping lane catalogs, and U-boat ship-logs. The interpretation of these documents was invaluable in constructing the analysis of the minefield.

Trips to the National Archives in Washington DC. were vital to uncovering both the records of the United States Coast Guard and the United States Navy since both played a role in the construction and maintenance of the minefield. The United States Naval Archive records containing information about merchant convoys were heavily used in the construction of new datasets. Holdings in Record Group (RG) 26 contain information regarding distressed ships and the aid rendered to them and merchant logs. Additionally, in College Park, Maryland at National Archives II there were several important sources. These included: RG 19 The Bureau of Ships, RG 24 Naval Personnel Records, RG 38 Chief of Naval Operations, RG 74 The Bureau of Ordnance and RG 181 Naval Districts and Shore Installations. The Naval History and Heritage Command staff and the archives housed there were consulted, specifically for their collection of translated logs from German U-boats. These were not as instrumental in discovering if the German U-boats were aware of the defensive wall of mines or avoided it by chance as initially thought. The Naval History and Heritage Command archives were also searched for the personnel and ship files for the minelayers *Miantonomoh* and USS *Wassuc* as these two vessels were essential in the construction of Cape Hatteras Minefield (Mooney 1991:483). These were not as fruitful as initially believed.

Numerical Data Collection

As a major cornerstone of this project's scope, the collection of numeric and statistical, data was taken extremely seriously. To populate the graphs and charts in the next chapter with statistics such as; lives lost, ships lost, tonnage lost, cargo type and the amount and the cost of that cargo several primary and reputable secondary sources were used. It was important for these sources to be as reputable as possible to produce the most accurate representation of Cape Hatteras Minefield.

In order to populate the statistics for the lives lost, ships lost, and date lost off the North Carolina coast during the Battle of the Atlantic several works were extremely beneficial (Freeman 1987; Wagner 2010; Bright 2012; Hoyt et al. 2017). After compiling a Microsoft Excel Spreadsheet of the ships lost and lives lost, the next step was to add the tonnage statistic for each of the merchant ships as well as the cargo each carried (Lloyd's 1989; Browning 1996).

Once these steps were completed, the most intensive part of the numeric collection came from the amassing of 1942 bulk cargo prices to visualize the monetary value of the shipment lost during the battle. Several sources were needed to cover the diverse types of cargo that the merchant ships carried (U.S. Department of Agriculture 1942; Mansfield 1942; U.S. Department of Commerce 1943; Mechler 1943; U.S. Department of Commerce 1944, 1949). This data collection was made even harder by some of the cargo descriptions being "General Supplies" or "General Army Supplies" Furthermore prices for items like "Explosives" and "Citrus Pulp" could not be located.

Geospatial Information

As there was no field component to this project, part of the methodology was based on viewing the historical documents as artifacts and analyzing datasets from prior works. Therefore, the role of GIS became crucial, as it formed the framework for analysis using ESRI's ArcMap 10.1.3. In order to expand the knowledge of the battlefield and to translate the maritime terrain into usable data, a geospatially rectified map of the minefield from historical documents was built. First, a basemap, the georectified map of the United States used as the foundation for the maps was pulled from Global Administrative Areas (GADM). The next layers, historical maps, and charts showing the minefield were rubbersheeted and georectified, they were added as a layer. Rubbersheeting is the process by which a non-georectified image of a map can be inserted into ArcMap and then georectified through the matching of reference points on the basemap and map image. The route trajectories for the wrecking events of *Keshena, F.W Abrams,* and *Chilore*, were populated from information collected by John Wagner in his work.

The maps also included a layer depicting the locations of major World War II shipwrecks at the hands of U-boats before and after the implementation of the minefield to ascertain if the minefield had any effect on how the U-boats operated. These locations were ascertained from historical documents from RG26 as well as archaeological data from NOAA. While these historical sources were important, the most valuable source for finding the accurate locations came from Hoyt et al. *Battle of the Atlantic: A Catalog of Shipwrecks off North Carolina's Coast from the Second World War* (2017). A separate geospatial layer highlighted the major convoy trajectories before and after the implementation of the minefield to show the volume of shipping that passed without incident. This process was similar to several of the geospatial maps created by Stephen Sanchagrin in "A View through the Periscope: Advanced and Geospatial Visualization of Naval Battlefields" (2013) (Figure 18). Other spatial datasets were consulted for specific convoys, John Bright's "The Final Ambush: An Adapted Battlefield Analysis of the U-576 Attack upon Allied Convoy KS-520 off Cape Hatteras during the Second World War" (2012) for instance shows the path KS-520 took from Virginia to Florida (Figure 19).

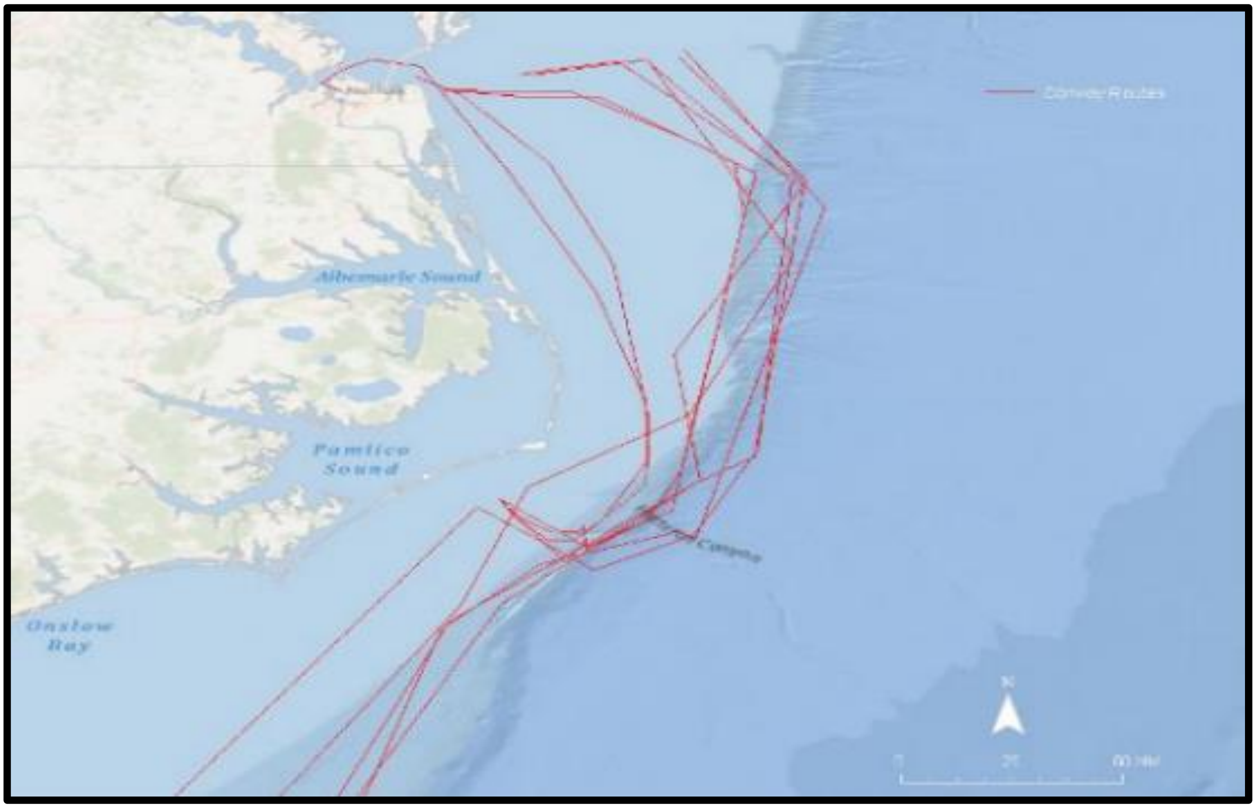


FIGURE 18. Digitized convoy routes meant to illustrate the differences in route reporting by individual vessels (Source: Sanchagrin 2013:94).

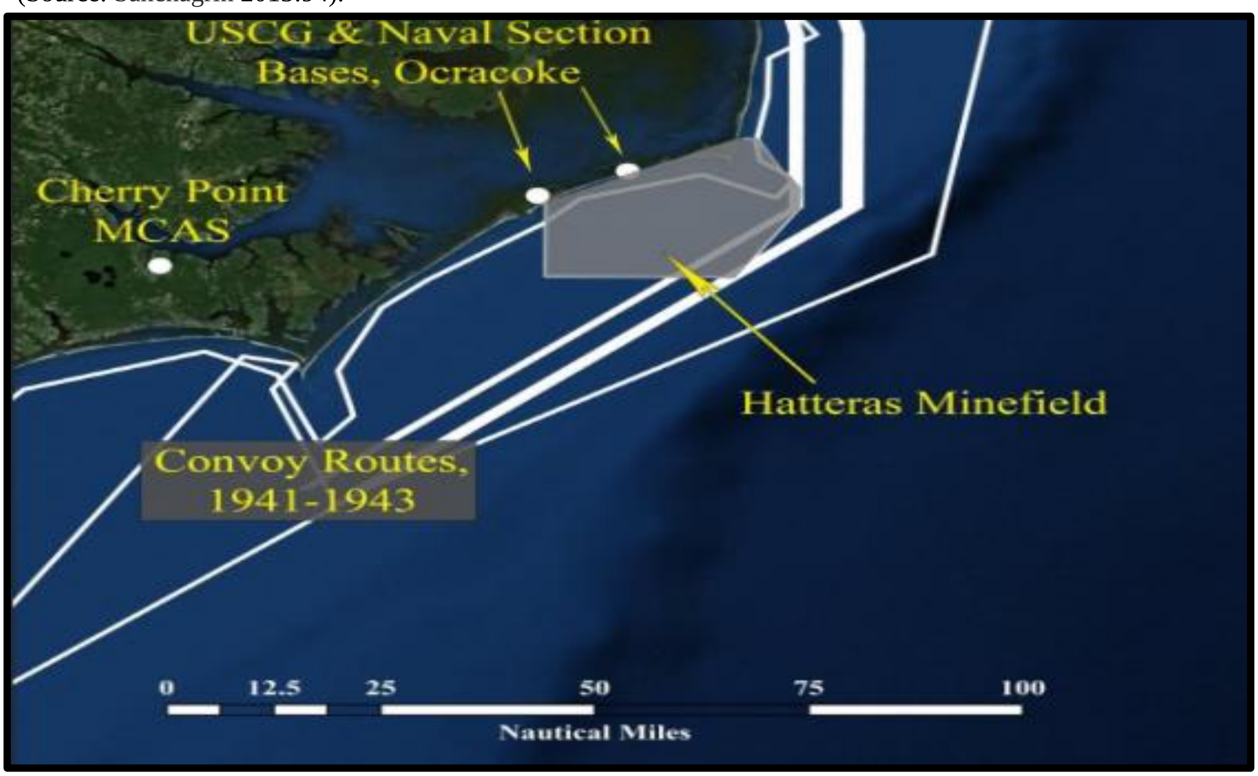


FIGURE 19. Chart depicting major military installments located at Cape Hatteras as well as major convoy routes (Source: Bright 2013:229).

GIS Creation

In order to successfully generate spatially rectified maps for this project, the ESRI ArcGIS 10.3.1 program was used. This multistep process will be detailed below. For many of the maps used in this project, the practice of rubbersheeting was used. This process involves taking a reasonably accurate historical map and fixing it to a georectified base map in order to ascertain the spatial extent of the historical map's content. The map featured below will serve as the example of how this process is performed (Figure 20).

During the historical research portion of this project, several U.S. Navy maps were found depicting the arms of the minefield along the coast of North Carolina (Figure 21). The inclusion of the coastline, drawn with relative accuracy made it an effective choice for rubbersheeting detailed outlines of the United States.

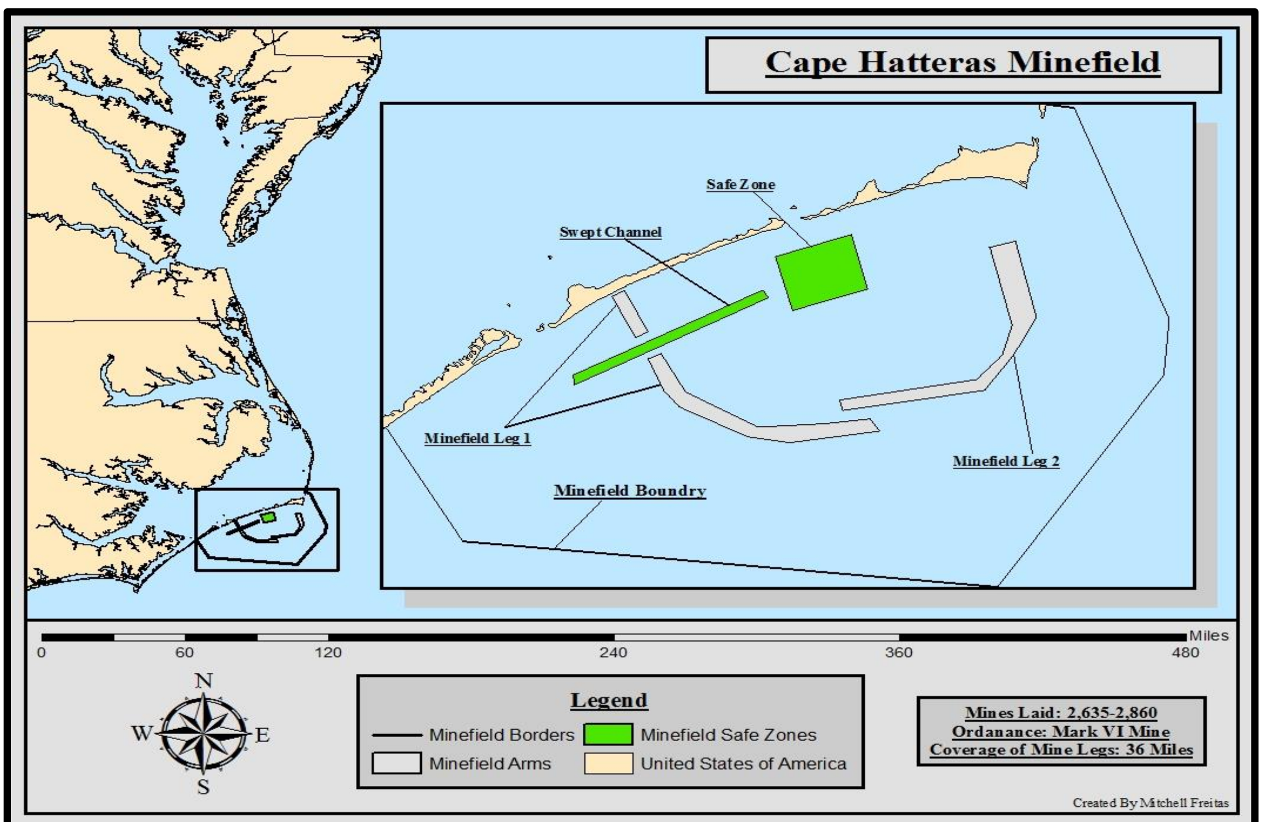


FIGURE 20. Map depicting Cape Hatteras Minefield's location along the American East Coast (Created by Mitchell Freitas).

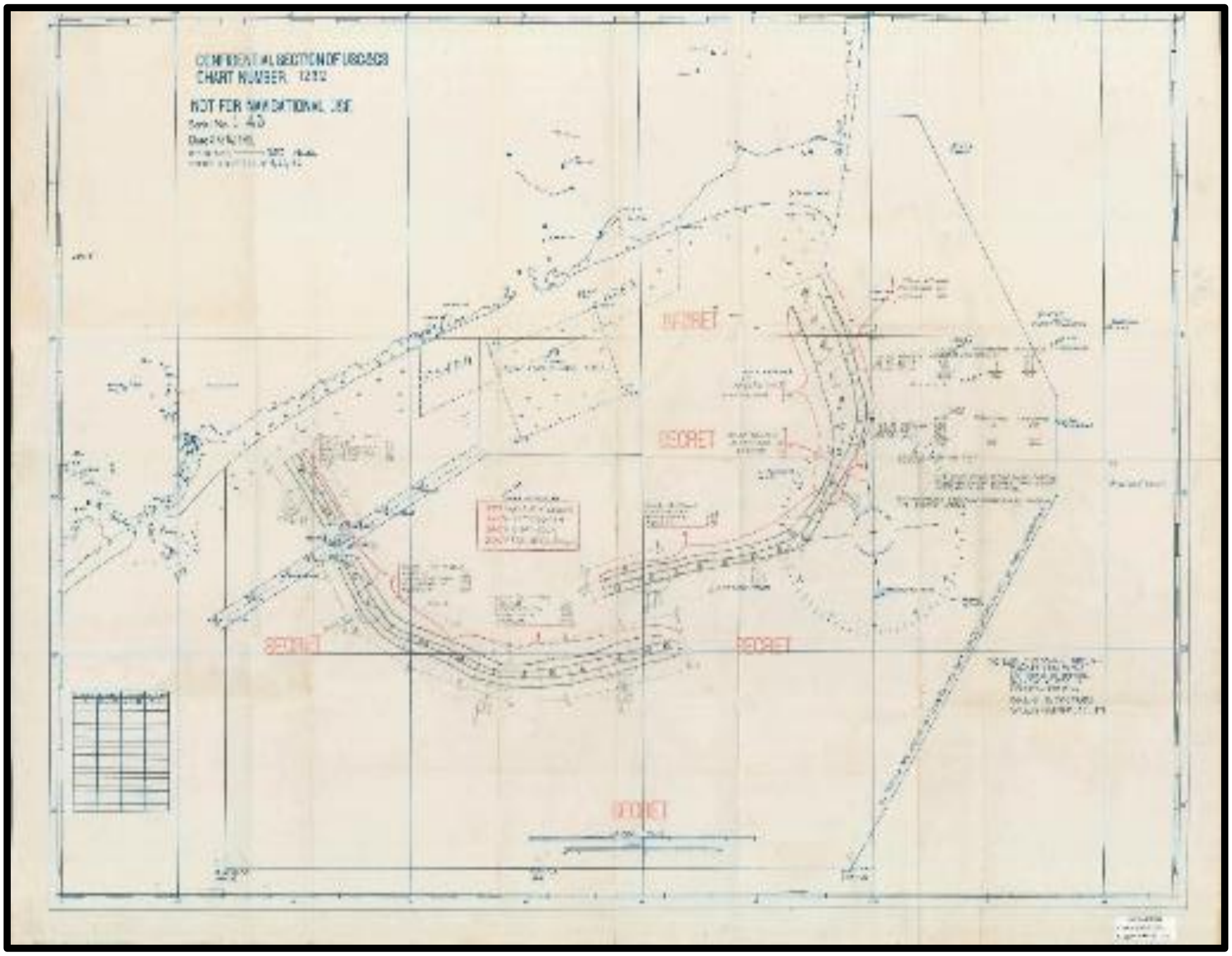


FIGURE 21. Confidential Section of USC&GS Chart 1232 showing the location and configuration of the Hatteras minefield, and the retrieval of mines post-conflict (National Archives).

The base map that was used for this map was sourced from NOAA and can be found in their geodata catalog, the most current version at the time of this writing is 11 August 2016. It is important to note that this base map uses the NAD 1983 datum and therefore all of the geodata in this project uses that projection. After the base map had been set, the historical map was put through Microsoft Illustrator in order to change the background color from tan to white for easier use (Figure 22). Once this was completed, the historical map was inserted into ArcMap 10.3.1 (Figure 23). The next step involved the use of the Georeferencing toolbox. The functions contained within the Georeferencing toolbox perform the actual operation of rubbersheeting.

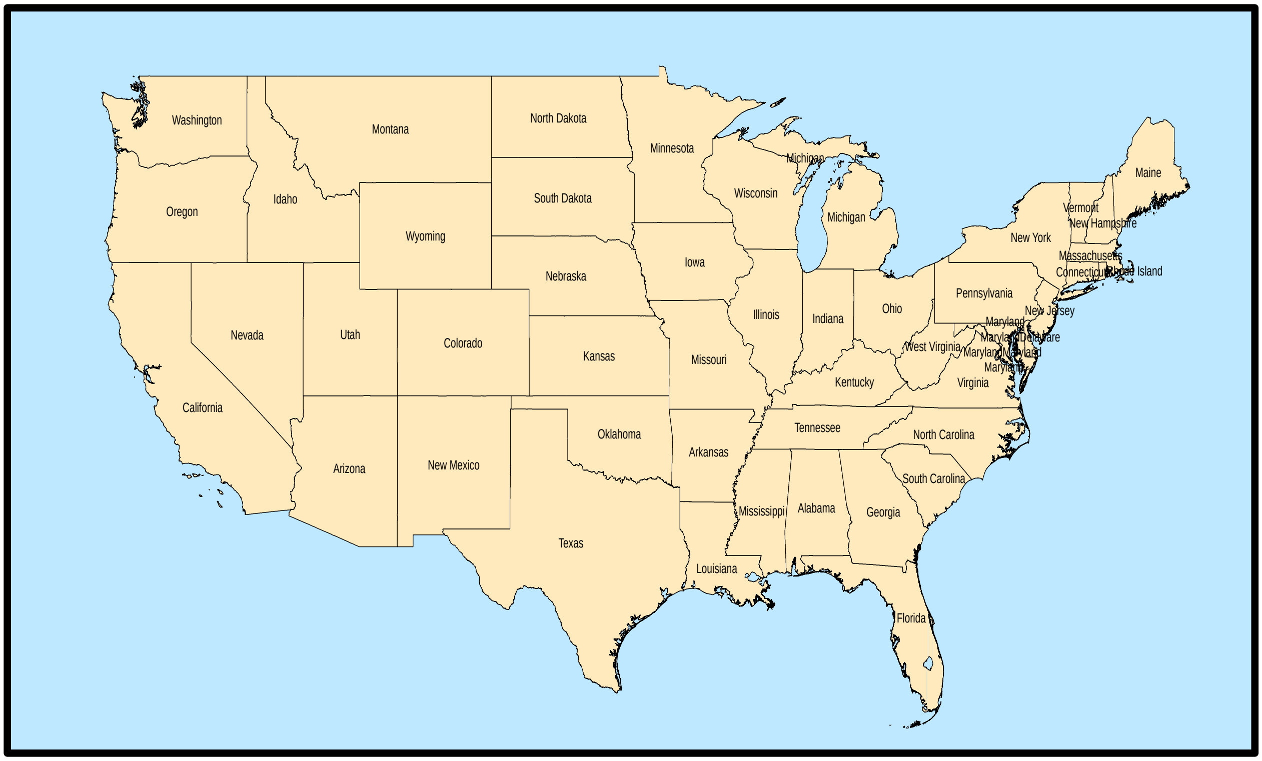


FIGURE 22. Basemap of the United States of America, GIS data provided by GADM (Created by Mitchell Freitas).

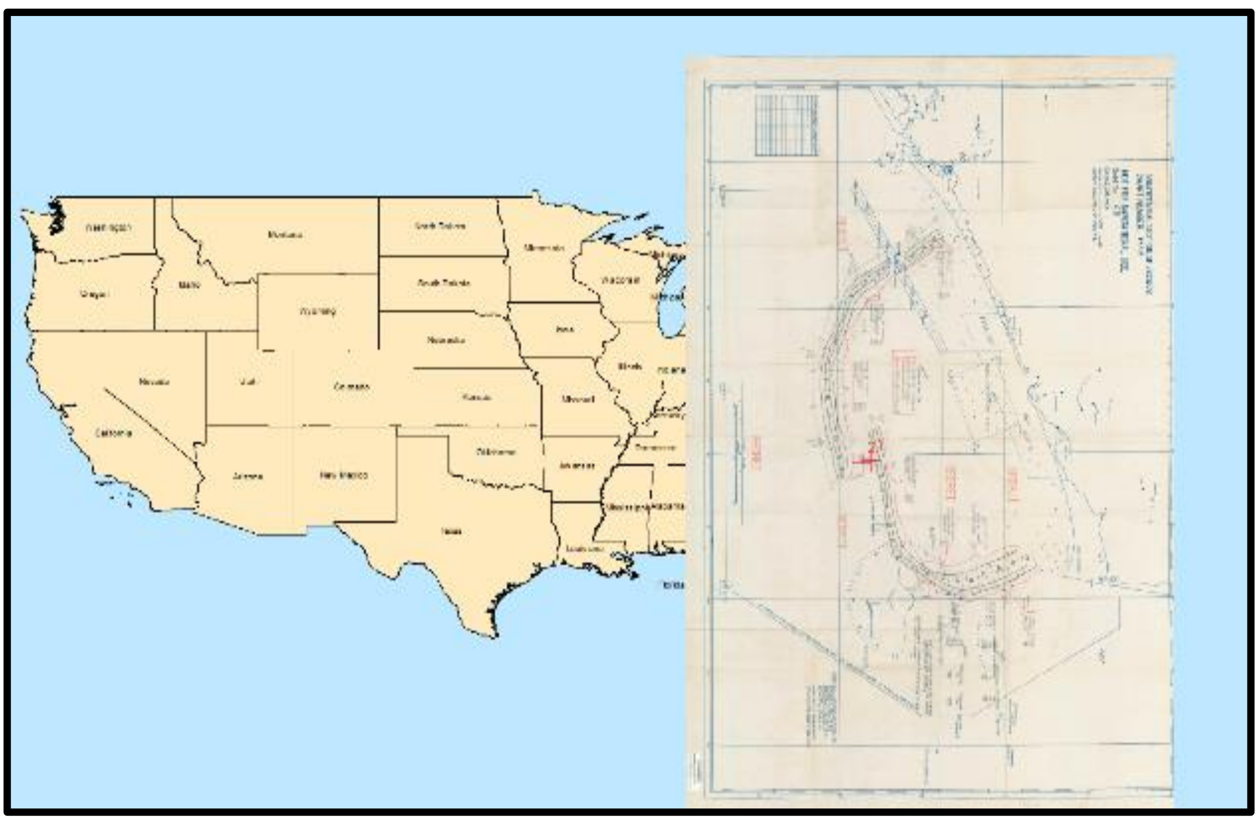


FIGURE 23. Image depicting the process of rubbersheeting, in this step the non-georectified image has be inserted into the ArcMap workspace (Created by Mitchell Freitas).

The program allows the user to mark a reference point on an inserted image and then place a second reference point on the base map. After this is completed, the historical map is moved so that the two reference points are placed on top of each other. The more distinct points that user chooses, the more the map is shaped to fit the base map. It is important to balance the distance between the points and the number of points themselves so that the historical map does not become warped. If the points are placed correctly, the map should appear as it does in Figure 24. Once the rubbersheeting step has been completed, the shapes and drawing tools were used to trace the outlines of the minefields legs in order to project them as polygons on the map (Figure 25). At this point in the process, the user now has a fully georectified map of the subject field, in this case, Cape Hatteras Minefield. In order for the magnified view to be implemented the user must copy the map to the clipboard and then paste it into the data frame. From here the map is put into layout mode, and the scale bar, legend, north arrow, and title are included.

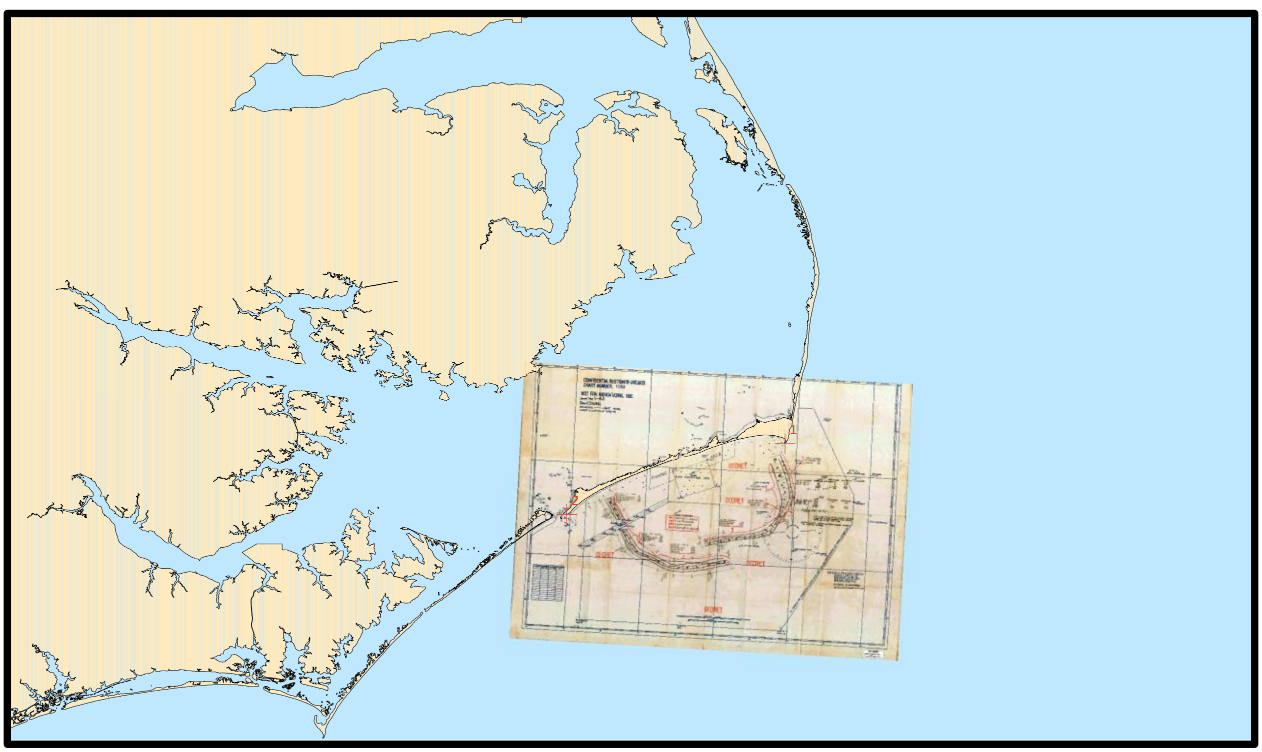


FIGURE 24. Image depicting the product of rubbersheeting. Notice the red and green colored crosses, these represent the points being matched together (Created by Mitchell Freitas).

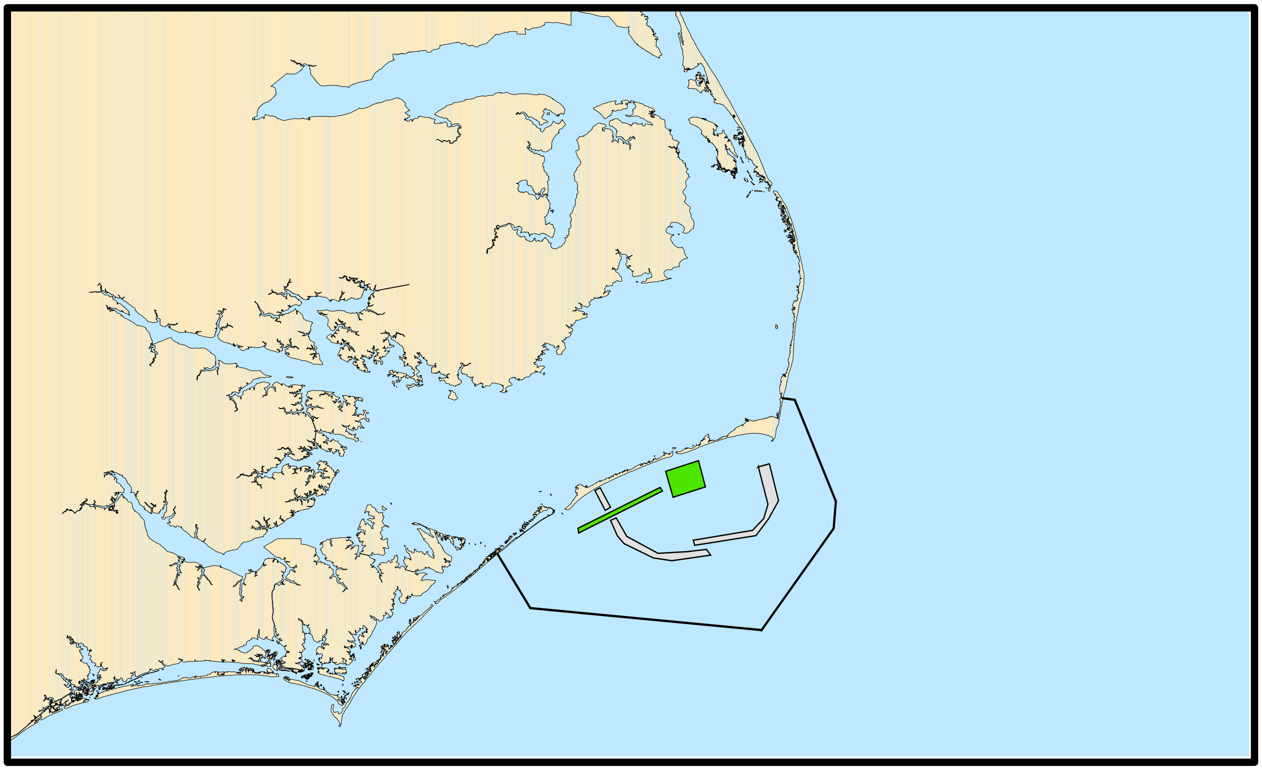


FIGURE 25. Map depicting the polygons that were overlaid on the historic map, leaving a clear representation of the minefield (Created by Mitchell Freitas).

Conclusion

Very similar processes are completed for the several other maps that were created for this project, these will be included and described in the next chapter, Results. The final chapter, Analysis, will detail how the historical data collection and the creation of the maps can be analyzed in order to attempt to answer the research questions outlined in the introduction.

CHAPTER FIVE: Results

Introduction

After collecting both historical and geospatial data, the next step was to augment the raw data into visualizations. This chapter serves to project these as raw datasets, devoid of the analytical lens that will be applied in the next chapter. A major cornerstone of not only the structure of this chapter but how the maps and charts pictured below are categorized, is by the temporal division of the Battle of the Atlantic. The first category contains the Allied merchant sinkings and the relevant numerical data such as the attack on convoy KS-520 that took place in the time before Cape Hatteras Minefield was active and will be labeled as the "Pre-Minefield Period." The second, "Active-Minefield Period" contains the minefield-specific data as well as the maps and numerical data for the events that took place while the minefield was active. Finally, the third category, "Post-Minefield Period" contains those maps and data that are relevant to the period after the minefield was deactivated. To better understand the extents of the three periods, a timeline was created as a visual aid (Figure 26).

The placement of the minefield off the coast of Cape Hatteras was extremely well calculated, as will be seen later in this chapter, the density of merchant sinkings in the area was extremely condensed. A major reason for this lies in the underwater terrain off the coast of North Carolina. The bathymetry naturally created a bottleneck that forced the Allied merchant convoys to travel close to shore in order to stay out of deeper waters. The limited range of air coverage exacerbated the bottleneck as well. All the while, the German U-boats could hide in the nearby deeper waters, avoiding detection by Allied escorts. This bottleneck is depicted in the *North Carolina Coastal Bathymetry* (Figure 27) map which shows the bathymetry represented by black lines as well as the georectified location of the minefield (Wagner 2012).

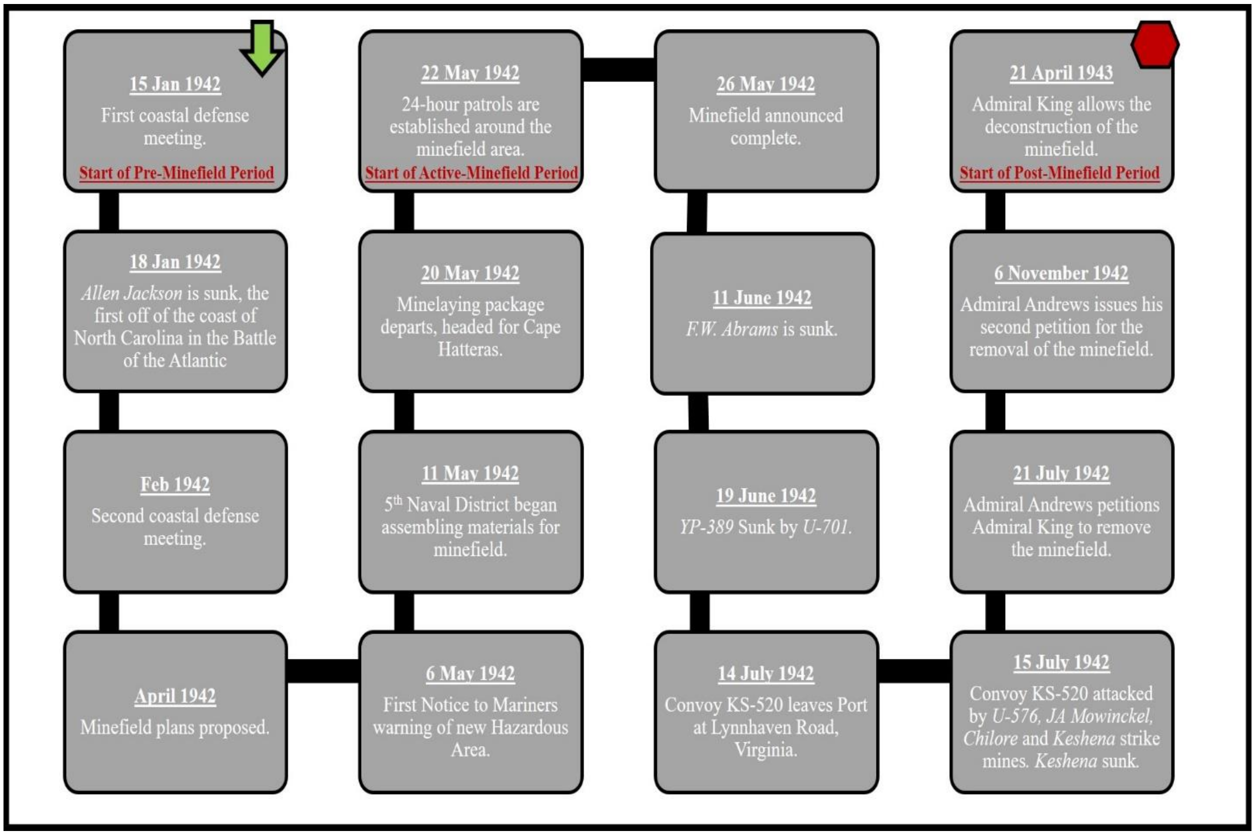


FIGURE 26. Timeline depicting the lifespan of Cape Hatteras Minefield, from the preliminary meetings discussing the need for coastal defense to its deactivation (Source: Freeman 1987, Created by: Mitchell Freitas 2016).

Once the timeline was established, the next logical step was to create a geospatial representation of the minefield. This map creation was done through the process of rubbersheeting, the steps of which was detailed in the last chapter. This map allowed the scope and precise location of the minefield to be visually represented. *Cape Hatteras Minefield* map (Figure 28) depicts the location of the minefield relative to the Eastern Seaboard of the United States as well as a magnified view of the minefield's layout. In this view, the minefield's legs, safe zone, swept channel, and the navigational boundary is highlighted. It also depicts the range of the 36 miles of mines that were laid and how the minefield increased the profile of Cape Hatteras. This map largely served as the basis for the other maps that were created.

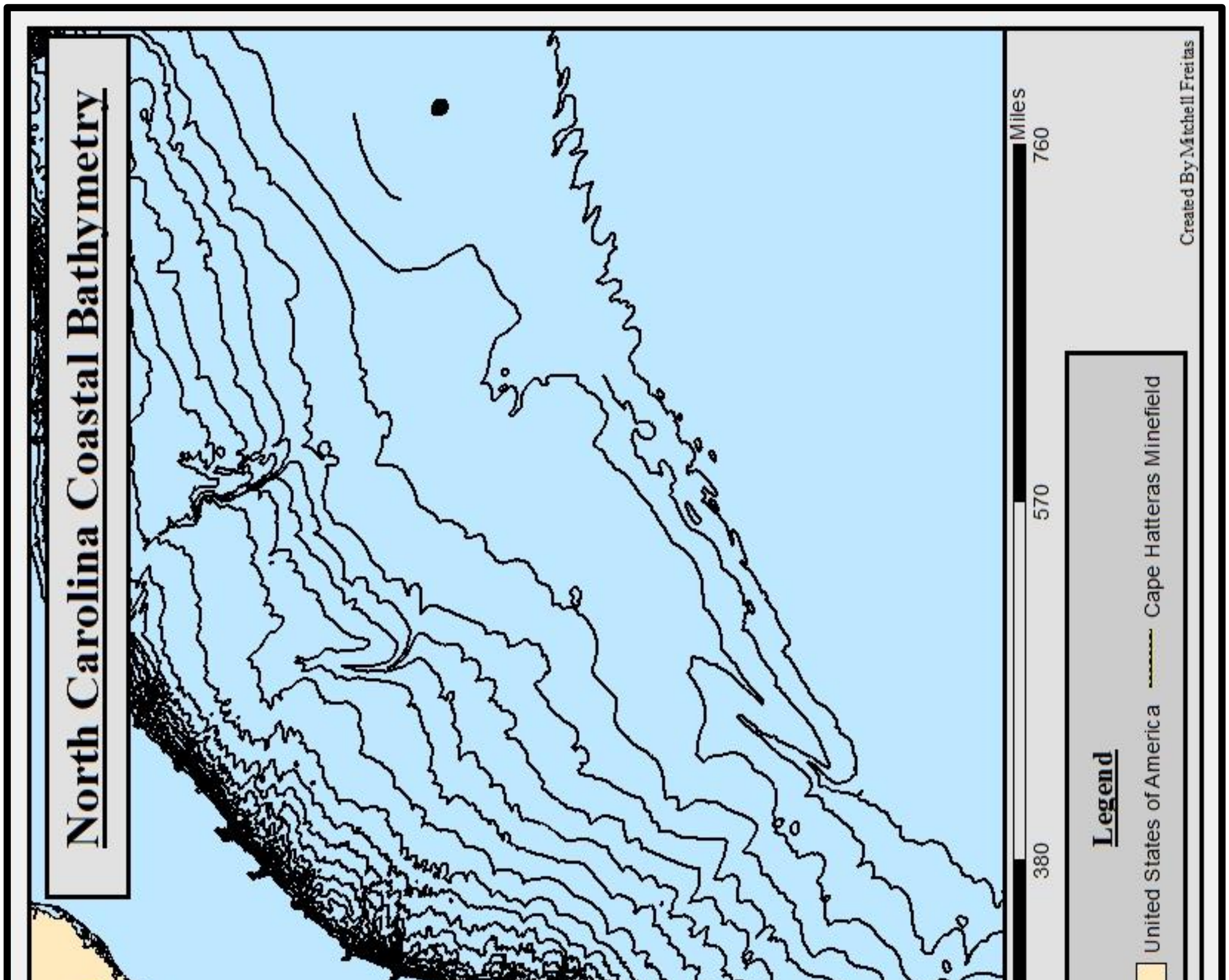


FIGURE 27. North Carolina Coastal Bathymetry (Source: Wagner data files 2012, Created by: Mitchell Freitas).

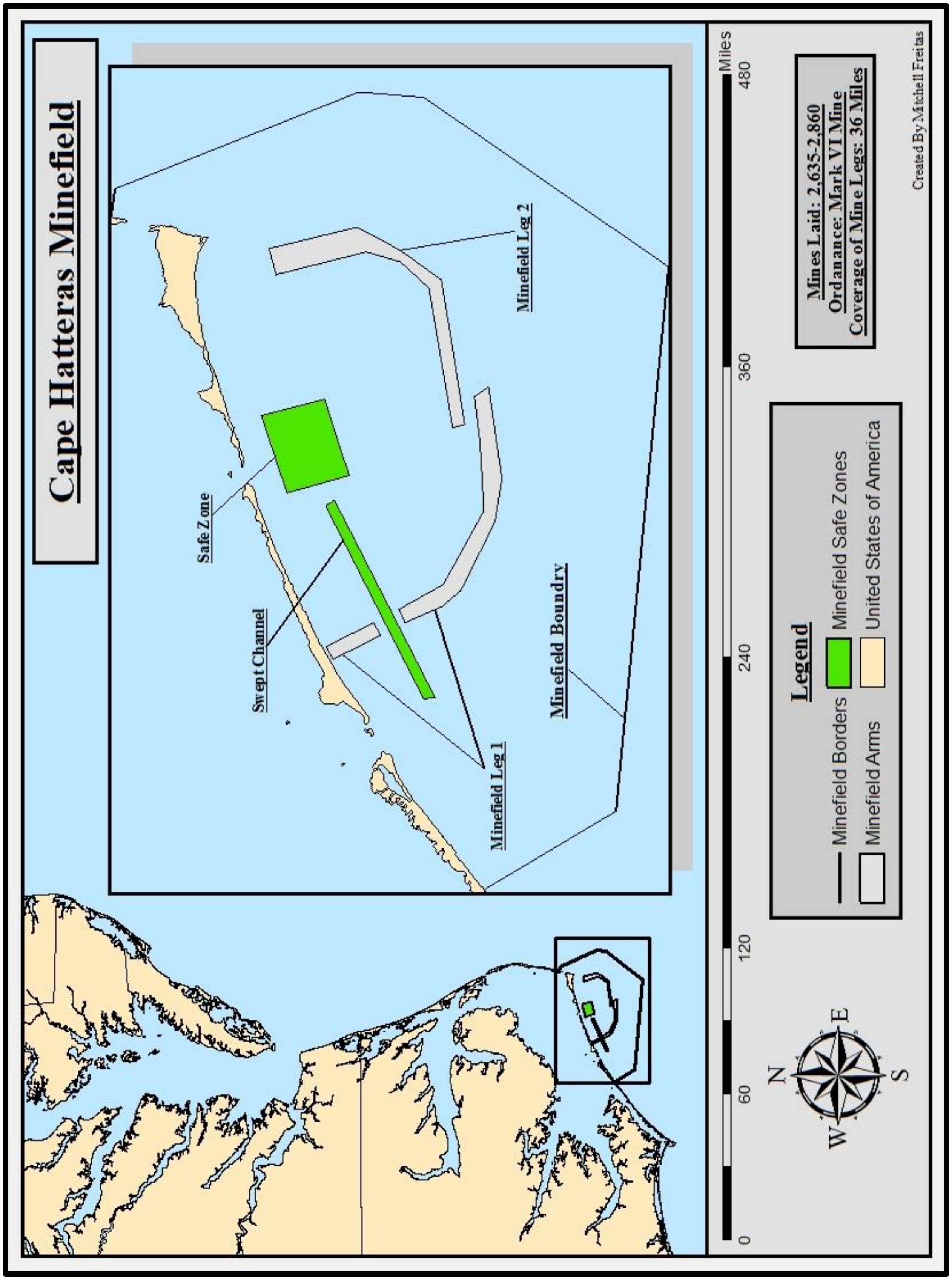


FIGURE 28. Cape Hatteras Minefield 1942-1943 (Source: National Archives, Created by: Mitchell Freitas 2016).

Pre-Minefield Period

The Pre-Minefield Period contains relevant maps and numeric data pertaining to offensive actions by German U-boats off North Carolina during the Battle of the Atlantic. This section will break down the Pre-Minefield numeric and geospatial data that has been collected and created.

Pre-Minefield Numeric Results

As with any wartime engagement, loss of life is a major factor in military planning. This issue is even more evident when the lives lost are those of noncombatant merchant sailors. The Pre-Minefield Period was a time of heavy loss of human life for the side of Allied merchant shipping. As can be seen in *Pre-Minefield Allied Lives Lost Per Month* (Figure 29) January 1942

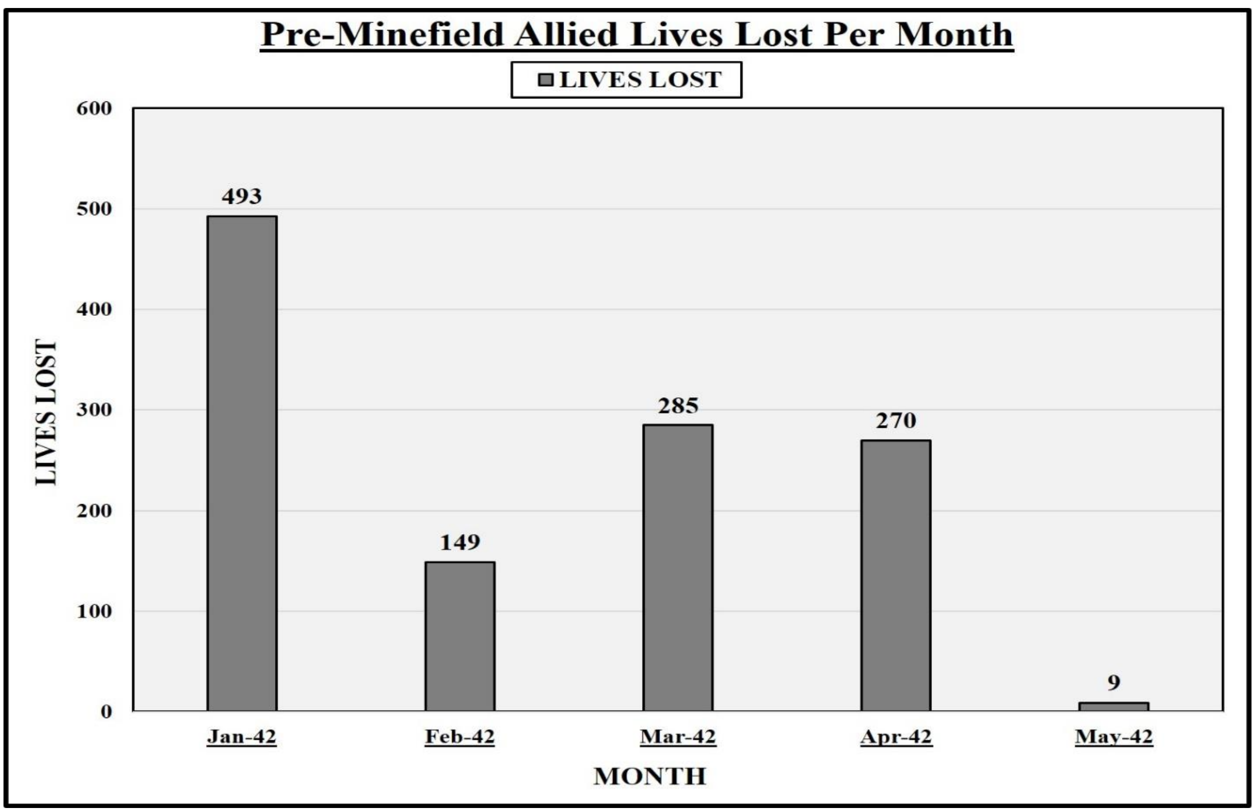


FIGURE 29. Chart depicting the lives lost during the Pre-Minefield Period by month, Total Lives Lost: 1206 (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

saw an immense amount of carnage, with the loss of 493 merchant sailors. While the remaining months in the Pre-Minefield Period did not reach this height, the numbers were still reasonably large. In the month of February 1942, the North Carolina coast saw 149 lives lost. In March of 1942, an upswing of 285 casualties occurred. In the following month, April, 270 merchant sailors perished while in May 1942 a massive drop occurred, and only nine lives were lost (Lloyds 1989; Hoyt et al 2017).

The number of lives lost per month in this period does not correlate directly with the numbers of merchant ships lost per month. As can be seen in *Pre-Minefield Allied Ships Lost Per Month* (Figure 30) only nine ships were lost during January 1942, the month with the highest Allied ships lost at 24, the lives lost during this month are only a little over half of those lost in January. The division of numbers shows that catastrophic wrecking events took place in January and February due to a significant amount of casualties spread over such a small sample size (Lloyds 1989; Hoyt et al 2017).

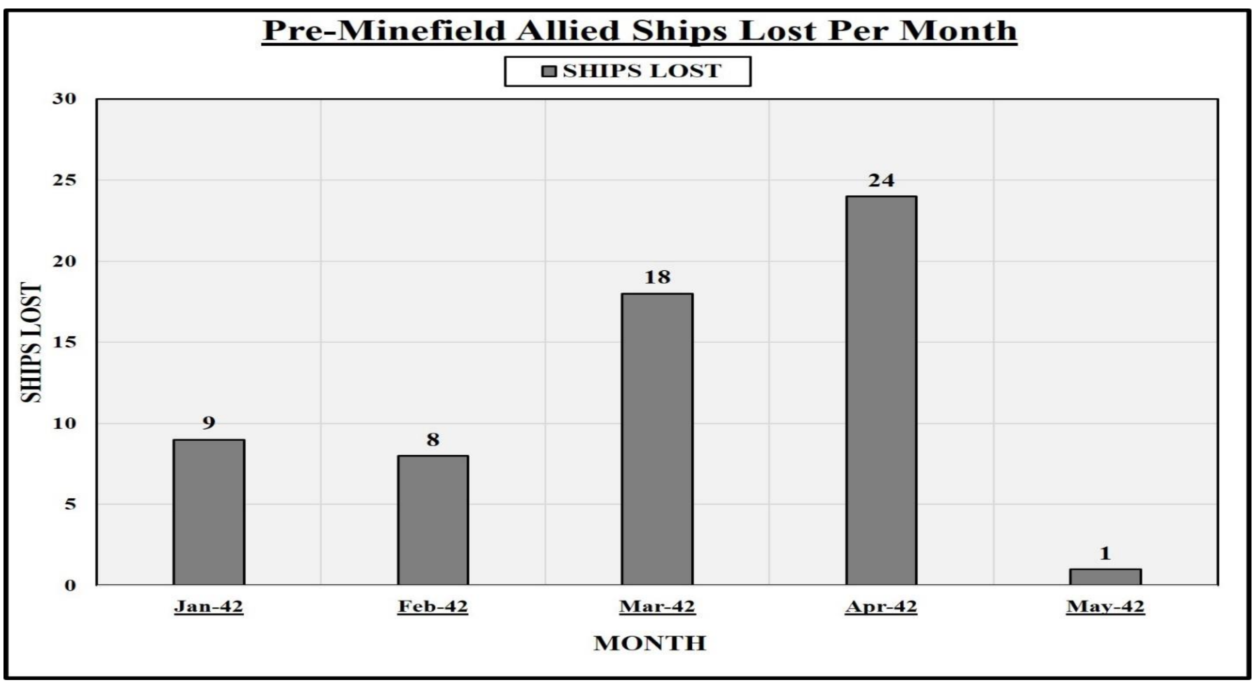


FIGURE 30. Chart depicting the ships lost during the Pre-Minefield Period by month, Total Ships Lost: 60 (Source: Hoyt et al. 2017. Created by: Mitchell Freitas 2016).

February of 1942 saw only eight ships lost but 149 lives lost. March 1942 however, was more along the lines of April, seeing 18 ships lost with the unfortunate number of 270 merchant lives lost. The entirety of both the lives lost and the ships lost trends can be viewed in the chart, *Pre-Minefield Allied Lives and Ships Lost* (Figure 31). The gray bars in this graph represent the Allied lives lost during the Pre-Minefield Period while the orange line represents the ships lost during this period. To allow for more detail, *Pre-Minefield Lives Lost By Ship* (Figure 32) breaks down the lives lost in each wrecking event by the ship lost. This graph once again represents the immense amount of ships lost during this period as well as highlights the enormous amount of destruction that the German U-boats inflicted on the Allied merchant shipping. It also reinforced that January 1942 was the worst month for casualties while April 1942 was the worst month for ships lost (Lloyds 1989; Hoyt et al. 2017).

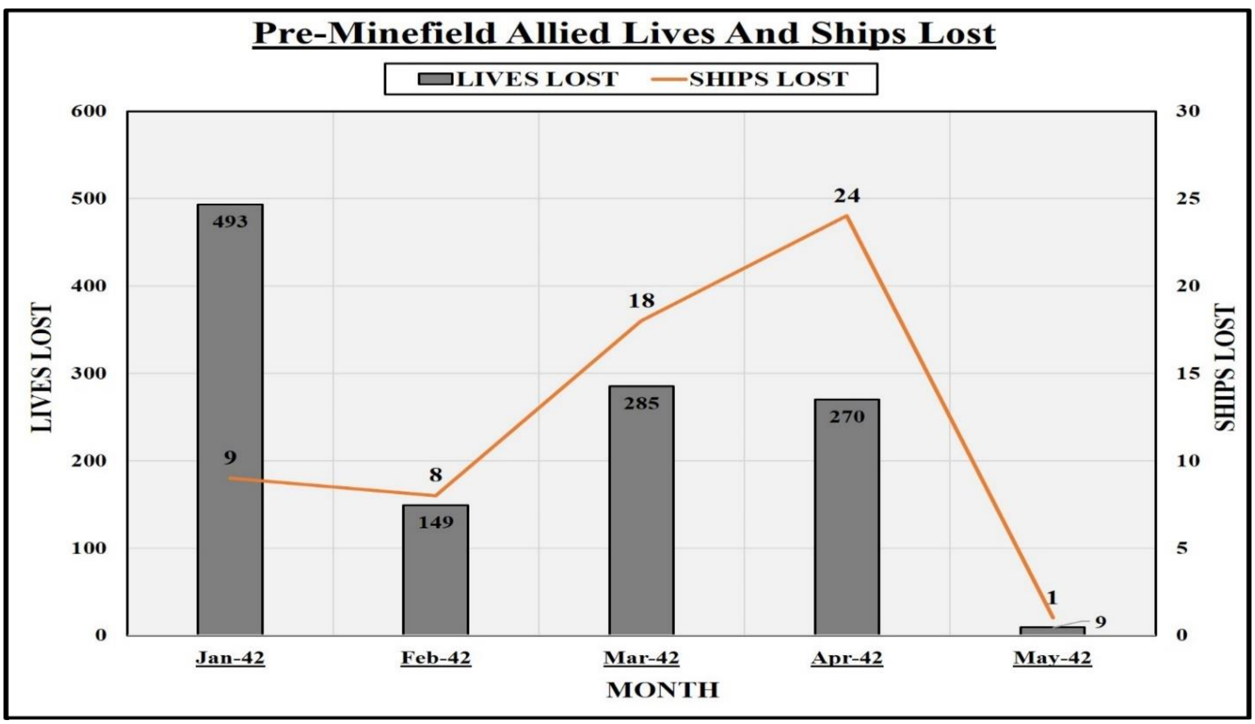


FIGURE 31. This is a combination bar and line graph showing the direct correlation between the lives and ships lost during the Pre-Minefield Period, Total Lives Lost 1206 Total Ships Lost: 60 (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

Another major consideration to factor into the loss of merchant vessels is the amount of tonnage lost and subsequently, the cargo lost. The amount of tonnage lost per ship is referenced in *Pre-Minefield Allied Tonnage Lost By Ship* (Figure 33). As would be expected, given the sheer number of ships that were sunk during the Pre-Minefield Period the tonnage lost was extremely high. What is notable about this chart is that it shows the individual ships that were lost with their tonnage statistic. This chart indicates that each ship lost was statistically relevant and that the large overall number of total tonnage lost at 381,742 tons was not only due to the large sample size. For example, the smallest ship, the Norwegian merchant vessel *Leif*, displaced 1,582 tons and carried 2,300 tons of general supplies while the largest the Swedish merchant vessel *Amerikaland* displaced 15,355 tons (Lloyd's 1989:345,360). The average size of a ship lost during this period was 6,289 tons per ship; this would be considered a substantially sized merchant ship. These successful U-boat attacks took a massive toll on the merchant shipping efforts during this period (Lloyd's 1989).

While the ship itself is a highly vital piece of equipment, especially during the Battle of the Atlantic where the need for seaworthy vessels far exceeded the supply that was available, many of these merchant ships sank with vital wartime supplies. Not only were the Allies losing a ship that could take years to replace, but the warfront and America's allies were also then suffering from the need of the supplies lost. These losses can be seen in *Pre-Minefield Cargo Lost* (Figure 34). Each cargo item lost is designated as either being measured as barrel or ton. As can be seen, a colossal amount of crude oil barrels were lost during the Pre-Minefield Period; this was due to a significant number of the ships sank being oil tankers. These numbers will be compared to those from the other time periods in the next chapter to better highlight the differences between the three periods (For a full list of ships lost, see Appendix A).

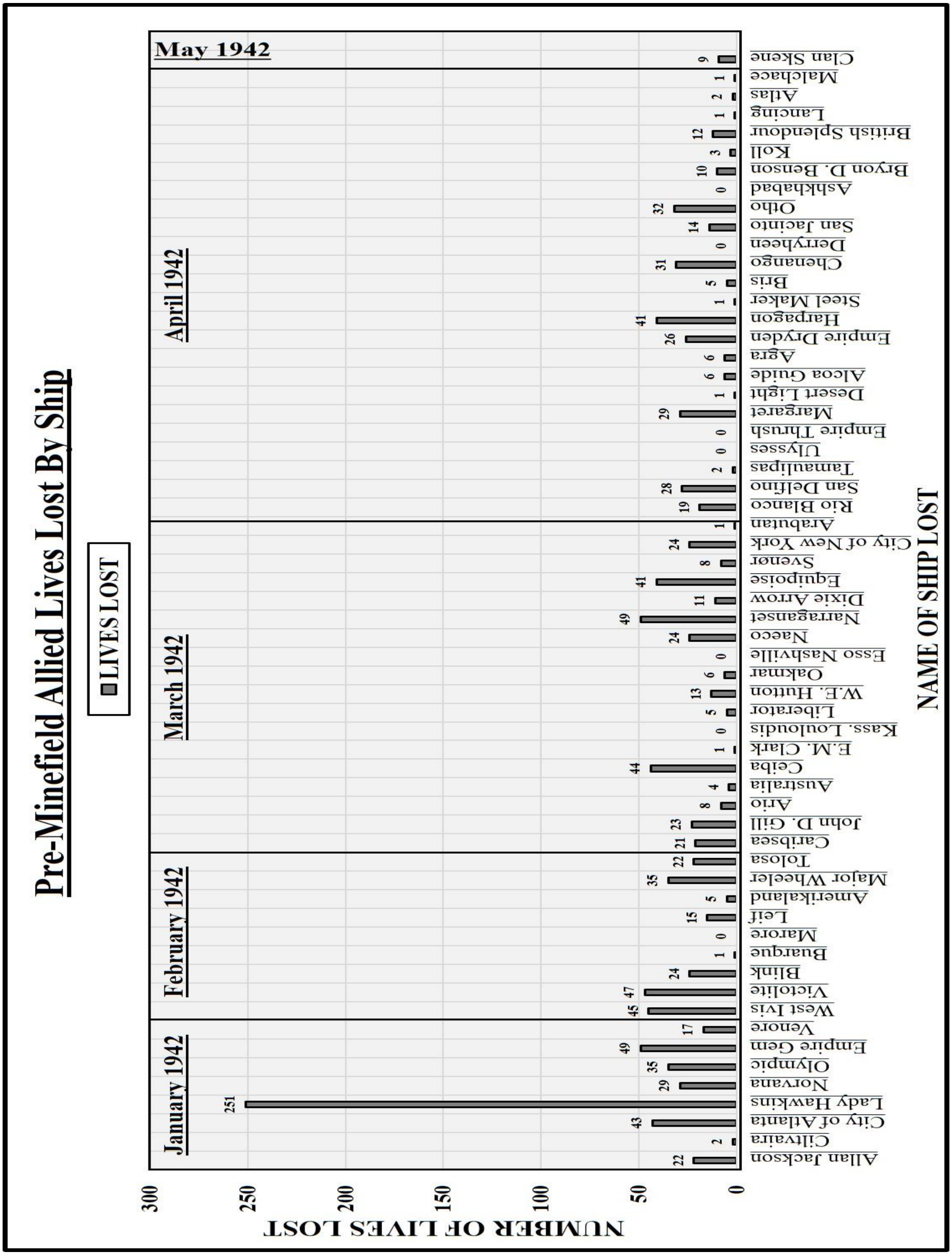


FIGURE 32. Bar graph representing the lives lost by ship, broken down by month, Total Lives Lost: 1204 (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

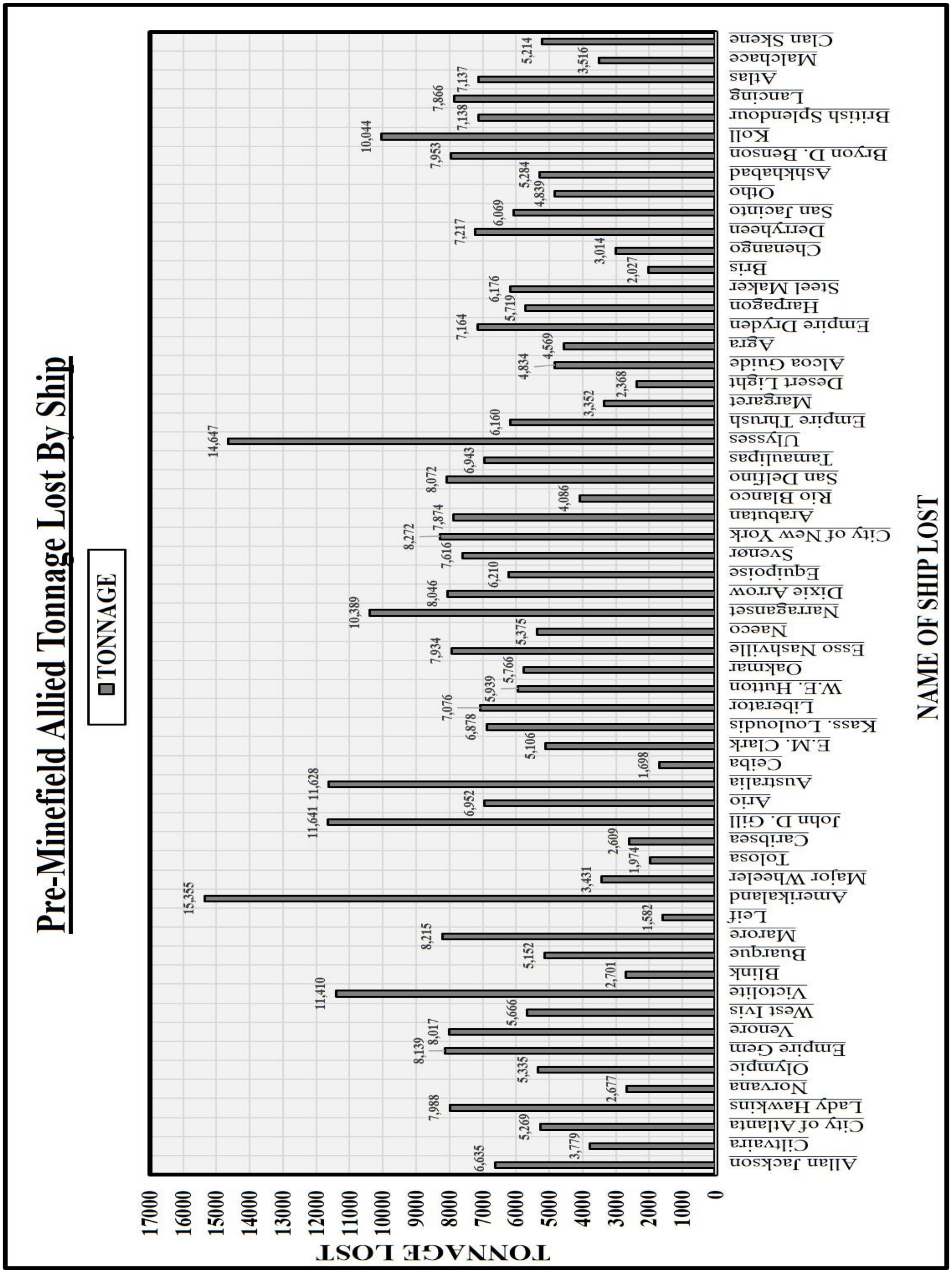


FIGURE 33. Graph showing the tonnage lost per ship during the Pre-Minefield Period, Total Tonnage Lost: 381,742 tons (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

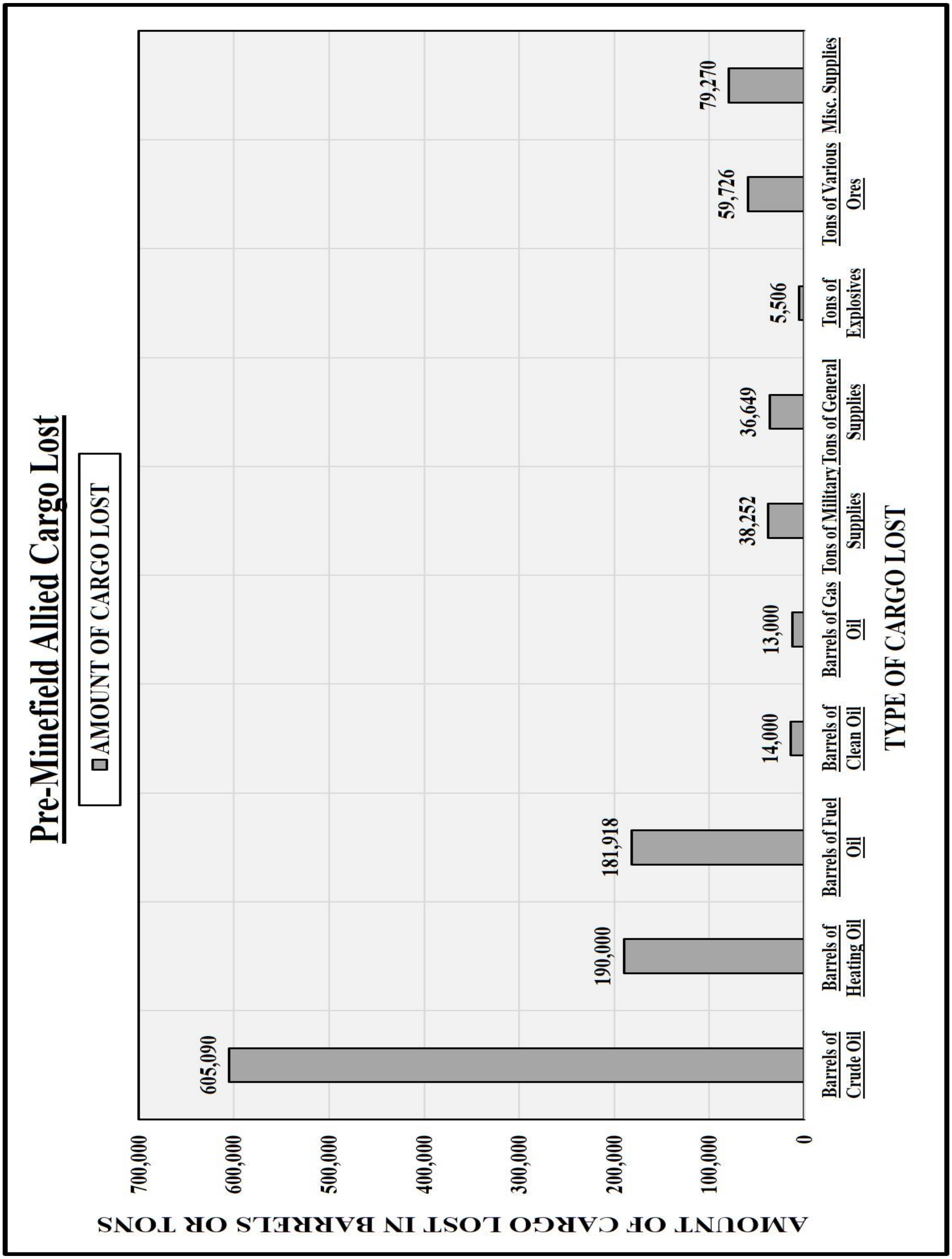


FIGURE 34. Graph breaking down the type and amount of cargo lost during the Pre-Minefield Period. Notice the amounts are either Barrels or Tons (Source: Lloyd’s 1989, Created by Mitchell Freitas).

Pre-Minefield Geospatial Results

A majority of the work done for this project rests in the geospatial products that are to follow. After using the processes outlined in the Methodology chapter, the data has been augmented to allow patterns to emerge as well as to convey geospatial data to the reader. There are three versions of the Pre-Minefield map, each of which contains its own set of analytical processes, and each of which will play a significant role in the next chapter. These maps include sinking locations, sinking site density, and a convex hull analysis.

As can be seen in the *Pre-Minefield Sinkings* map (Figure 35), the visual representation of the charts in the previous section highlight the vast number of sinkings that took place prior to the implementation of the minefield. Shown in the main view of *Pre-Minefield Sinkings* are the losses that occurred within the present-day Exclusive Economic Zone (EEZ), while the view within the magnified view box depicts those that took place outside the EEZ. The red diamonds represent an individual merchant vessel sinking, and each is labeled with the vessel name. Also included is the future location of Cape Hatteras Minefield which is indicated by the yellow outline. From this, it is easy to highlight the significant number of sinkings that took place in the immediate area of the future minefield.

To further expand upon the density of ships lost around the location of the minefield, a density geoprocessing tool was used in order to show the areas off the North Carolina coast where the largest number of losses took place. In the map, *Pre-Minefield Sinking Density* (Figure 36) red denotes the areas of the highest concentration of sunk merchant ships, yellow denotes the area of modest numbers, and green represents the area where no sinkings took place. As can be seen, the highest concertation of red takes place in and around the future location of

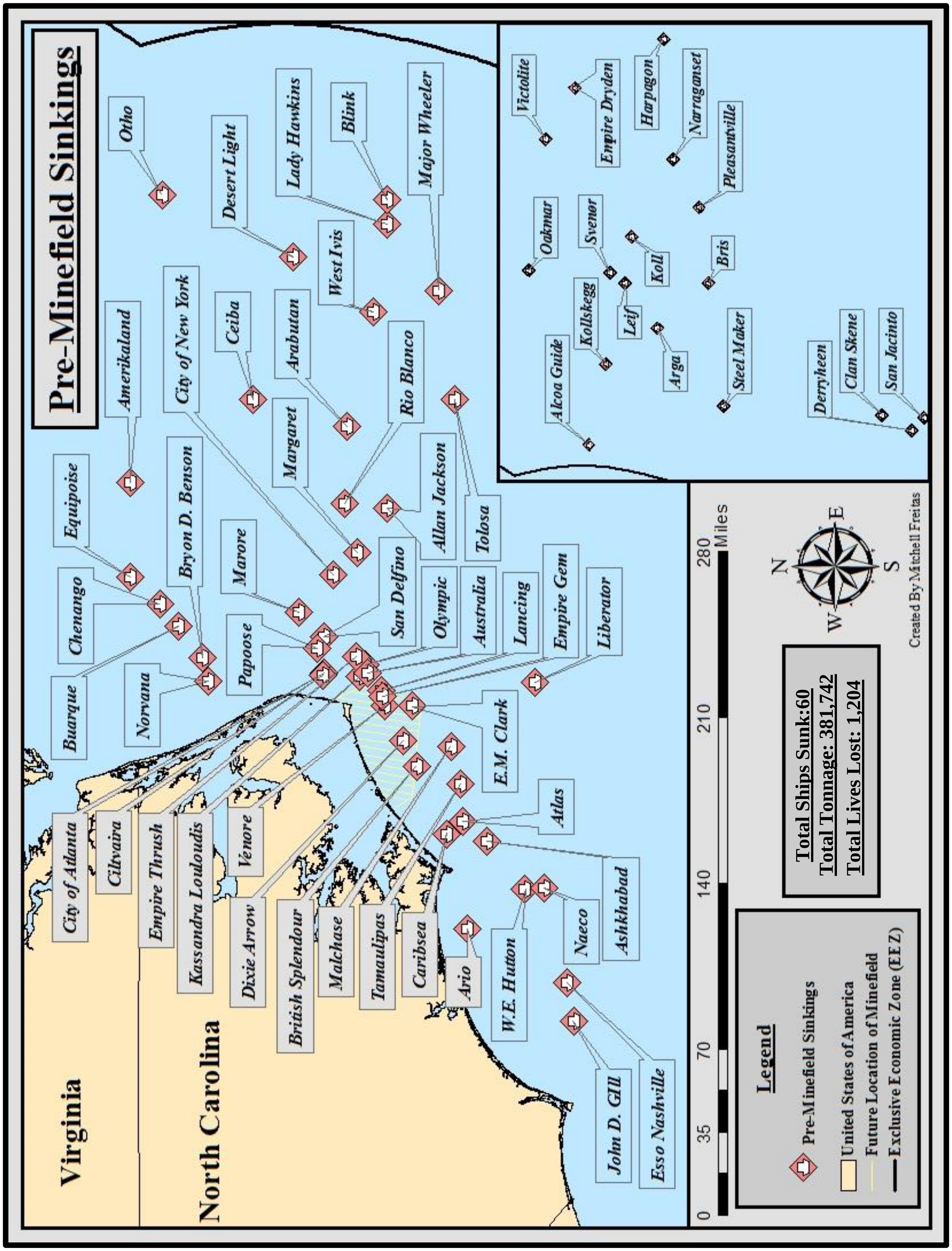


FIGURE 35. Pre-Minefield Sinkings, January 1942-May 1942 (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

the minefield. This patterning played a significant role in the placement choice of Cape Hatteras Minefield and will provide major insight in the next chapter when viewing the wartime statistics as part of the overall analysis of the minefield.

The final map type depicts the Pre-Minefield Period subjected to a convex hull analysis. These maps calculate the smallest amount of space needed to include all the entered points, and thus the ever-changing size of the naval battlefield can be tracked. In this case, geospatial points of the merchant ships that were sunk were subjected to the convex geoprocessing tool. In the *Pre-Minefield Convex Hull* map (Figure 37) this area is represented by a purple polygon and occupies 228,472 square miles. The immense extent of the area that the battlefield covers can be seen on the map as the polygon takes up nearly the entirety of the North Carolina coastline and extends out well past the EEZ. Throughout the Battle of the Atlantic, the area of the battleground was constantly changing; this is typical of naval battles which are archetypally more fluid than their terrestrial counterparts.

Understanding the extent of the battlefield in each phase of the minefield's lifespan not only shows how the battle progressed over time but also allows the analysis of defense system placements. In the later sections of this chapter, the change in the convex hull polygon will be extremely evident, allowing for a comparison to the other time period's battlefield extends in the next chapter. This information along with the data from the *Pre-Minefield Sinking Density* become incredibly important in analyzing the placement of Cape Hatteras Minefield as an effective defensive structure.

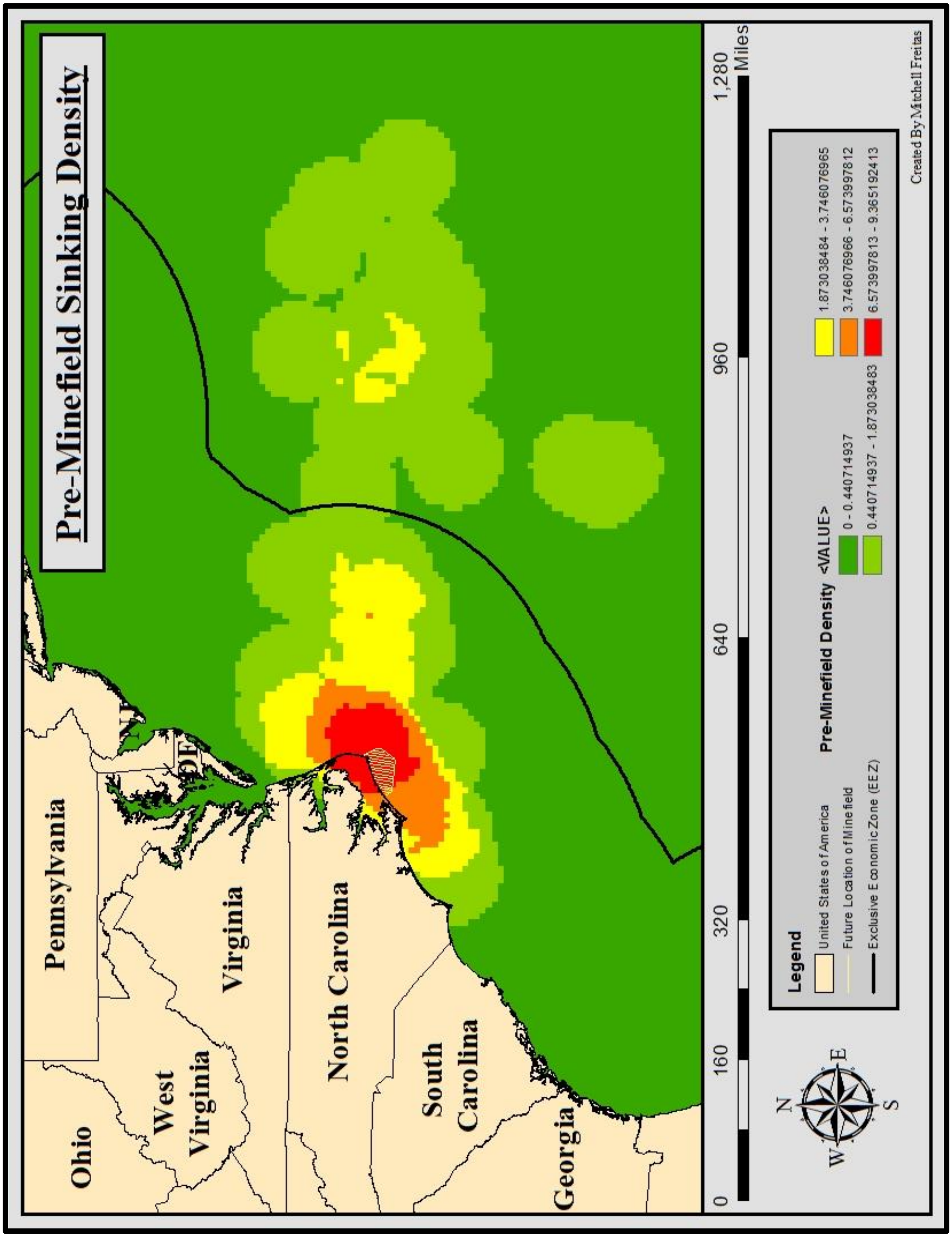


FIGURE 36. Pre-Minefield Sinkings Density, January 1942-May 1942 (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

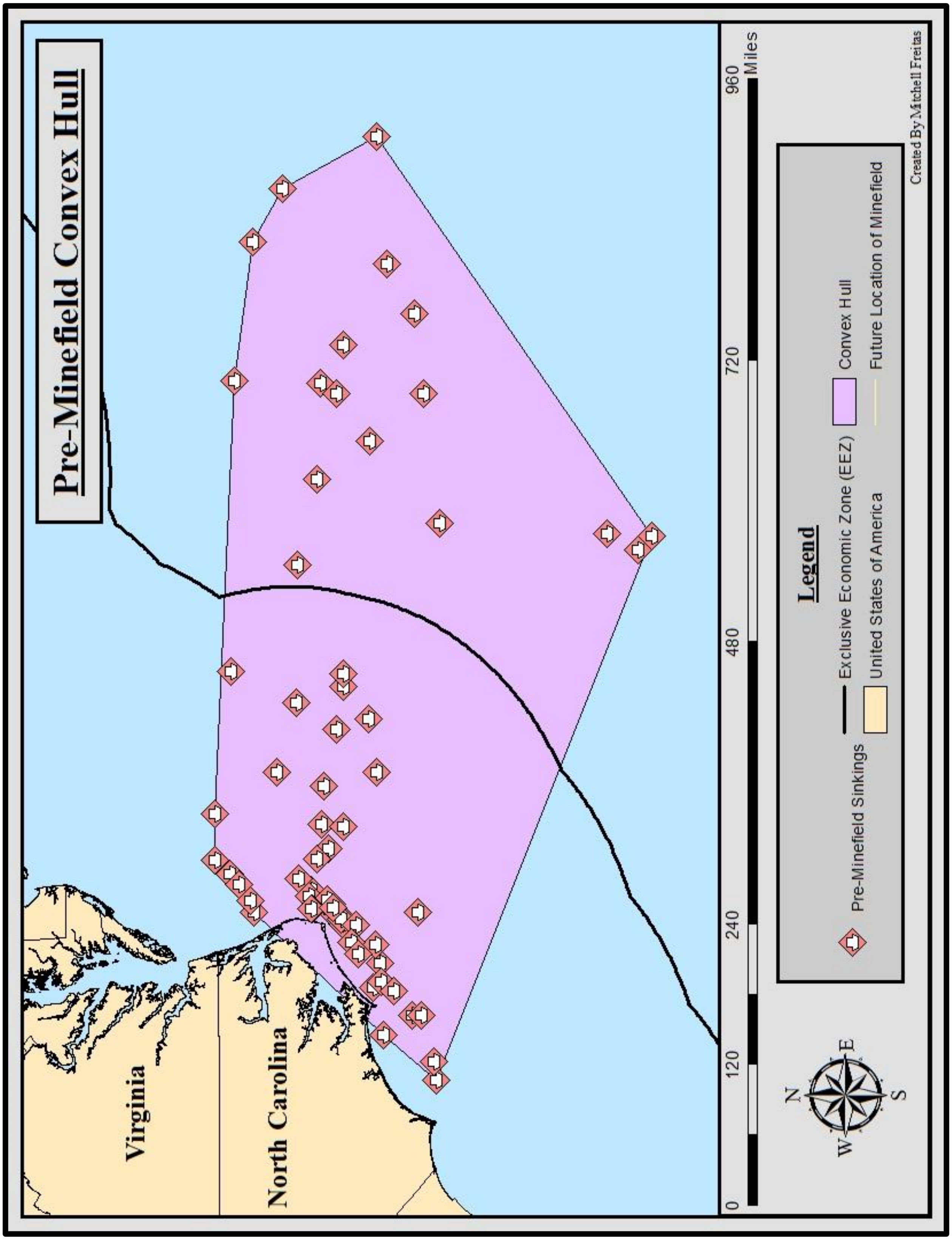


FIGURE 37. Pre-Minefield Convex Hull, January 1942-May 1942 (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

Active-Minefield Period

The numeric and geospatial results used to analyze the Active-Minefield Period include those sinkings and events that took place during the time in which the minefield was fully operational. Similar to the section above, the numeric results will show the breakdown of wrecks, including their locations, the lives lost per month as well as the tonnage and value per month. As this section deals with the minefield itself, greater detail will be paid to the wrecks directly associated with the minefield, namely *F.W. Abrams*, *Chilore* and *Keshena.* This section also deals with the German U-boat *U-576'*s attack on the Allied merchant convoy KS-520, and therefore the relevant numeric and geospatial data will be included as well.

<u>Active Minefield Numeric Results</u>

Beginning again with the lives lost during this period, the most obvious trend in the *Active-Minefield Allied Lives Lost Per Month* chart (Figure 38) is the lack of lives lost between August 1942 and March 1943. This gap leaves the epicenter of activity during this period in the months of June and July of 1942. It is important to note that the convoy system was already being implemented during the same period that Cape Hatteras Minefield was active. As will be seen, the attack on Convoy KS-520 and the subsequent after-action reactions were responsible for the majority of attacks in July. During the month of June 1942 the overall trend of a reduced amount of lives lost continued with 12 lives lost, while the following month, July 1943 only saw 13 lives lost (Lloyds 1989; Hoyt et al. 2017).

The *Active-Minefield Allied Ships Lost Per Month* chart (Figure 39) looks remarkably like the *Active-Minefield Allied Lives Lost Per Month* chart, this is due to the fact that all sinkings during the Active-Minefield Period occurred between to June and July 1942. The ships lost during June 1942 totaled nine, while the ships sunk during July totaled five. As before, these numeric datasets can be seen overlaid in the *Active-Minefield Lives, and Ships Lost* graph (Figure 40). Just as in the last section, the gray bars signify the Allied merchant sailors that were lost while the orange line charts the ships that were lost. Moving to the more detailed view, *Active-Minefield Allied Lives Lost by Ship* (Figure 41) lists the ships lost by name. Within this dataset, are the sinkings that have been directly associated with the minefield. These sinkings span the two active months, though majority take place in July 1942 as they are associated either directly or indirectly with the KS-520 Convoy attack. The breakdown of minefield associated sinkings and lives lost can be seen in *Minefield Associated Lives and Ships Lost* (Figure 42), there are only three ships whose sinkings were attributed to the minefield (Lloyds 1989; Hoyt et al. 2017).

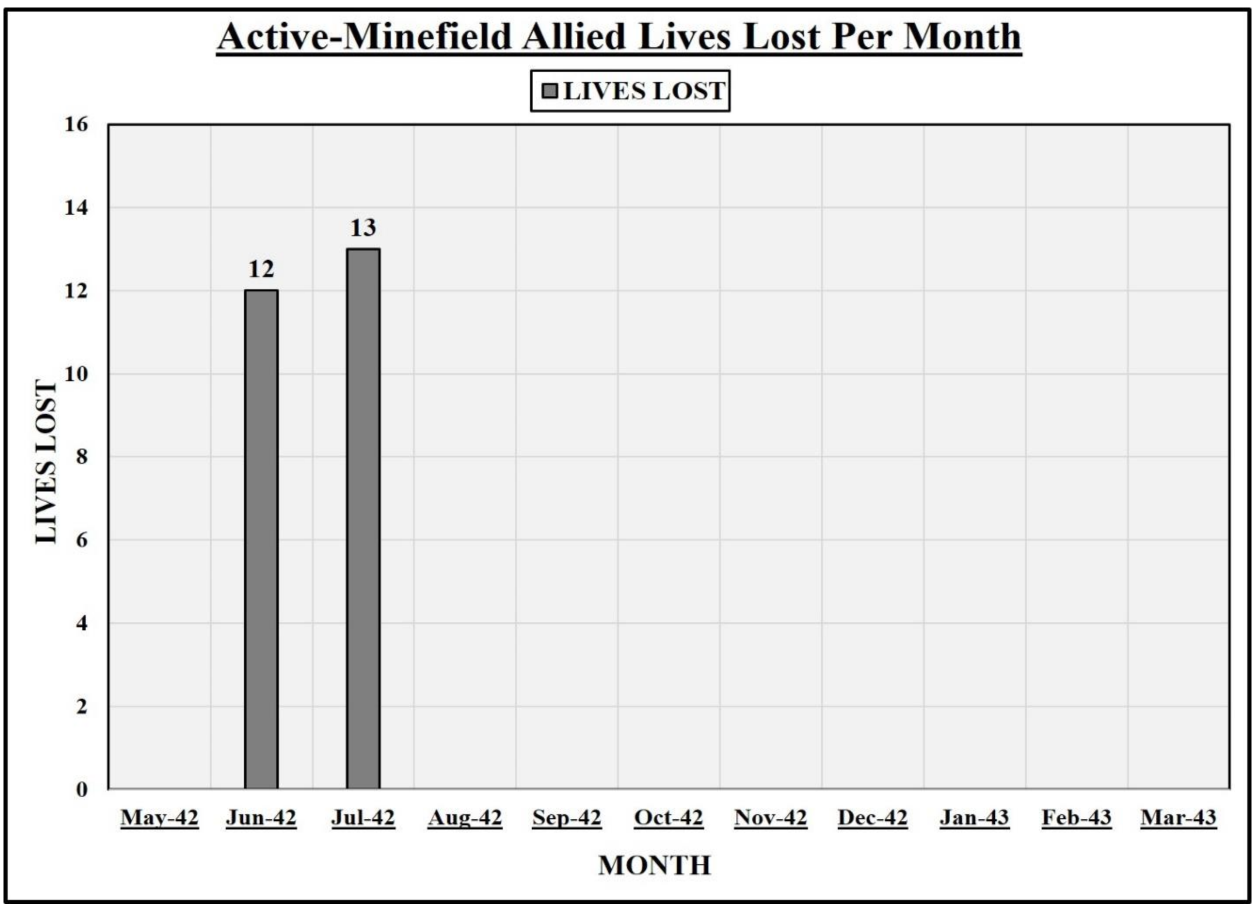


FIGURE 38. Graph showing the Allied lives lost per month during the Active-Minefield Period, Total Lives Lost: 25 (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

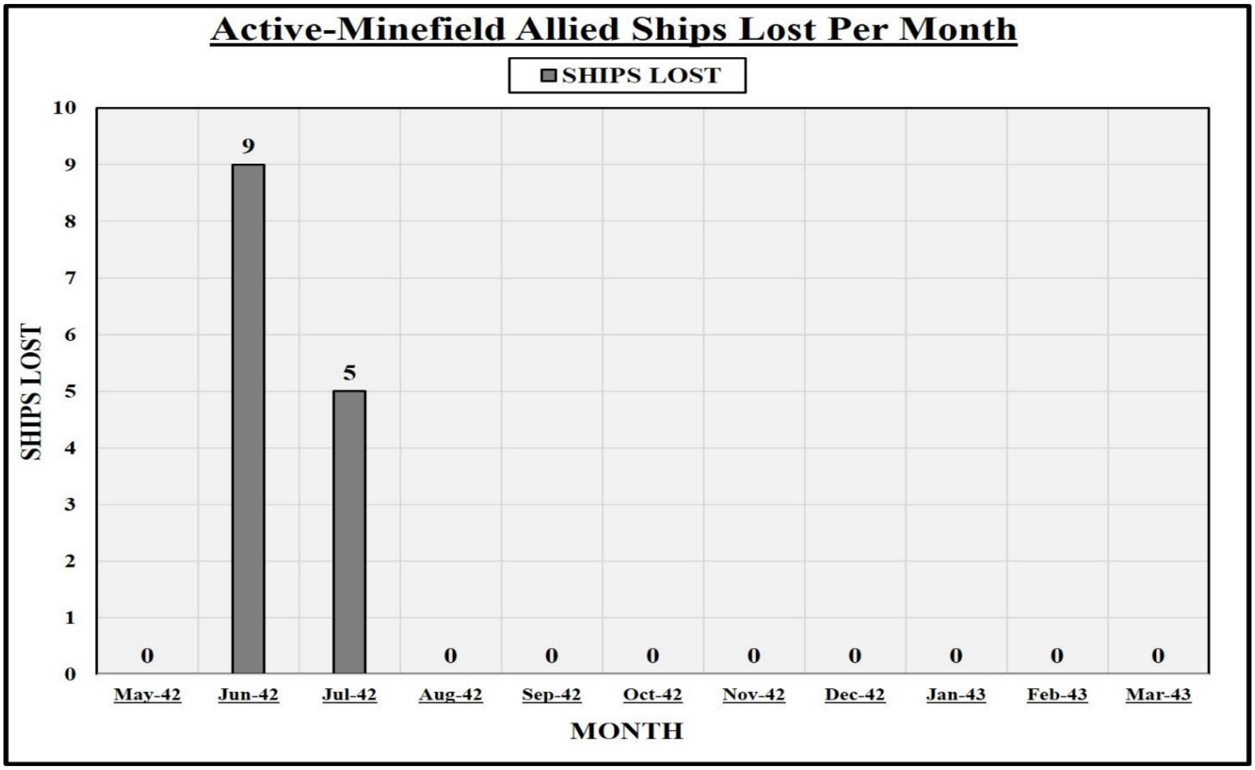


FIGURE 39. Graph showing the Allied merchant ships lost per month during the Active-Minefield Period, Total Ships Lost: 14 (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

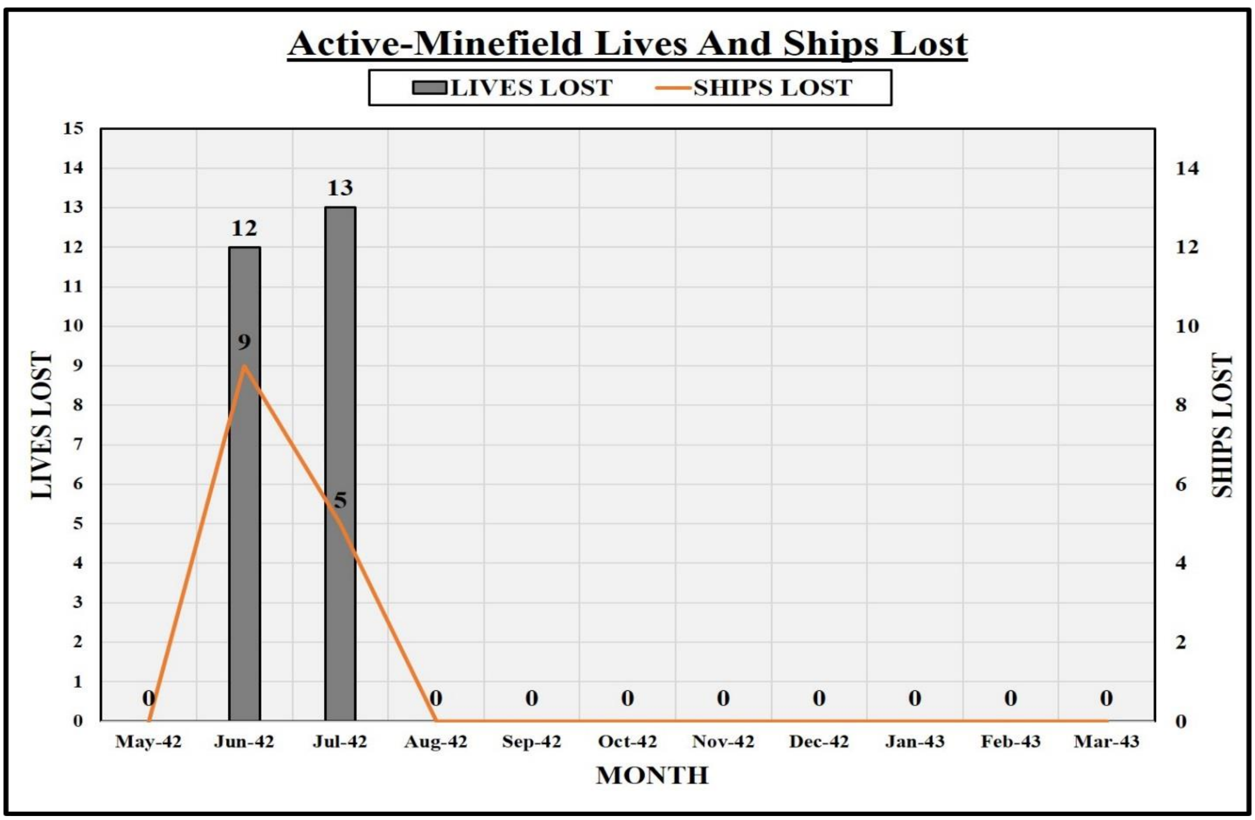


FIGURE 40. This is a combination bar and line graph showing the direct correlation between the lives and ships lost during the Intra-Minefield Period, Total Lives Lost: 25, Total Ships Lost: 14 (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

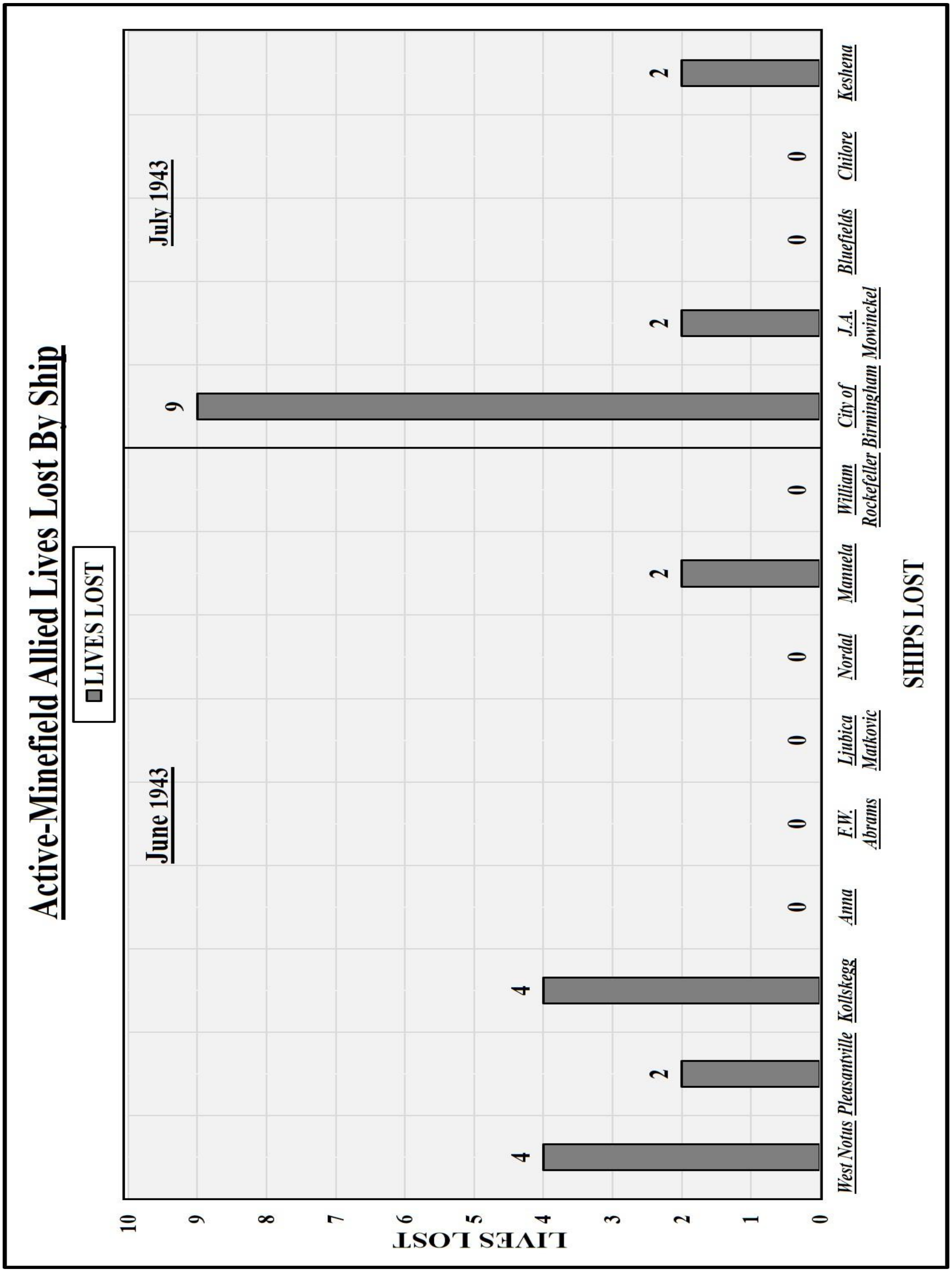


FIGURE 41. Amount of Allied lives per each individual wrecking event, broken down by the month they were lost during the Active-Minefield Period, Total Lives Lost: 25 (Source: Lloyd's 1989, Created by: Mitchell Freitas 2016). *Note: J.A. Mowinckel is included in this graph to highlight the casualties.*

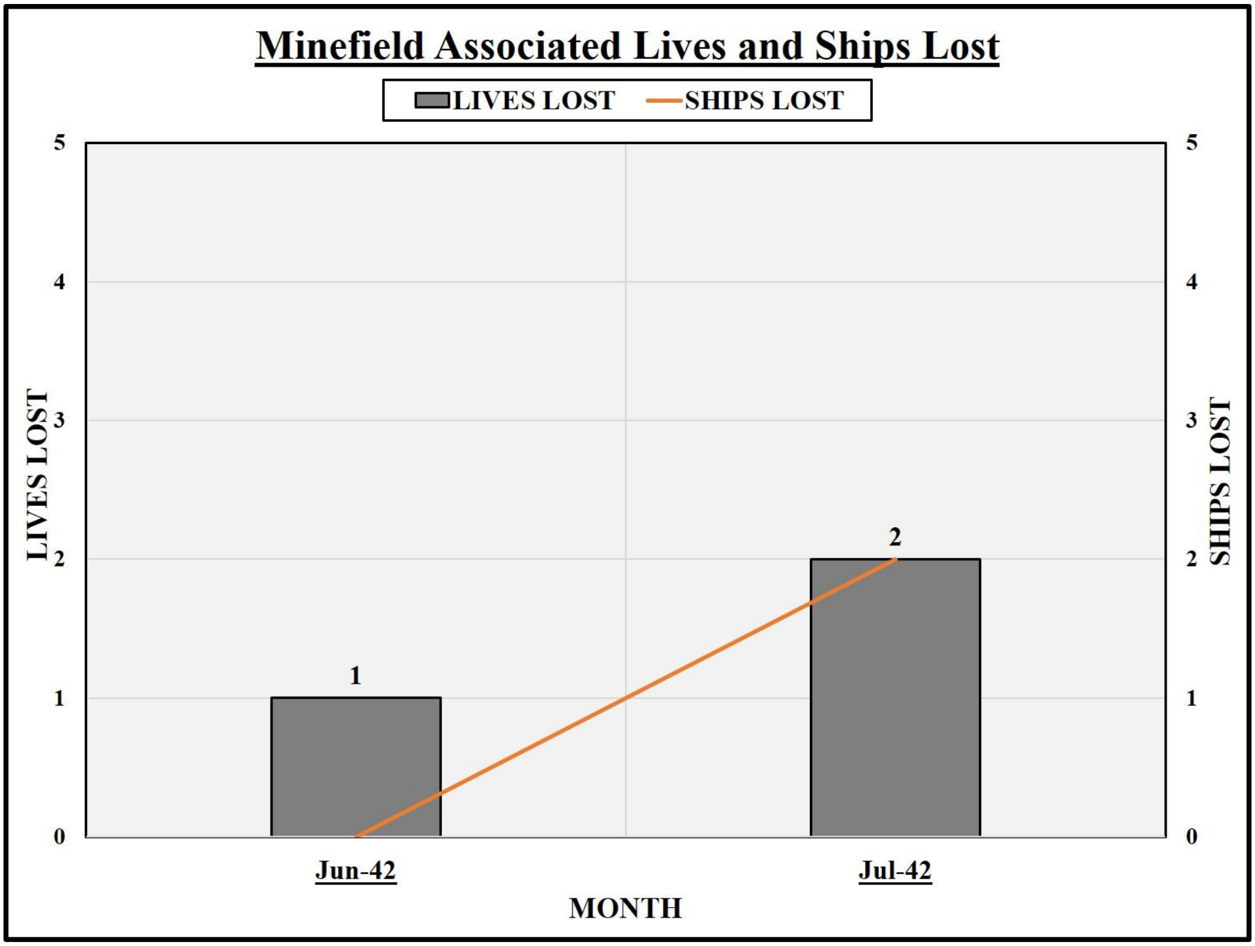


FIGURE 42. This is a combination bar and line graph showing the direct correlation between the lives and ships lost during the operation of the minefield while being directly associated with the minefield, Total Ships Lost: 3 Total Lives Lost: 2 (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016). *Note: J.A. Mowinckel was not included in this count as it was repaired and put into service 12 March 1943.*

The first happened in June and can be seen in Figure 41 listed as *F.W. Abrams.* The remaining two wrecks were lost in July of 1942. Before going any further, it is important to mention that *J.A. Mowinckel* was ultimately repaired and returned to service and therefore was not counted among vessels lost due to the minefield. This vessel was only included in these statistics due to its association with the minefield and KS-520. The tonnage lost during the Active-Minefield Period can be seen in the graph *Active-Minefield Tonnage Lost by Ship* (Figure 43), which totals to 84,633 tons lost (Lloyd's 1989). This tonnage is spread over 13 vessels, though not all of them were merchant vessels. For instance, the smallest vessel lost during this period was the tug *Keshena*, which was sunk attempting to rescue the vessels that fled the attack on Convoy KS-520. *Keshena* only displaced 427 tons (Lloyd's 1989:494). While there was no cargo lost, two sailors lives were lost after the ship struck a mine in Cape Hatteras Minefield. This loss is in stark contrast to the American oil tanker *William Rockefeller*. This tanker displaced 14,054 tons and carried a startling 135,000 barrels of fuel oil (Lloyd's 1989:475). The remaining ships sank during this period average out to 5,465 tons per ship lost. As mentioned in the previous section, this would represent decently sized merchant vessel, however, in this section, this figure was only extrapolated over 11 ships.

The cargo lost during the Active-Minefield Period also reflects the declining nature of attacks. As can be seen in *Active-Minefield Allied Cargo Lost* (Figure 44) the loss of barrels of fuel oil was paramount during this period with 228,250 barrels being lost. In comparison to the fuel oil, the barrels of dirty oil lost severely drops off where only 14,000 barrels of dirty oil were lost. Surprisingly the third highest amount of cargo lost during this period was 10,600 tons of sugar. As can be seen, the diversity of the class of freight lost has been severely diminished. Therefore, the cost comparison discussed in the next chapter highlights the stark differences between the value of each item lost per period will become evident (Lloyds 1989).

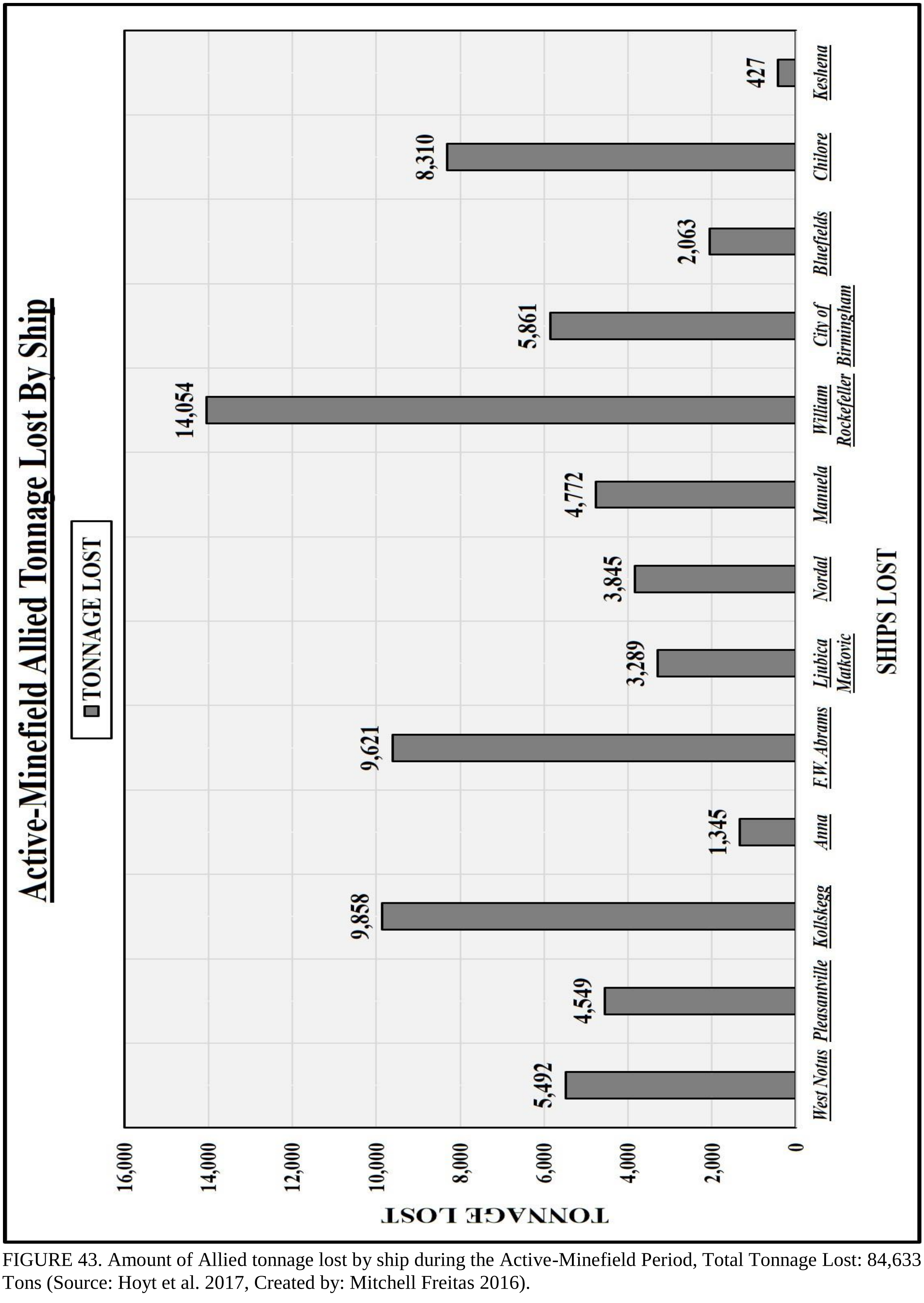


FIGURE 43. Amount of Allied tonnage lost by ship during the Active-Minefield Period, Total Tonnage Lost: 84,633 Tons (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

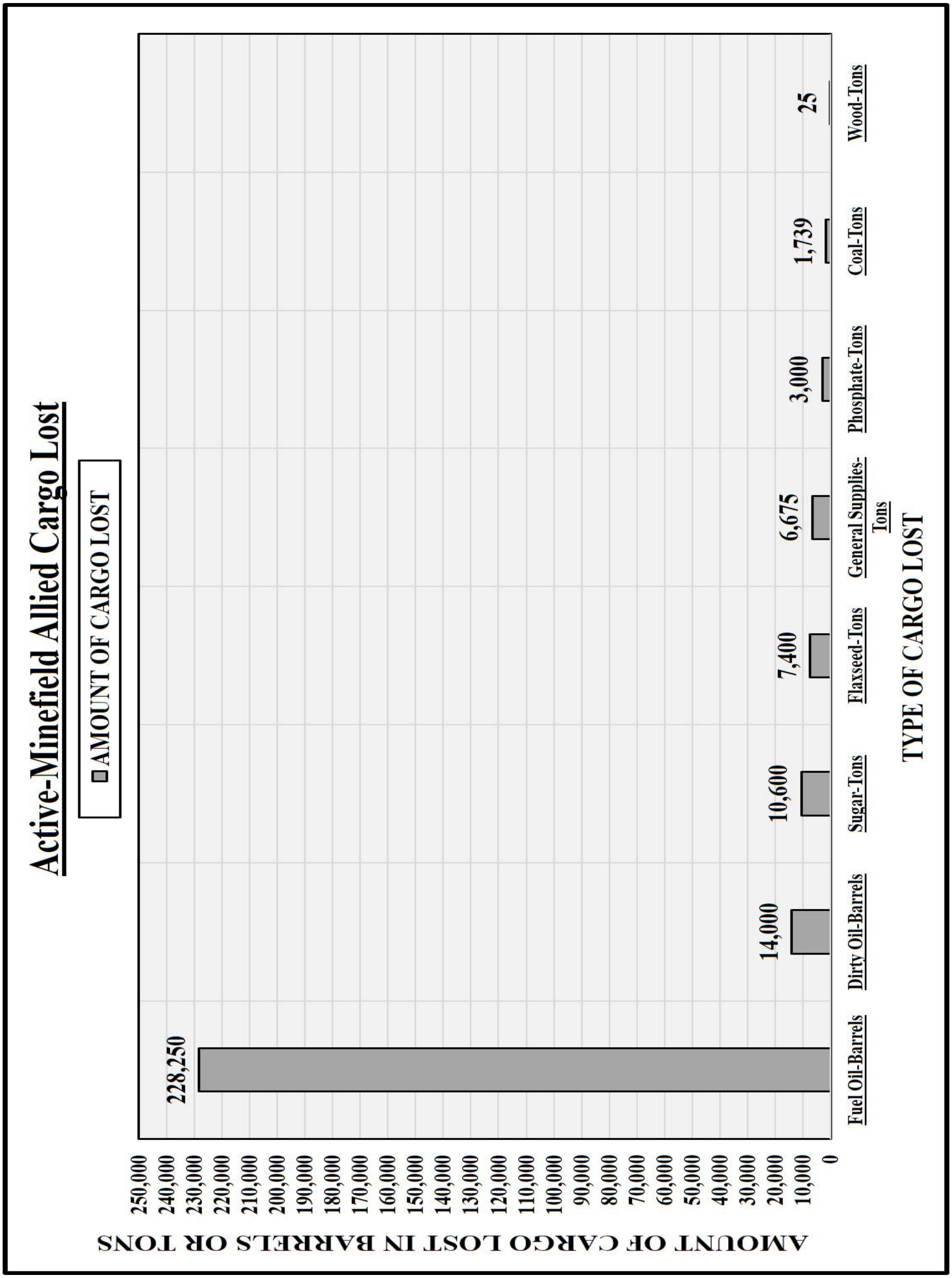


FIGURE 44. Amount and type of cargo lost during the Active-Minefield Period, notice that the amounts are either in barrels or tons (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

Active-Minefield Geospatial Results

Before discussing the wrecks involved with the KS-520 Convoy attack, an overall view of the sinkings is necessary to provide context. Notice in the *Active-Minefield Sinkings* map (Figure 45) that the blue circles depict the associated minefield sinkings, while the red squares represent the other non-minefield associated sinkings that occurred. As seen previously, a recessed view shows the wrecks that took place outside of the EEZ. As per the first section, the *Active-Minefield Density* (Figure 46) shows the hotspots of sinking activity during the time the minefield was active. The next map, the *Active-Minefield Convex Hull* (Figure 47) shows the battlefield area of the Active-Minefield Period. In this map, the sinking points that were associated with the minefield are group under the orange, convex hull polygon, which occupies 249 square miles, while the points that were sunk by other causes are covered by a red polygon covering 28,406 square miles in area.

The next map, the *Attack of Convoy KS-520* (Figure 48), plays host to a plethora of elements. It is important to point out the bold red line and yellow-black checkered line as they depict the two accepted navigational routes for merchant ships. The bold red line is the route dedicated to the merchant ships traveling as individuals. This route directed the merchant ships closer to the coastline for protection and made use of Cape Hatteras Minefield as a waypoint. The yellow-black checkered line depicts the path for convoys. As shown, the convoy route is further out to sea and bypasses the minefield altogether.

The main elements of the attack are depicted, including the convoy itself, as the cluster of yellow diamonds. The convoy escorts are represented by green squares, the aerial escorts as black plane outlines, and *U-576* as a red polygon.

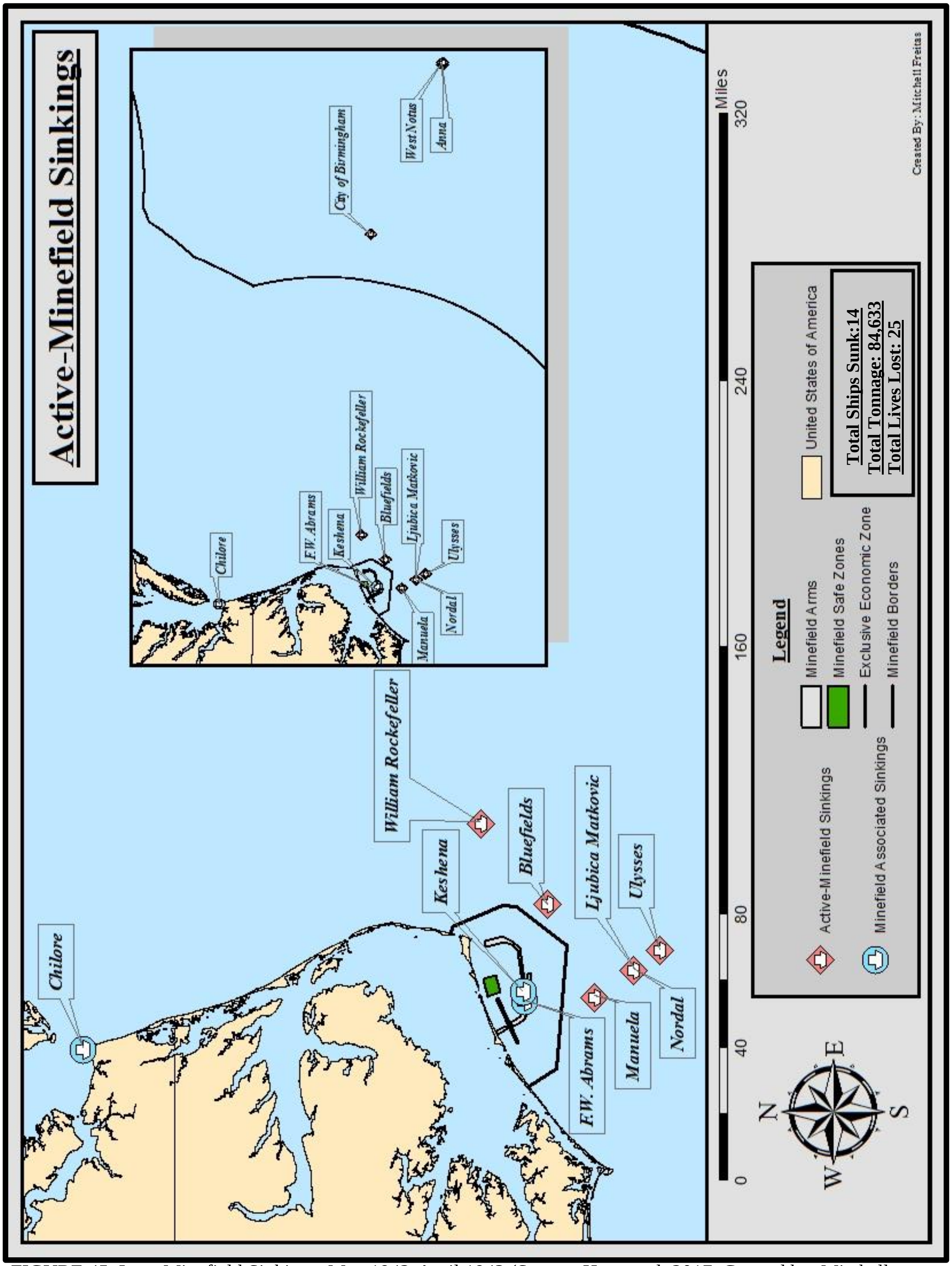


FIGURE 45. Intra-Minefield Sinkings, May 1942-April 1943 (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

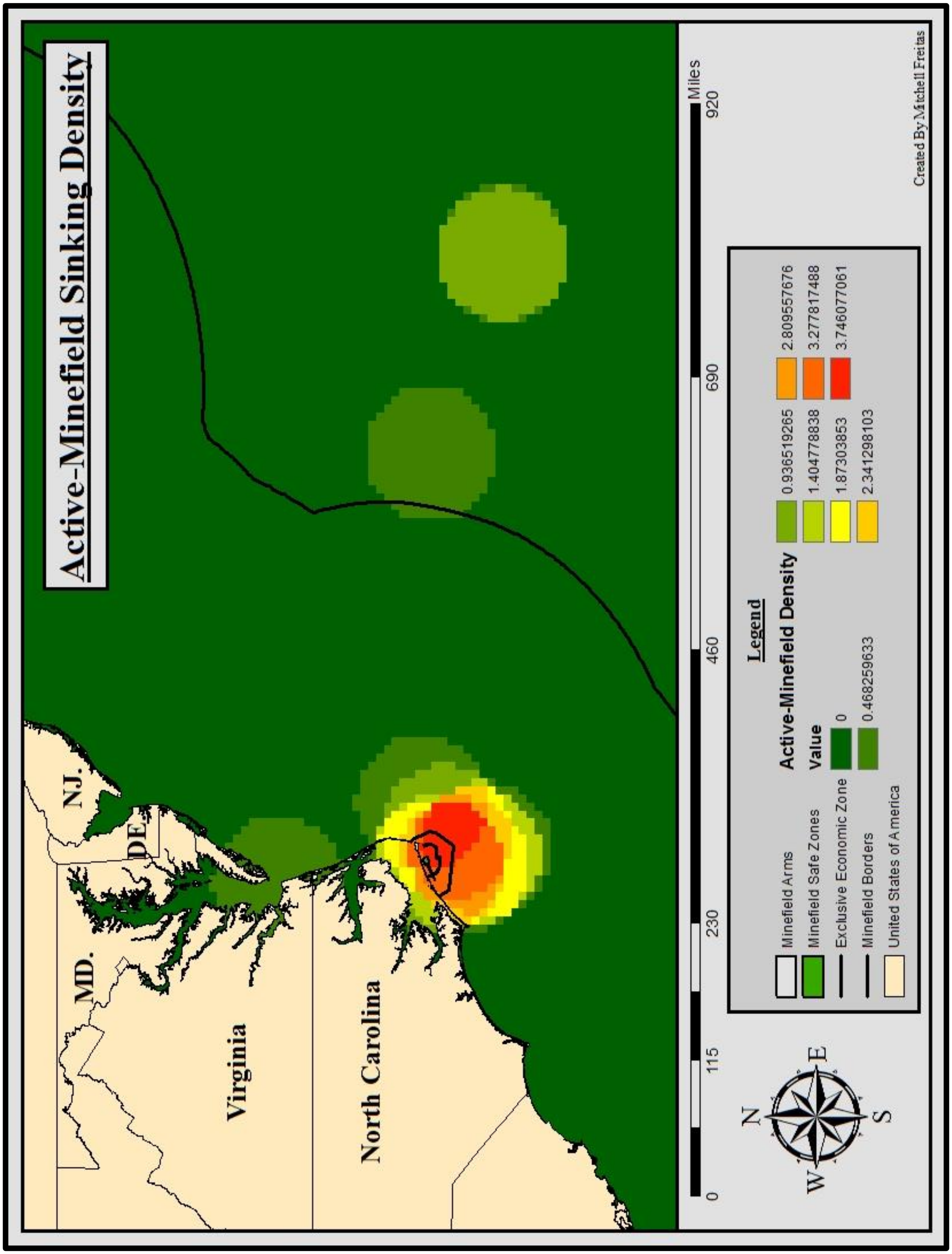


FIGURE 46. Intra-Minefield Sinking Density, May 1942-April 1943 (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

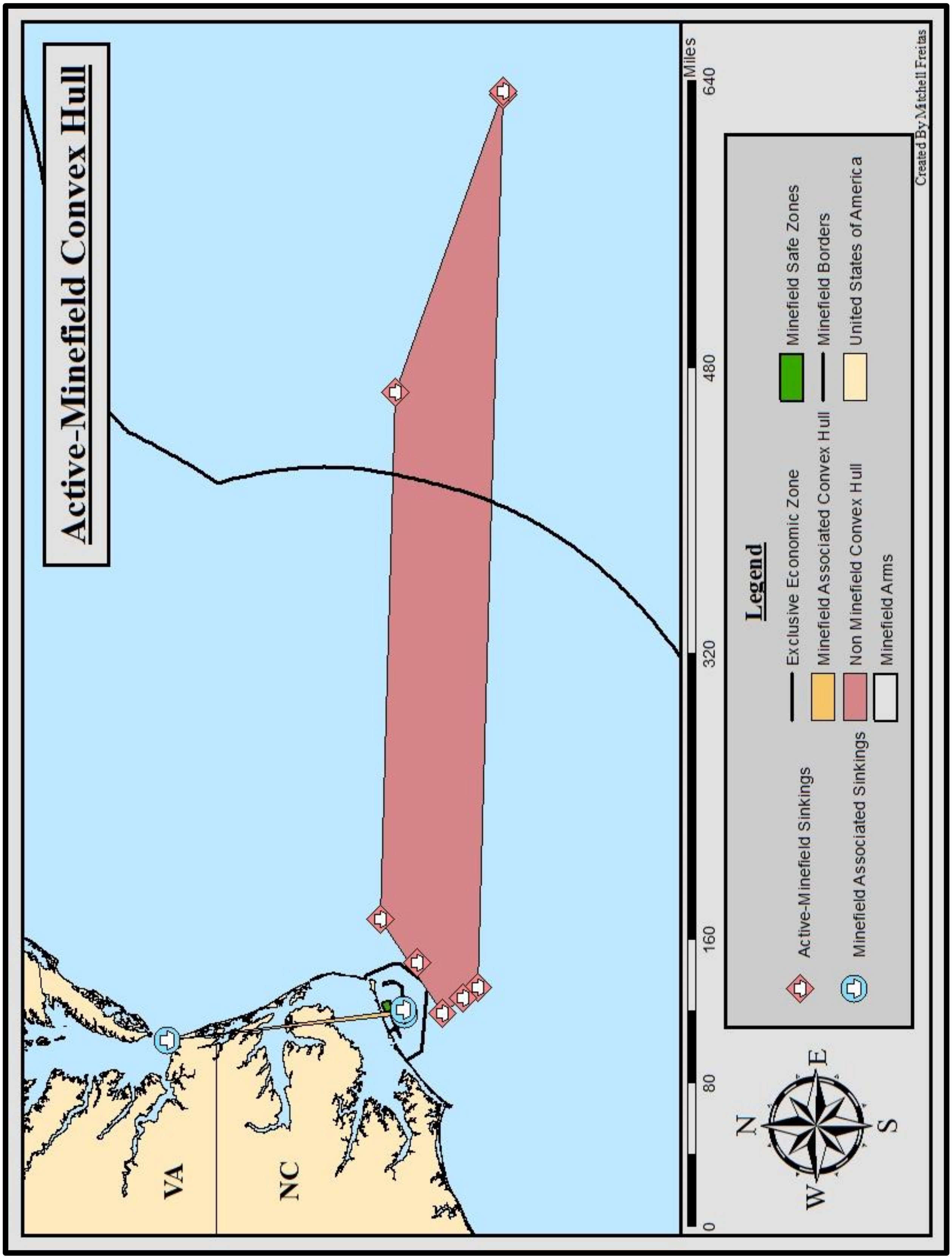


FIGURE 47. Intra-Minefield Convex Hull, May 1942-April 1943 (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

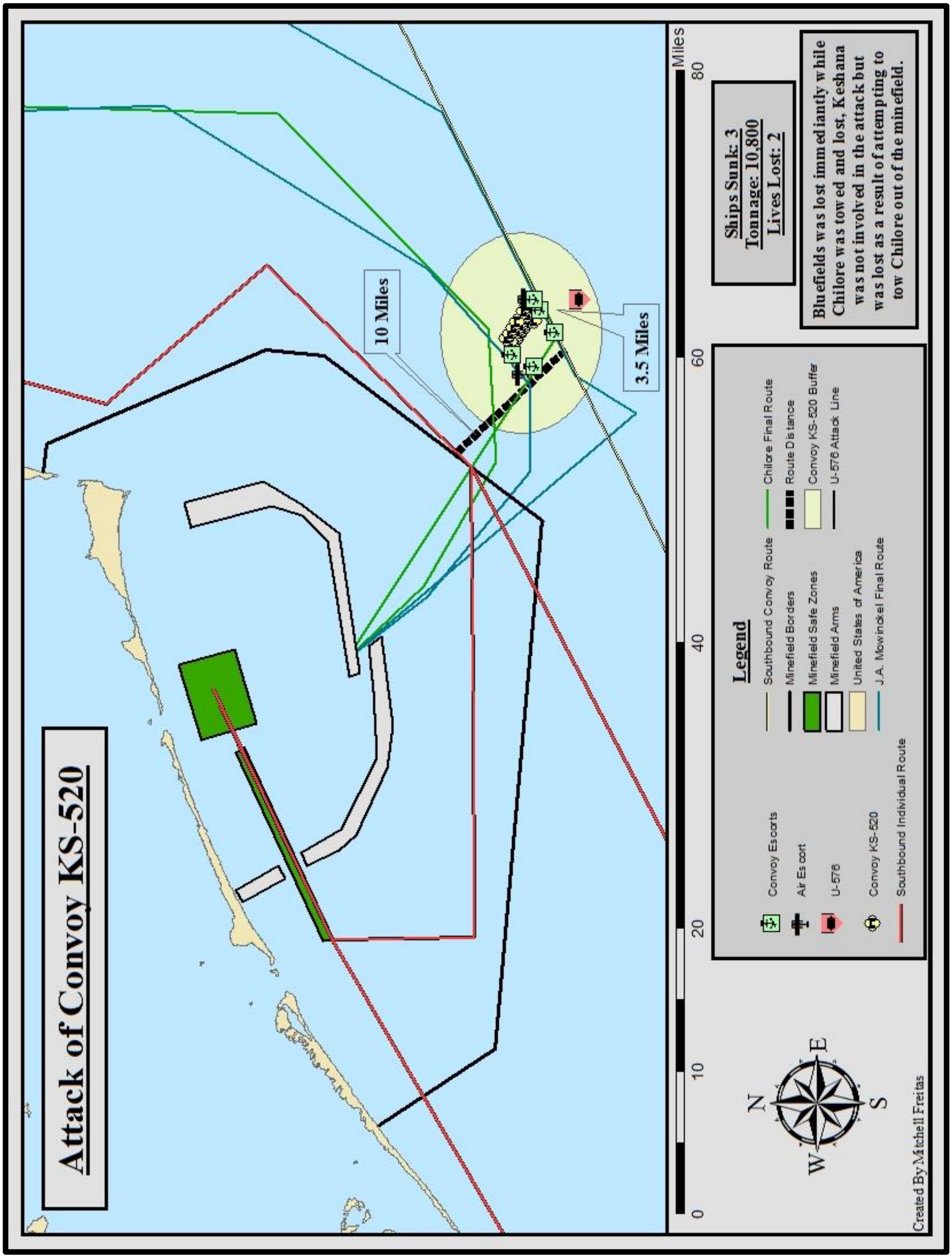


FIGURE 48. Attack of Convoy KS-520, 15 July 1942 (Source: Wagner 2012: Data Files, Created by: Mitchell Freitas 2016). *Note: Shipwreck locations are historical interpretations by Wagner.*

The positions of the various ships and aircraft are depicted at the time of the attack. The green and blue lines show the routes and reactions of the merchant ships *Chilore* and *J.A. Mowinckel*, which were members of the KS-520 convoy and were part of the group led by the U.S. Naval escort ship USS *Spry* back into the depths of Cape Hatteras Minefield. Finally, the black dotted line denotes the distance of 10 miles, and highlights the difference in distance between the individual and convoy routing lines; this distance between the two routes will be discussed further in the next chapter.

The next two maps in this section depict the routes taken by the Allied merchant ships *Chilore* (Figure 49) and *J.A. Mowinckel* (Figure 50). Both ships were part of the ill-fated Convoy KS-520, and it follows each ship's progress, starting at the teal octagon. This, however, is simply the the extent of the geospatial data available, the true starting point of Convoy KS-520's was from a shipyard in Norfolk, Virginia (Freeman 1987:411). This port is denoted by a blue rectangle emblazed with an anchor. From there, the map depicts the two ships' route down the coastline until the attack by *U-576* occurs. The attack is denoted by the red asterisks that appear on both maps. From the offensive zone, the sharp angle inland shows the attempted flee to safety that was led by USS *Spry*, and the party's general location of contact with mines from Cape Hatteras Minefield. Following the interaction with mines and the unfortunate sinking of the tug *Keshena,* the routes show the two merchant ships towing back to Norfolk, Virginia.

The major difference between the two maps lies in the ending positions of the merchant ships. While still attributed to the minefield, the final resting place of *Chilore* is just off the coast of Cape Henry in Virginia. After *Chilore* well along the way back to Norfolk the ship foundered and finally sank (Freeman 1987:419). In comparison, the *Final Route of J.A. Mowinckel* map reflects the fact that *J.A. Mowinckel* was able to be successfully towed back to the shipyard.

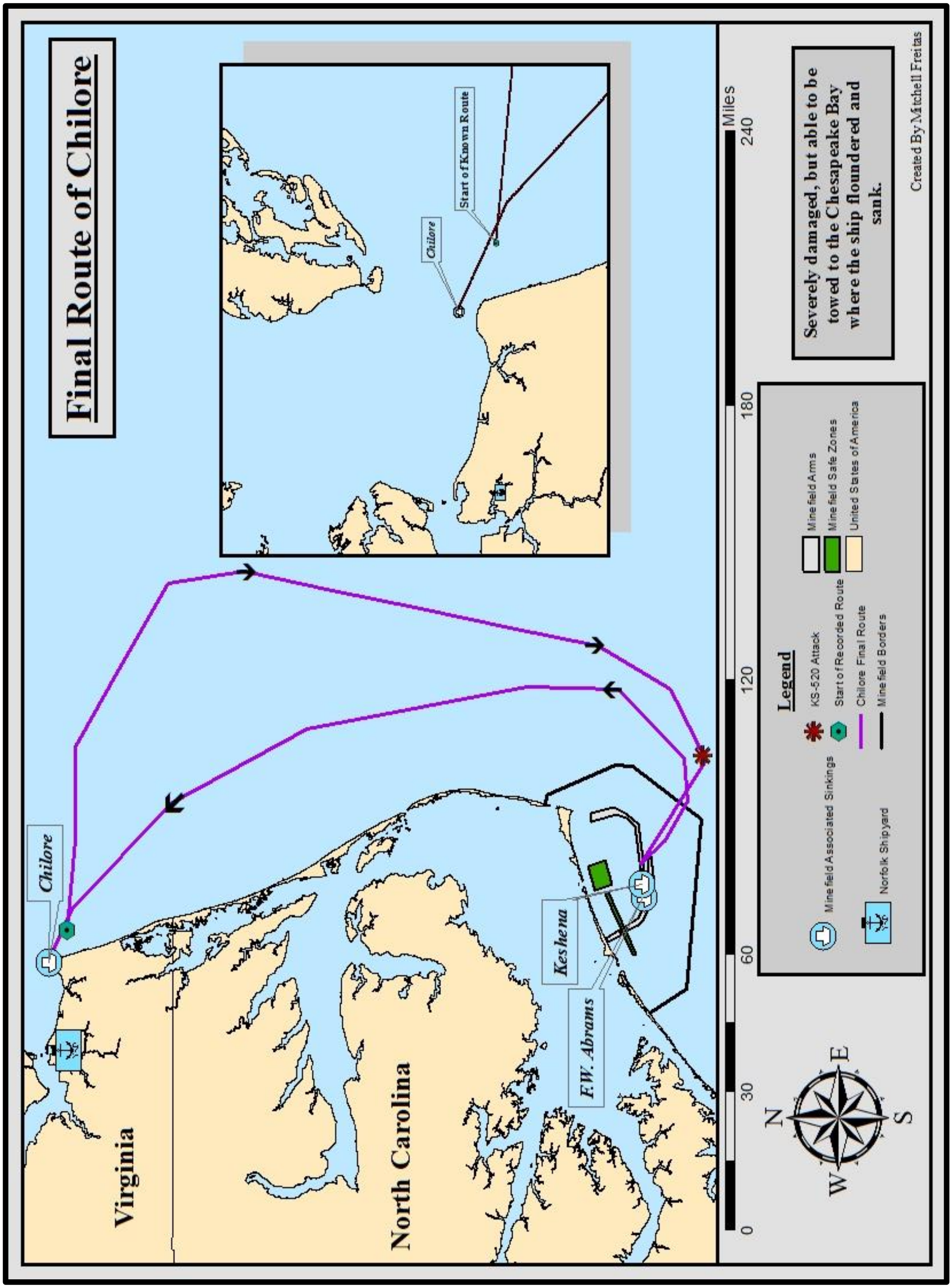


FIGURE 49. Final Route of *Chilore* (Source Wagner 2012: Data Files; Hoyt et al 2017, Created by: Mitchell Freitas 2016).

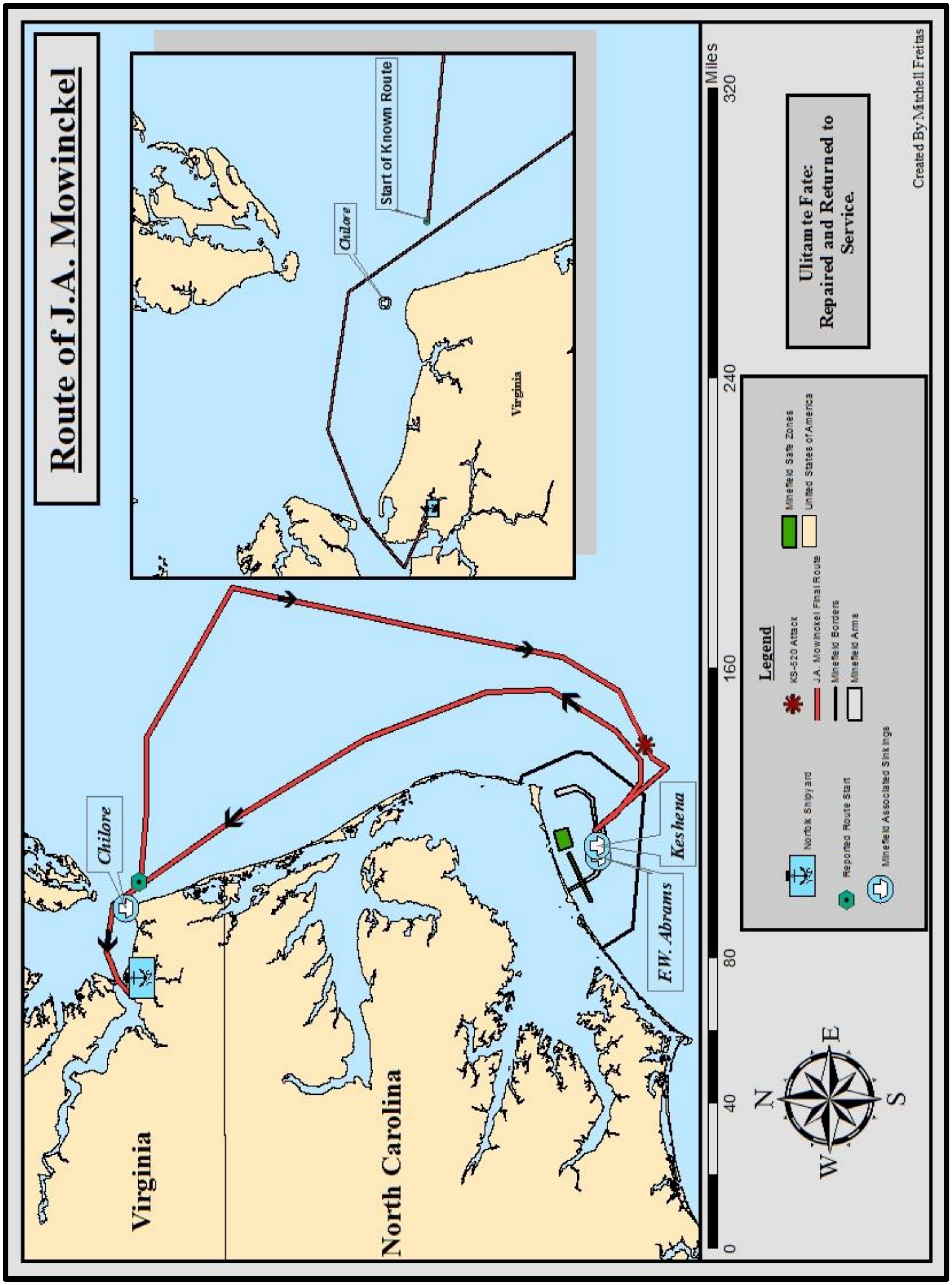


FIGURE 50. Final Route of *J.A. Mowinckel* (Source: Wagner 2012: Data Files; Hoyt et al 2017, Created by: Mitchell Freitas 2016).

Post-Minefield Period

This section contains the results pertaining to the period after the minefield was deconstructed and rendered safe to the standard of the navy at the time. Unlike the two preceding sections, this section does not boast nearly as much data. While the products included are similar, it will become readily apparent that there is less detail shown in these data products. This lack of information does not mean that patterning cannot be seen. The data in this section will serve as valuable comparative information relative to the previous two time periods in the next chapter.

Post-Minefield Numeric Results

While containing the fewest results, the temporal length of this period dwarfs the prior two sections. Beginning in April of 1943, this period would stretch to the end of the battle in April 1945. As can be seen in *Post-Minefield Allied Lives Lost Per Month* (Figure 51), the Allied

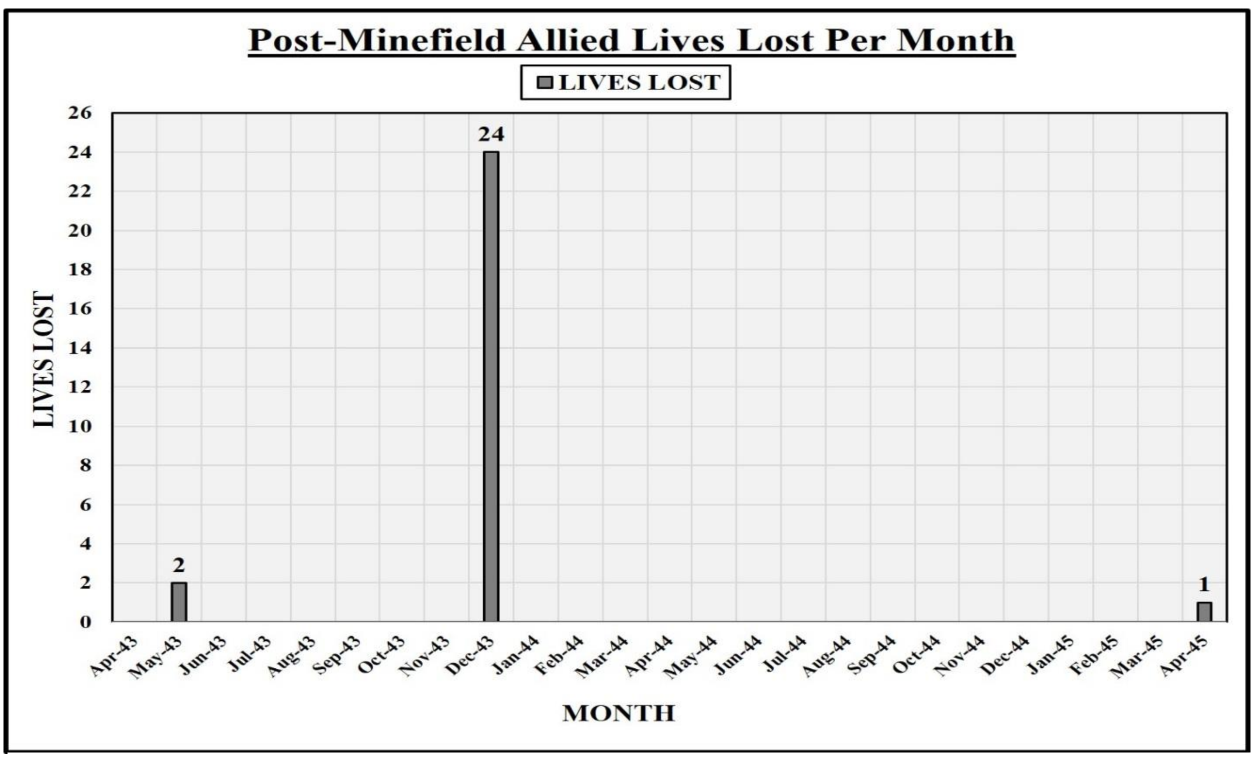


FIGURE 51. Lives lost during the Post-Minefield Period broken down by month, Total Lives Lost: 27 (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

lives lost had decreased dramatically with the exception of December of 1943 when the wrecking event of *Libertad* killed 24 merchant sailors, but this is atypical for this dataset. The remaining sinkings produced two dead in May of 1943 with the wrecking of *Panam* and one life lost during the sinking of *Belgian Airman* (Lloyds 1989; Hoyt et al 2017).

Even more sparsely populated is the *Post-Minefield Allied Ships Lost Per Month* graph (Figure 52). With the sinking of *Santa Catalina* in April 1943 and *Panam* in May of 1943, it would be another seven months without the sinking of an Allied merchant ship off the coast of North Carolina. December 1943 saw the sinking of *Libertad,* the last ship sunk for another 15 months with the final sinking of the conflict, *Belgian Airman*, in April of 1945. There is a host of reasons why this wind down occurred. However, these will be further explored in the following chapter. The next two figures emulate these two datasets together each in varying detail. The first, *Post-Minefield Lives and Ships Lost* (Figure 53), shows the ships lost per month with the lives lost per month superimposed over the top. The next graph, *Post-Minefield Allied Lives Lost By Ship* (Figure 54), shows the four ships by name and their resulting casualties, this is then split up by month (Lloyds 1989; Hoyt et al 2017).

Following the prevailing trend of the Post-Minefield Period, the total amount of tonnage is severely diminished. This reduction in tonnage lost can be directly attributed to the minuscule sample size of four merchant ships. While this section does not boast any large merchant vessels in the vicinity of *Amerikaland* or *William Rockefeller,* the ships lost were not of insignificant size. As it can be seen in *Post-Minefield, Allied Tonnage Lost* (Figure 55) the Panamanian tanker *Panam* displaced 7,277 tons and was the largest sunk in this period (Llyod's 1989:670).

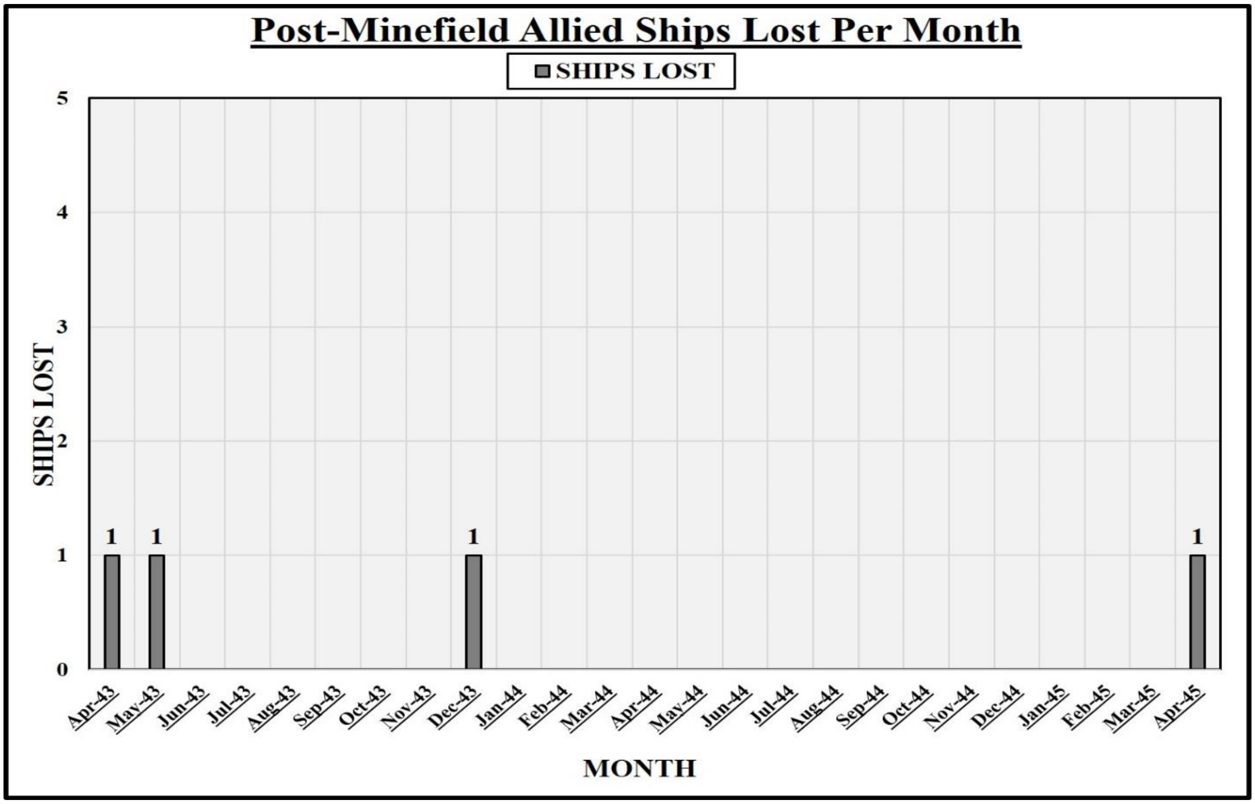


FIGURE 52. Allied ships lost per month during the Post-Minefield Period by month, Total Ships Lost:4 (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

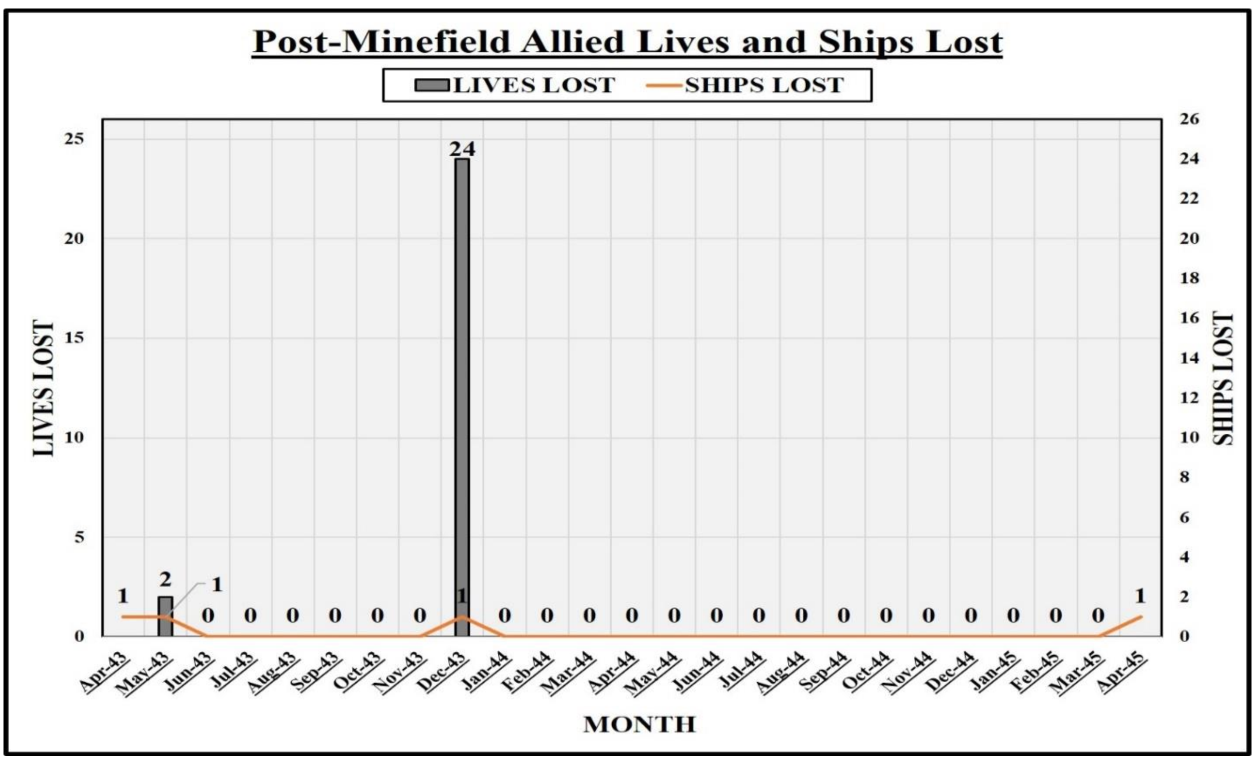


FIGURE 53. This is a combination bar and line graph showing the direct correlation between the lives and ships lost during the Post-Minefield Period, Total Lives Lost 27 Total Ships Lost 4 (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

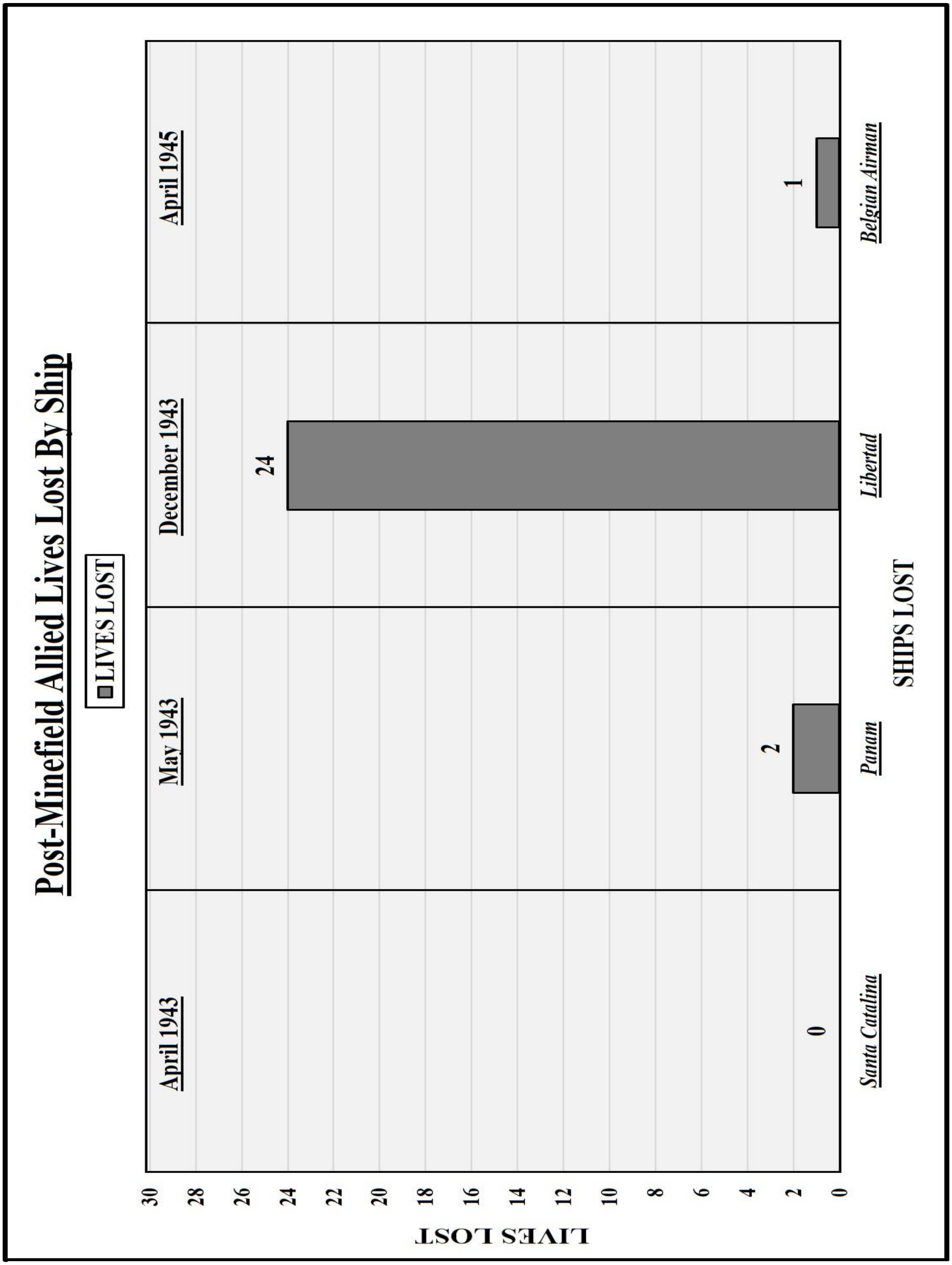


FIGURE 54. Lives lost per ship during the Post-Minefield Period broken down by the month in which the wrecking event occurred, Total Lives Lost:27 (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

The smallest, the Cuban merchant *Libertad*, displaced 5,441 tons (Lloyd’s 1989:725). These numbers are comparable to the average ship sizes in both the Pre-Minefield Period and the Active-Minefield Period. The average tonnage displaced in this time period totals 6,733 tons, and, while this is the largest average of the three periods, it was only spread across two ships. The actual tonnage of the remaining two ships were 6,507 tons for the American merchant *Santa Catalina* and 6,959-ton Belgian merchant *Belgian Airman* (Lloyd’s 1989:644,804).

The cargo lost statistics during the Post-Minefield Period are even more meagerly populated than the ships lost. For this period, only two classes of cargo were lost in this case sugar and general supplies. These two cargo categories are reflected in *Post-Minefield Allied Cargo Lost* (Figure 56). In this period, 8,000 tons of sugar were lost, as well as 6,700 tons of general supplies (Lloyd’s 1989). These numbers reflect the diminishing nature of attacks that occurred during this period. The cost analysis in the next chapter will shed more light on the comparisons with the other periods.

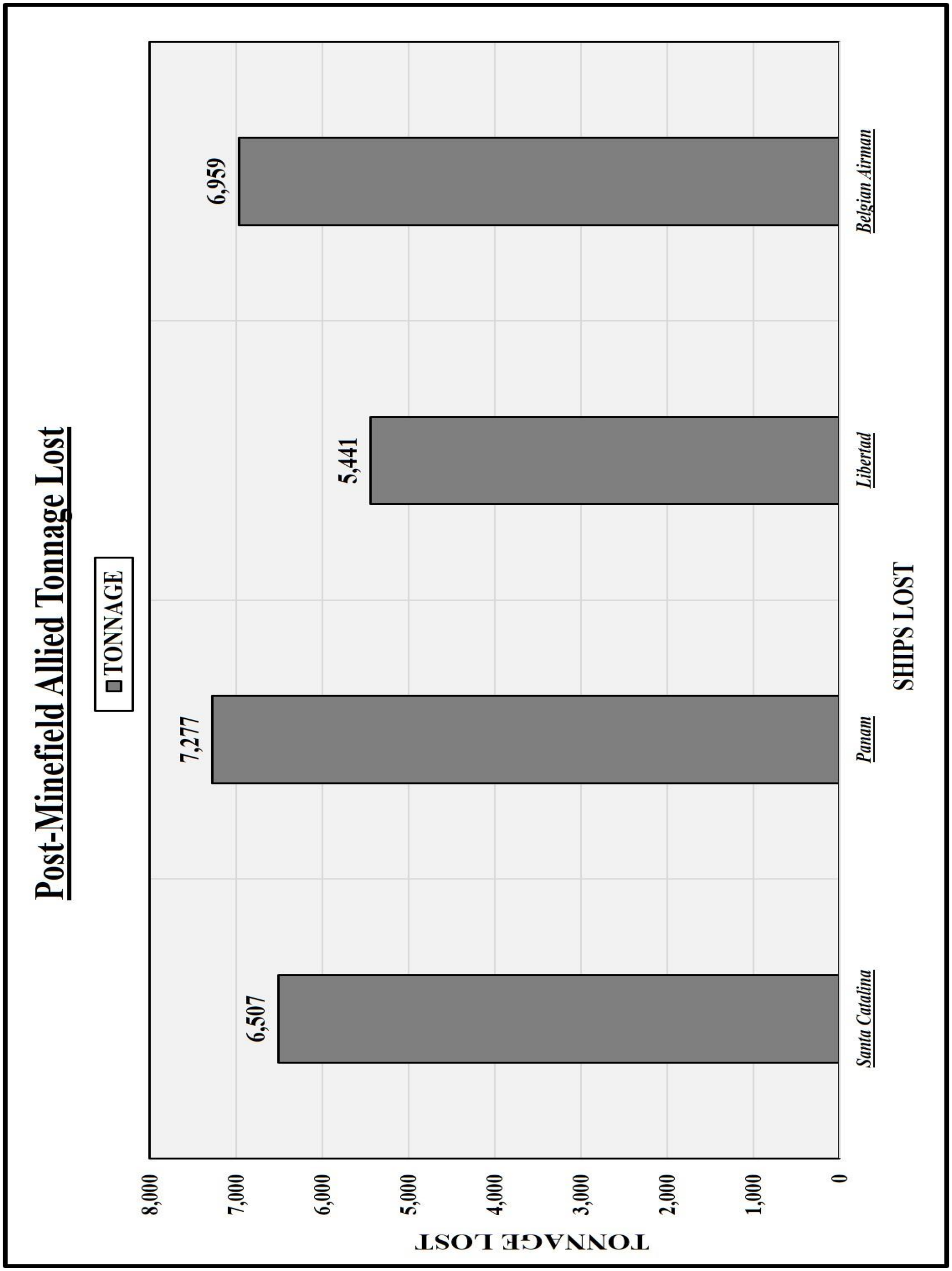


FIGURE 55. Amount of Allied merchant tonnage sunk during the Post-Minefield Period by individual ship, Total Tonnage Lost: 26,184 (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

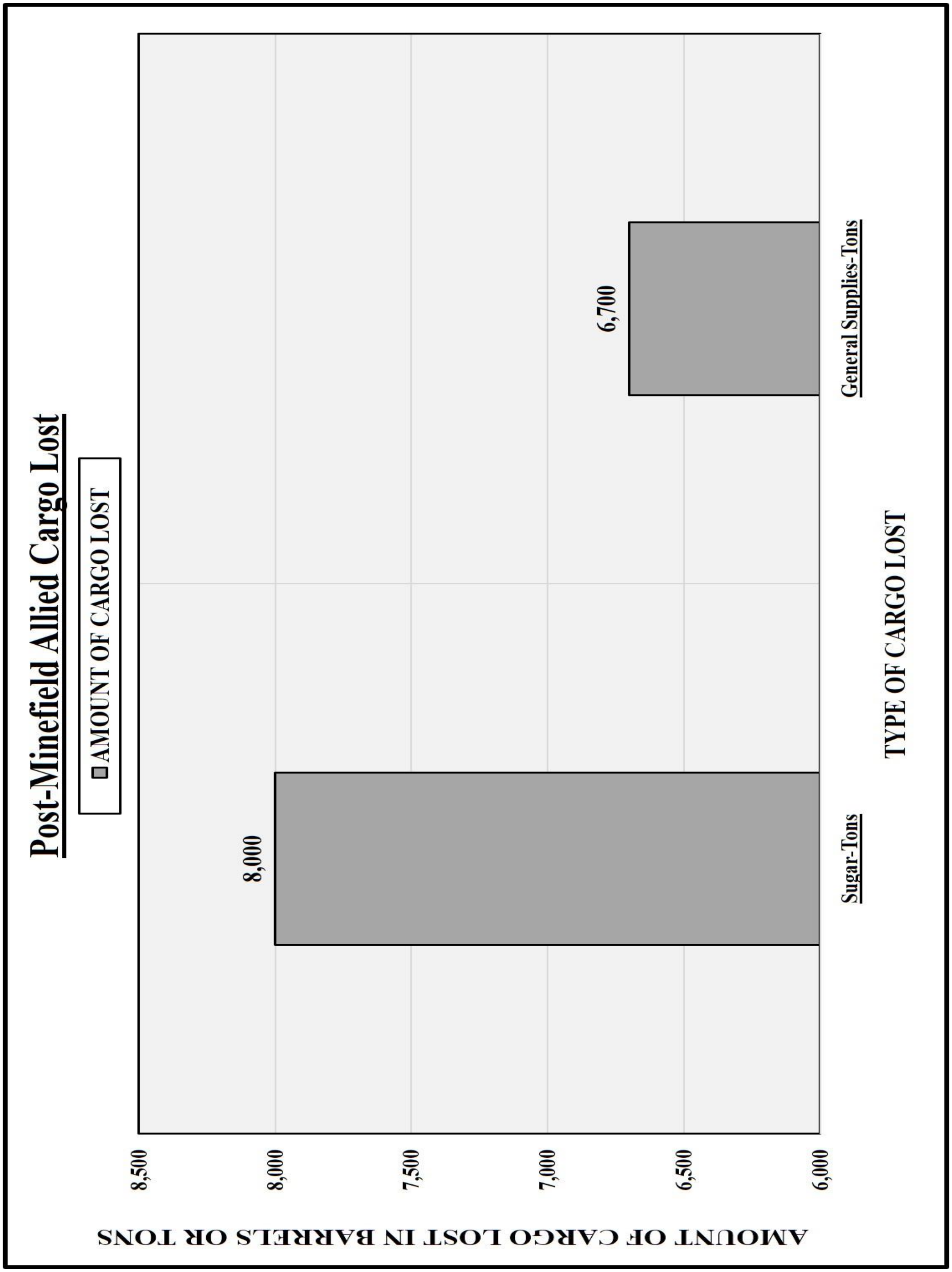


FIGURE 56. Type and amount of cargo lost during the Post-Minefield Period (Source: Lloyd’s 1989, Created by: Mitchell Freitas 2016).

Post-Minefield Geospatial Results

The maps in this section mimic those above. However, the sparseness of the Post-Minefield Period data above becomes even more apparent when putting into a visual representation. The map below, *Post-Minefield Sinkings* (Figure 57), shows the very few sinking points that occurred during the Post-Minefield Period. It becomes a common theme in this section that the fewer the data points entered, the product that is produced by the geoprocessing tools is much less detailed. This can certainly be seen in the *Post-Minefield Density* (Figure 58), where the range of color depicting density is much less detailed than the previous density maps. However, even after the minefield was removed, the results still show the heaviest density in red within the same area as the other maps. When comparing the Pre-Minefield and the Active-Minefield maps with the Post-Minefield map, it is apparent that the density analysis tends to work better when more points are included as part of the algorithm. Even so, it is still evident that the concentration of shipwrecks is still located in the immediate vicinity of Cape Hatteras Minefield in the Post-Minefield Density map.

The final map in the section is Cape Hatteras Minefield operational area subjected to the convex hull algorithm. In the map, *Post-Minefield Convex Hull* (Figure 59) the polygon represents the smallest amount of area between the four shipwrecks in the Post-Minefield Period, represented by red diamonds. In this iteration, the battlefield's area is represented by a green triangle. This polygon represents 48,546 square miles and will serve as a better comparison in the next chapter (For a full library of maps from all three periods see Appendix B)

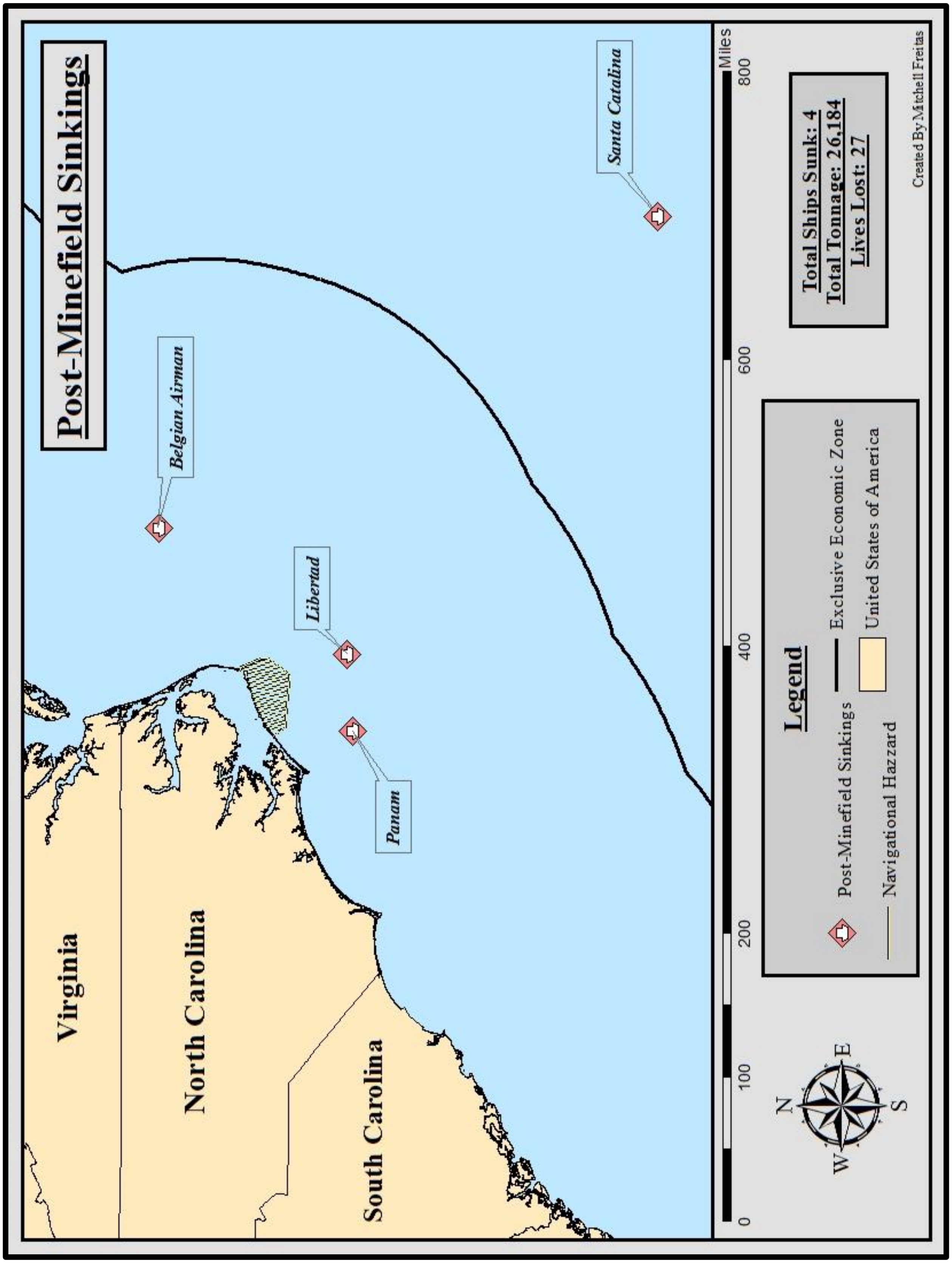


FIGURE 57. Post-Minefield Sinkings, May 1943- April 1945 (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

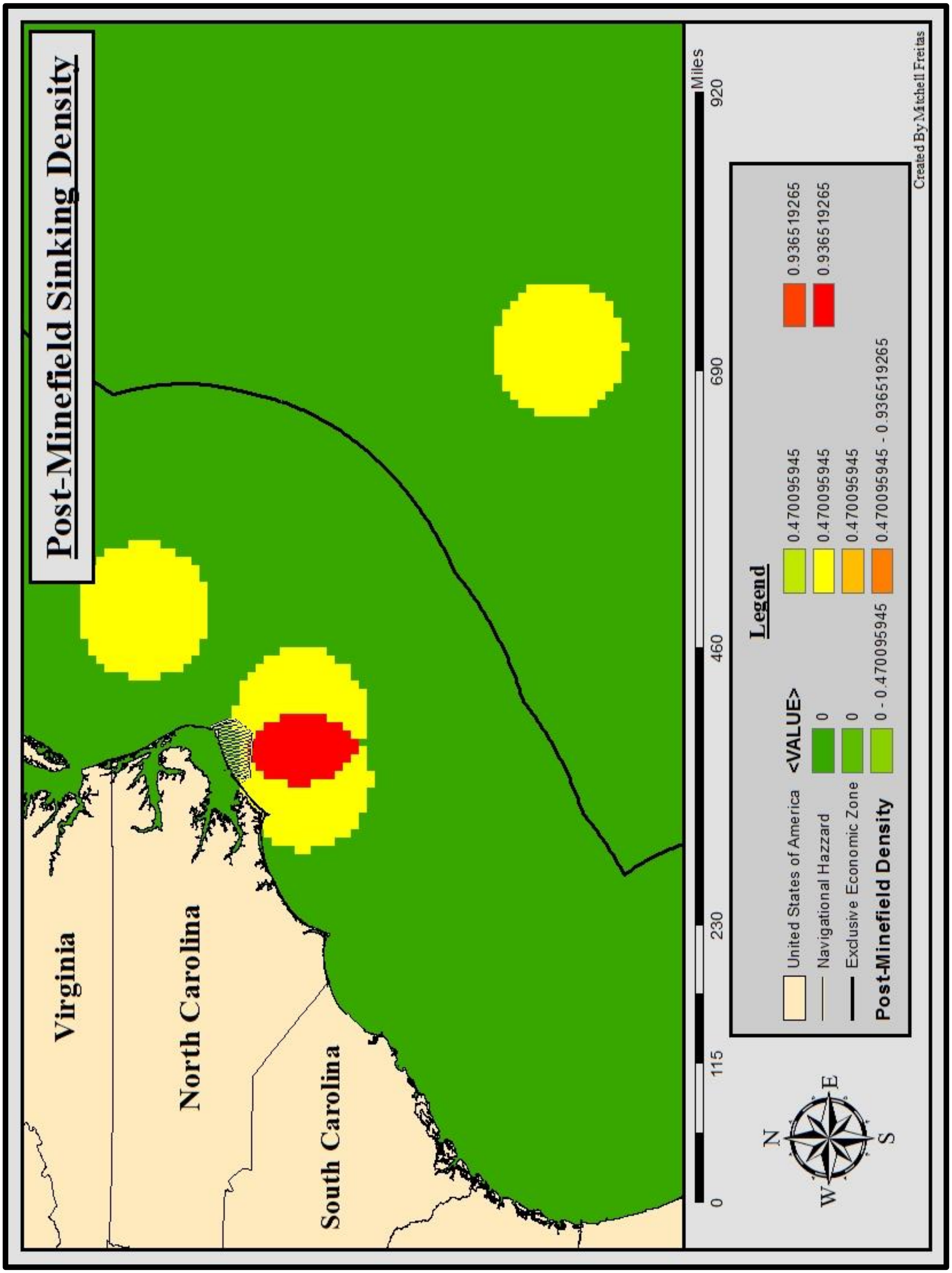


FIGURE 58. Post-Minefield Sinking Density, May 1943- April 1945 (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

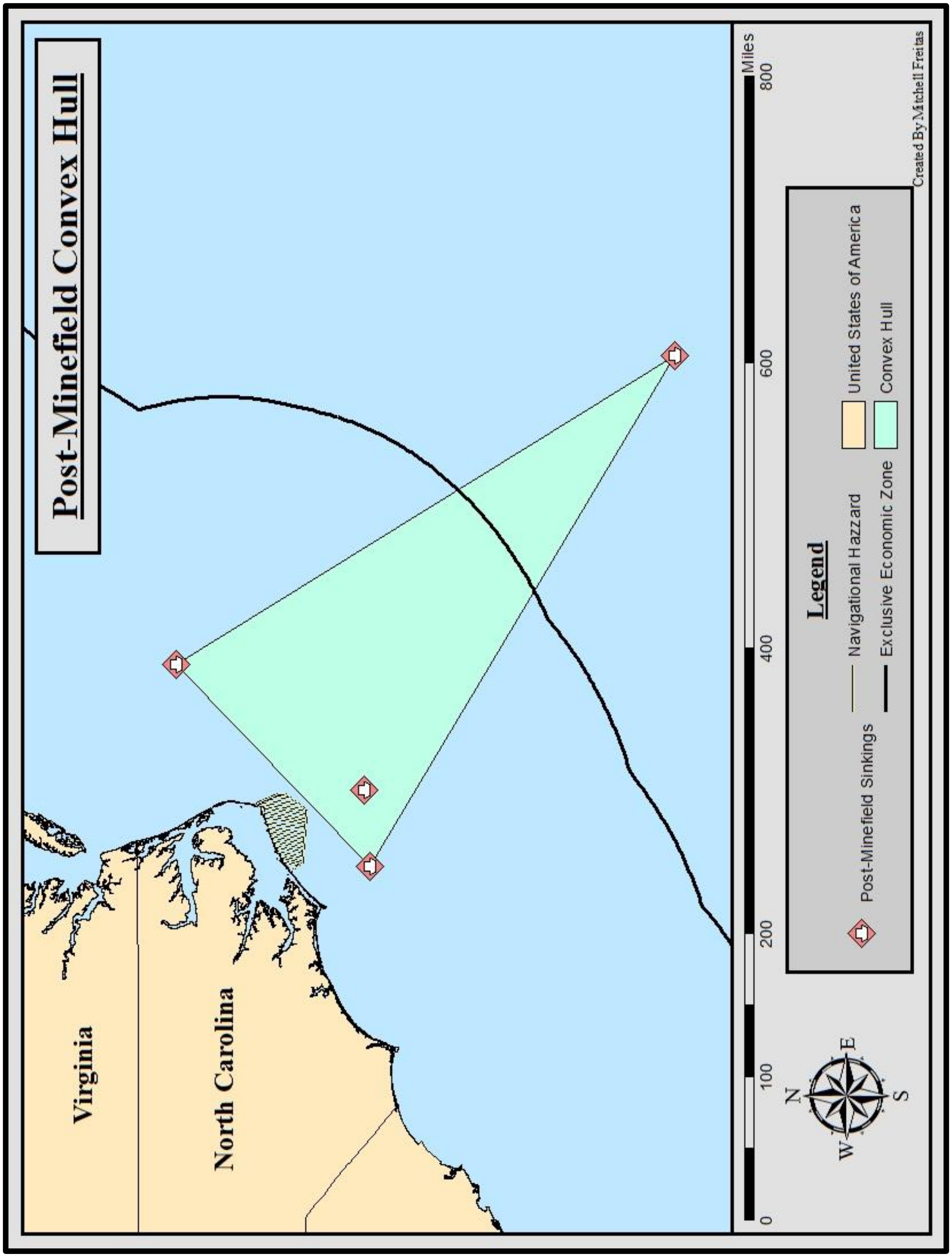


FIGURE 59. Post-Minefield Convex Hull, May 1943- April 1945 (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

Conclusion

As has been alluded to throughout this chapter, the next chapter, Analysis will be used to delve into these results. While this chapter listed and explained the various result products that were created, the Analysis chapter will stand as the final culmination of this work. It will use the products that were described in this chapter to draw conclusions about Cape Hatteras Minefield and its true effectiveness, as well as seek to answer the research questions listed at the start of this project. Both the numerical and geospatial data tabulated and mapped in this chapter will be vital in the arguments made in the following chapter.

CHAPTER SIX: Analysis

Introduction

This chapter serves as a platform to answer the research questions posed at the beginning of this work. To reiterate, the overall goal of this project was to identify the ways in which a naval minefield could be adequately assessed using Cape Hatteras Minefield as a trial case. The first step in this chapter is to briefly reestablish the historical narrative of the minefield in order to set the baseline for the assessment. This will be discussed in the first section of this chapter. In the next section, the actual assessment will take place. Each of the evaluation quantifiers that make up the secondary research questions will be individually addressed. These quantifiers include losses to human life, economic losses, theoretical categorization of the minefield itself, and, finally, the assessment of protection offered by the minefield. Ultimately, these markers should successfully reassess Cape Hatteras Minefield as either a success or failure.

The Traditional Narrative

As stated many times throughout this work, the opinion held by not only Admiral Andrews, but reflected in the sparse literature dedicated to the minefield is that Cape Hatteras Minefield was a total failure. Therefore, more of a hindrance than an aid against the German U-boats. These arguments hinge on the number of ships lost in direct association with the minefield, as well as the impact of the minefield on local shipping (ESF 1942b; ESF 1943:8; Freeman 1987:415-419; Wagner 2012:100).

The principal argument against the minefield centers on the losses of *Chilore, F.W. Abrams,* and *Keshena* (Figure 60). Both *F.W. Abrams* and *Chilore* were substantially sized merchant ships, and, while *Chilore* was only carrying water ballast, *F.W. Abrams* was carrying

90,000 barrels of fuel oil (Lloyd’s 1989:458). This was an incredibly large cargo worth $215,100.00 in 1942, and subsequently $3,204,580.91 in 2017 (McMahon 2017). These losses are compounded with the unfortunate loss of life experienced during the wrecking event of *Keshena.* These losses were among the major evidence that Admiral Andrews brought to the attention of Admiral King with the suggestion to remove the minefield. Admiral King adamantly opposed the removal of the minefield, citing the inability of Cape Hatteras’ geography to support Admiral Andrews’ suggestion of torpedo nets as a defensive alternative.

Throughout the life of the minefield, the theme of miscommunication was ever present. The loss of *F.W. Abrams* was due in large part to the fact that the merchant captains were not informed of the true danger of the minefield. After losing the naval escort leading the merchant vessel out of the minefield in a heavy storm, the captain of *F.W. Abrams* believed the ship could follow a course directly out to open sea. This decision resulted in the detonation of several mines and, subsequently, the loss of the ship itself (Freeman 1987:345; Wagner 2010:91; Bright 2012:110).

Following this unfortunate event, the next major wrecking event in the life of the minefield led to the loss of *Chilore, Keshena*, and the damaging of *J.A. Mowinckel*. The ill-fated convoy KS-520 left port at Lynnhaven Road, Virginia on 14 July 1942. At 19 merchant ships strong, the convoy escorts included two U.S. Coast Guard cutters, two U.S. Navy destroyers, one corvette, and two coastal patrol vessels. Two allied aircraft augmented this escort package. Even with a heavy defensive escort, *U-576* still managed to ambush the convoy sinking *Bluefields* almost instantly and managing to damage both *Chilore* and *J.A. Mowinckel.* In order to protect the wounded ships, the escort ship *Spry* led the two ships towards what was thought to be the closest area of safety. Due to miscommunication on the part of LtCdr. Firth, in control of *Spry,*

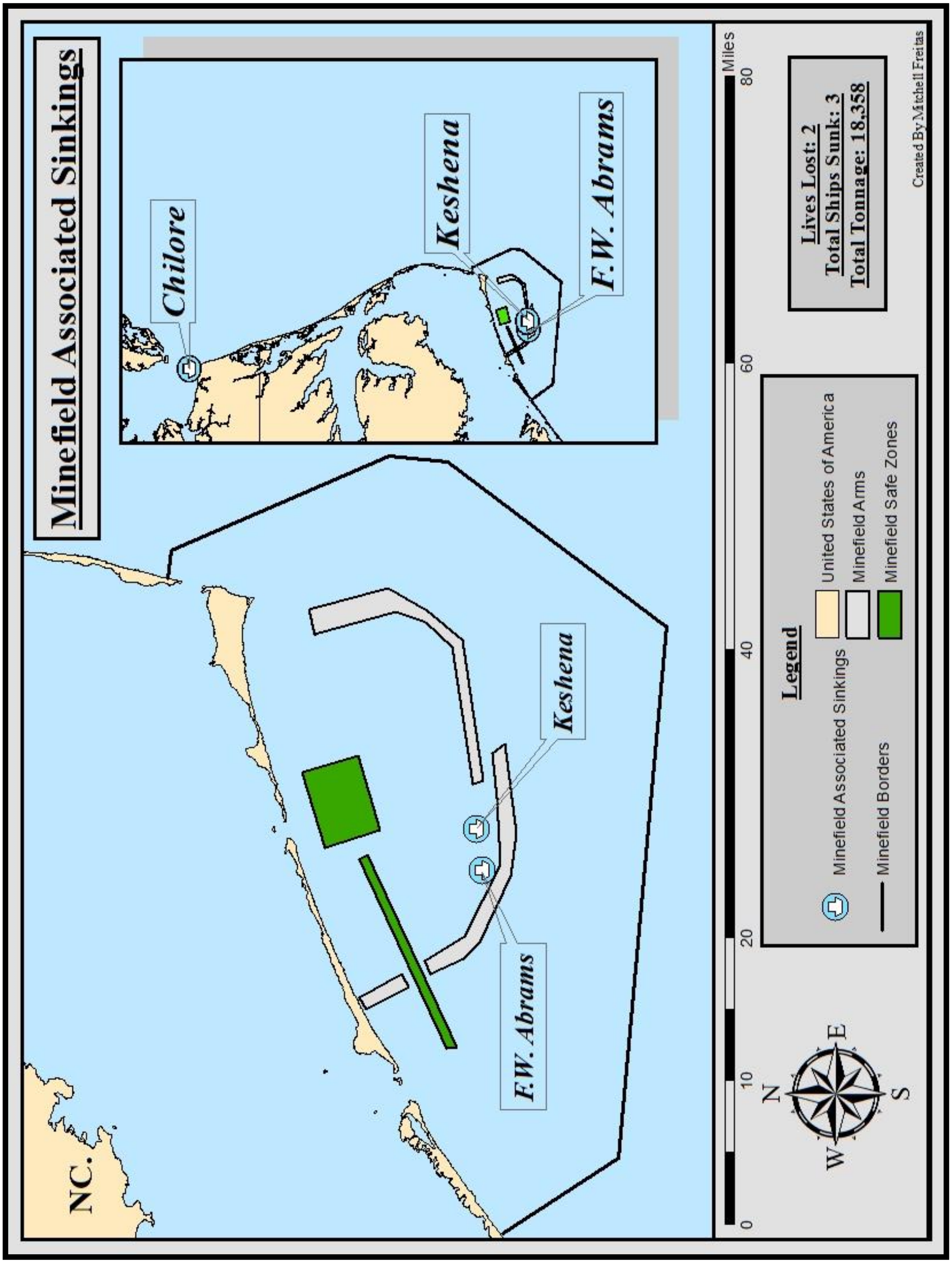


FIGURE 60. Cape Hatteras Minefield 1942-1943 (Source: National Archives, Created by: Mitchell Freitas 2016).

and the Convoy Commodore Nichols, who was aboard *J.A. Mowinckel,* the three ships were set on a course directly into the minefield (ESF 1942b; Freeman 1987:412; Wagner 2012:98).

After a series of ignored attempts by the minefield patrol vessels to ward off the ships, both *Chilore* and *J.A. Mowinckel* struck mines, halting their progress but remaining afloat. *Spry* was able to navigate out of the minefield to safety (ESF 1942b; ESF 1943:8; Freeman 1987:418; Wagner 2012:100). In response to these events, two tugs were dispatched to tow the two ships to safety It was at this point that the tug *Keshena* struck a mine and sank instantly. Thus, the minefield claimed its second victim (Standard Oil Company 1946:36; Bright 2012:151).. This incident was not the final loss attributed to the minefield. As *Chilore* and *J.A. Mowinckel* were being towed back to the shipyard in Norfolk, Virginia, *Chilore* would founder off Cape Henry and sink (SOC 1946:370-371; Bright 2012:152). These events are critical and serve as one of the cornerstones of Admiral Andrews' argument against the minefield. It also was the only time that the convoy system and the minefield defense came into direct contact with one another, allowing for a direct comparison, which will take place in the next section.

Admiral Andrews also made the case that the minefield was causing an immense strain on the fishing economy of North Carolina. The statistic proffered by Admiral Andrews to Admiral King was that there was a decrease in 80,000,000 pounds of catch during the time that Cape Hatteras Minefield was active. This decline, Admiral Andrews asserted, was due to the inability of the fishing vessels to navigate near the minefield. The combination of the losses in ships and the effect on the local economy were enough to convince Admiral King to order the decommissioning of the minefield on 21 April 1943 (ESF 1943:11; Andrews in Wagner 2012:101). In addition, these are the two reasons that carry the argument of the ineffectiveness of the minefield through to modern scholarship.

Reassessing Cape Hatteras Minefield

In the last chapter, each time period was presented independently and without significant commentary in order to avoid the formulation of premature conclusions. In this chapter, assessment markers will overlay the data from all three time periods in order to allow for direct comparison. The first section, *Lives and Ships Lost*, will compare the data from all three periods with a view to identify trends of the improvement or degradation of protection. Next, the *Economic Losses* including fishing statistics, cargo lost, and value lost will be matched across the time periods and compared. A portion of the theoretical framework includes an analysis of the minefield through the lens of METT-T and KOCOA which will help illustrate the minefield's placement and the movement of the battlefield across the three periods. Finally, the survival and safety of the merchant ships will be compared across defense systems.

Lives and Ships Lost

The opening moves of the Battle of the Atlantic on the North Carolina coast from 18 January 1942 to 26 May 1942 by German U-boats saw an immense strain put upon the Allied merchant shipping operation. During this time period, an astounding 1,204 merchant lives were lost from German U-boat attacks (Hoyt et al 2017). As can be seen in the *Allied Lives Lost* chart (Figure 61), the lives taken during the Pre-Minefield Period account for 96% of the total number of casualties on the North Carolina coast during the Battle of the Atlantic. Compared to the following periods, the improvement is exceptional. In the Active-Minefield Period, a significant drop in lives lost occurred whereas, in this period, the lives lost totaled 25 or 2%. The Post-Minefield Period touted similar numbers with 27 lives taken, also amounting to 2% of the total lives lost.

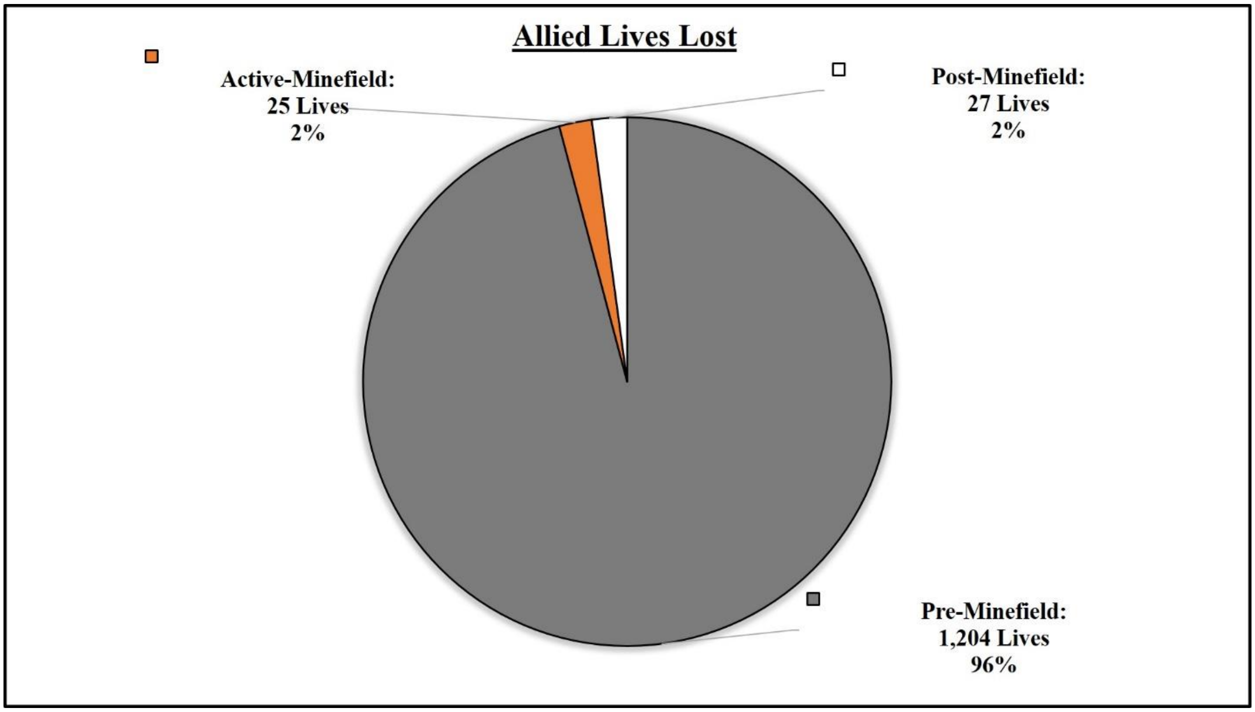


FIGURE 61. Pie chart that breaks down the lives lost during the Battle of the Atlantic in relation to the life of the minefield (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

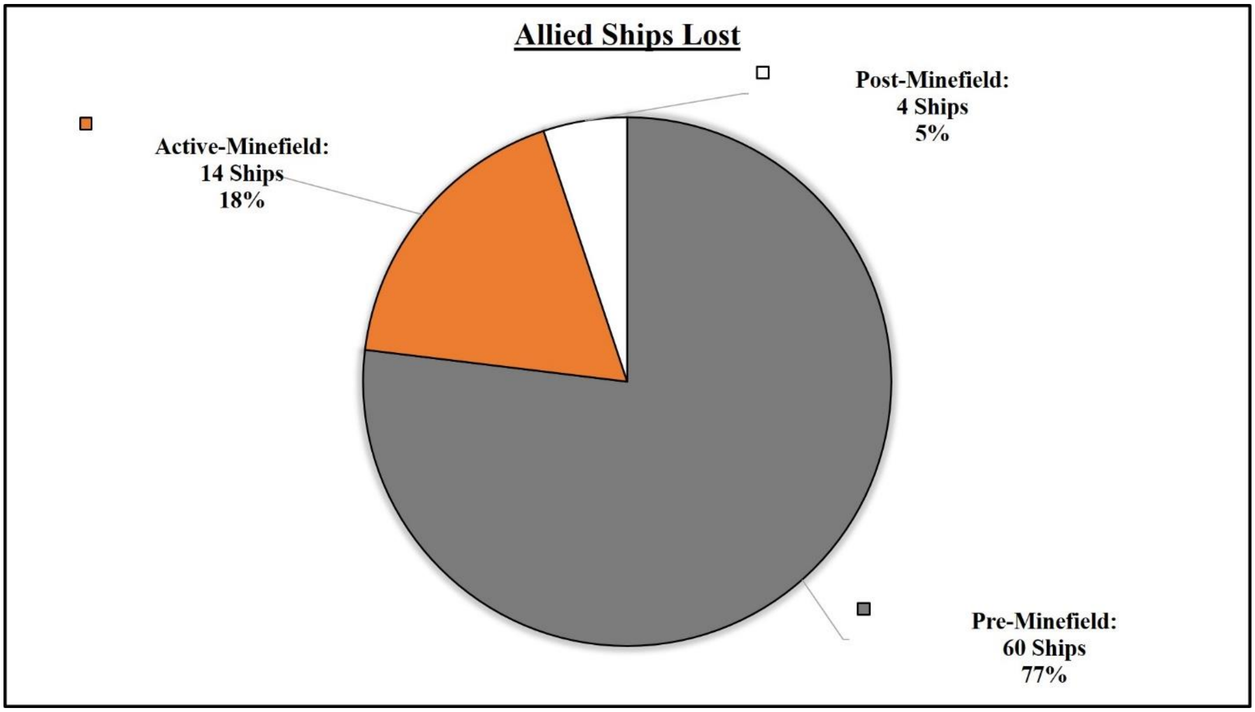


FIGURE 62. Pie chart that breaks down the ships lost during the Battle of the Atlantic in relation to the life of the minefield (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

The patterns seen in the Allied lives lost are heavily echoed when considering the quantities of Allied ships lost. These patterns can be viewed in the *Allied Ships Lost* (Figure 62): the Pre-Minefield Period occupies the largest portion of the chart at 60 ships, or 77%, of the graph. Such a high number of casualties had to be spread over a large sample of ships. While still hosting more ships sunk than the Post-Minefield period, the Active-Minefield period saw 14 ships sunk, making up 18% of 78 total ships sunk (Hoyt et al 2017). Finally, during the Post-Minefield time period, only four ships were sunk, consisting of only 5% of the *Allied Ships Lost* chart. The early losses were a direct result of a lack of defensive planning at the beginning of the conflict. When considering the two datasets together, the disparaging gap between the Pre-Minefield Period and the Active-Minefield Period becomes evident. As can be seen in *Allied Lives and Ships Lost* chart (Figure 63) the period corresponding with the installation of the minefield show the severe drop that is illustrated in the pie charts above (Figures 62 and 63).

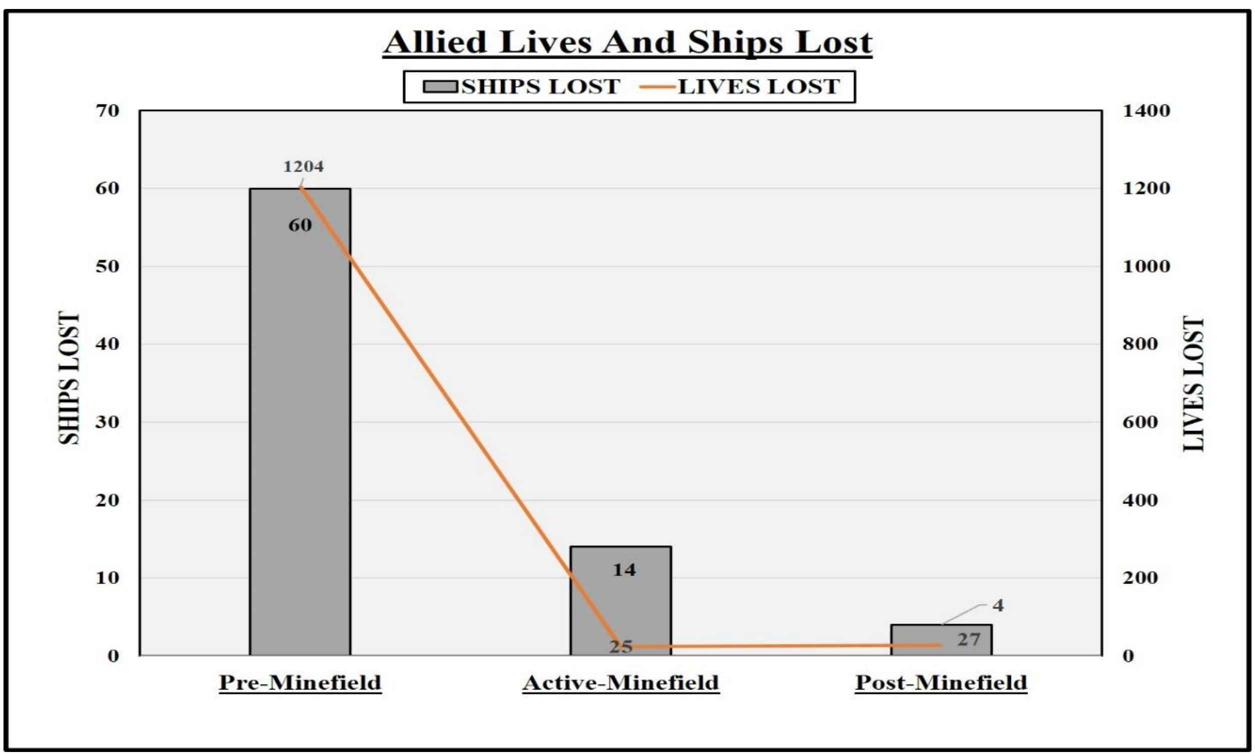


FIGURE 63. This combination bar and line graph shows the direct correlation between the lives and ships lost across all three time periods. Total Lives Lost: 1,256, Total Ships Lost:74 (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

While the decreased ships and lives lost are direct evidence of the strengthening of the Allied defenses, it is not direct proof that the minefield was performing correctly. Proof of the functional or dysfunctional status of the minefield will continue to be built up as the chapter progresses.

Economic Losses

Now that the number of lives lost have been discussed, which arguably is the greatest loss from a social standpoint, the commodities that these ships were carrying will be analyzed. The ship tonnage and the tonnage of materials are arguably the most valuable commodities lost from a wartime aspect. The sinking of large ships represented damage to an already strained merchant fleet. The larger the ship, the longer it would take to replace. The loss of the ships comes with the compounded loss of mass amounts of materials that were supporting the war effort in Europe. The loss of cargo represented a substantial economic loss across all three time periods.

TONNAGE LOST

Without a doubt, there exists a major discrepancy between the Pre-Minefield Period and the following two periods. As can be seen in *Allied Tonnage Sunk* (Figure 64), the tonnage sunk during the Pre-Minefield Period is responsible for 78% of the total tonnage sunk during the engagement off the North Carolina coast at 381,742 tons. This loss is to be expected as the total number of ships sunk during the Pre-Minefield Period total a similar statistic. Moving to the Active-Minefield Period, the tonnage lost severely drops off, following the overall trend of the

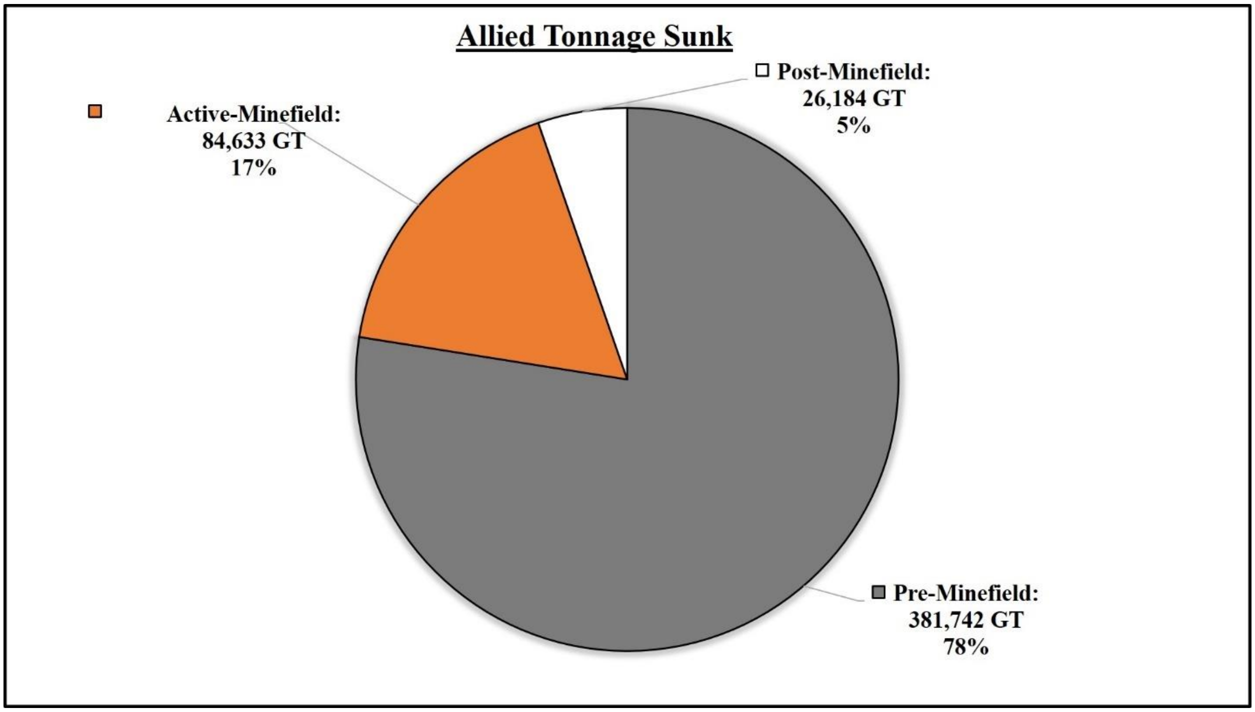


FIGURE 64. Pie chart showing the tonnage sunk, allowing a direct comparison between the Pre-Minefield, Active-Minefield and Post-Minefield (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

engagement. With only 84,633 tons of merchant ships lost, it pales in comparison to the previous time period. Finally, the tonnage lost in the Post-Minefield Period occupies only 5% of the total chart with 26,184 tons lost. These statistics reinforce that the Pre-Minefield Period signified a time of immense violence aginst merchant shipping. From an economic standpoint, the significant amount of tonnage lost represented a colossal toll taken on shipping companies and wartime efforts. The statistical drop from the Pre-Minefield Period to the Active-Minefield Period shows that the Anti-Submarine efforts made by the U.S. Navy were beginning to take effect. The key here is to acknowledge that there were several different systems of Anti-Submarine Warfare being employed, and, while Cape Hatteras Minefield cannot be solely credited with the drop in tonnage lost, there are no significant anomalies that show the minefield causing atypical harm.

CARGO LOST

While the loss of the merchant ship itself was a blow to the Allies, each of the ships sunk was either transporting cargo or en route to acquire the cargo the merchant sailors were tasked to deliver. As will be seen in this section, the amount of freight lost represented a massive economic loss and would have had a profound effect upon both the warfront and the homefront. It is important to understand that the numbers featured in these charts are unfortunately and unavoidably incomplete. As shown in the last chapter, there were several cargo listings such as "General Army Supplies" whose values could not be ascertained. However, the data included does more than enough to project the patterns echoed throughout this chapter.

In *1942 Value of Cargo Lost* (Figure 65), a different pattern emerges compared to previous pie charts. In this purview, the Pre-Minefield Period only occupies 51% of the total value of cargo lost. In 1942, this was estimated at $3,061,827, however, as shown in *2017 Value*

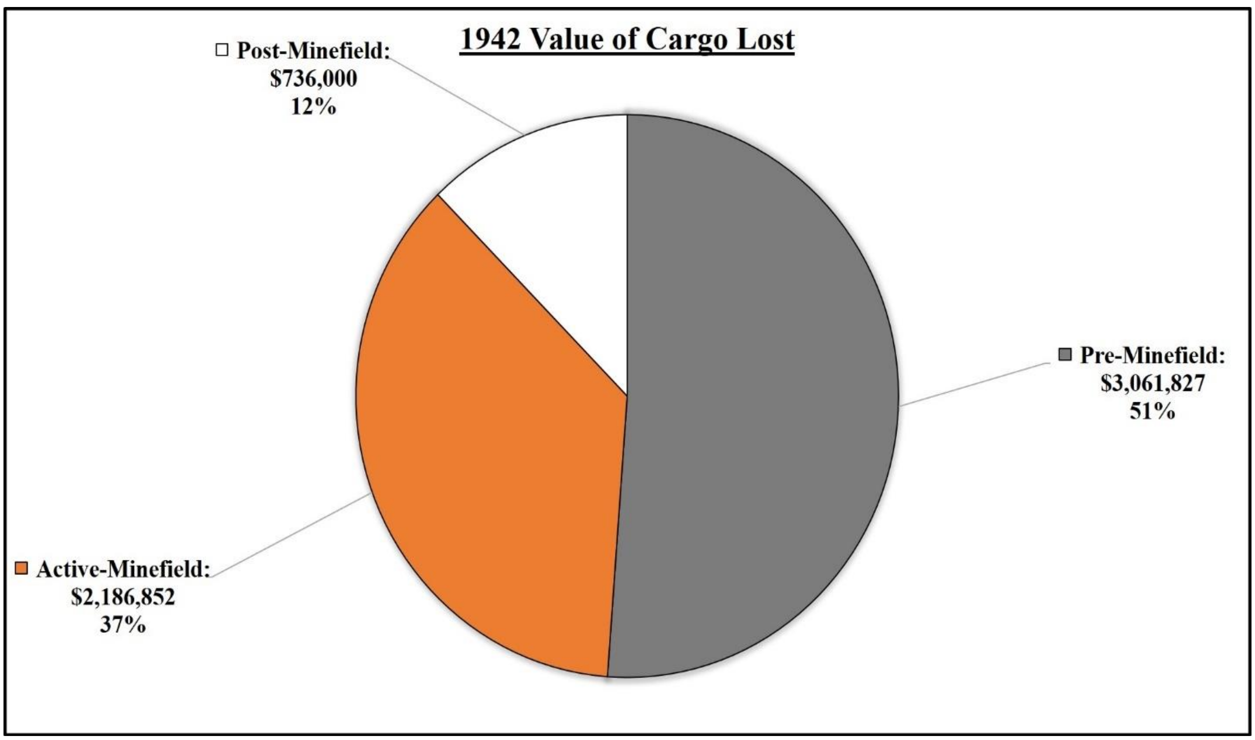


FIGURE 65. Pie chart showing the value of cargo sunk across the three time periods, in this chart the amounts are in 1942 American currency (Source: United States Department of Commerce 1942, Created by: Mitchell Freitas 2016

of Cargo Lost (Figure 66), in 2017 the total value of cargo lost would be $45,615,395 (adjusted for inflation). This is a substantial amount of capital lost during a time when rationing was already being implemented, and resources were already stretched thin. During the Active-Minefield Period the value lost totals 37%, this meant the loss of $2,186,852 in 1942 ($32,579,941 in 2017). The reason for this change in patterning is due to the various costs associated with the commodities that were being carried by each ship. In *Value of Cargo Lost By Commodity in 1942* (Figure 67), the Active-Minefield Period's losses are represented by the orange bars showing that Fuel Oil, Sugar, and Flaxseed were amongst the highest total values lost. While the number of ships lost during the Post-Minefield Period as indicated was lower than the other two time periods, the much lower total value lost is due to the fact that only one of the four ships lost during the time period were carrying cargo whose values could be ascertained (Lloyds 1989; United States Department of Commerce 1942).

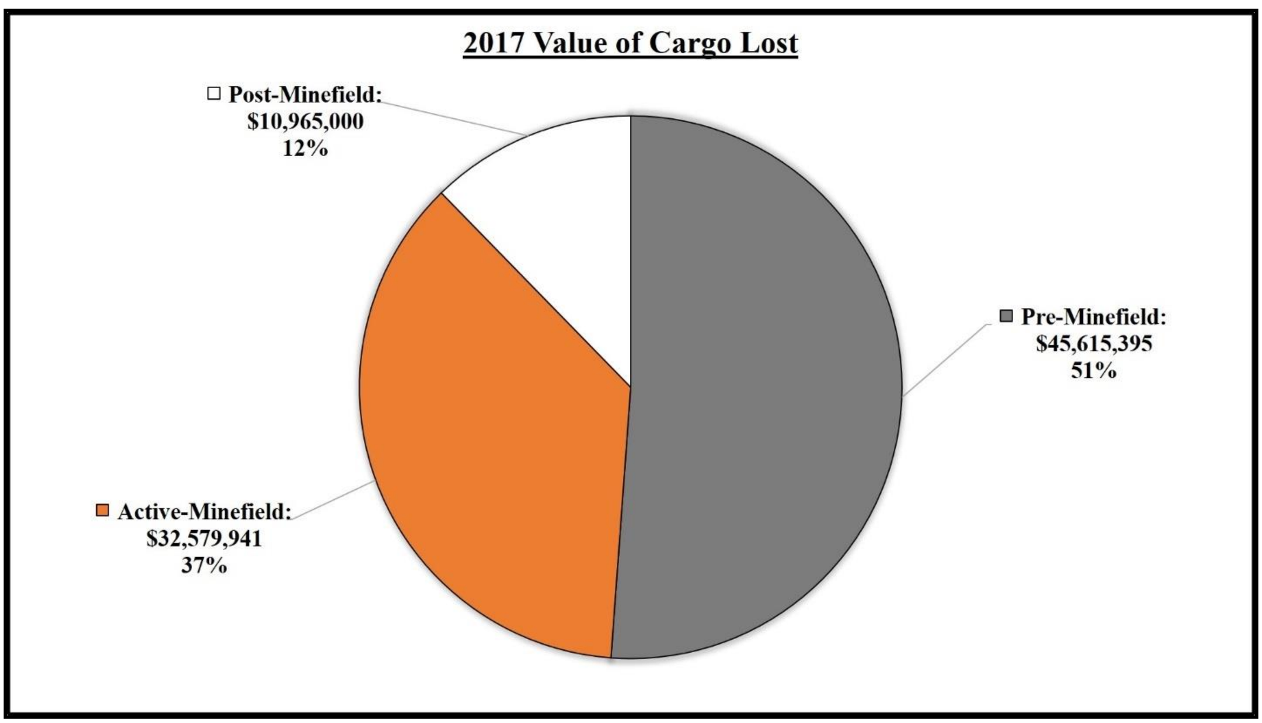


FIGURE 66. Pie chart showing the value of cargo sunk across the three time periods, in this chart the amounts are in 2017 American currency (Source: United States Department of Commerce 1942, Created by: Mitchell Freitas 2016).

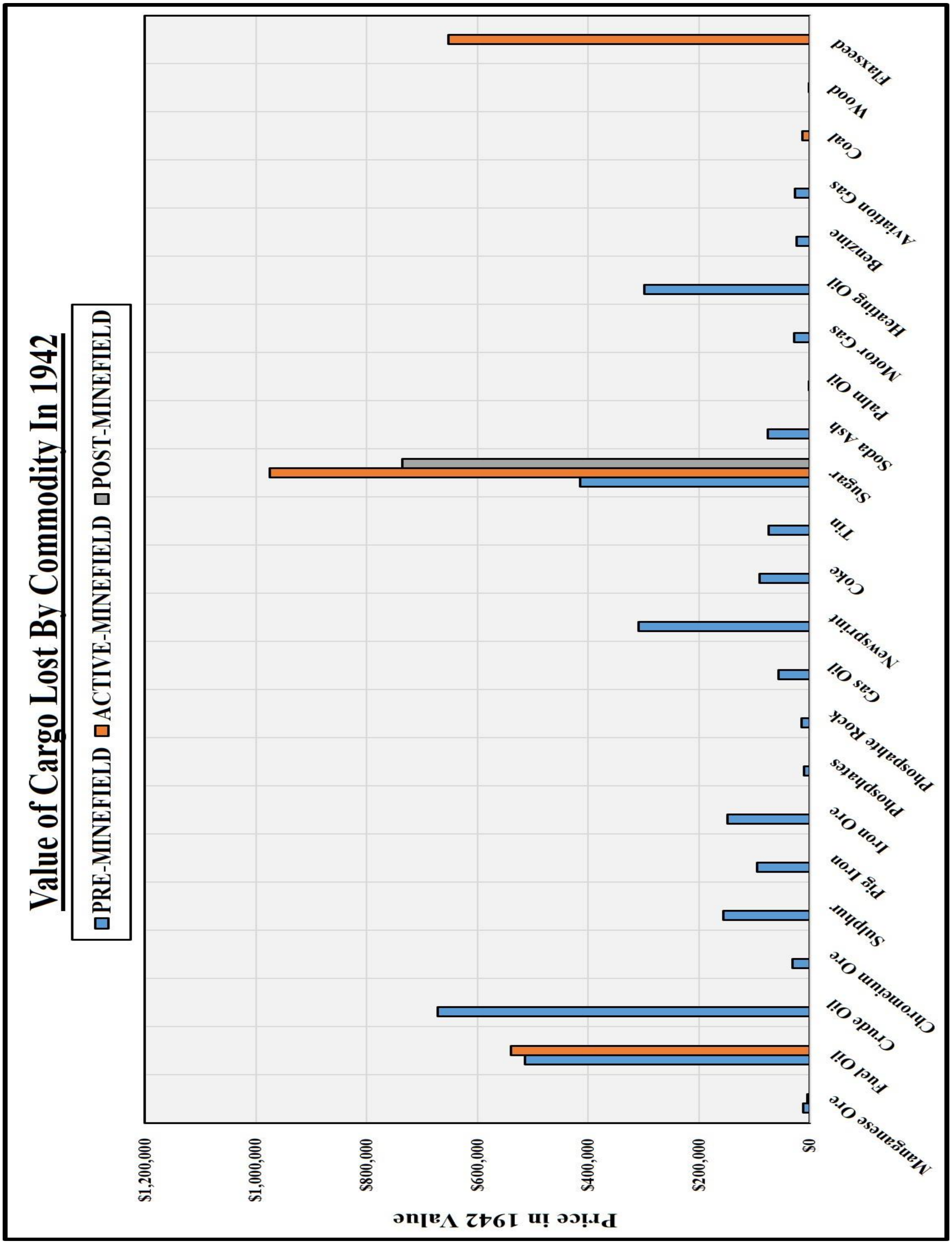


FIGURE 67. Bar graph showing type of commodity lost as well as the cost associated with each loss (Source: United States Department of Commerce 1942, Created by: Mitchell Freitas 2016).

In *Value of Cargo Lost* (Figure 68), the values of each time-period in 2017 can be seen superimposed with their values in 1942. This group of graphs continues to show the increased amount of defense and protection implemented during the Active-Minefield Period (For a full price list see Appendix C).

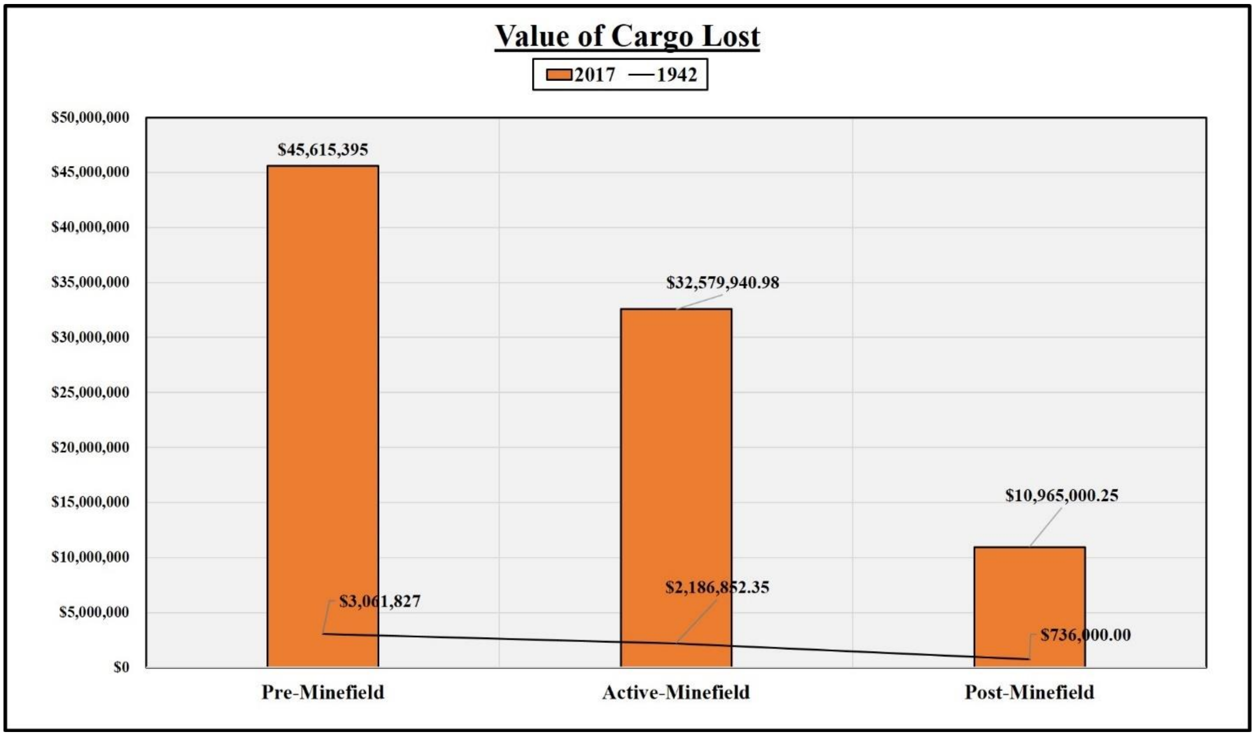


FIGURE 68. Combination bar and line graph comparing the amount of value lost in 1942 as well as 2017 across the three time periods (Source: United States Department of Commerce 1942, Created by: Mitchell Freitas 2016).

COMMERICAL FISHING

While the cargo value lost has declined over this period, one of the major economic arguments against Cape Hatteras Minefield was the effect on the local commercial fishing. One of the central arguments that Admiral Andrews made to Admiral King while petitioning to have the minefield deactivated was the impact that it was having on the local commercial fishing numbers. Admiral Andrews cited an 80,000,000-pound decrease in North Carolina commercial fishing numbers following the implementation of the minefield (ESF 1943:11; Andrews in Wagner 2012:101). Admiral Andrews claimed that the damage to the local economy was too high to continue the minefield's operation. The commercial fishing numbers are taken from the North Carolina Division of Fisheries charts, and represented in *Total Poundage of Fish Caught off the North Carolina Coast* (Figure 69) and *Value of Fish Caught off the North Carolina Coast* (Figure 70), which show the total numbers of pounds and value respectively from 1880 to 1971 (Chestnut et al. 1975: 55). Unfortunately, a gap exists from 1941-1944. While not ideal, information can still be taken from the Divisions of Fisheries data. In these charts, major events taking place in the United States have been overlaid to show the effects of external events on North Carolina's ability to maintain its commercial fishing numbers.

As can be seen in the following two charts, the nature of commercial fishing in North Carolina was extremely elastic, and no long-term effects were suffered. In fact, it was quite the opposite; the fishing numbers exploded after the end of the war. This rebound is significant since the area occupied by the minefield was marked a navigational hazard and is still cordoned off for unrestricted surface navigation, but warns against floor disturbance in 2017. If the minefield was directly responsible for the drop-in fishing numbers, as opposed to the military engagement happening off of the North Carolina coast, the suppression of fisheries numbers would have continued to present day. There is also the consideration that during any type of homeland defense there will be strain and stress put on the local population to benefit their greater safety.

As demonstrated in this section, Cape Hatteras Minefield, at best, could be considered as part of a greater system of coastal defenses that were proven effective by the statistical drop in lives, ships, tonnage, and cargo lost moving from the Pre-Minefield Period to the Active-Minefield Period. At worst, there are no statistical irregularities that would point to the minefield being a hindrance or ineffective.

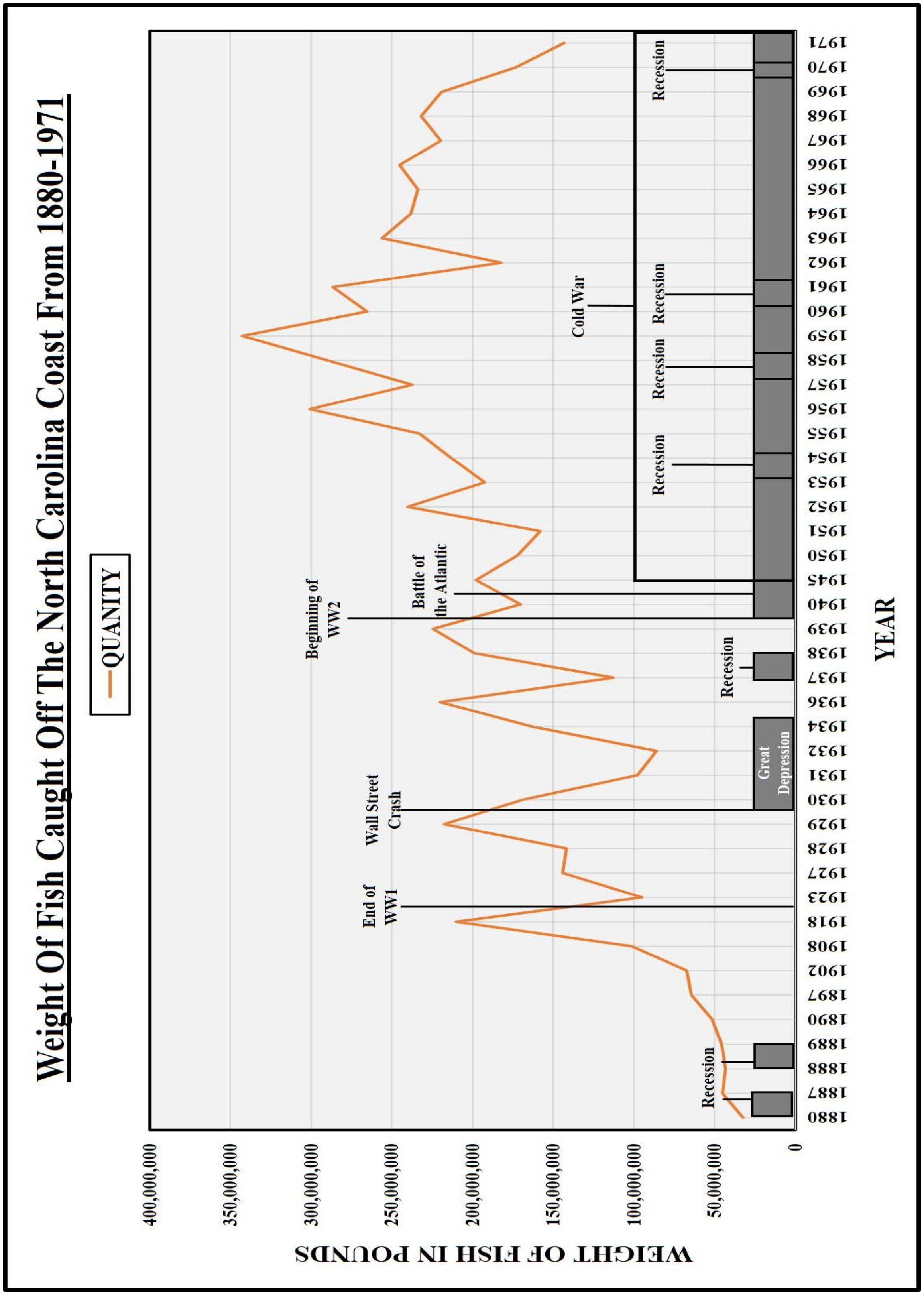


FIGURE 69. The total pounds of fish commercially caught off the coast of North Carolina from 1880-1971, this is superimposed with major American events to show the effect they may have on the numbers (Source: Chestnut et al. 1975: 55, Created by: Mitchell Freitas 2016).

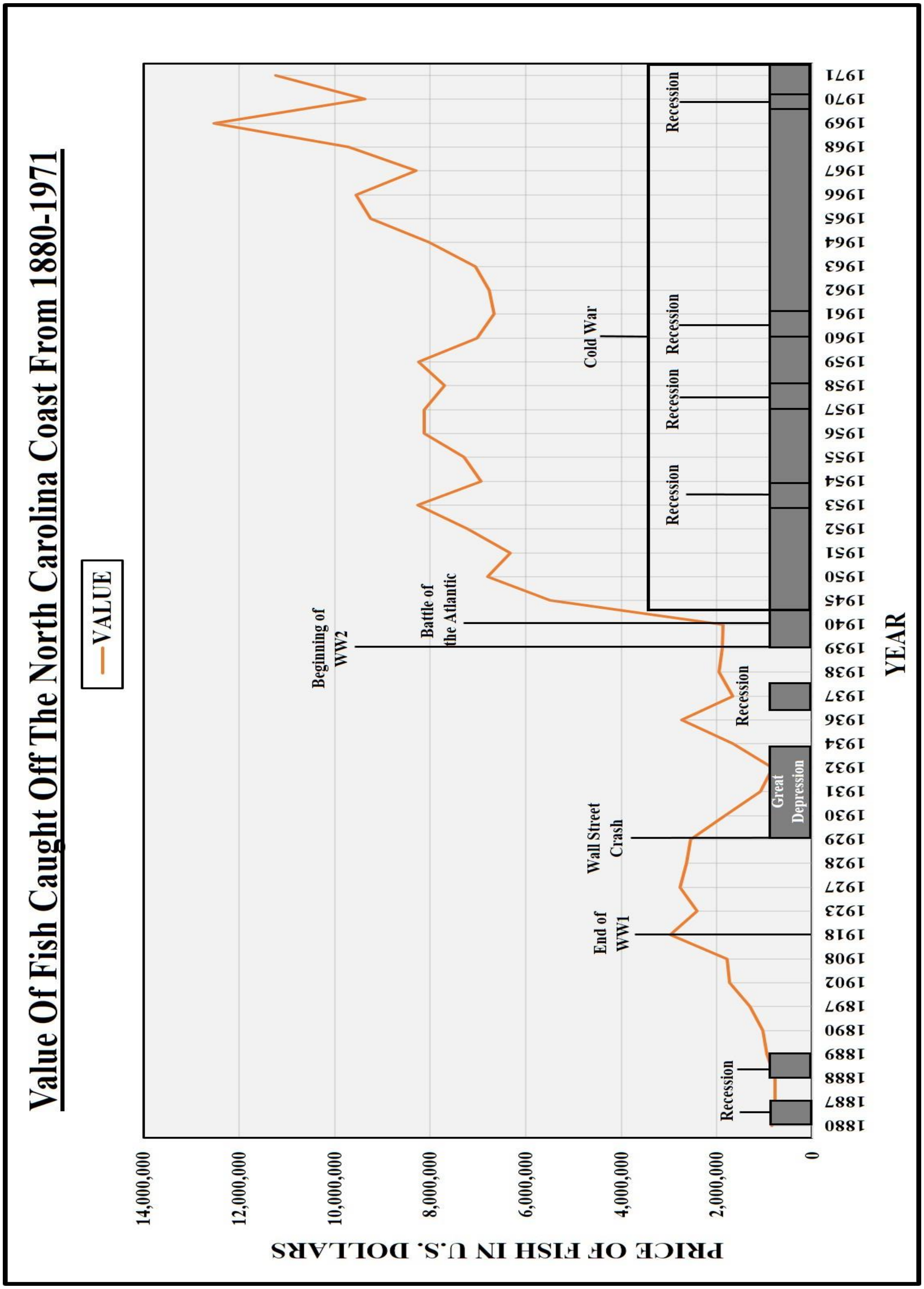


FIGURE 70. The total value of fish commercially caught off the coast of North Carolina from 1880-1971, this is superimposed with major American events to show the effect they may have on the numbers (Source: Chestnut et al. 1975: 55, Created by: Mitchell Freitas 2016).

Safety and Security

The wrecking events that are associated directly with the minefield need to be assessed in order to determine if the minefield was at fault, and, if so, how or why the system broke down. The locations of the three wrecked ships are depicted in the map *Minefield Associated Sinkings* (Figure 71). This map is an important graphic as the final locations of the wrecks have significant implications for the assessment of the wrecking events. After these developments have been assessed, the minefield will then be compared to other defensive systems that were in place at the time.

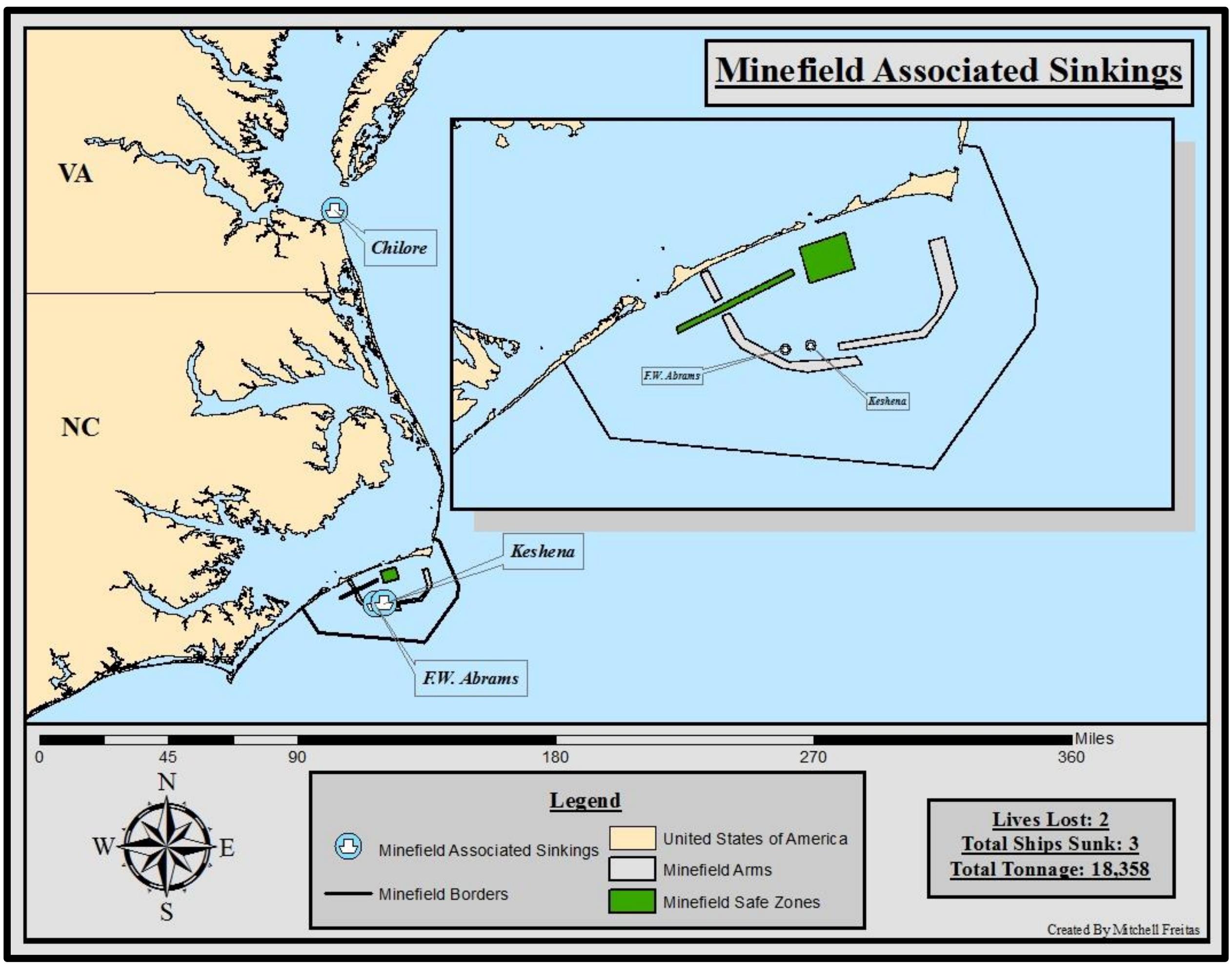


FIGURE 71. Cape Hatteras Minefield 1942-1943 depicting the minefield associated wrecks (Source: National Archives, Created by: Mitchell Freitas 2016).

The Wrecking Event of *F.W. Abrams*

To recap the events that led to the sinking of the oil tanker *F.W. Abrams* a timeline (Figure 72) has been created to highlight the major events leading up to the sinking quickly. For a more detailed, non-analytical account, please see page 8 in *Chapter Two: History*. The first significant event surrounding the sinking of *F.W. Abrams* occurs on 10 June 1942 when the merchant ship is successfully escorted into the minefield's harbor by the Coast Guard escort *CG-484.* Safe passage through the minefield was regulated by the use of an escort ship since the escort ships were the only entities that had access to the locations of the swept channels. To reiterate a major point from *Chapter Two: History*, the merchant ships at this time were only

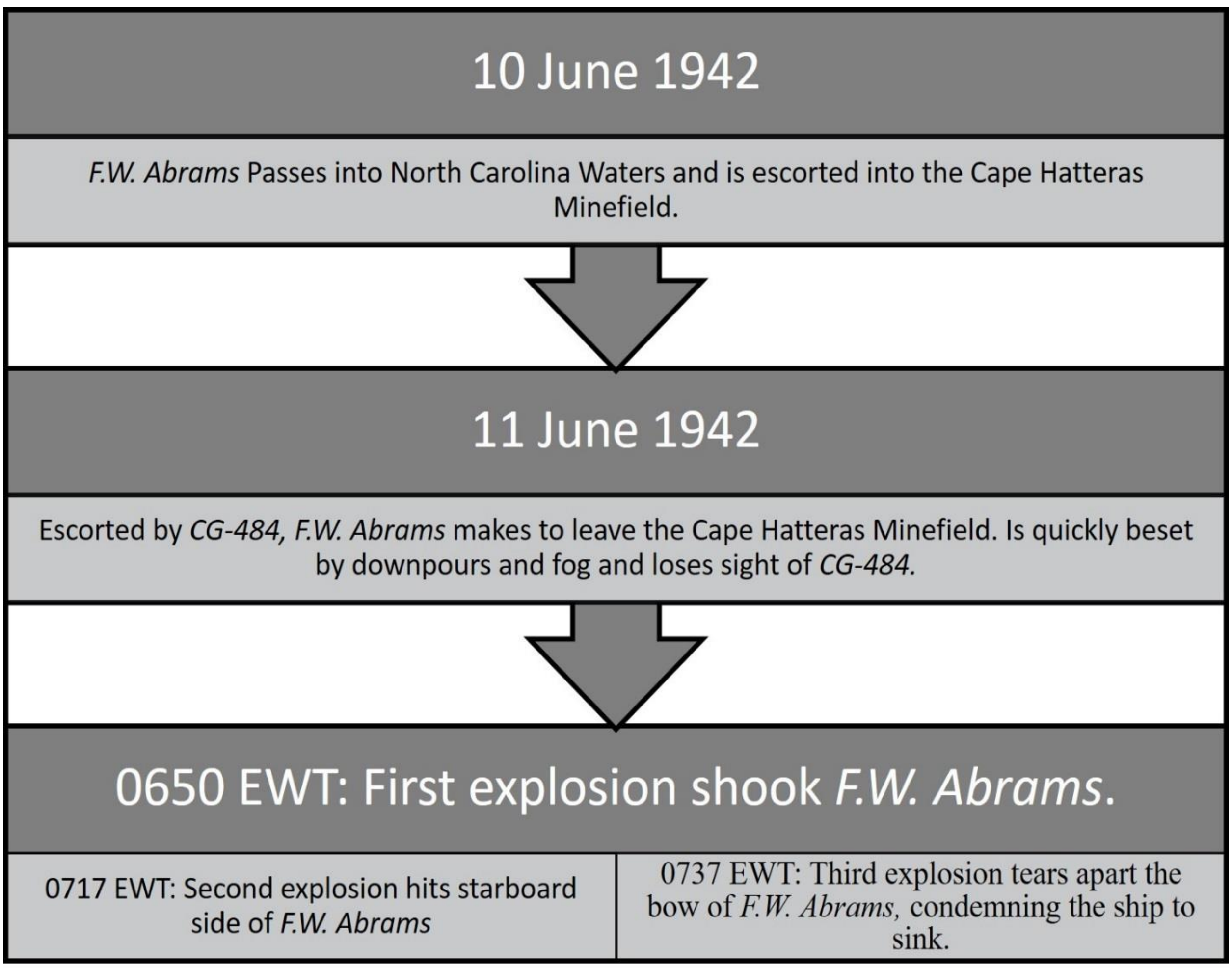


FIGURE 72. Timeline briefly highlighting the major events leading to the wrecking event of *F.W. Abrams* deactivation (Source: Freeman 1987, Created by: Mitchell Freitas 2016).

given the knowledge that the geospatial extent of the minefield was a “Hazardous Navigation Area,” no information about the mines was disclosed ((Freeman 1987:343; Hickam 1996:275; Wagner 2012:91).

Moving to the next event, the breakdown in the standard operating procedure becomes readily apparent. On 11 June 1942, while *F.W. Abrams* was being escorted from the minefield, the two vessels were overtaken by extremely heavy downpours and fog. This sudden and violent weather made it impossible for the merchant vessel to make visual contact with the Coast Guard escort. The decision was made by Captain Anthony Coumelis to attempt a clean break to open waters believing that the navigational hazard was an overstatement. This choice was the ship’s undoing. Shortly after this choice was made, at 0650 EWT, the first mine detonated damaging the merchant tanker. This detonation would soon be followed by a second explosion at 0717 EWT and a third at 0737 EWT. The third detonation proved to be all *F.W. Abrams* could withstand, and the merchant vessel sank quickly. Looking at this event logically, with the added knowledge that many merchant captains held a great contempt for U.S. Navy orders, it is quite an easy incident to break down (Freeman 1987:345; Wagner 2010:91; Bright 2012:110).

The cause and blame for this wrecking event fall on two offenders. First, the sudden weather system caused for great, unavoidable confusion as it often does in wartime events. This cannot be helped, sudden storms have been the cause of countless shipwrecks throughout time and the added danger of a minefield created for a dangerous environment. That being said, operating on the belief that the minefield was a necessary defense at this time, this portion of the event can and should be considered unfortunate incidental damage.

Moving on to the second portion of the blame, Captain Coumelis and the crew of *CG-484* both claimed that the other was at fault. Claims of torpedo wakes by Captain Coumelis along with the insistence by the crew of *CG-484* that they issued several commands to Captian Coumelis that were ignored points to a good portion of the blame laid on Captian Coumelis. There were no torpedo wakes as the explosions were caused by mines and the choice to navigate to open sea was against the express orders issues by the 5th Naval District (ESF 194344:7,8; Freeman 1987:345-346; Wagner 2012:92).

In all, the choices of a merchant captain and the uncontrollable nature of weather are to blame. The minefield being a static structure cannot move to initiate violence. It is, in theory, a defensive wall intended to keep enemies out. *F.W. Abrams* in a way ran into that wall, causing its own demise. One of the claims that Admiral Andrews made in his appeals to Admiral King for the removal of the minefield was the argument that the secretive nature of the minefield was causing a great deal of the issues with Allied merchant losses, citing this event (ESF 1943:6; Wagner 2012:88). This is a highly problematic argument. It is the opinon of this author that an important facet of the effectiveness of any minefield is the surprise element. If the merchant captains were issued the knowledge and extent of the minefield, this could have arguably leaked to the German U-boat Corps, making Cape Hatteras Minefield a higher value target.

The next issue with this argument is that if the merchant captains were held more accountable to the orders published by the navy, the function of the minefield would have been significantly improved in the case of *F.W. Abrams*. As it has been said before, the merchant captains were traditionally wary of the orders given by the US Navy (Geroux 2016:94). As seen in the wrecking event of the merchant oil tanker *F.W. Abrams*, the merchant crew felt as if they did not need the naval escort and could make their own heading out of the minefield. Moving to the following wrecking events, it becomes clear that miscommunication is a major factor in these incidents.

Convoy KS-520: The Wrecking of *Keshena* and *Chilore*

A month after the sinking of *F.W. Abrams*, the minefield experienced the most violent event. The attack of Convoy KS-520 is highlighted in the timeline above (Figure 73). After rounding the coast of North Carolina on 14 July 1942, the convoy was struck by fast, intense violence from the German U-boat *U-576.* The merchant vessel *Chilore* was immediately struck by two torpedoes, followed by *J.A. Mowinckel* taking one torpedo hit. Understanding the need to evacuate the 60 wounded merchant sailors and attempt to save the damaged ships, Convoy Commodore, Captain N.L. Nichols ret. relinquished his command and joined the crews aboard *J.A. Mowinckel.* The two merchant ships and the escort ship *Spry* began to make their way towards Hatteras Inlet (ESF 1942b; ESF 1943:10; Freeman 1987:413-415; Wagner 2012:98).

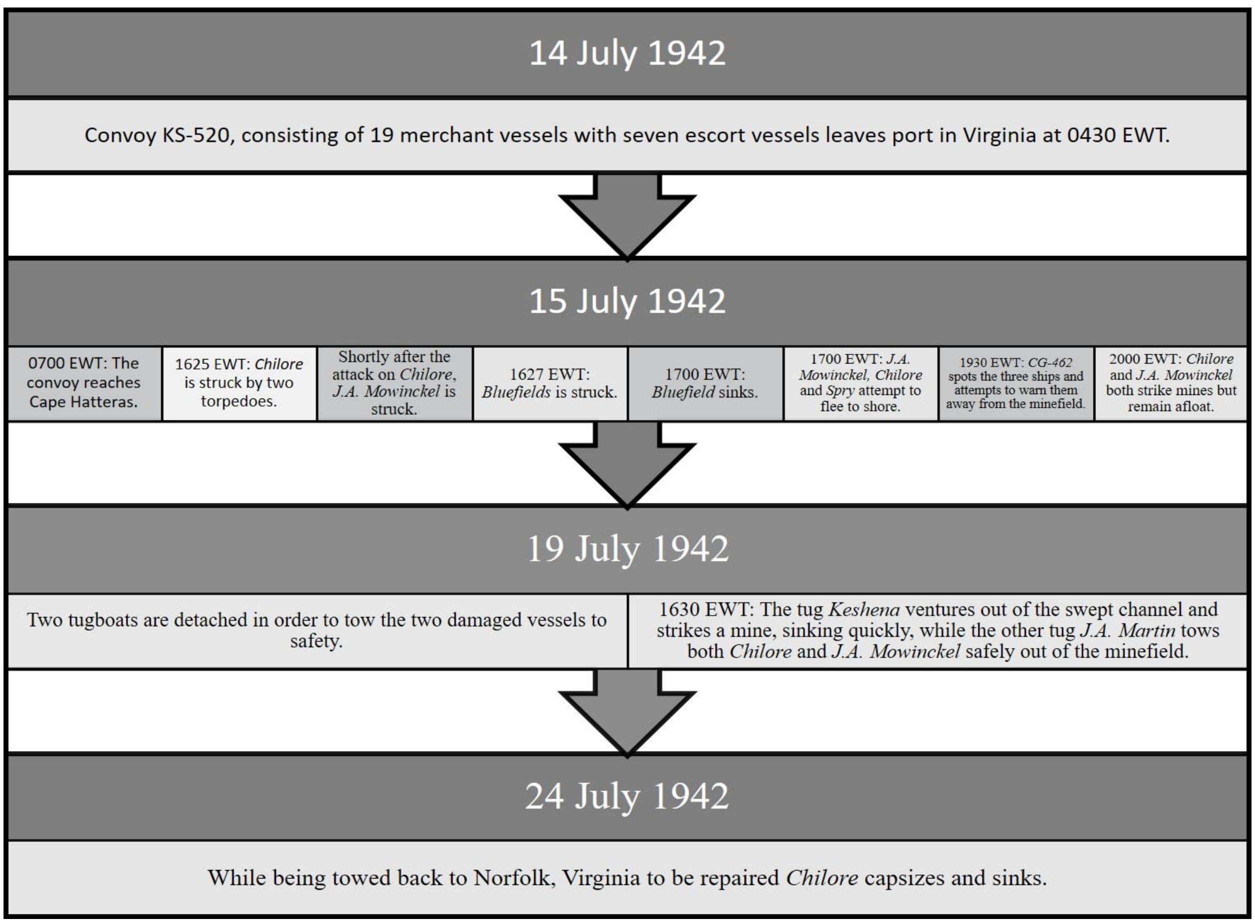


FIGURE 73. Timeline briefly highlighting the major events leading to the wrecking event of *Keshena* and *Chilore* deactivation (Source: Freeman 1987, Created by: Mitchell Freitas 2016).

Their course brought them directly on a path to interact with Cape Hatteras Minefield. This charting was due to the commanding officer on *Spry,* LtCdr. Maxim Firth, not wanting to press the higher ranking Cpt. Nichols to respond to his calls for a change of course. This lack of communication was further compounded by the three ships ignoring two separate attempts by the minefield patrolling assets to warn them off their path. One dirigible dropped smoke in an effort to warn them off their path, while a patrol vessel tried to chase them down, firing their guns in a bid to get their attention. Regardless, the three ships plowed directly into the minefield resulting in both *Chilore* and *J.A. Mowinckel* striking mines. Remarkably, the two ships remained afloat. The action did not stop there, four days later after two tugboats were dispatched to tow the two merchant ships to have repairs made, the tug *Keshena* strayed out of the swept channel. This misstep resulted in a mine detonation, causing the tug to sink and killing two. Five days later, as the two merchant ships were being towed to Virginia by the tug *J.A. Martin, Chilore* floundered and sunk off of Cape Henry, Virginia (ESF 1942b; Freeman 1987:415).

The first major issue in this event is the lack of communication by the escort captain and the former Convoy Commodore. When Cpt. Nichols left command of the convoy; he was no longer the superior officer. LtCdr. Firth had every right and responsibility to request the proper headings from Cpt. Nichols. Escort vessels frequently operated off dead reckoning as they were tasked with leaving the convoy and patrolling for U-boats. This was a major lapse in command judgment and can be put on Cpt. Firth for being reluctant to perform his duties. The next major blunder was ignoring the two attempts by patrol vessels to warn the convoy ships from their heading. It is reported that Cpt. Firth believed the smoke to simply be warning the ships that U-boats were in the area. No comments were made about the Coast Guard vessel that attempted to stop the convoy ships. These once again were major blunders on the command of LtCdr. Firth, who, after the two merchant ships were struck by mines, maneuvered *Spry* out of the field and left the scene to return to the convoy (ESF 1942b; ESF 1943:8; Freeman 1987:418; Wagner 2012:100).

Finally, one of the biggest glaring inconsistencies that have persisted from the beginning of this project is how *Chilore* is considered a victim of the minefield. By the time the two merchant vessels entered the minefield, *Chilore* had already been struck by two torpedoes. After adding a mine detonation to the ship's damage, it was still afloat and was seaworthy enough to be towed 190 miles as can be seen in *Final Route of Chilore* (Figure 49). The final resting place of *Chilore* is nowhere near the minefield, and, even after taking a massive amount of damage from two U-boat torpedoes, the vessel was still afloat. Once again, when considering Cape Hatteras Minefield as a static wall, neither the sinking of *Chilore* nor *Keshena* (Figure 74) are the minefield's fault in the way that the sinking of *Bluefields* was *U-576*'s fault. Both vessels were lost due to grave operational errors perpetrated by those in command.

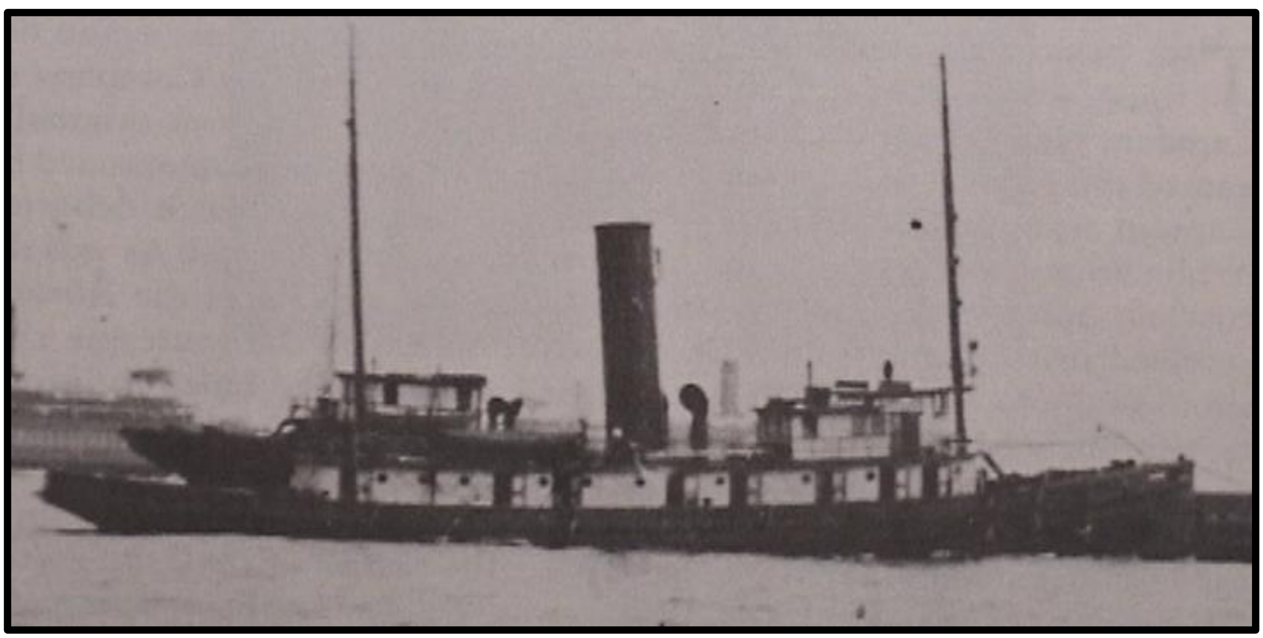


FIGURE 74. The tug *Keshena* (Source: The Mariners' Museum).

A Comparative Look: Minefield and Convoys

The only way to guarantee that a defense system will have no casualties is to be at peace. However, there are introductions to the battlefield landscape that are touted as changes that turned the tide of battle. Battle of the Atlantic scholars and naval officers have often promoted the convoy system as one of these introductions (Andrews in Hickman 1991:134; Axelrod 2007:247: Bright 2010:133; Wagner 2012:102). There are specific benefits of the convoy system; for instance, during the Battle of the Atlantic when military vessels were in short order, the convoy system allowed for multiple merchant ships to be under the watch of military escort vessels. However, this system was not perfect. If it had been then no merchant casualties would have occurred after the instatement of convoys (Figure 75), this is highlighted to show that Andrew's overly hostile opinion of the minefield was unwarrented.

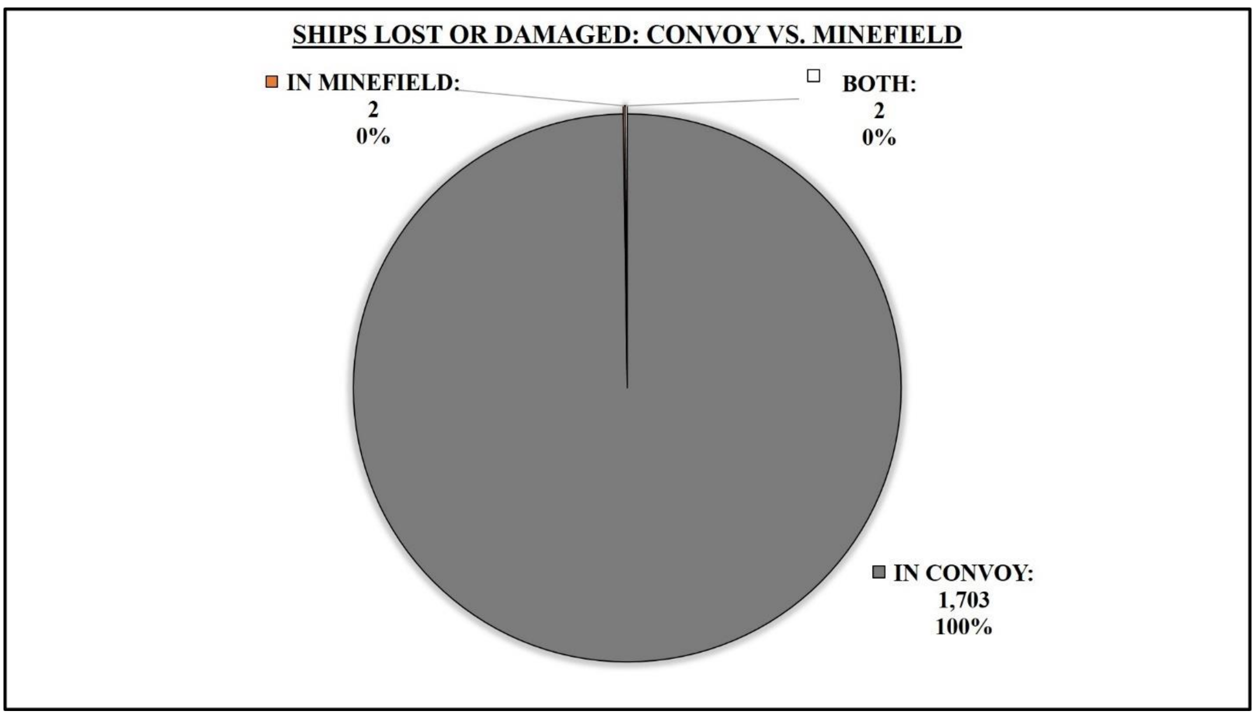


FIGURE 75. Pie chart showing the comparison between the ships lost and damaged in the minefield and in the convoy system (Source Hague 2000, Created by: Mitchell Freitas 2016).

When applying the same pressure and reasonings as Admiral Andrews when petitioning Admiral King for the removal of the minefield, it can be seen where the argument breaks down. Take the attack on Convoy KS-520 as an example. First, given the theoretical doctrine of convoy systems, larger numbers of merchant ships and various escort vessels should have warned off any attack by U-boats to start. As shown above, this was not the case: *U-576* not only attacked Convoy KS-520 but surfaced in the middle of the convoy and was able to hit three ships with torpedoes. This can absolutely be construed as a failure on the convoy's part as *Bluefields,* and arguably *Keshena* and *Chilore* were sunk due to a breakdown in the safety of the convoy system. This was not the only case of convoys being attacked. In fact, throughout the duration of the war 1,705 Allied merchant ships were either damaged or sunk by German U-boats. This is obviously a far cry from the four ships (*F.W. Abrams*, *Chilore*, *J.A. Mowinckel*, and *Keshena*) that were damaged or sunk by Cape Hatteras Minefield; even less when it is taken into consideration that two of the ships were damaged both in convoy and in the minefield (*Chilore* and *J.A. Mowinckel*).

This comparison is not intended to attack the convoy system; it is meant to highlight the comparatively irrelevant number of ships lost or damaged by the minefield. It also serves to act as a measurable comparison to a defense system that was in use at the same time the minefield. It shows that the cornerstone of Admiral Andrews' argument of the minefield's damage to merchant shipping could much easier be applied to the significant losses experienced by merchant ships in convoy. It also shows that even a defense system so highly regarded as the convoy system still suffered major collateral damage that could be extrapolated over the duration of the war. The minefield system, on the other hand, was never fully installed and was deactivated very shortly after becoming active. Therefore, there is no way to measure what the actual effect that the minefield would have had on merchant shipping for the duration of the war.

Categorizing Minefields

In order to understand how the minefield functioned as a military defensive structure and further categorize its static operation in a fluid environment, the theoretical framework that was discussed in *Chapter Three: Theory* will be applied. To quickly recap, this project seeks to employ the United States Army's method of METT-T and KOCOA battlefield terrain analysis. While there are setbacks from using a land-based analysis system, there are still benefits from subjecting the minefield to this analysis.

<u>METT-T</u>

This section will take the METT-T (Mission, Enemy, Terrain, Troops Available and Time Available) system and break down each battlefield consideration as it applies to Cape Hatteras Minefield. The mission of the minefield was to provide a haven for Allied merchant ships that were traveling up or down the American East Coast. The minefield was charged simply to create a wall in which merchant vessels could dock for the night when U-boat attacks were at their highest. Unlike most defense systems, which are propelled towards the enemy, this mission was not to be accomplished by any type of outward aggression; it was a static defensive system. However, as the minefield itself can cause damage, it is contrary to a traditional fortification or base where barricades are augmented with weapons. It puts the minefield in an interesting category of its own when considering that naval warfare is based entirely around the ability to be fluid, constantly moving whereas held ground is much more of a general concept. The static mined port minefield offers an interesting challenge to a terrestrial theoretical system.

The E portion of METT-T refers to Enemy. In the case of the minefield, the enemy is simply the German U-boats that had the proclivity for sudden, devastating attacks against merchant vessels. The German U-boats had the advantage of maneuverability and armament when facing merchant vessels. The advantages of German U-boats are part of the reason they were still marginally successful while attacking merchant convoys. From a theoretical standpoint, METT-T was intended for the sailor, marine or solider to chose the best suited battlefield and weapons to use therein. Therefore, it is reasonable to assert that matching the static minefield with the German U-boats would rob the U-boats of one of their greatest attributes in mobility. As U-boats primarily hunted at night in order to take advantage over merchant ships, the safe harbor offered by the minefield could have served to rob this benefit as well.

While the Type XIIC was the most commonly used U-boat by the Kriegsmarine throughout the war, various altered designs were constructed. The Type XIIC itself was armed with five torpedo tubes, had a top speed of 17.7 knots on the surface, and 7.6 knots submerged and was specifically designed as an attack U-boat. Many of the other U-boat types were created for specific operational purposes rather than just as upgrades to the Type VIIC. For instance, the Type XIV known as the Milch Cow were designed specifically as refuel ships. Their role was to support Type VII and Type IX attack U-boats during patrols by carrying fuel, torpedoes, food, and other supplies. This allowed attack type U-boats to stay at sea longer (Elliott 1977:221).

While the Type XIIC could be considered the workhorse of the Kriegsmarine U-boat arm, the Type IXB was the most successful attack submarine in terms of total tonnage sunk. While only fourteen were constructed, each averaged over 100,000 tons. This can be partially attributed to the store of twenty-two 21-inch torpedoes that supported six torpedo tubes. The Type IXB had a much larger range of 12,000 miles as compared to the Type XIIC, which only ranged 8,500 miles. For this purpose, they were initially used exclusively for Operation Drumbeat, which saw German U-boats on the American east coast. Type IX eventually joined the Type IXB U-boats and Type VII U-boats who could reach American waters when supported by Milch Cows (Elliott 1977:221).

The first T (Terrain) will be fully explored in the next section through analysis of KOCOA. Next, Troops Available in this case will refer to ships available for various roles and was a predominant theme throughout the Battle of the Atlantic. There was a massive shortage of battle worthy vessels for the use of homeland defense as most resources were being diverted to the war effort. The minefield's finish date was delayed as the few minelayers available to homeland defense were needed elsewhere. Following laying the mines, troops and vessels available were scarce enough for the U.S. Navy to convert commercial vessels into equipped patrol vessels. Local air support was present but was not particularly strong. This is why the system of mined anchorages was an appealing tactic. Instead of needing a large fleet of escort vessels, a smaller number of less seaworthy vessels could stay closer to shore and patrol a fixed point. Vessels such as *YP-389* were converted trawlers that were outfitted with a three-inch deck gun, two depth charge rails, six depth charges and two .30 caliber machine guns (Figure 76) (ESF 1942b; Headquarters Fifth Naval District 1942:3-6,9-10; ESF 1943:8; Freeman 1987:352, Wagner 2012:93).

Time Available, the last metric of METT-T, poses another interesting thought for the minefield. Time Available typically refers to time needed to set up a military operation, most often with a shorter overall duration. However, when considering time for the minefield, it is not just time needed to set up the minefield, but also the duration of the minefield's life that had to be considered. It was necessary that minefield was able to last throughout the entirety of the engagement, which had no foreseeable end. This meant the need for experienced minesweepers was incredibly high in order to police the minefield and keep secure channels swept and cleared. Another major toll in time was how long it would take to install all 12 of the mined anchorages off of the eastern coast. As only two mined anchorages were ever laid, and, thus the system was incomplete. The constraints of Troops Available and the Time Available were proved too prodigious to finish. Had more resources and time been allocated to the minefield system, a much more productive outcome could have been produced.

FIGURE 76. Photo depicting the converted trawler *YP-389* (Source NOAA).

KOCOA

In conjunction with the system of METT-T, KOCOA (Key Terrain, Observations, and Fields of Fire, Cover and Concealment, Obstacles, Avenues of Approach) will be used to better understand the placement of Cape Hatteras Minefield and the movement of the battlefield around it. Key Terrain in context of Cape Hatteras Minefield is exceedingly important because the placement of a static structure had to produce the best results in terms of protection against German U-boats. In this case, as was mentioned before in *Chapter Two: History*, the coastal waters of North Carolina have significant advantages to the German U-boats. As the continental shelf is at its narrowest is only 33.5 nautical miles, it allowed the U-boats to initiate a surprise attack and then quickly flee back to deep waters where they could avoid detection by Allied ships (Figure 77).

The geography also gave the U-boats a known point at which to find Allied merchant ships. In a bid to avoid deeper waters, merchant ships would travel closely along the coastline. This created the bottleneck that was mentioned in earlier chapters. Thus, placement of the minefield created a strategic safe point in an area plagued with enemy U-boats. It not only created a port of safe harbor for Allied merchant ships but also provided a Section Base at Ocracoke that could be used to bolster Allied forces in the region. The greater number of forces in the region and a static structure that could provide not only safety for Allied merchant ships but also held the possibility of harming U-boats that attempted to penetrate the minefield aiding the war effort.

As can be seen in *Convex Hull Overlay* (Figure 78), the edges of each of the battlefield areas from the three time periods overlay at some point near the location of the minefield. The centroid of each is shown, depicting movement of the center of the battle over time. The issues with using a convex hull analysis for this purpose is that each polygon represents a significant amount of dead space in which there was no battlefield action. This can foreseeably cause the polygons to misrepresent the actual extent of a naval battle. However, what can be seen is the lessening of the scale of the battlefield, and, therefore, the terrain involved after the minefield had been installed.

The Observations and Fields of Fire refer to any point on the landscape that allows observation of the movements, deployments, and activity of the enemy that is not necessarily key terrain. On a flat surface, such as the surface of the ocean, there are not many changes in the line of sight. However, in this case, the minefield working in conjunction with the Section Base at Ocracoke offering the Allies air coverage; thus, changing the elevation and offering the Allies a better field of vision. Continuing with the theme of advancing technology, SONAR, RADAR and radio communications all began extend the ability of “sight” for the Allies, these come into play heavily in the roles of Hunter-Killer groups towards the end of the war. The mines themselves offer a new look on fields of fire. As mines are subsurface, as were the U-boats much of the possible engagements would happen out of the direct line of sight of surface vessels. This also places a new look on Cover and Concealment. In the past when KOCOA has been applied to naval engagements, this category referred to things such as storms as the flat surface of the ocean does not normally offer any other forms of concealment (Bright 2012). However, much of the German U-boats time was spent concealed by the ocean itself. Therefore, the use of mines and their subsurface habitat offered a direct challenge to the German U-boats, creating cover and concealment where there was none.

The Obstacle section of KOCOA is described as landscape elements that hinder troop movement and affect the ultimate course of battle such as hazards to navigation both natural and man-made. The minefield itself represents a human-made hazard to navigation, as seen in the wrecking event of *F.W. Abrams.* As with any navigational hazard, the merchant ships would have to be made aware in order to avoid a collision. However, as discussed earlier, the U.S. Navy could not disclose the actual nature of the minefield and simply labeled the area a navigational hazard. This became an issue due to the nature of the hazard itself, unlike most navigational

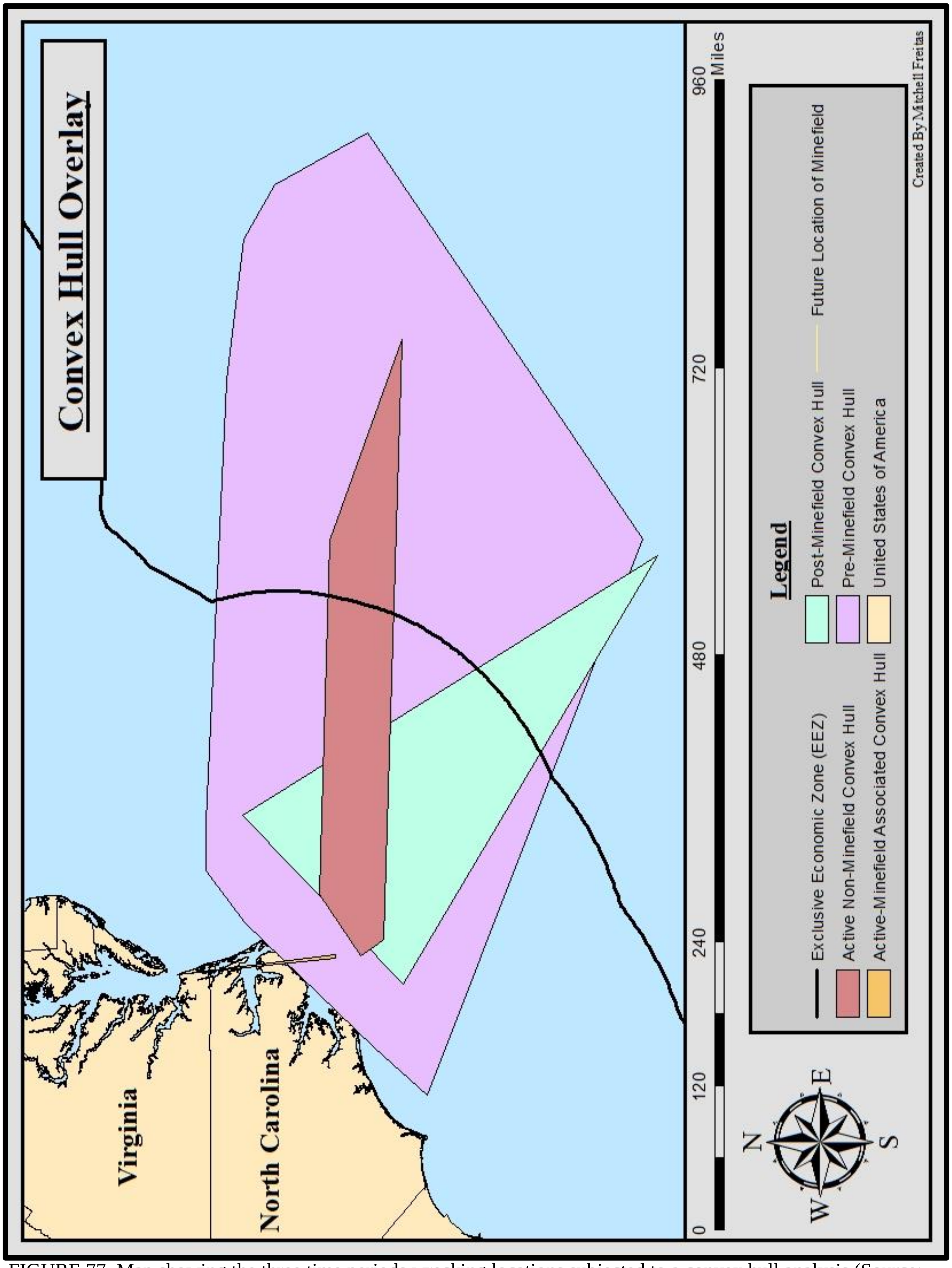


FIGURE 77. Map showing the three time periods wrecking locations subjected to a convex hull analysis (Source: Hoyt et al. 2017, Created by: Mitchell Freitas 2016).

hazards the minefield took up an exorbitant amount of area and posed a danger at any point. This intentional misleading for the sake of operational security gave a false sense of safety to the captain and crew of *F.W. Abrams*, who believed they were skilled enough to navigate the hazard themselves.

Finally, Avenues of Approach is described as corridors used to transfer troops between the core battle area and outer logistical zones or natural aids to navigation along the prescribed route. This overlaps heavily with the Key Terrain section as the coastline and the continental plate provided for and fostered the movement of merchant vessels down the coast. In total, these two systems are used to analyze the placement and battle surrounding Cape Hatteras Minefield. It shows the flaws of applying a terrestrial system of analysis to a naval battlefield as well as the flaws in applying this method to a static defense system. This is something that should be reassessed if a naval-specific theoretical framework is ever created. Perhaps the thought processes being played out in this study could contribute to the formulation of such a paradigm.

Conclusion

This concludes the analysis section of this work, the next chapter Conclusion, will address if the analysis presented above were able to assess a minefield successfully. It will also serve to address the historical narrative of the minefield and assert in finality if it was justified or not. The analysis markers presented in this chapter were the products of the research questions posed at the beginning of this work. The lives and ships lost during across the engagement were discussed in order to make a case for the relative security that was afforded to merchant shipping as the engagement progressed. The natural progression from examining the ships lost was to consider the tonnage lost both in ship and cargo. As stated in this chapter, the ship itself was an important commodity but the cargo ships carried allowed for a direct value comparison across the three time periods. The safety and security of the minefield were assessed by reexamining the events leading up to the sinking of the merchant ships lost in the minefield. This was important to establish a direct assessment of the traditional narrative. Lastly, the minefield was subjected to the theoretical framework of METT-T and KOCOA. These evaluations will be concluded in the next chapter.

CHAPTER SEVEN: Conclusion

Introduction

In order to conclude this work, it is imperative that the questions outlined in the introduction were fully addressed. The primary question being “What methods are suitable for the assessment of the success or failure of naval minefields during the Second World War?”. The subject of this study was Cape Hatteras Minefield, a defensive installation off the coast of North Carolina that was labeled as a failure by high ranking naval officers such as Admiral Adolphus Andrews. Each of the secondary questions asked at the beginning of this work were to serve as possible avenues of assessment and were each put into the context of Cape Hatteras Minefield, some with a large success while others may be better served with other minefields due to site specific issues. These analytical questions will be addressed briefly in this chapter to determine their usefulness in assessing a naval minefield. Shown below for easy reference are those original questions.

Primary:

- What methods are suitable for the assessment of the success or failure of naval minefields during the Second World War?

Secondary:

How can the success of a minefield be defined?

- Categorizing Minefields
    - Minefields are both passive and active depending on the situation; therefore, can they be assessed by a single set of standards?
- Economic stability

    - How will economic records and statistics reflect the presence of the minefield?
- Survival and Safety
    - Can the safe passage of tonnage past Cape Hatteras whose goods were used to fuel the war effort be cited as the success of the minefield?

How can the failure of a minefield be ascertained?

- Economic losses
    - How many ships were lost?
    - How much cargo was lost?
    - How much local commerce was lost in the form of local fishing and shipping?
- Losses to human life
    - What was the total number of crew lost to the minefield?
    - Was there negative public perception of the minefield?
    - Was there political pressure to remove the minefield?

<u>Categorizing Minefields</u>

- Minefields are both passive and active depending on the situation; therefore, can they be assessed by a single set of standards?

As seen in the last chapter, this question was addressed using the United States Army's battlefield assessment framework known as METT-T and KOCOA. While for this study they served their purpose, however, these systems for use by maritime archaeologists have their drawbacks. First, the most glaring issue is that these frameworks were created for terrestrial use and therefore are designed for environments with more natural cover and for the most part understanding that the enemy will not be underneath the user's position. The second shortcoming is centered around the user of the systems. METT-T and KOCOA were designed for army officers to be used in the field to quickly address the landscape and set up the most adventitious battlefield. The use in archaeology is different. The archaeologist is utilizing these assessments with full knowledge of pre-, during, and post-engagement. This is a great deal more data than these frameworks were meant to process. It may be an area of future study in which an archaeological system of battlefield interpretation and assessment can be created to offer a more robust structure of analysis. This study may contribute to a new paradigm, other studies have pointed out the same shortcomings of KOCOA and METT-T (Simonds 2014; Parker 2016).

While the standards, in this case, were imperfect, it is possible to address them by a single set of standards. The assessment work performed in this work provided solid supporting information that helped inform the choices behind the need and placement of Cape Hatteras Minefield. This, however, should not be considered the paramount quantifier for the success or failure of the minefield as it was originally believed. Other methods of investigation proved to be much more successful and had a greater impact on the study. This may be due to more data populating these regions, or it may fall on the imperfect pairing of METT-T and KOCOA with a naval minefield.

Economic Stability

- How will economic records and statistics reflect the presence of the minefield?

As one of the arguments against Cape Hatteras Minefield was the impact on local fishing, local records were investigated to ascertain the incidence of the minefield on the local economy. What was not considered was the immense impact that the war had on the home front. This caused a suppression of all local economy numbers, especially after rationing was enacted. Most records were either incomplete, missing, or too impacted by the war to find any type of pattern that could indicate the minefield's impact. The best that could be done to counter Admiral Andrews' fishing argument was to show the elastic nature of North Carolina's fishing economy and the impact that other major events had not only on the total weight of fish caught but also the value thereof. In all, it might be possible to apply this assessment to other minefields of other engagements depending on local records.

Survival and Safety

- Can the safe passage of tonnage past Cape Hatteras whose goods were used to fuel the war effort be cited as the success of the minefield?

While the above was the original question, it had to be amended throughout the research process in order to work with more reasonable and tangible data. The path of this questioning proved outside the scope of this study to follow as once the cargo arrived on site, it was impossible to definitely tell if that cargo was used successfully and made a difference. Instead, the minefield statistics were compared with those of contemporary defense systems such as the convoy system to assess survival and safety. In the case of Cape Hatteras Minefield where the reputation centered around the loss of three Allied merchant ships, it was an easy comparison in safety to the 1,705 ships lost while in convoy. The division of the sunk merchant ships into three periods offered an easy framework in which to compare the safety across the progression of the battle. These, as the reader is in no doubt familiar with at this point, were the Pre-Minefield Period, the Active-Minefield Period and the Post-Minefield period. This allowed for the collection of tangible data showing the progression of the relative safety of the merchant shipping lanes throughout the protracted engagement. Upon further analysis of the safety of the minefield, it will be unequivocally asserted by this author that the wrecking event of the merchant ship *Chilore* was *not* the fault of the minefield and should be credited as a mark by *U-576* and a victim of a convoy attack. *Chilore* was struck by two torpedoes and was then subsequently led into the minefield by situationally incompetent officers in charge. The ships were warned multiple times to halt their progress into the minefield but refused to even acknowledge the warnings. Lastly, *Chilore* was in good enough shape to be towed into another state's waters where it floundered, a culmination of damage could have been the reason the merchant ship ultimately sank, but the initial damage and the leadership from convoy KS-520 are to blame here. Furthermore, the author is comfortable confirming that both the wrecking of *F.W. Abrams* and *Keshena* remain credited to the minefield, despite the breakdown in communication on the part of the crews of *F.W. Abrams* and *Spry*.

How Can the Failure of A Minefield Be Ascertained?

While initially separated as success and failure questions, the questions in this section were amalgamated into the overall process of assessment. Therefore, questions in this section will seem out of order as compared to the layout of the Results and Analysis chapters.

Economic Losses

- How many ships were lost?
- How much cargo was lost?

The question of "How many ships were lost?" was the easiest to populate with data, and yet proved to be the most critical to this thesis. The ships lost field served as a cornerstone for the division of the time periods and provided the most striking visual maps. This can especially be seen when comparing the Pre-Minefield Sinkings with the Active-Minefield and Post-Minefield sinking maps. When asking if a number of ships lost can determine the failure of a minefield, the answer is that it certainly can. However, the questions in this section should be made clear that this is considering friendly ships, cargo, and crew lost. In the case of Cape Hatteras Minefield, the two ships lost while on the micro scale were important when compared to the overall macro of the Battle of the Atlantic are statistically irrelevant and should not impact the assessment of the minefield.

The question of cargo lost also provided crucial competitive data. When looking at the cargo lost in the Pre-Minefield Period compared to the cargo lost in the minefield the numbers are astounding. The only cargo lost directly to the minefield were the 80,000 barrels of fuel oil carried by *F.W. Abrams.* While this is a substantial loss in a vacuum, it is once again an insignificant statistical number in the overall conflict. During the Battle of the Atlantic specifically, where so much importance was riding on the transference of goods and commodities this is a paramount question to be asked by any researcher looking at any of the other minefields placed during the conflict.

Losses to Human Life

- What was the total number of crew lost to the minefield?
- Was there negative public perception of the minefield?
- Was there political pressure to remove the minefield?

The loss of lives in association with the wrecking events logically became linked directly with the question of how many ships were lost. Initially, the thought was to separate them as the loss of human life tends to carry more weight with both decisions being made by military officers and politics as well as the public’s perception of the military action in question. The question of the crew lost was supportive in comparing the time periods and should be looked at in any assessment of a minefield. What was found early in the research was that the minefield's true nature, due to operational security, was not disclosed to even the merchant captains that were operating their vessels in mined waters let alone the general public. It would be an interesting comparison to see if this is different in the cases of other minefields and the question may be asked as a tertiary or supplemental question and not as a secondary question.

Finally, the question of the political pressures to remove the minefield served to be one of the roots of the original issues with Cape Hatteras Minefield. It was not necessarily pressured from politicians but the pressure of navy brass in the form of Admiral Andrews; to remove the minefield. In the case of most if not all military installations, it is important to look at the biases and influences of the naval officers in charge of the project. Admiral Andrews' had invested interest in the convoy system and served as the major voice against the minefield. Many of his claims were exaggerated, and the written proposals to Admiral King for its removal served as the cornerstone of the bastardization of Cape Hatteras Minefield by following accounts.

As a side note, as the author of this study, I have thrown around phrases such as "statistically insignificant" when addressing ships sunk in and around the minefield. It is unavoidable that these wrecking events are tied to the loss of crew. While in a macro research study, the crew lost is frequently represented only by a number. It is important to remember that each one of those numbers represents a human life lost which many times impacted a family at home. Mothers, fathers and other relatives lost loved ones during a conflict that barely garners a passing mention in high school and college history courses. Therefore, it is up to the stewards of the Battle of the Atlantic to keep the record of these men. For one is not truly gone as long as their name is still spoken.

Final Verdict

The last word of this thesis on the success or failure of Cape Hatteras Minefield is as follows. While Cape Hatteras Minefield is completely undeserving of the overly negative connotations attached by Admiral Andrews, it cannot be determined to the full extent if the minefield was a true success or failure. This is due to the fact that Cape Hatteras Minefield was intended to be one of twelve mined anchorages of which, only one other was installed in Florida (Lott 1959:43). In addition, while waiting on the minelayers to arrive at Cape Hatteras and begin the installation process, the convoy system had started to function. This makes it hard to attribute increased merchant security solely to the minefield definitively. In fact, much of the reasoning the minefield plan was agreed upon in the first place was due to the United States Navy attempting to field as many Anti-Submarine Warfare defenses at the disposal of the navy as possible.

This may seem anti-climactic after working through much of the data included in this work but, it is the most unbiased and fair assessment that could be offered. Cape Hatteras Minefield has been vindicated to some degree with the earlier assertion that the merchant ships *Chilore* that was traveling as part of Convoy KS-520, was struck by two torpedoes from *U-576*, one mine from Cape Hatteras Minefield and could be towed into the waters of another state before sinking was not the fault of the minefield. If the entire mined anchorage system was installed and was given the time to function properly the results may have been different.

Future Research

There are several avenues that future research can take in both the assessment of minefields and specifically the mined anchorage system of the Battle of the Atlantic. First, it would be the hope of this author that the structure of this thesis is applied by a future researcher to a minefield of a different time and conflict. An excellent example of this would be the assessment of the minefields in use during the Russo-Japanese War. This would be even more advantageous if the arguments used in this thesis were applied to a naval engagement specific version of METT-T/KOCOA as mentioned earlier in this chapter. It is imperative that at some point a theoretical structure that can accommodate the questions of archaeologists (not just those of military officers) in a naval setting is developed.

Concerning the mined anchorage system, it would be an interesting comparison to assess the mined anchorage installed off the coast of Florida with the same questions asked in this thesis. Furthermore, regarding Cape Hatteras Minefield itself, several lines of research could not be contained within the scope of the study. For instance, at the time of writing this thesis, it is not known if a record of ships was kept as they utilized the minefield. This data would surely bolster the data contained within this thesis. Furthermore, the German U-boat accounts could be better utilized and the view of the enemy taken into more consideration. While this is not a research question that could be undertaken by a graduate student, it would be extremely interesting if a survey could be done in the area currently marked as a “Navigation Hazzard” to determine if any of the mines still remain on site as a large number were left after the deactivation of the minefield.

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APPENDIX A: SHIP LIST

Ship Name	Lives Lost	Notes	Date	Tonnage	Cargo	Convoy or Individual
Agra	6		April 20 1942	4569	6,666 tons General Army Supplies	Individual
Alcoa Guide	6		April 17 1942	4834	5,890 tons General Army Supplies	Individual
Allan Jackson	22		Jan 18 1942	6635	72,870 barrels Crude Oil	Individual
Amerikaland	5		Feb 3 1942	15355	Unknown	Individual
Arabutan	1		Mar 7 1942	7874	9,680 tons Coal & Coke	Individual
Ario	8		Mar 15 1942	6952	Water Ballast	Individual
Ashkhabad	0		April 30 1942	5284	Water Ballast	Escort FY-124
Atlas	2		April 9 1942	7137	84,239 barrels Crude Oil	Individual
Australia	4		Mar 16 1942	11628	110,000 barrels Crude Oil	Individual
Blink	24		Feb 12 1942	2701	3,600 tons Phosphates	Individual
Bris	5		April 21 1942	2027	Asphalt	Individual
British Splendour	12		April 7 1942	7138	10,000 tons Benzine	Escort FY-176/FY-280
Bryon D. Benson	10		April 5 1942	7953	100,000 barrels Crude Oil	Informal Convoy
Buarque	1		Feb 15 1942	5152	General Supplies	Individual
Caribsea	21		Mar 11 1942	2609	3,600 tons Manganese Ore	Individual
Ceiba	44		Mar 17 1942	1698	Unknown	Individual

Chenango	31		April 21 1942	3014	Manganese Ore	Individual
Ciltvaira	2		Jan 19 1942	3779	6,200 tons Newsprint	Individual
City of Atlanta	43		Jan 19 1942	5269	2,870 tons General Supplies	Individual
City of New York	24		Mar 29 1942	8272	6,612 tons General Supplies	Individual
Clan Skene	9		May 10 1942	5,214	2,006 tons Chrome Ore	Individual
Derryheen	0		April 22 1942	7,217	11,036 tons General Army Supplies	Individual
Desert Light	1		April 16 1942	2368	3,800 tons General Supplies, 104 tons Explosives	Individual
Dixie Arrow	11		Mar 26 1942	8046	96,000 barrels Crude Oil	Individual
E.M. Clark	1		Mar 18 1942	5106	118,000 barrels Heating Oil	Individual
Empire Dryden	26		April 20 1942	7164	7,000 tons General Army Supplies	Individual
Empire Gem	49		Jan 24 1942	8139	10,692 tons Motor Spirit, 920 tons Machinary	Individual
Empire Thrush	0		April 14 1942	6160	5,000 tons Rock Phosphate, 740 tons TNT, 2,800 tons Citrous Pulp	Individual
Equipoise	41		Mar 27 1942	6210	Unknown	Individual
Esso Nashville	0	Partially Sunk	Mar 21 1942	7934	106,718 barrels Fuel Oil	Individual
Harpagon	41		April 20 1942	5719	5,415 tons General Supplies, 2,602 tons Explosives	Individual

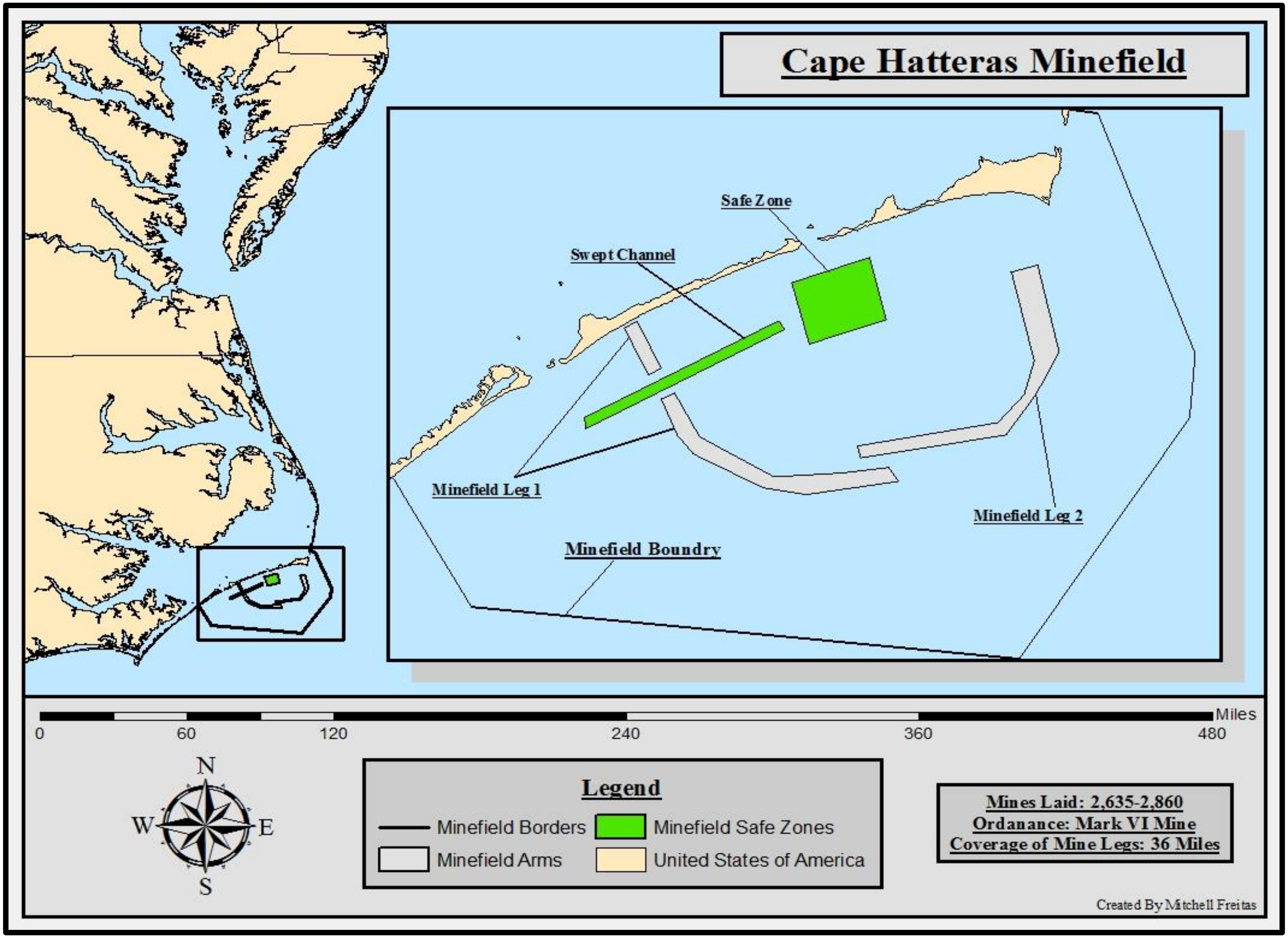
John D. Gill	23	Mar 13 1942	11641	141,981 barrels Crude Oil	Individual
Kassandra Louloudis	0	Mar 18 1942	6878	General Army Supplies	Individual
Koll	3	April 6 1942	10044	13,000 tons Gas Oil	Individual
Lady Hawkins	251	Jan 19 1942	7988	2,908 tons General Supplies	Individual
Lancing	1	April 7 1942	7866	8,900 barrels Fuel Oil	Individual
Leif	15	Feb 28 1942	1582	2,300 tons General Supplies	Individual
Liberator	5	Mar 19 1942	7076	11,000 tons Sulphur	Individual
Major Wheeler	35	Feb 6 1942	3431	Unknown	Individual
Malchace	1	April 9 1942	3516	3,628 tons Soda Ash	Individual
Margaret	29	April 14 1942	3352	4,508 tons Sugar	Individual
Marore	0	Feb 27 1942	8215	23,000 tons Iron Ore	Individual
Naeco	24	Mar 23 1942	5375	72,000 barrels Heating Oil	Individual
Narragansett	49	Mar 25 1942	10,389	14,000 barrels Clean Oil	Individual
Norvana	29	Jan 19 1942	2677	3,980 tons Ore	Individual
Oakmar	6	Mar 20 1942	5766	8,300 tons Manganese Ore	Individual
Olympic	35	Jan 22 1942	5335	Unknown	Individual
Otho	32	April 3 1942	4839	4,400 tons MO, 1,296 tons PO, 750 tons Tin	Individual
Rio Blanco	19	April 1 1942	4086	6,440 tons Iron Ore	Individual
San Delfino	28	April 10 1942	8072	11,000 barrels Aviation Spirit	Individual

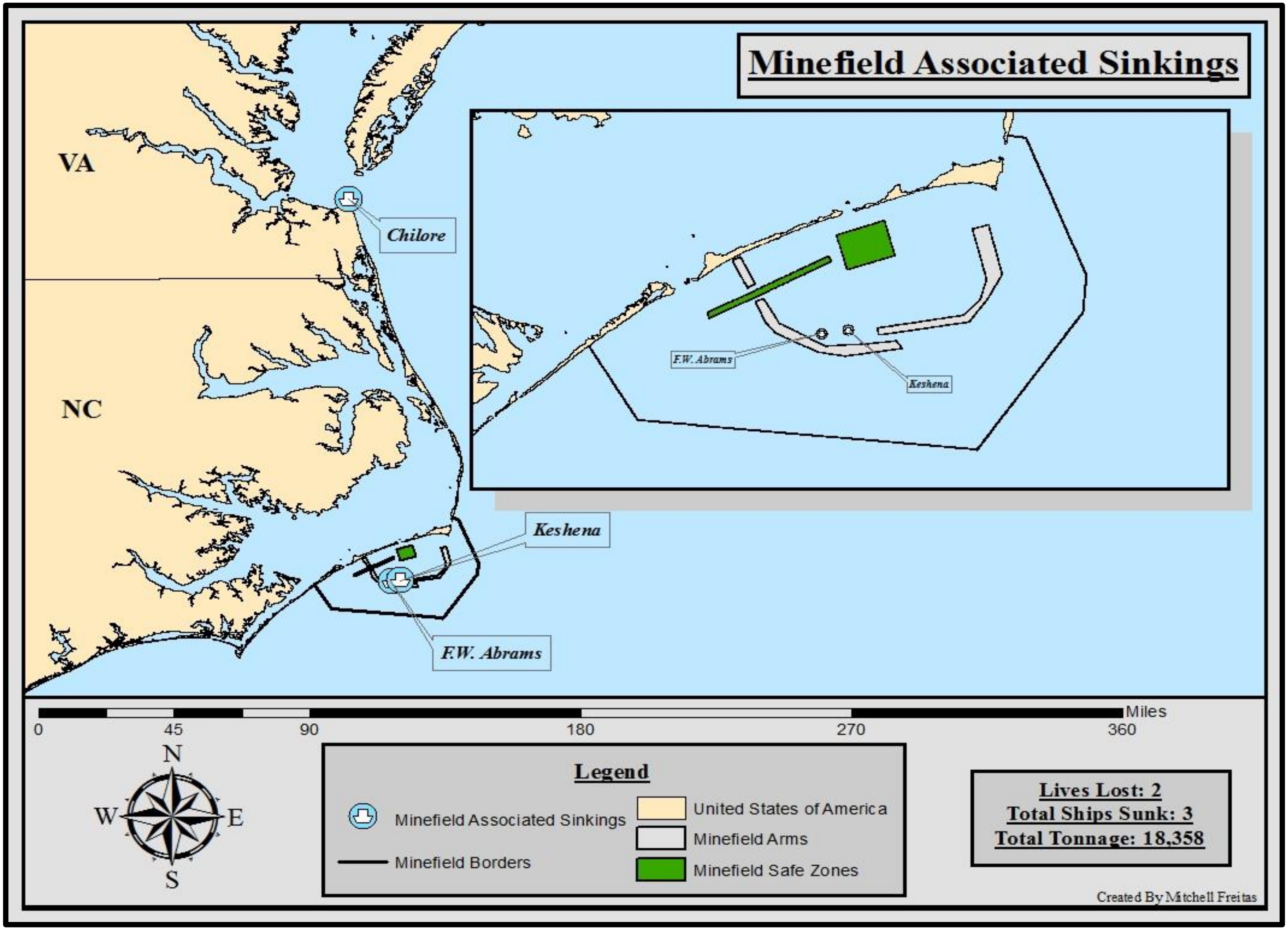
San Jacinto	14		April 22 1942	6,069	3,200 barrels General Supplies	Individual
Steel Maker	1		April 20 1942	6176	7,660 tons General Army Supplies	Individual
Svenør	8		Mar 27 1942	7616	11,401 barrels Fuel Oil	Individual
Tamaulipas	2		April 10 1942	6943	10,200 barrels Fuel Oil	Individual
Tolosa	22		Feb 9 1942	1974	Unknown	Individual
Ulysses	0		April 11 1942	14647	9,544 tons General Supplies, 4,000 tons Pig Iron	HX-232
Venore	17		Jan 24 1942	8017	8,000 tons Iron Ore	Individual
Victolite	47		Feb 11 1942	11,410	Water Ballast	Individual
W.E. Hutton	13		Mar 19 1942	5939	65,000 barrels Fuel Oil	Individual
West Ivis	45		Jan 26 1942	5666	Unknown	Individual
Total	1204			381742		

Anna	0		June 3 1942	1345	1,739 tons Coal	Individual
Bluefields	0		July 15 1942	2063	General Supplies	KS-520
Chilore	0	Minefield	July 15 1942	8310	Water Ballast	KS-520
City of Birmingham	9		July 1 1942	5861	2,400 tons General Supplies	Escort DMS-8
F.W. Abrams	0	Minefield	June 11 1942	9621	90,000 barrels Fuel Oil	Individual
J.A. Mowinckel	2	Not Sunk	July 15 1942	11147	N/A	KS-520
Keshena	2	Minefield	July 19 1942	427	NONE	Individual

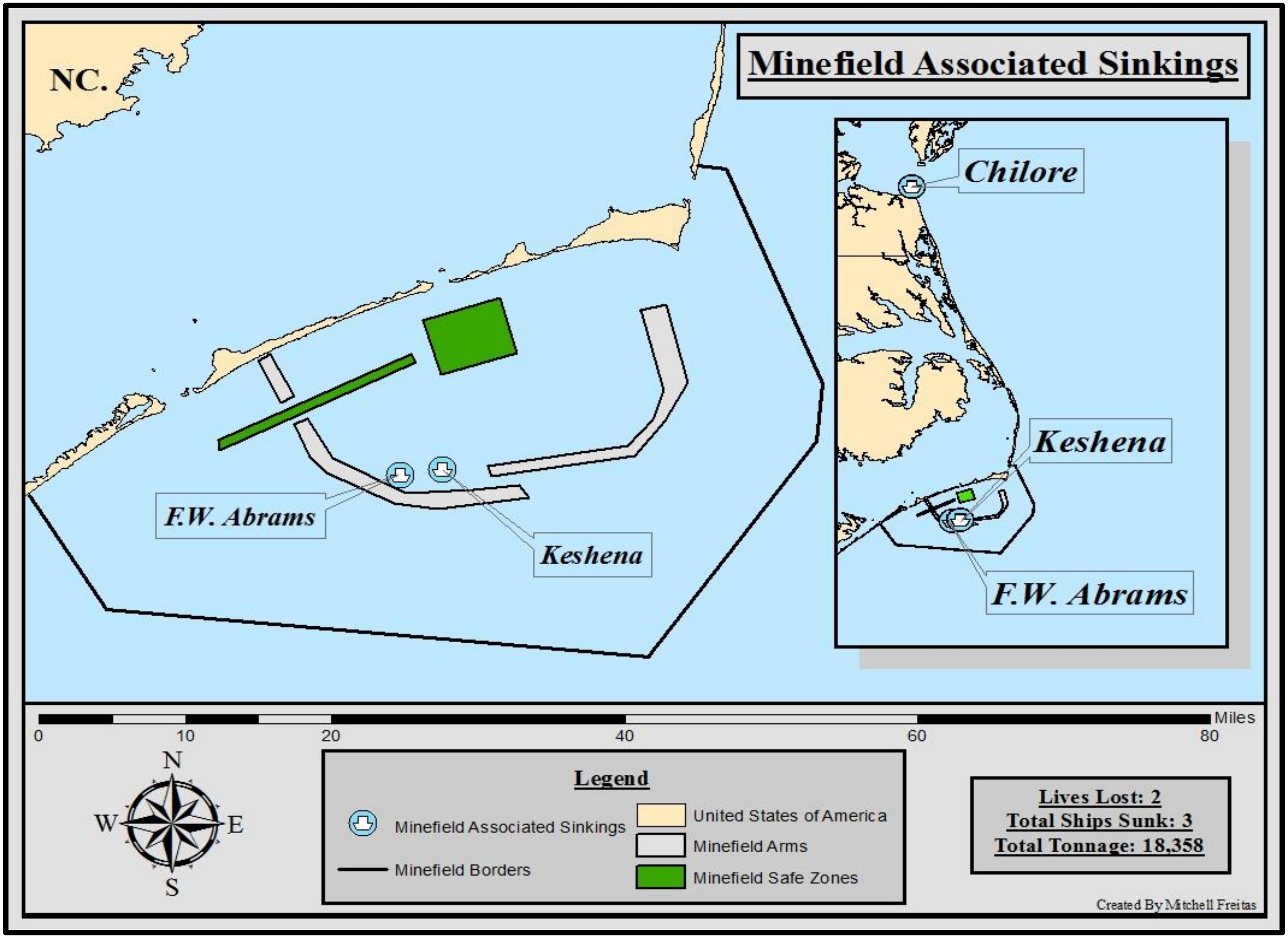
Kollskegg	4	June 19 1942	9858	14,000 tons Dirty Oil	CW-7
Ljubica Matkovic	0	June 24 1942	3289	4,100 tons Sugar, 850 barrels Fuel Oil, 25 tons Wood	Individual
Manuela	2	June 25 1942	4772	6,500 tons Sugar	Convoy
Nordal	0	June 25 1942	3845	6,675 tons Manganese Ore	Convoy
Pleasantville	2	June 8 1942	4,549	3,000 tons Phosphate	Individual
West Notus	4	June 1 1942	5492	7,400 tons Flaxseed	Individual
William Rockefeller	0	June 29 1942	14054	135,000 barrels Fuel Oil	Escort CG-460
Total	25		84633		
Belgian Airman	1	April 14 1945	6959	General Army Supplies	Individual
Libertad	24	Dec 4 1943	5441	8,000 tons sugar	KN-280
Panam	2	May 4 1943	7277	Water Ballast	NK-538
Santa Catalina	0	April 24 1943	6,507	6,700 tons General Army Supplies	Individual
Total	27		26184		
(Lloyd's 1989; Hoyt et al 2017)					

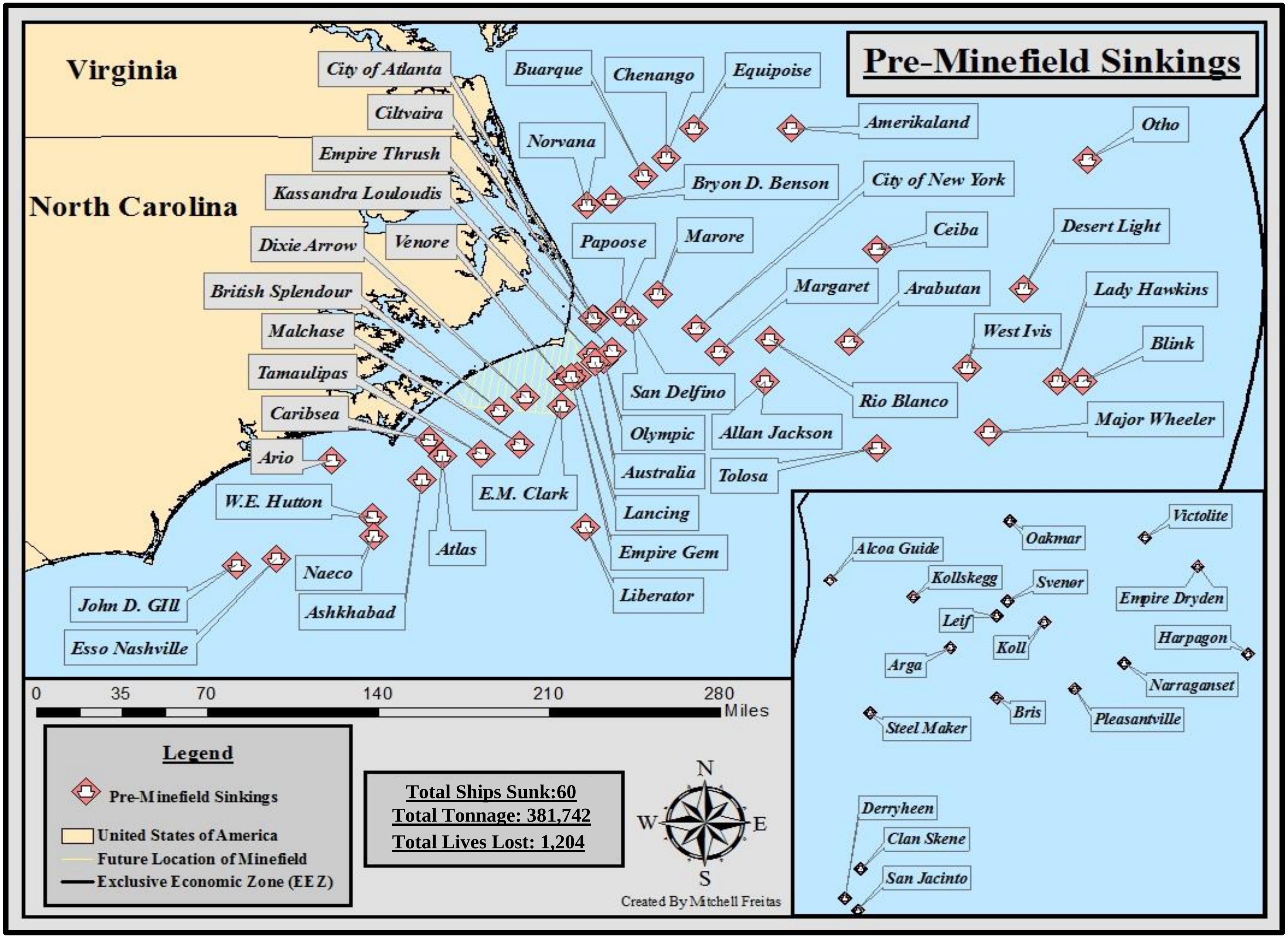
APPENDIX B: MAPS

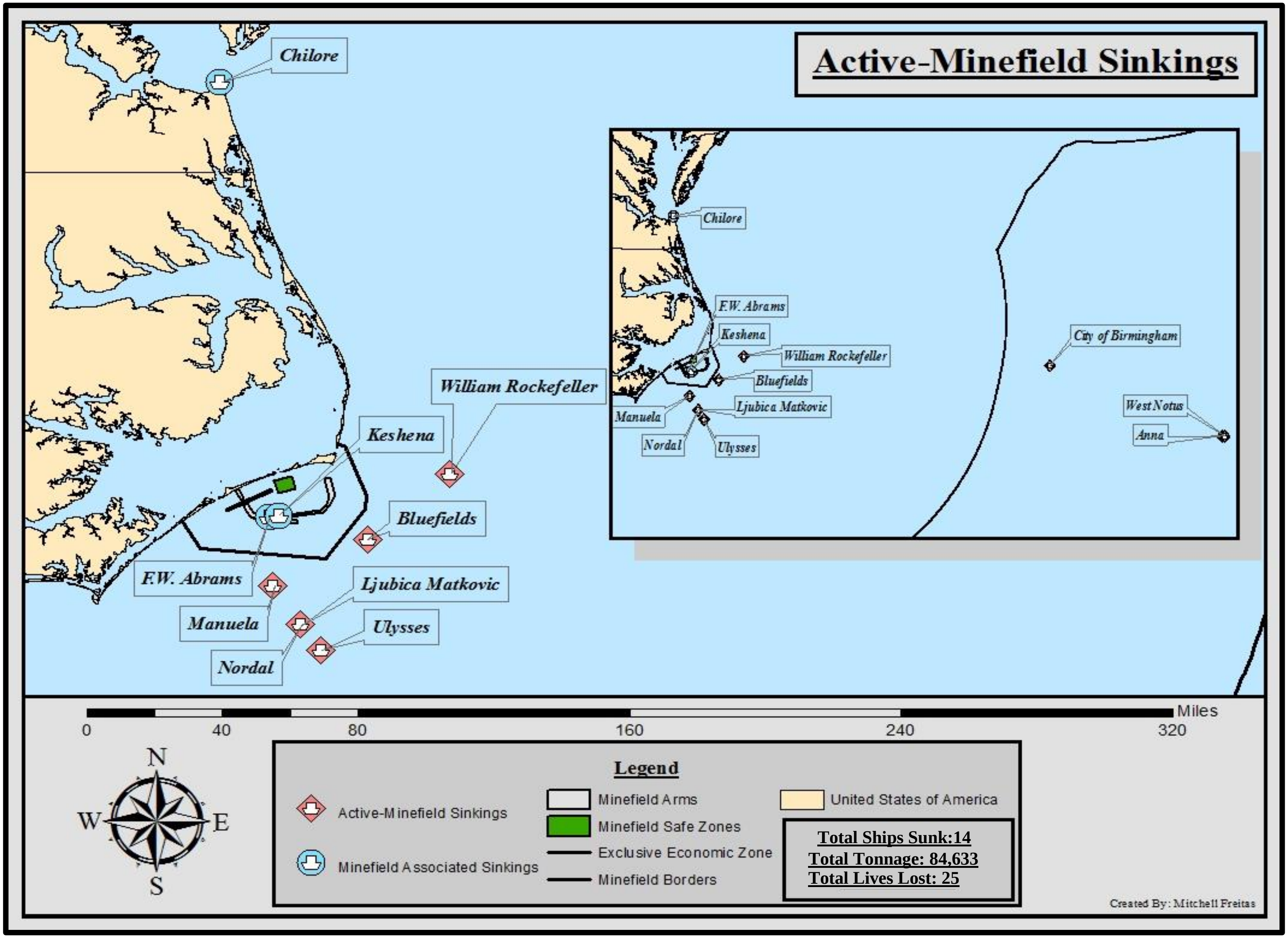

Cape Hatteras Minefield
Safe Zone
Swept Channel
Minefield Leg 1
Minefield Leg 2
Minefield Boundry
Miles
0
60
120
240
360
480
N
W
E
S
Legend
Minefield Borders
Minefield Safe Zones
Minefield Arms
United States of America
Mines Laid: 2,635-2,860
Ordanance: Mark VI Mine
Coverage of Mine Legs: 36 Miles
Created By Mitchell Freitas

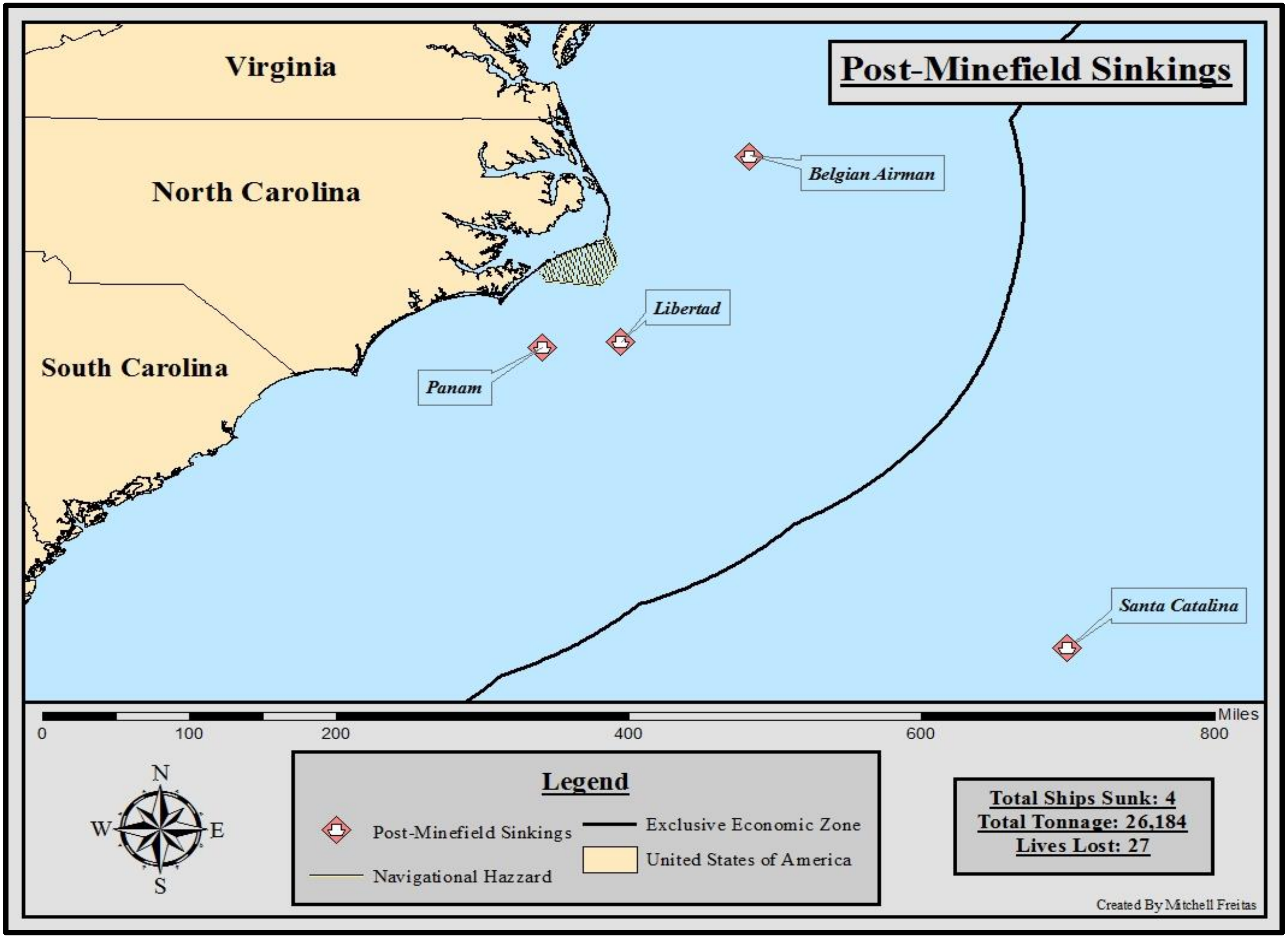


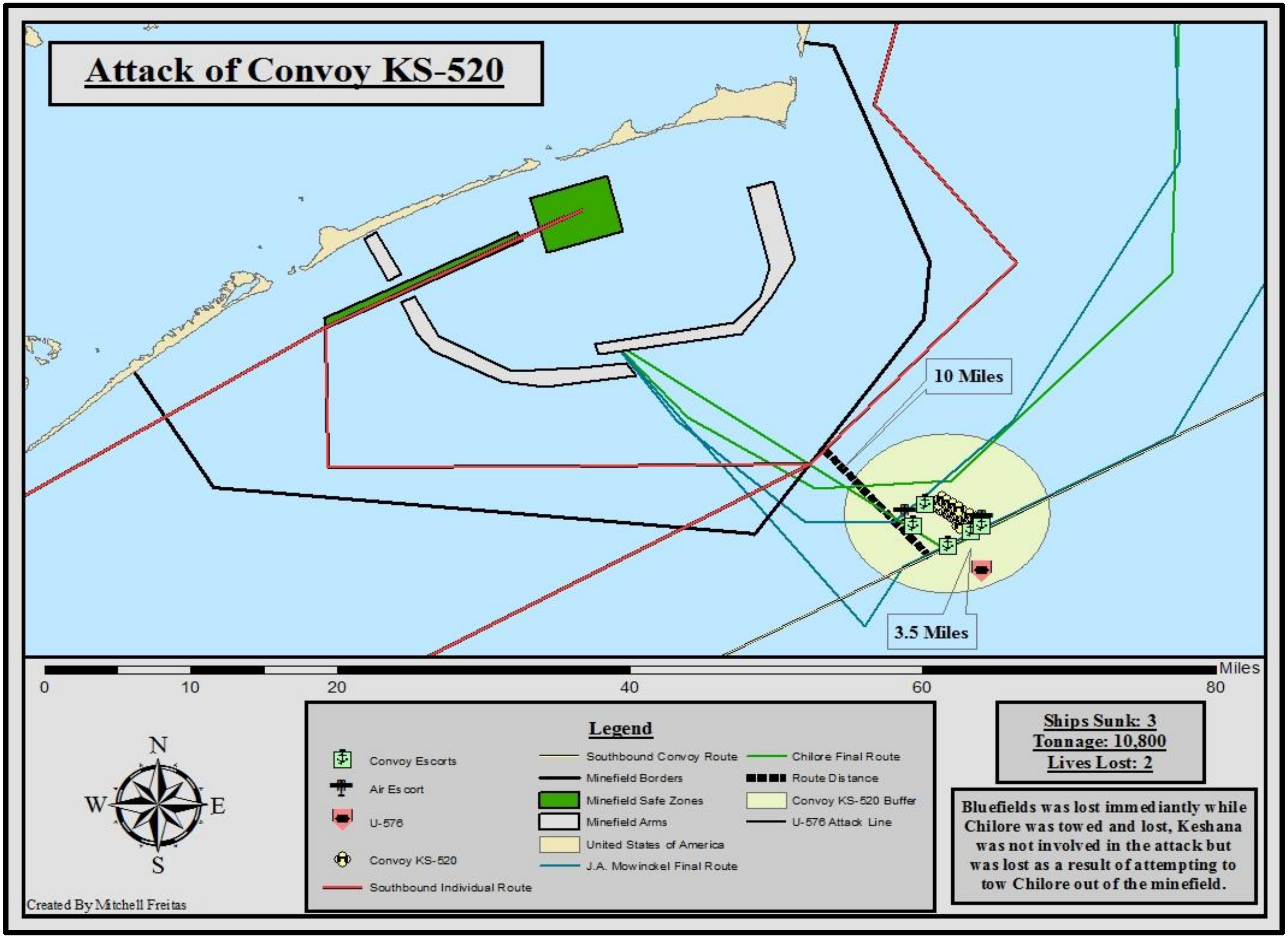
Minefield Associated Sinkings
VA
NC
Chilore
Keshena
F.W. Abrams
F.W. Abrams
Keshena
Miles
0
45
90
180
270
360
N
W
E
S
Legend
Minefield Associated Sinkings
Minefield Borders
United States of America
Minefield Arms
Minefield Safe Zones
Lives Lost: 2
Total Ships Sunk: 3
Total Tonnage: 18,358
Created By Mitchell Freitas

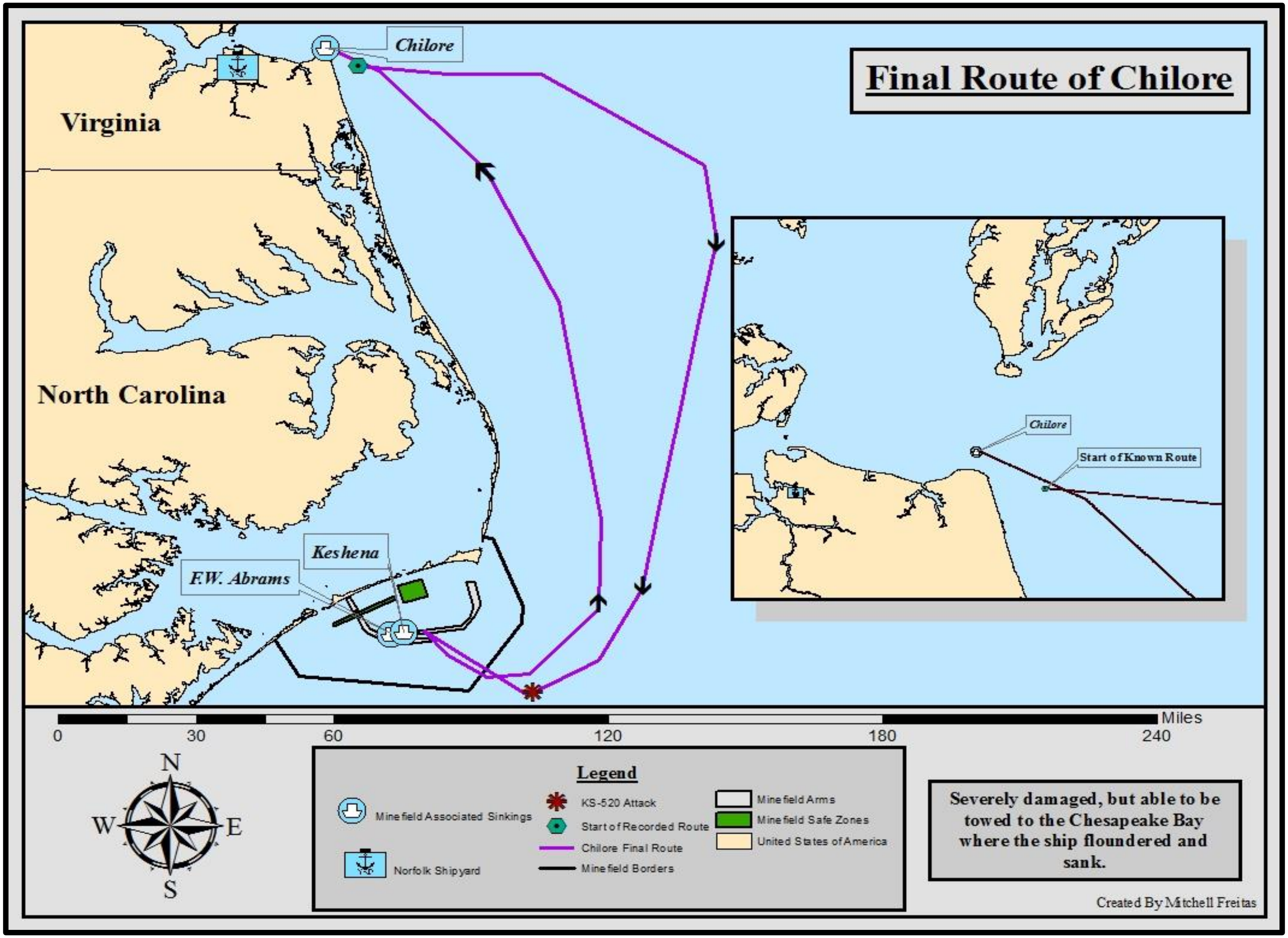

Minefield Associated Sinkings
NC.
F.W. Abrams
Keshena
Chilore
Keshena
F.W. Abrams
0
10
20
40
60
80
Miles
N
W
E
S
Legend
Minefield Associated Sinkings
Minefield Borders
United States of America
Minefield Arms
Minefield Safe Zones
Lives Lost: 2
Total Ships Sunk: 3
Total Tonnage: 18,358
Created By Mitchell Freitas


Pre-Minefield Sinkings
Virginia
North Carolina
City of Atlanta
Ciltvaira
Empire Thrush
Kassandra Louloudis
Dixie Arrow
Venore
British Splendour
Malchase
Tamaulipas
Caribsea
Ario
W.E. Hutton
Naeco
John D. Gill
Esso Nashville
Ashkhabad
Atlas
E.M. Clark
Buarque
Chenango
Equipoise
Norvana
Bryon D. Benson
Papoose
Marore
Amerikaland
City of New York
Ceiba
Margaret
Arabutan
Desert Light
Otho
Lady Hawkins
West Ivis
Blink
San Delfino
Olympic
Allan Jackson
Rio Blanco
Major Wheeler
Australia
Tolosa
Lancing
Empire Gem
Liberator
Alcoa Guide
Oakmar
Victolite
Kollskegg
Svenør
Empire Dryden
Leif
Koll
Harpagon
Arga
Narraganset
Bris
Pleasantville
Steel Maker
Derryheen
Clan Skene
San Jacinto
0 35 70 140 210 280 Miles
Legend
Pre-Minefield Sinkings
United States of America
Future Location of Minefield
Exclusive Economic Zone (EEZ)
Total Ships Sunk:60
Total Tonnage: 381,742
Total Lives Lost: 1,204
N
W
E
S
Created By Mitchell Freitas

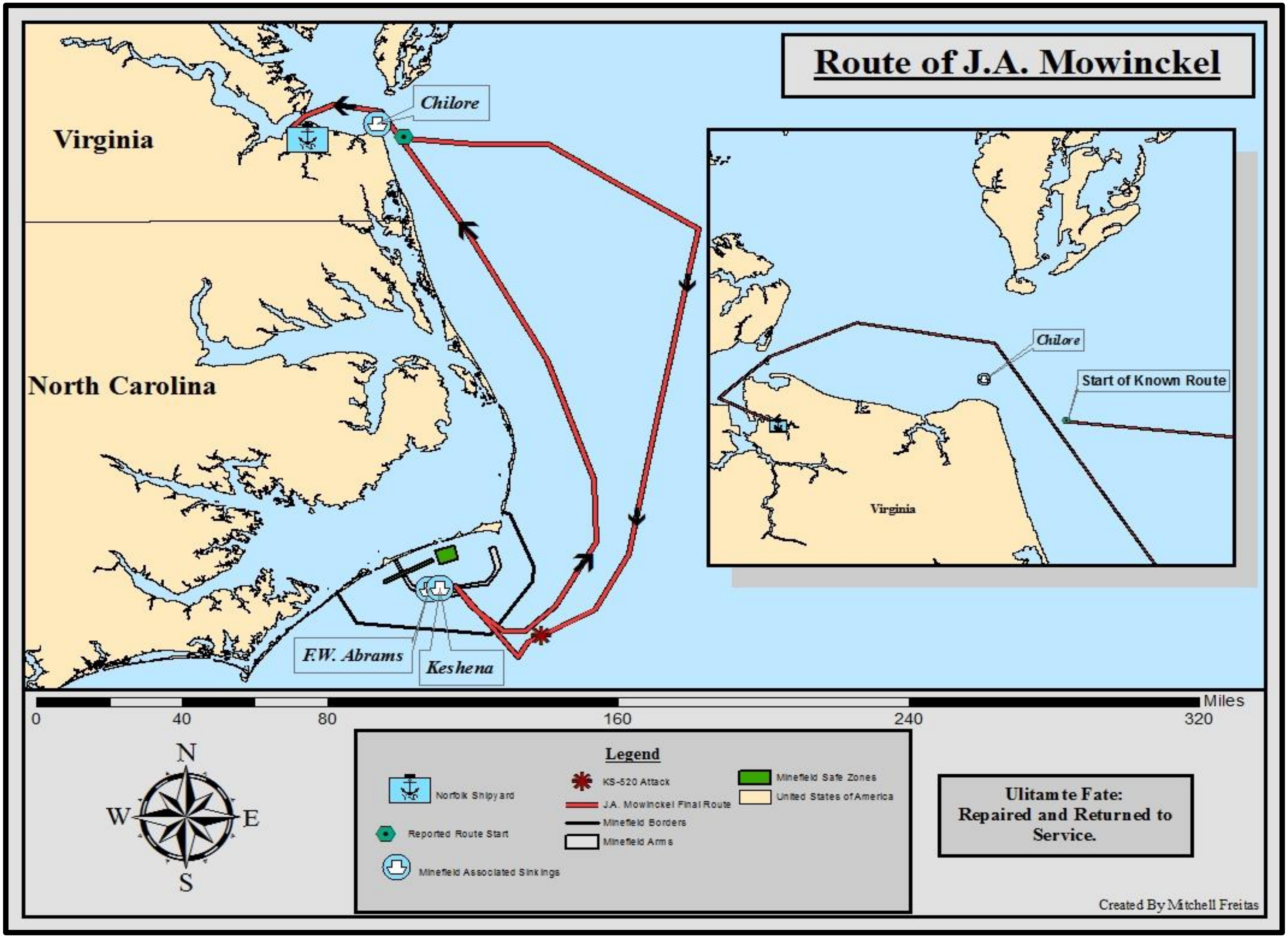

Active-Minefield Sinkings
Chilore
William Rockefeller
Keshena
Bluefields
F.W. Abrams
Manuela
Ljubica Matkovic
Ulysses
Nordal
City of Birmingham
West Notus
Anna
Miles
0
40
80
160
240
320
N
S
E
W
Legend
Active-Minefield Sinkings
Minefield Associated Sinkings
Minefield Arms
Minefield Safe Zones
Exclusive Economic Zone
Minefield Borders
United States of America
Total Ships Sunk:14
Total Tonnage: 84,633
Total Lives Lost: 25
Created By: Mitchell Freitas

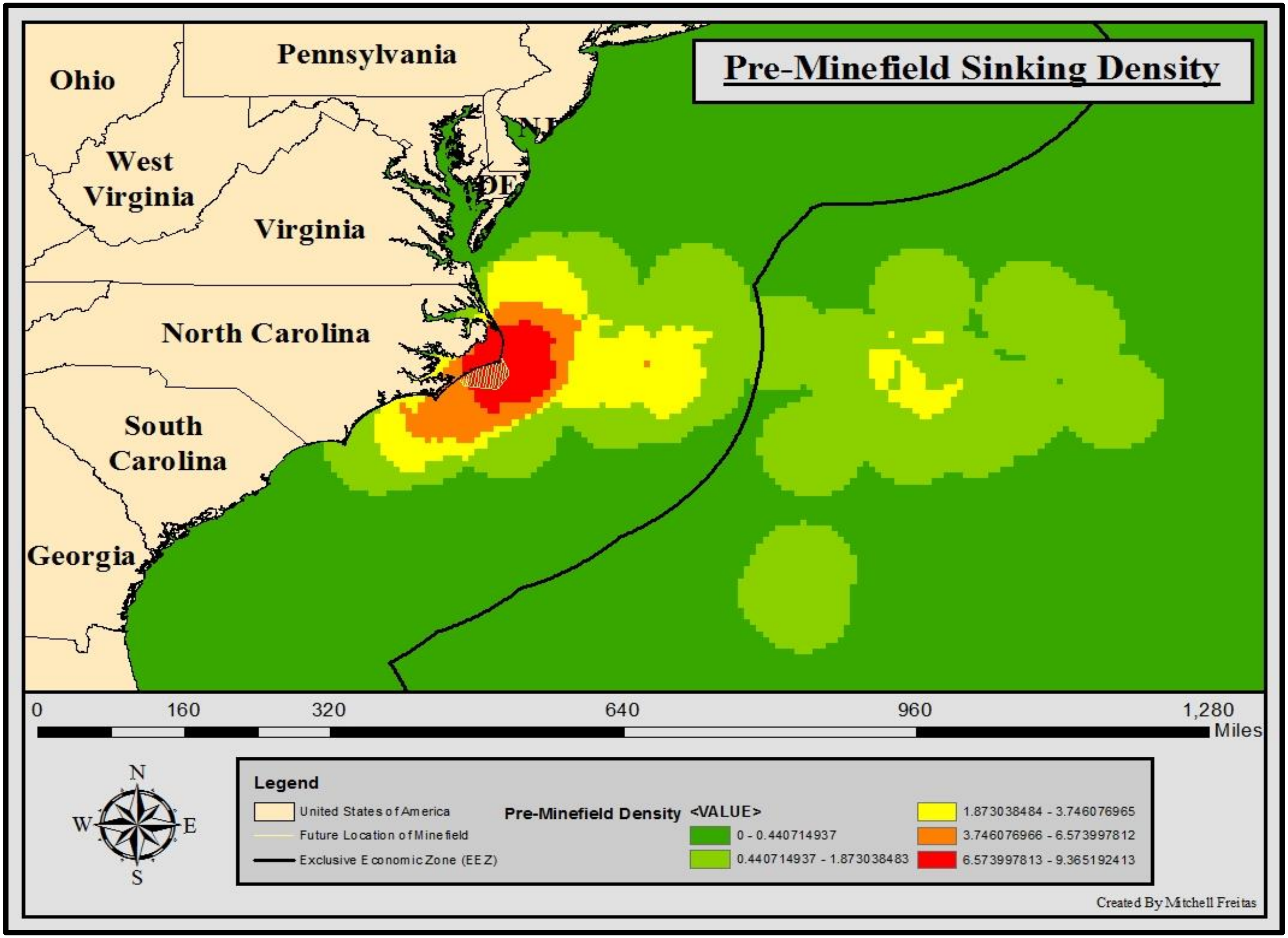

Post-Minefield Sinkings
Virginia
North Carolina
South Carolina
Belgian Airman
Libertad
Panam
Santa Catalina
Miles
0
100
200
400
600
800
N
W
E
S
Legend
Post-Minefield Sinkings
Navigational Hazzard
Exclusive Economic Zone
United States of America
Total Ships Sunk: 4
Total Tonnage: 26,184
Lives Lost: 27
Created By Mitchell Freitas


Attack of Convoy KS-520
10 Miles
3.5 Miles
Miles
0
10
20
40
60
80
N
W
E
S
Legend
Convoy Escorts
Air Escort
U-576
Convoy KS-520
Southbound Individual Route
Southbound Convoy Route
Minefield Borders
Minefield Safe Zones
Minefield Arms
United States of America
J.A. Mowinckel Final Route
Chilore Final Route
Route Distance
Convoy KS-520 Buffer
U-576 Attack Line
Ships Sunk: 3
Tonnage: 10,800
Lives Lost: 2
Bluefields was lost immediantly while Chilore was towed and lost, Keshana was not involved in the attack but was lost as a result of attempting to tow Chilore out of the minefield.
Created By Mitchell Freitas

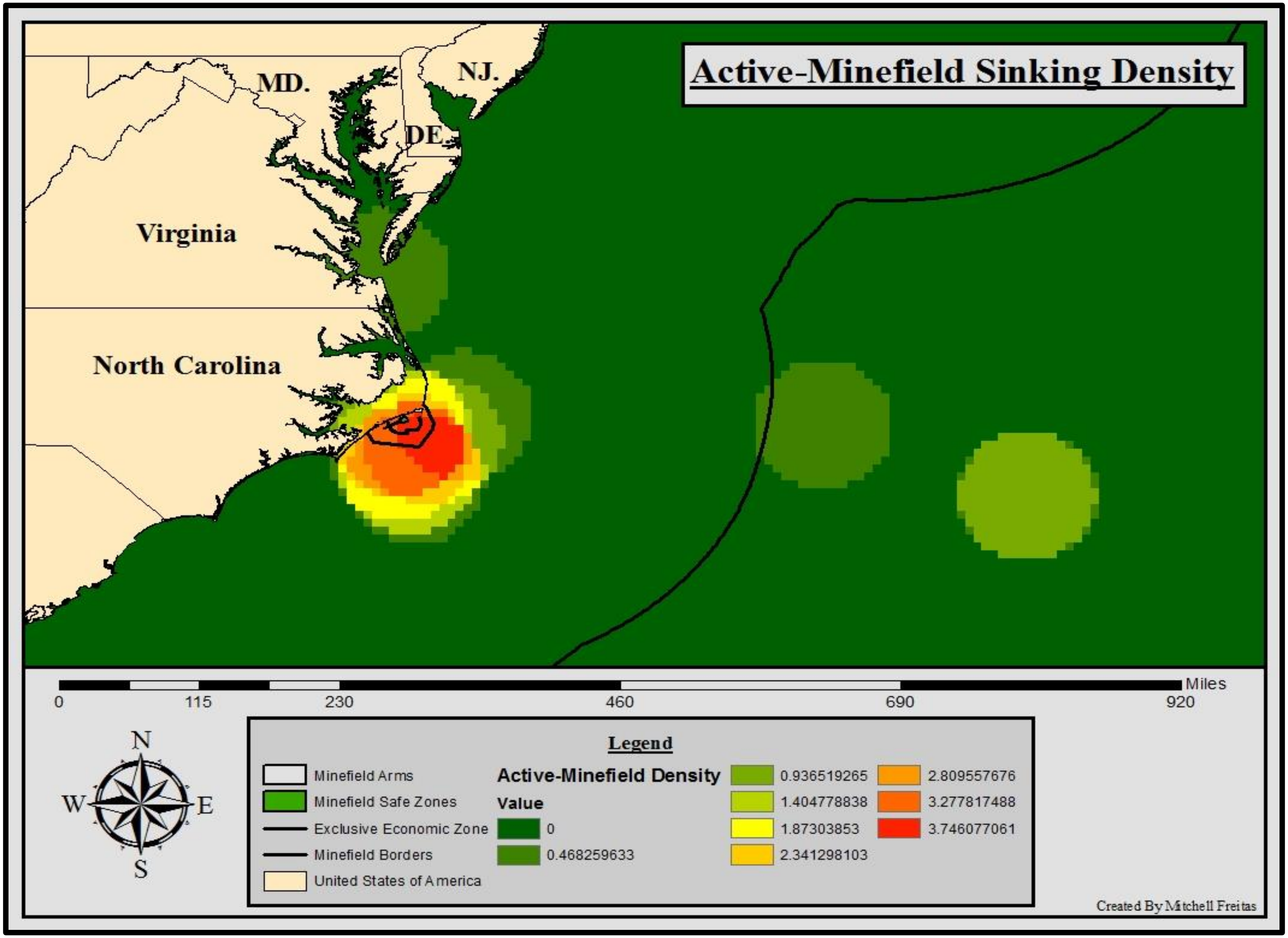


Final Route of Chilore
Chilore
Virginia
North Carolina
Keshena
F.W. Abrams
Chilore
Start of Known Route
Miles
0
30
60
120
180
240
N
W
E
S
Legend
Minefield Associated Sinkings
Norfolk Shipyard
KS-520 Attack
Start of Recorded Route
Chilore Final Route
Minefield Borders
Minefield Arms
Minefield Safe Zones
United States of America
Severely damaged, but able to be towed to the Chesapeake Bay where the ship floundered and sank.
Created By Mitchell Freitas

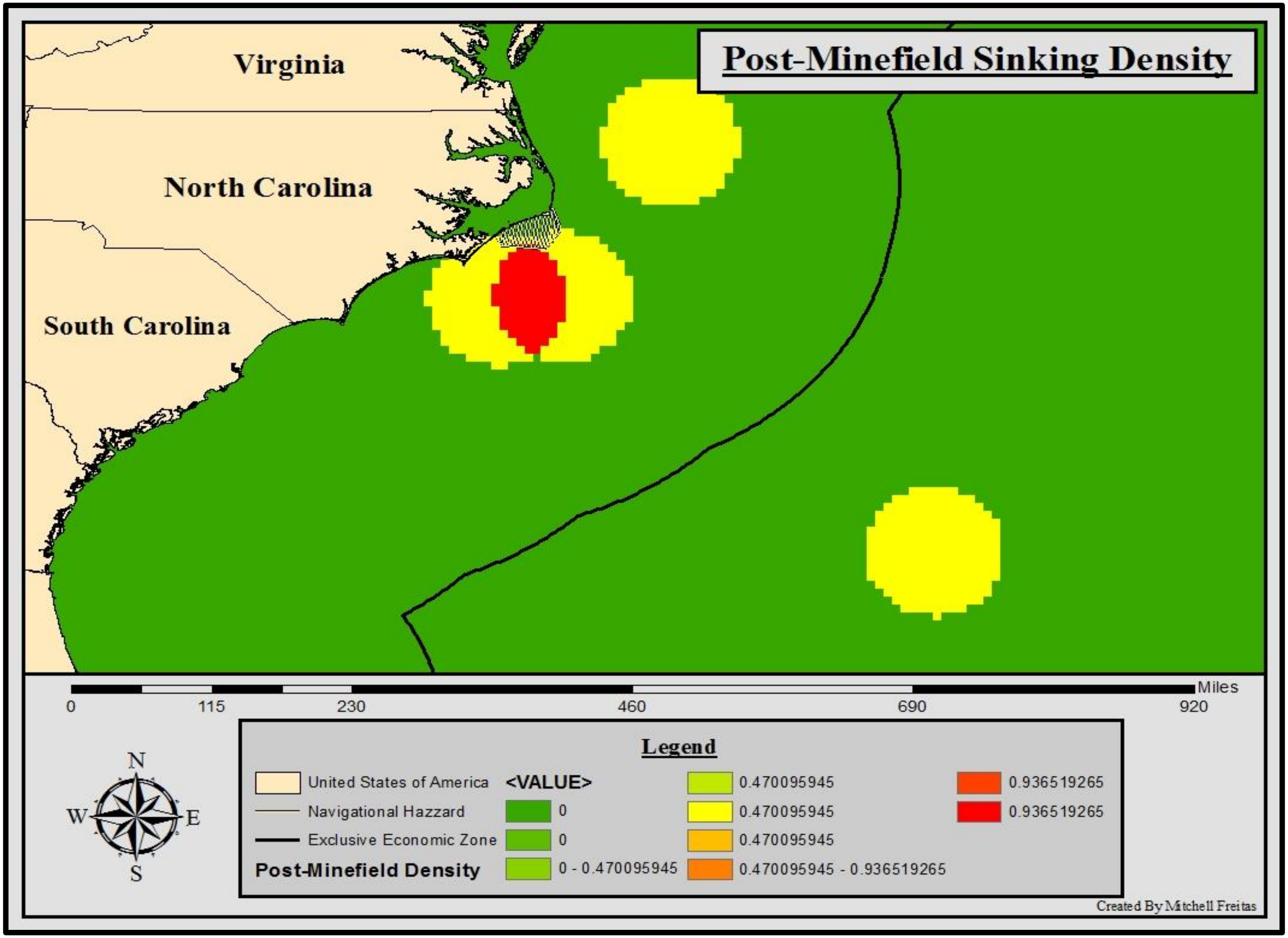

Route of J.A. Mowinckel
Virginia
North Carolina
Chilore
F.W. Abrams
Keshena
Chilore
Start of Known Route
Virginia
Miles
0
40
80
160
240
320
N
W
E
S
Legend
Norfolk Shipyard
Reported Route Start
Minefield Associated Sinkings
KS-520 Attack
J.A. Mowinckel Final Route
Minefield Borders
Minefield Arms
Minefield Safe Zones
United States of America
Ulitamte Fate:
Repaired and Returned to Service.
Created By Mitchell Freitas

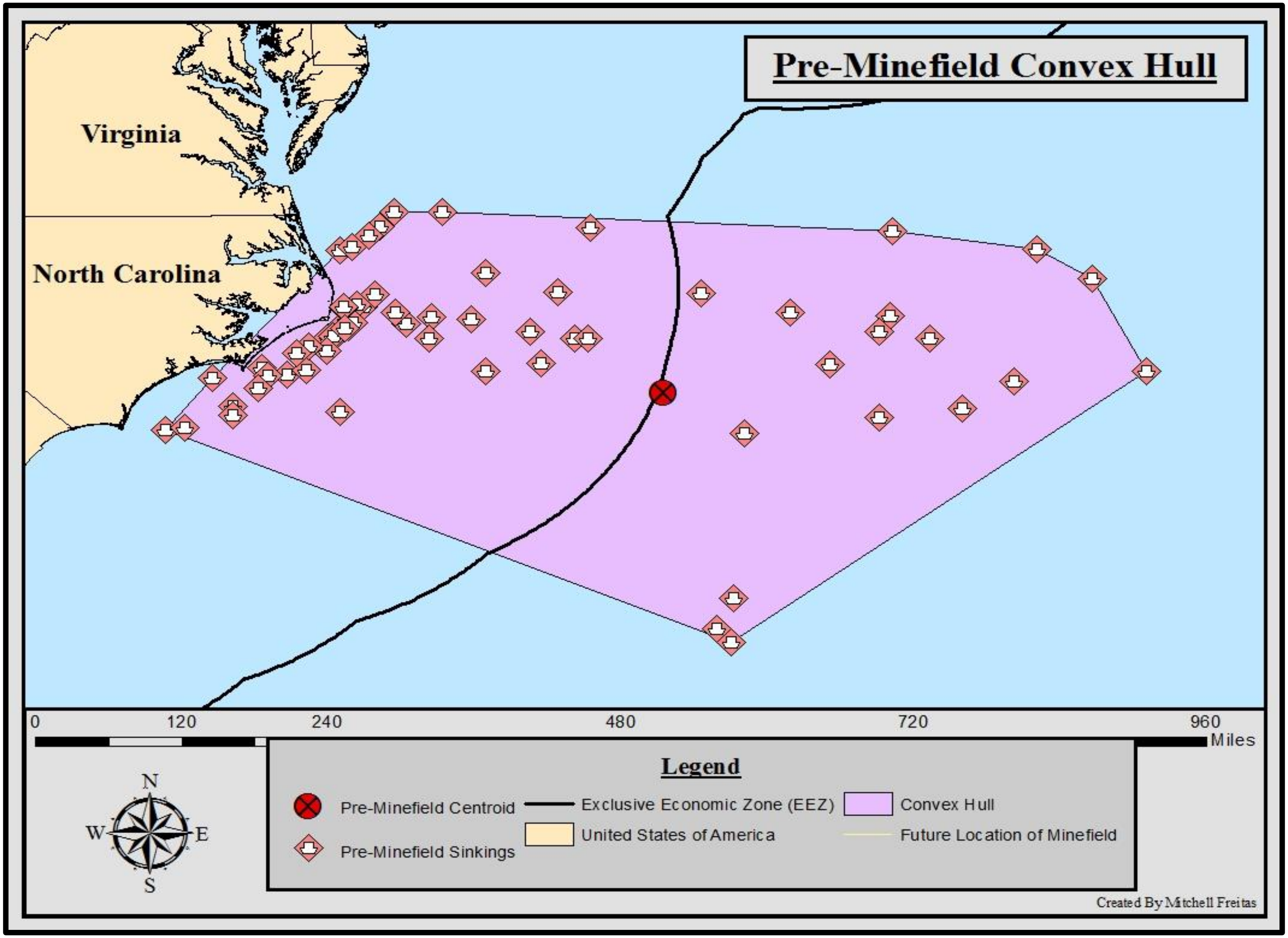


Pre-Minefield Sinking Density
Ohio
Pennsylvania
West Virginia
Virginia
North Carolina
South Carolina
Georgia
NJ
DE
0
160
320
640
960
1,280
Miles
N
W
E
S
Legend
United States of America
Future Location of Minefield
Exclusive Economic Zone (EEZ)
Pre-Minefield Density <VALUE>
0 - 0.440714937
0.440714937 - 1.873038483
1.873038484 - 3.746076965
3.746076966 - 6.573997812
6.573997813 - 9.365192413
Created By Mitchell Freitas

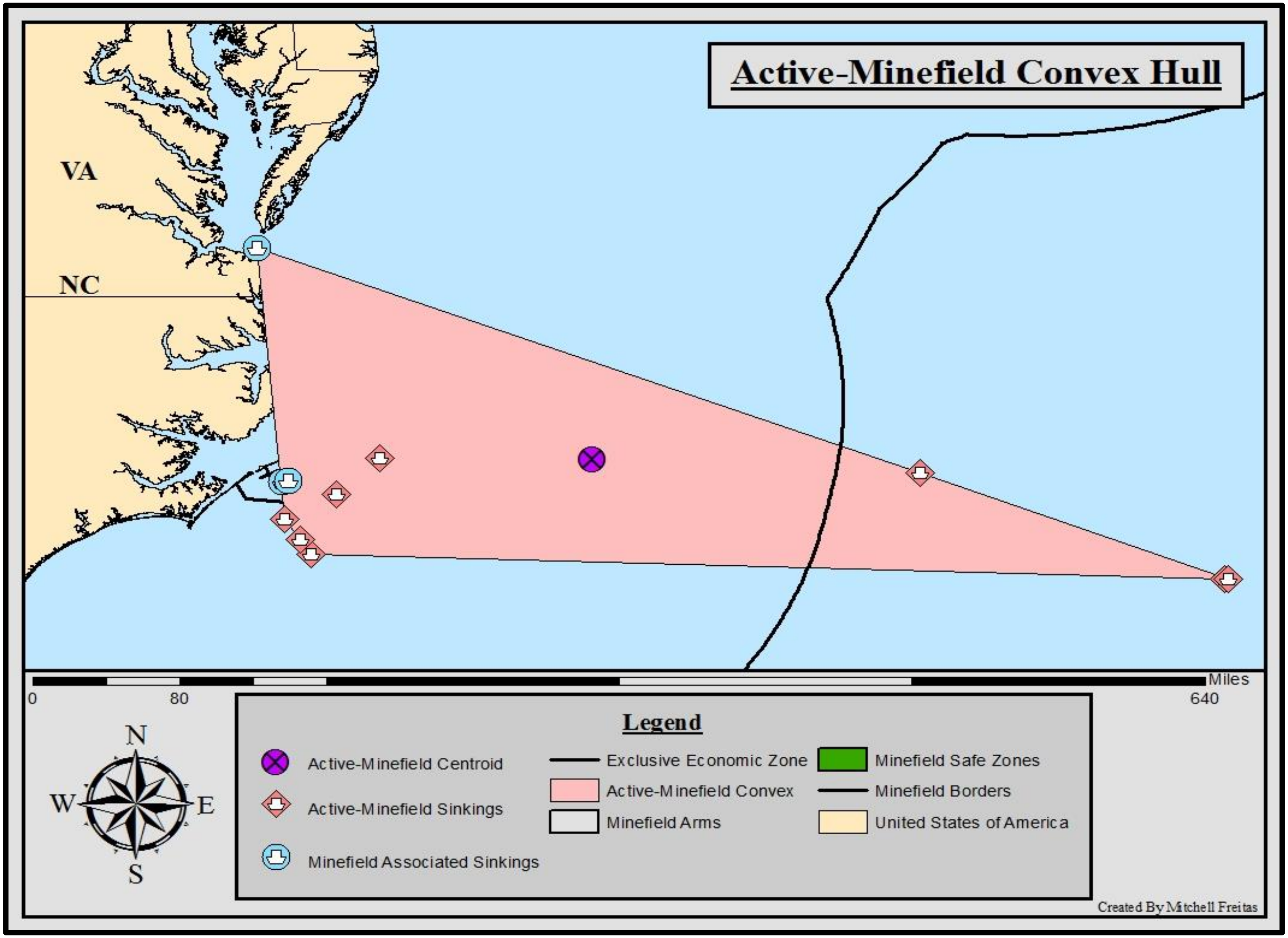


Active-Minefield Sinking Density
MD.
NJ.
DE.
Virginia
North Carolina
0
115
230
460
690
920
Miles
N
W
E
S
Legend
Minefield Arms
Minefield Safe Zones
Exclusive Economic Zone
Minefield Borders
United States of America
Active-Minefield Density
Value
0
0.468259633
0.936519265
1.404778838
1.87303853
2.341298103
2.809557676
3.277817488
3.746077061
Created By Mitchell Freitas

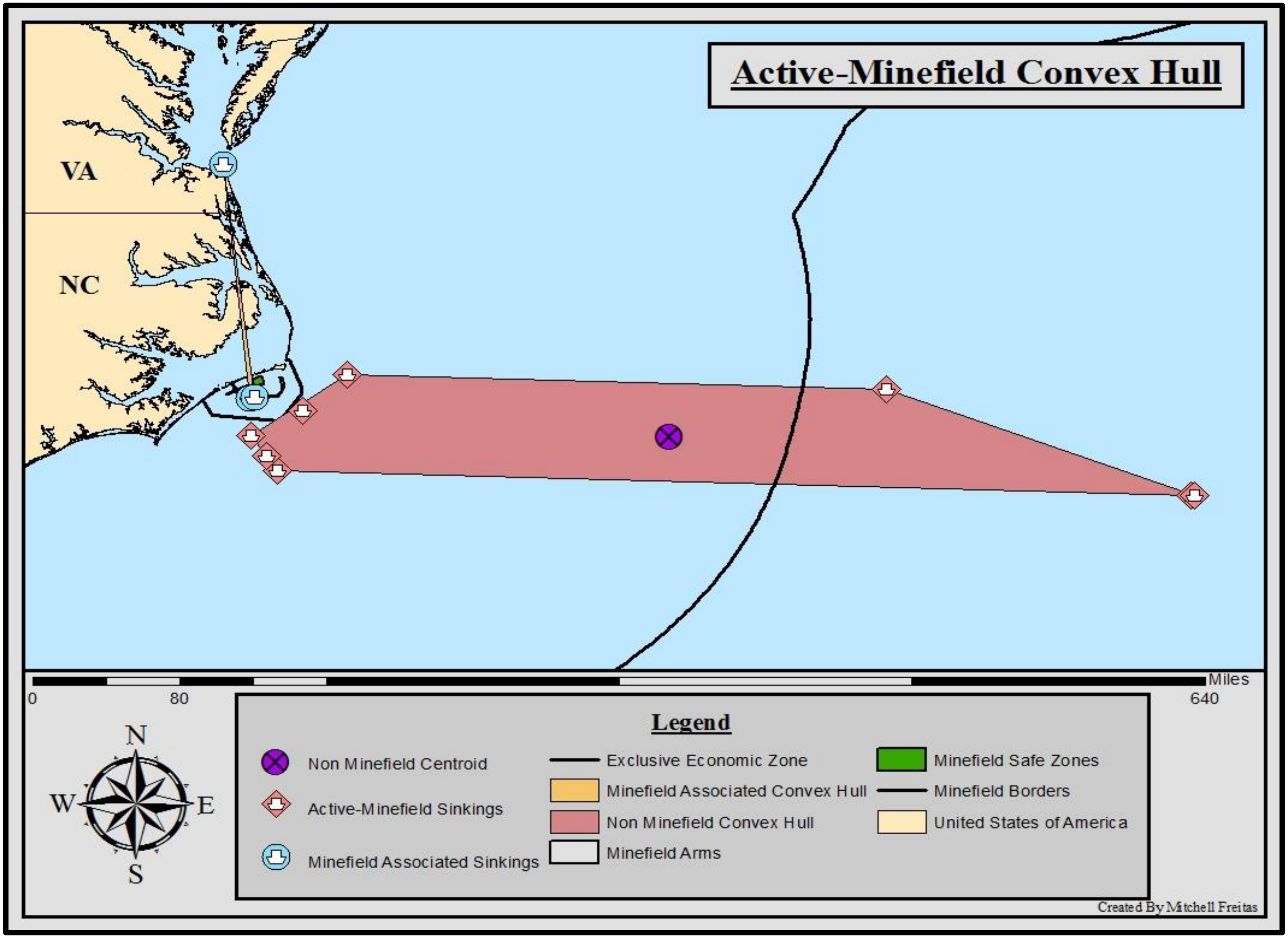

Post-Minefield Sinking Density
Virginia
North Carolina
South Carolina
Miles
0
115
230
460
690
920
N
W
E
S
Legend
United States of America
Navigational Hazzard
Exclusive Economic Zone
Post-Minefield Density
<VALUE>
0
0
0 - 0.470095945
0.470095945
0.470095945
0.470095945
0.470095945 - 0.936519265
0.936519265
0.936519265
Created By Mitchell Freitas

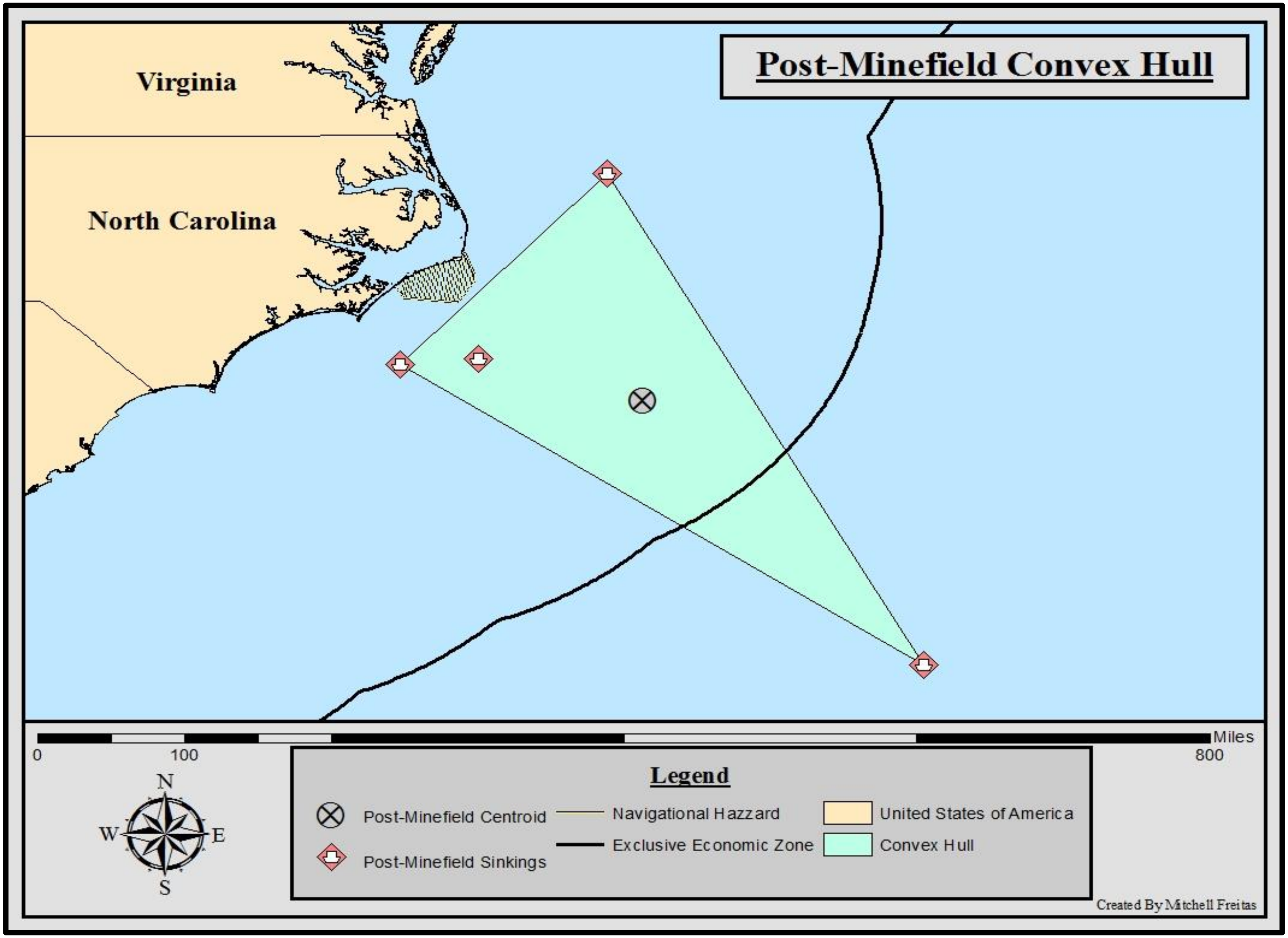


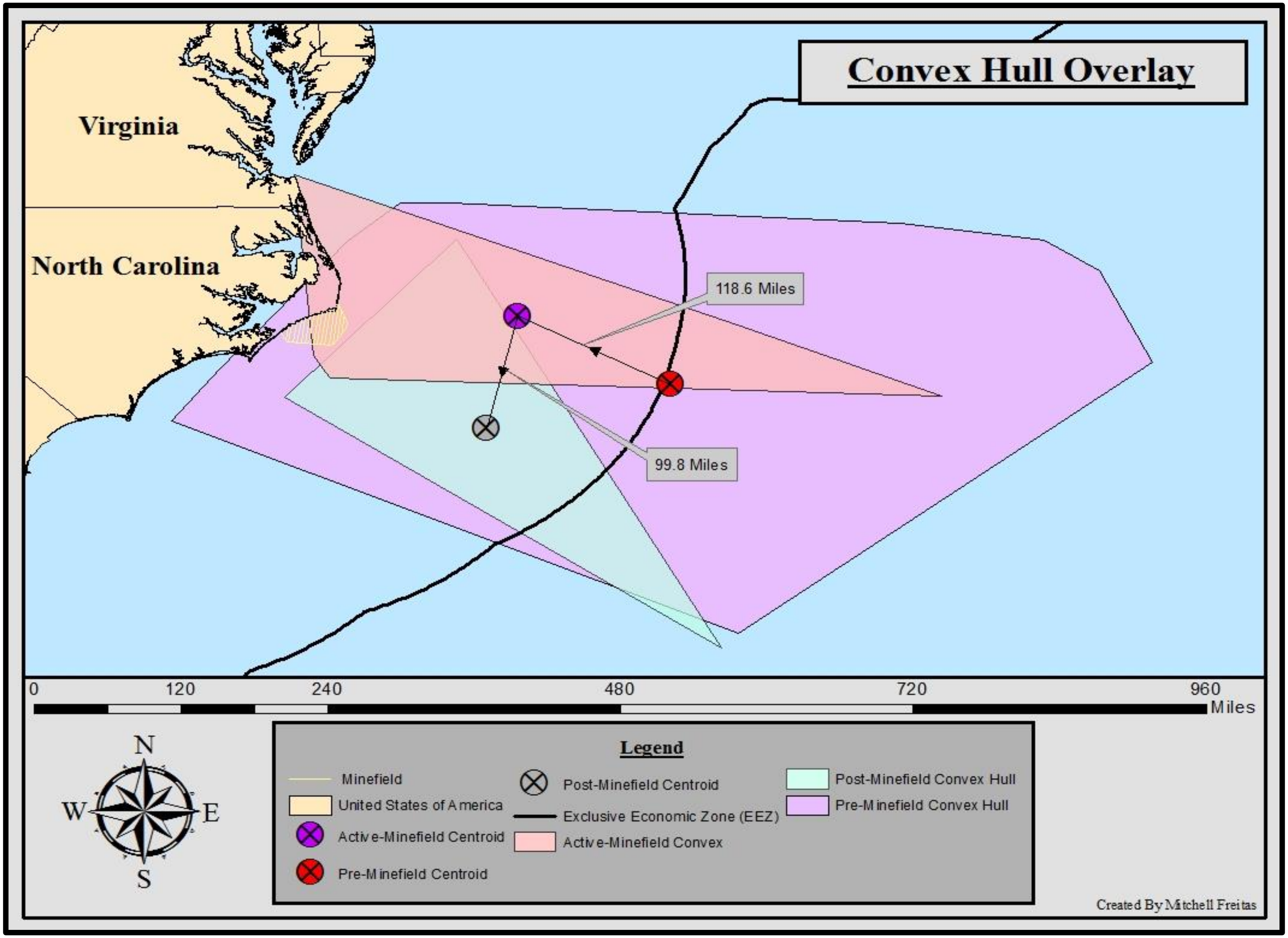
Pre-Minefield Convex Hull
Virginia
North Carolina
0
120
240
480
720
960
Miles
Legend
Pre-Minefield Centroid
Exclusive Economic Zone (EEZ)
Convex Hull
United States of America
Future Location of Minefield
Pre-Minefield Sinkings
N
W
E
S
Created By Mitchell Freitas

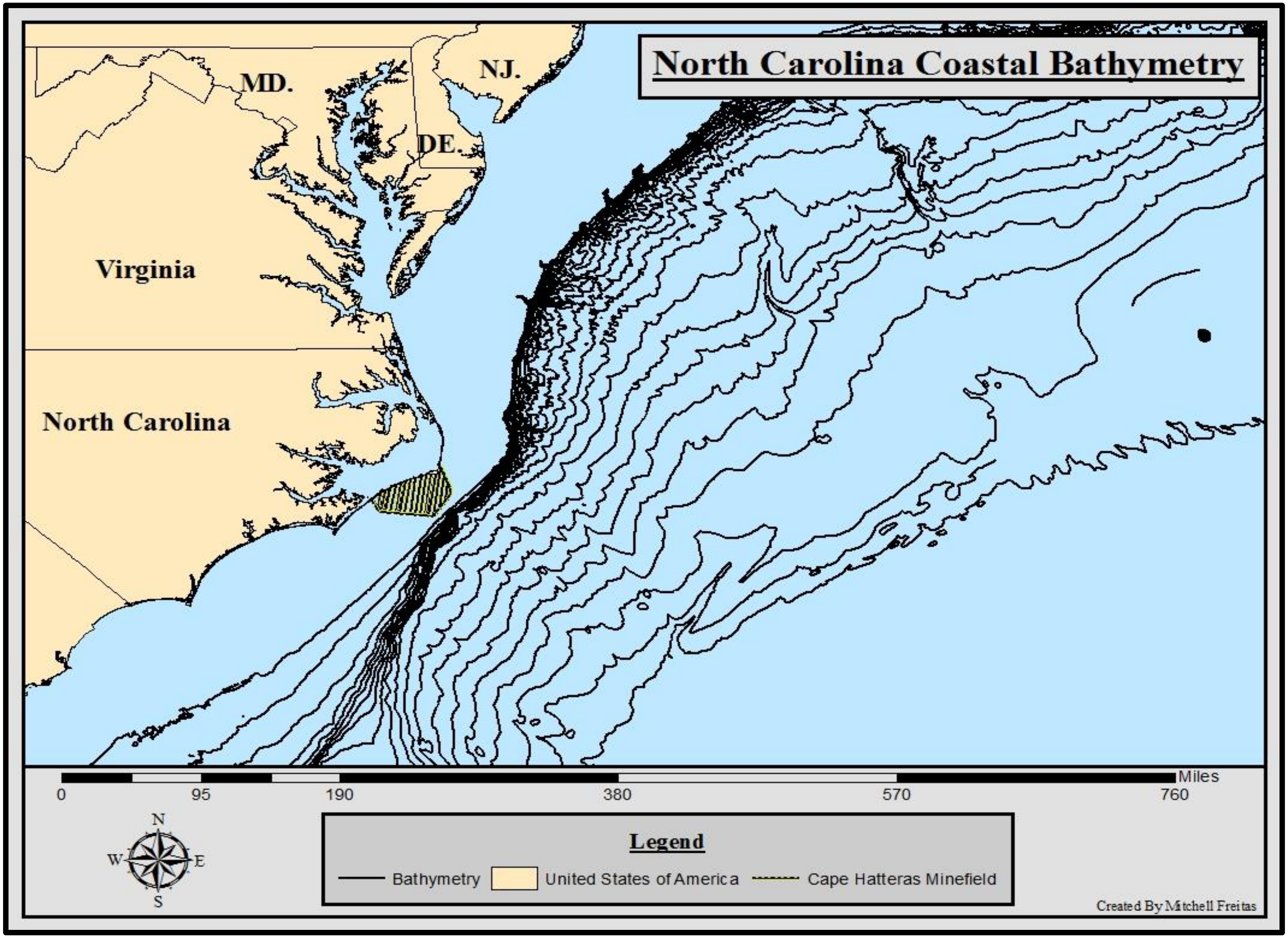


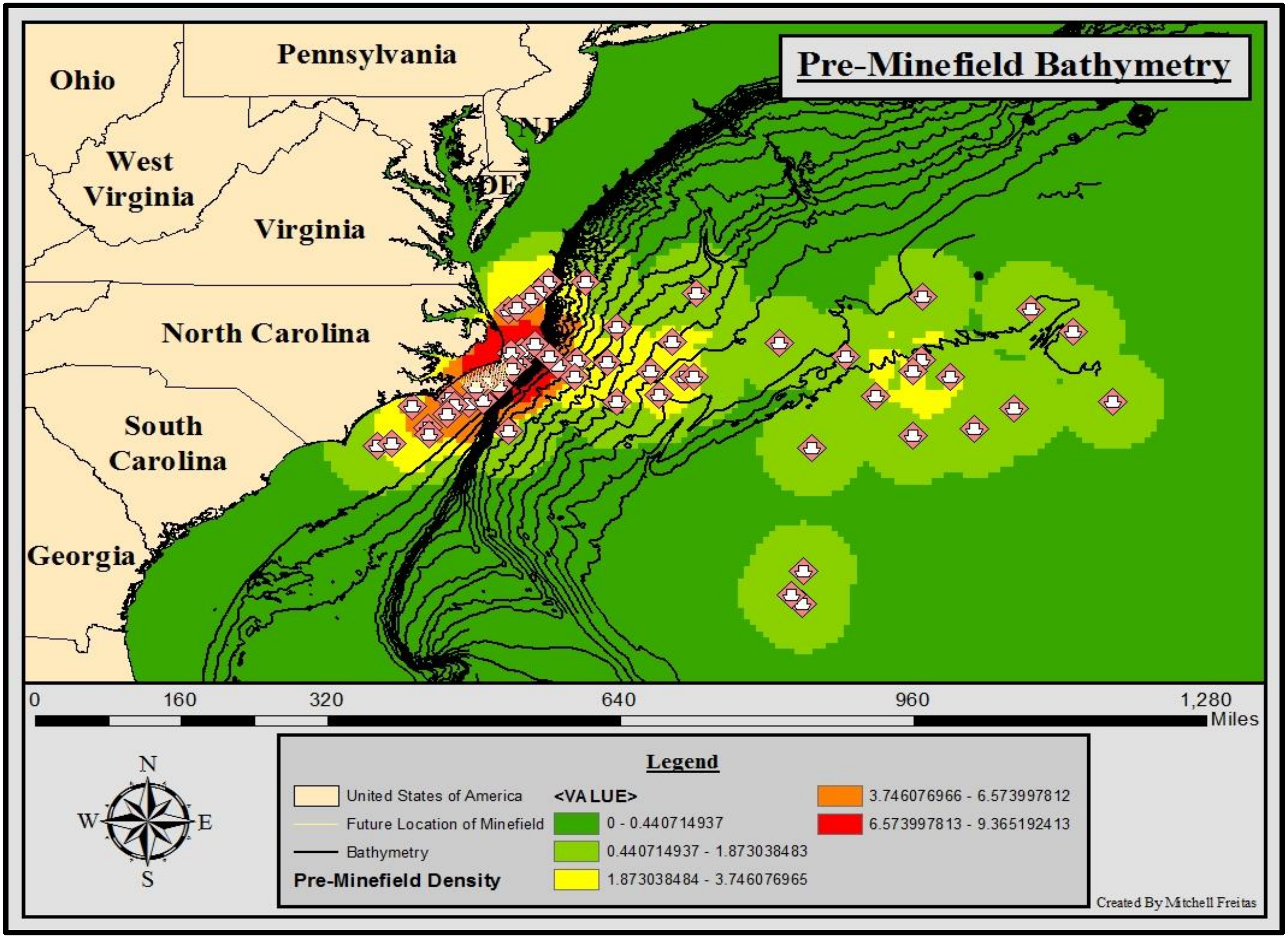
Active-Minefield Convex Hull
VA
NC
Miles
0
80
640
N
W
E
S
Legend
Active-Minefield Centroid
Active-Minefield Sinkings
Minefield Associated Sinkings
Exclusive Economic Zone
Active-Minefield Convex
Minefield Arms
Minefield Safe Zones
Minefield Borders
United States of America
Created By Mitchell Freitas

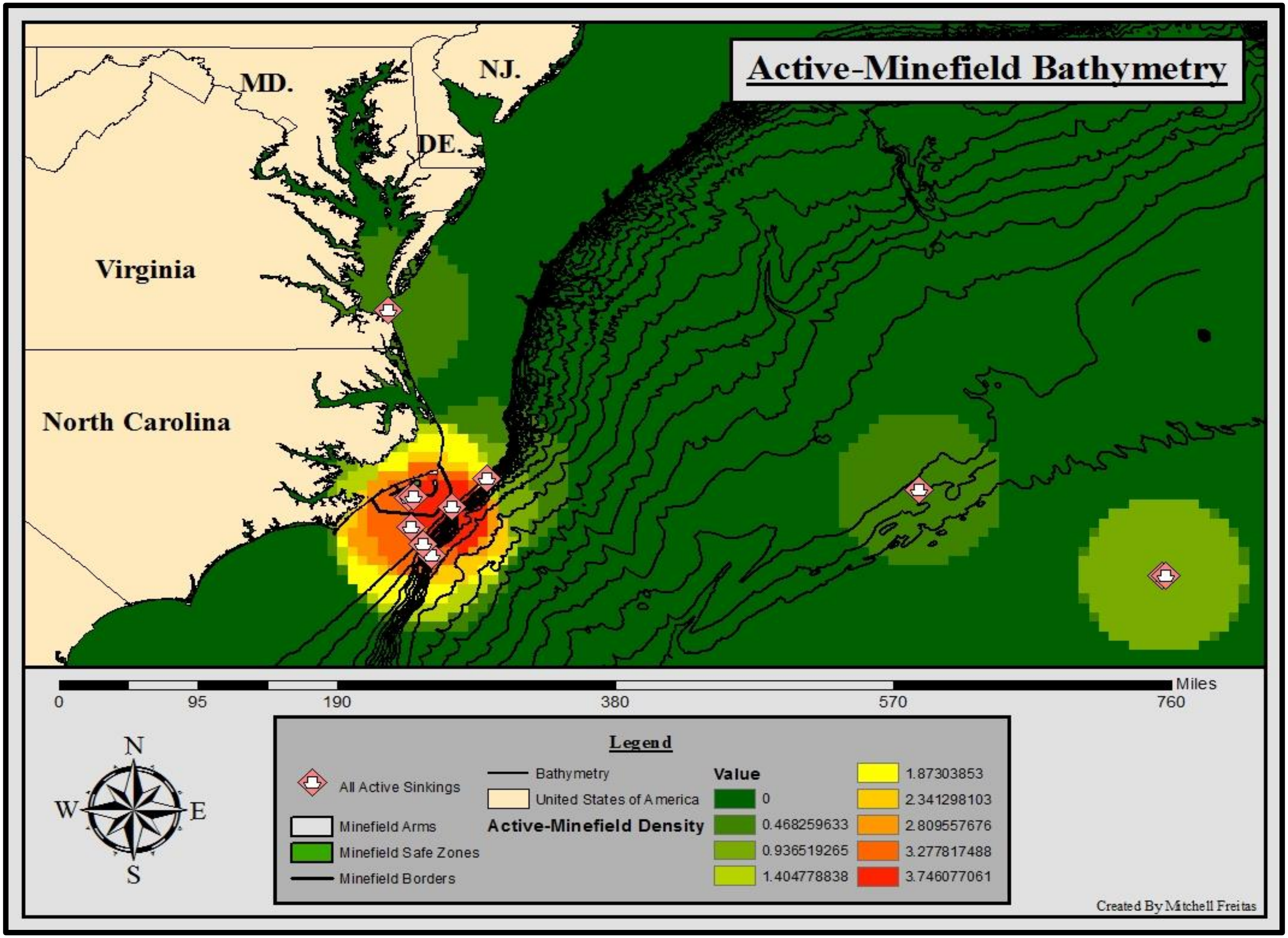

Active-Minefield Convex Hull
VA
NC
Miles
0
80
640
N
S
W
E
Legend
Non Minefield Centroid
Active-Minefield Sinkings
Minefield Associated Sinkings
Exclusive Economic Zone
Minefield Associated Convex Hull
Non Minefield Convex Hull
Minefield Arms
Minefield Safe Zones
Minefield Borders
United States of America
Created By Mitchell Freitas

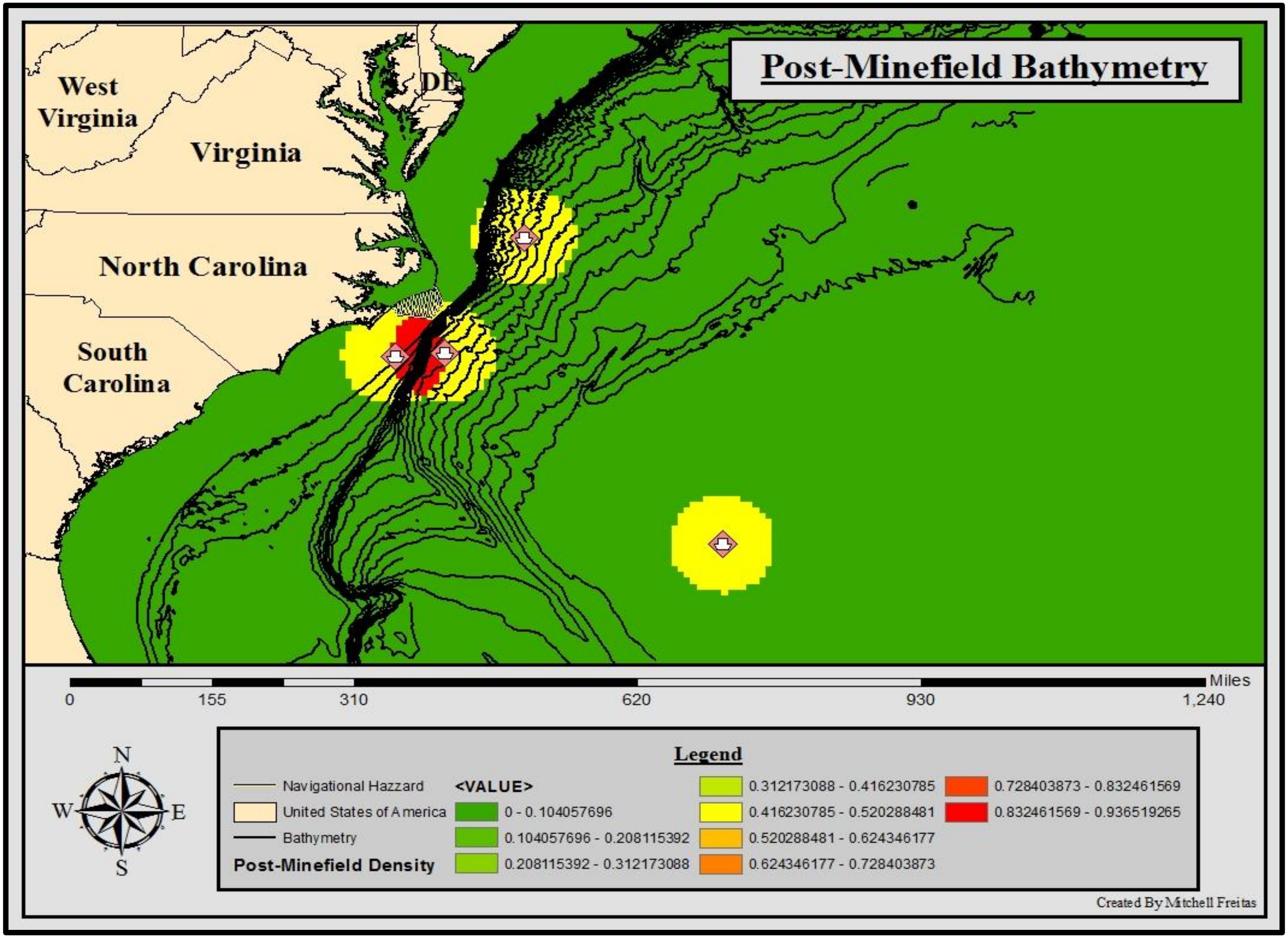

Post-Minefield Convex Hull
Virginia
North Carolina
Miles
0
100
800
N
W
E
S
Legend
Post-Minefield Centroid
Post-Minefield Sinkings
Navigational Hazzard
Exclusive Economic Zone
United States of America
Convex Hull
Created By Mitchell Freitas


Convex Hull Overlay
Virginia
North Carolina
118.6 Miles
99.8 Miles
0
120
240
480
720
960
Miles
N
S
W
E
Legend
Minefield
United States of America
Active-Minefield Centroid
Pre-Minefield Centroid
Post-Minefield Centroid
Exclusive Economic Zone (EEZ)
Active-Minefield Convex
Post-Minefield Convex Hull
Pre-Minefield Convex Hull
Created By Mitchell Freitas


North Carolina Coastal Bathymetry
MD.
NJ.
DE.
Virginia
North Carolina
Miles
0
95
190
380
570
760
N
W
E
S
Legend
Bathymetry
United States of America
Cape Hatteras Minefield
Created By Mitchell Freitas


Pre-Minefield Bathymetry
Ohio
Pennsylvania
West Virginia
Virginia
North Carolina
South Carolina
Georgia
DE
0
160
320
640
960
1,280
Miles
N
S
W
E
Legend
United States of America
Future Location of Minefield
Bathymetry
Pre-Minefield Density
<VALUE>
0 - 0.440714937
0.440714937 - 1.873038483
1.873038484 - 3.746076965
3.746076966 - 6.573997812
6.573997813 - 9.365192413
Created By Mitchell Freitas


Active-Minefield Bathymetry
MD.
NJ.
DE.
Virginia
North Carolina
Miles
0
95
190
380
570
760
N
W
E
S
Legend
All Active Sinkings
Minefield Arms
Minefield Safe Zones
Minefield Borders
Bathymetry
United States of America
Active-Minefield Density
Value
0
0.468259633
0.936519265
1.404778838
1.87303853
2.341298103
2.809557676
3.277817488
3.746077061
Created By Mitchell Freitas



Post-Minefield Bathymetry
West Virginia
Virginia
DE
North Carolina
South Carolina
0
155
310
620
930
1,240
Miles
N
W
E
S
Legend
Navigational Hazzard
United States of America
Bathymetry
Post-Minefield Density
<VALUE>
0 - 0.104057696
0.104057696 - 0.208115392
0.208115392 - 0.312173088
0.312173088 - 0.416230785
0.416230785 - 0.520288481
0.520288481 - 0.624346177
0.624346177 - 0.728403873
0.728403873 - 0.832461569
0.832461569 - 0.936519265
Created By Mitchell Freitas

APPENDIX C: PRICE LIST

			Pre-Minefield			
Item	**Quantity**	**Year**	**Bulk Price**	**1940s Price**	**2017 Price**	**Notes**
Manganese Ore	16,300 Tons	1942	$.72 Per Ton	$11,736	$174,844.08	
Fuel Oil	215,219 Barrels	1942	$2.39 Per Barrel	$514,373.41	$7,663,185.55	
Crude Oil	605,090 Barrels	1942	$1.11 Per Barrel	$671,649.90	$10,006,306.14	
Chromium Ore	2,006 Tons	1942	$16 Per Ton	$32,096	$478,169.36	
Sulphur	11,000 Tons	1942	$16.01 Per Long Ton	$157,080	$2,340,193.26	
Pig Iron	4,000 Tons	1942	$24 Per Ton	$96,000	$1,430,217.42	*
Iron Ore	37,440 Tons	1942	$4.45 Per Long Ton	$148,624.44	$2,214,221.50	
Phosphates	3,600 Tons	1940	$3.08 Per Ton	$11,088	$165,190.11	
Phosphate Rock	5,000 Tons	1942	$3.57 Per Long Ton	$15,923.28	$237,226.59	
Gas Oil	13,000 Barrels	1942	$4.36 Per Barrel	$56,680	$844,424.20	
Newsprint	6,200 Tons	1942	$50 Per Ton	$310,000	$4,618,410.43	
Coke	9,680 Tons	1942	$9.41 Per Ton	$91,088.10	$1,357,039.45	
Tin	750 Tons	1942	$100 Per Ton	$75,000	$1,117,357.36	*
Sugar	4,508 Tons	1942	$92 Per Ton	$414,736	$6,178,777.64	
Soda Ash	3,628 Tons	1942	$21 Per Ton	$76,188	$1,135,056.30	*
Palm Oil	1,296 Tons	1942	$.12 Per Drum- .74 Per Ton	$959.04	$14,287.87	
Motor Gas	10,692 Barrels	1942	$2.68 Per Barrel	$28,654.56	$426,898.45	
Heating Oil	190,000 Barrels	1939	$1.57 Per Barrel	$298,300	$4,444,102.68	*
Benzine	10,000 Tons	1939	$2.47 Per Barrel	$24,700	$367,983.02	
Aviation Gas	11,000 Barrels	1939	$2.45 Per Barrel	$26,950	$401,503.75	
Total				**$3,061,827**	**$45,615,395.16**	

Active-Minefield						
Item	**Quantity**	**Year**	**Bulk Price**	**1940s Price**	**2017 Price**	**Notes**
Coal	1,739 Tons	1942	$7.54 Per Ton	$13,112.06	$195,344.76	*
Fuel Oil	225,850 Barrels	1942	$2.39 Per Barrel	$539,781.50	$8,041,717.77	
Sugar	10,600 Tons	1942	$92 Per Ton	$975,200	$14,528,625.33	
Manganese Ore	6,675 Tons	1942	$.72 Per Ton	$4,906	$73,090.07	
Flaxseed	7,400 Tons	1942	$2.47 Per Bushel-$88.21 Per Ton	$652,754.00	$9,724,793.17	
Wood	25 Tons	1942	$45.49 Per 1,000 Feet/ $2,070 Per Pound	$1,098.79	$16,369.88	*
Total				**2,186,852.35**	**$32,579,940.98**	

Post-Minefield						
Item	**Quantity**	**Year**	**Bulk Price**	**1940s Price**	**2017 Price**	**Notes**
Sugar	80,000 Tons	1942	$92 Per Ton	$736,000	$10,965,000.25	
Total				**736,000**	**$10,965,000.25**	

(Lloyd’s 1989; United States Department of Commerce)

*Denotes average of similar items