Reading Between the Iron Lines:

An Analysis of Cannon Arrangement on Caribbean Shipwrecks

By:

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ABSTRACT:

The aim of this study was to explore patterns of cannon distribution on shipwreck sites using primary historical sources and archaeological case studies. This archaeological data set comprised ten shipwreck sites with multiple cannons located in the Caribbean and in the waters of Bermuda. The intent was to determine signature characteristics of cannon patterns. These patterns may potentially reflect the wrecking event, crew procedure or emergency action jettisoning heavy artifacts during a time of disaster or post wrecking salvage operations. Historical sources revealed information concerning maritime insurance protocols for jettisoning artifacts.

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An Analysis of Cannon Arrangement on Caribbean Shipwrecks.

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CHAPTER 1: INTRODUCTION

Introduction

This thesis will investigate cannon distribution on shipwreck sites and analyze the wrecking event of the ship, crew procedure or emergency action of jettisoning heavy artifacts during a time of disaster, post-wrecking salvage operations and in situ changes on the site. The focus area for this research will be within Caribbean and Bermuda waters, where sufficient historic and archaeological information on shipwreck sites displaying cannons is available.

The locations selected for this study include: Cannons Site, Costa Rica; *Quedagh Merchant*, The Dominican Republic; Pedro Bank, Jamaica; Manilla Wreck, Bermuda; *El Buen Consejo*, Anguilla; The French Cannon Site (GC-017), Cayman Islands; Rockley Bay (TRB-5) Scarborough Harbour, Tobago. Historical research using primary sources addressed the various material types and caliber of cannon most likely carried and arrangement of ordnance on decks aboard these ships during the Age of Sail. This research will attempt to answer the following research questions:

Primary Research Question:

- To what extent is it possible to explain or characterize the wrecking process of a ship by the arrangement of cannons on the site?

Secondary Research Questions:

- Can the case studies yield historical information on cannon type and original stowing pattern on the ship?
- Are some patterns representative of methods of cannon used as ballast or stowage?

Methodology

The methodology used for this research will require examining historical and archaeological reports from: Cannons Site, Costa Rica; *Quedagh Merchant*, The Dominican Republic; Pedro Bank, Jamaica; Manilla Wreck, Bermuda; *El Buen Consejo*, Anguilla; The French Cannon Site (GC- 017), Cayman Islands; Rockley Bay (TRB-5); and Scarborough Harbour, Tobago. Specifically, the methodology focused on identifying cannon placement on the site and analyzing arrangement of the cannons on each site in relation to Cultural Transforms (C-Transforms). Figure 1.1 shows how ordnance or cannons can reflect wrecking events influenced by C-Transforms through patterns of distribution.

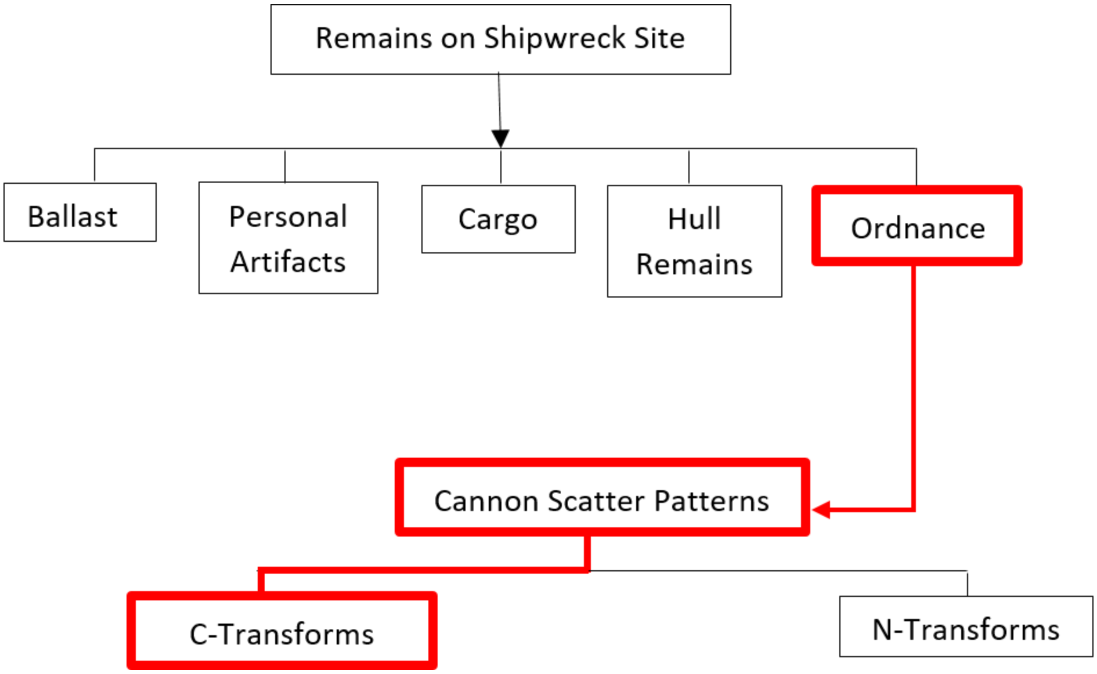


FIGURE 1.1. Diagram linking C-Transforms to Cannon Scatter Patterns (Author 2018).

To establish the extent of prior documentation of historical cannon shipwreck sites by scholars in the published record, a historical research review was conducted. The researcher utilized journals, proceedings, and archaeological field reports. The images and sitemaps from the publications were visually enhanced using Adobe Illustrator and Photoshop software programs. The author marked the direction of the cannons (arrow tip on the muzzle end), as a technique to establish a foundation for highlighting potential patterns. The author researched organization methods and patterns practiced in various scenarios during the Age of Sail to provide possible scenarios of cannon location and organization prior to wrecking. While N-Transforms of the marine environments have great potential for scrambling features of a submerged site over time, some patterns reflect little evidence of scrambling.

The research in this study focused on analyzing the behavioral aspects of the crew during emergency situations. Supportive information was reflected in journal entries and documents of maritime law procedures used during the Age of Sail. Once procedures from primary sources were accounted for, a framework of scenarios requiring the jettison of cannons, which included topics focusing on cannon storage and security, insurance procedures when the act of jettison is performed, and general seafaring techniques was established (Anon 1767; Brady 1852; Magens 1755; Rowbotham 1961).

Once the chart was created, information from the primary sources and the archaeological reports were then cross examined for cannon patterns, or formations, that had potential for explaining pre and post wrecking events. Each site was examined with by these parameters to best attempt narrowing a distribution signature for each categorized feature.

Classification of the different patterns grew quickly and required the researcher to create a list of terms to be used in this study as well as typologies of the different cannon formation patterns. After the definitions and frame work of the study was established, data was then extracted from the available sources and then entered into a Google Sheets database, which was sorted by the author’s list of feature classifications: *Cluster, Fan, Pair, Riggs,* and *Stray*. Each site was analyzed by cannon features and assigned a referral ID and number (Cannon Feature #)

that was labeled and circled in blue. A feature total was also processed per site. Sitemaps showing the referral IDs, spreadsheet tables, and pie charts of each site are provided in the analysis and results chapter of this study.

Analysis

The combination of archaeological reports of each site containing hypotheses based on the remaining evidence, documents from the historical record giving the author knowledge and insight to seamanship and protocols on ships during the Age of Sail, and an understanding of site formation theory and behavioral archaeology provided valid structure in the analysis of this study. The results from this study show signature patterns which have potential for linking to C-Transforms prior and after the wrecking of the ship(s).

Conclusion

The application of site formation theory, as formulated by Muckelroy (1975), Schiffer (1975), and Gibbs (2006) to case studies will further assist in interpreting a specific type of wreck site signature – a cannon scatter or pile. These cannon sites are prevalent in the archaeological record of the Caribbean and Bermuda, yet there is a paucity of systematic analysis to build a more substantive foundation of archaeological, historical, and environmental knowledge. This study was the first step to further expand site formation framework to focus on linking cannon distribution patterns to C-Transforms.

CHAPTER 2: THE HISTORY OF CANNONS AND ELEMENTS OF SHIP DESIGN

Introduction

Cannons provide a wide array of underlying information about the historical context within cultures, such as politics, economics, military tactics, and overall naval presence. This thesis aims to examine whether particular variables correlate between the orientations of cannons found on underwater archaeological sites and the wrecking or abandonment processes.

Parts of a Cannon

The first step in dating a cannon is to understand its various parts. Historical maritime archaeologists need to possess this skill to produce accurate analyses of such an artifact. Cannons vary in shape, size, and material, and over time their design and role in warfare evolved. Figure 2.1 represents a standard diagram of a cannon with its associated parts labeled.

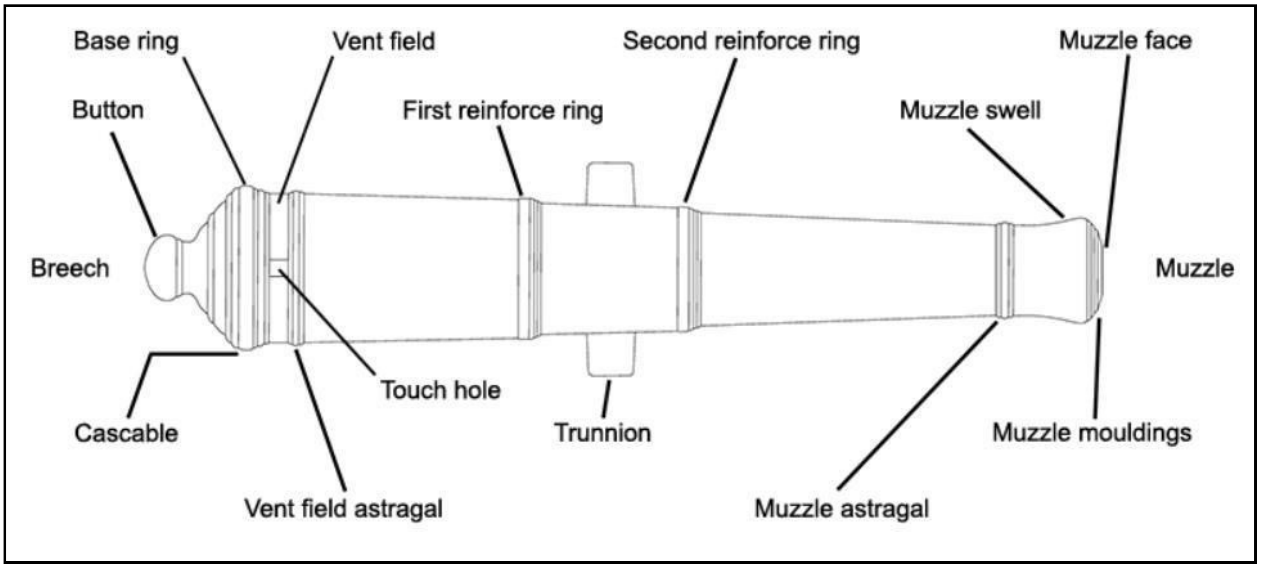


FIGURE 2.1. Parts of a Cannon (Camidge 2017).

During the manufacturing process, cannons were made with a tapering mold, which required extra support added to specific parts of the cannon’s body. Gunfounders added a ring of metal, known as reinforcement rings, to provide additional strength to the weapons; these were typically dispersed along the cannon. The number and layout of rings varied based on factors such as size or caliber, cannon material or make, and personal preference established by the gunfounder.

The chase designates the most extended shaft of the cannon; it also has the largest gradient of metal thickness of the cannon. The mouth of the cannon then follows the chase, also referred to as the muzzle. The total length of a gun is found by measuring from the breech to the end of the muzzle.

The vent is located on the top surface of the cannon between the breech and first reinforcement ring. This area is the typical location for the touchhole, a small opening where gunpowder was loaded behind the shot in the bore, or the barrel from which the shot would be projected. The touchhole required either gunpowder stacked to the touchhole or a fuse that could be lit for a delayed time of fire (Masefield 1971:14–17).

The cascabel is typically located at the back of the cannon. While most cascabels share a design similar to a doorknob, history shows that they vary in shape and size. These noticeable changes have been used by archaeologists to date cannons from many different cultures and eras. A rope attached to the inside of the ship’s hull was tied to the cascabel to keep the cannon firmly in place after it was fired (Brown 2011:54-59).

Trunnions are small to medium sized cylindrical handles on cannons, intentionally designed to fit into small transport carriages. These carriages had a half circle carved into them that allowed cannon trunnions to fit into position, much like a puzzle piece. Trunnion locks were also developed later to stabilize the cannon during transport and when being fired.

The History of Cannons

The history of changes in cannon design reflects significant changes in tactical innovations for navies and merchant ships. Initially, cannons were a purely supplemental method of protection and were extremely limited in the sense of application on ships (Gardiner 1992:7). Thus, providing insight to understand why ships carried the number of ordnances, any changes to ship designs to accompany such endeavoring enhancements, and how the political tensions of powerful nations fueled the desire for a powerful naval presence.

The 1300s

With the invention of gunpowder, cultures around the world attempted to harness this material into a weapon that could give them power over adversaries. There is an abundance of evidence supporting multiple cultures possessing an engineered or modified version of a projectile that uses gunpowder propelled ordnance. However, there are no definitive methods for precisely deciphering which records accurately qualify as cannon. This issue is due to the underlying fact that historical representations of the earliest form of cannons before the 15th century do not meet the minimal criteria that define a cannon today. The earliest known record of European use of cannons dates to A.D. 1326 (Cipolla 1996:21).

Naval historian Carlo Cipolla referred to an official Florentine document in his research which stated, "*Pilas Seu Palloctas Ferreas et Canones de Mettallo* [The Cannons of Metals and Iron Pellets]" (Cipolla 1996:21). Since their introduction in A.D. 1326, cannons have been a vital factor in determining success in warfare. Europeans were fascinated with this new concept of armament, and shortly after 1330, it was standard that ships were equipped with cannons. The historical record illustrates how cannons were perceived approximately 25 years after their introduction into naval combat. Francesco Petrarch (A.D. 1358), Italian poet and scholar during the Renaissance period, wrote one dialog referring to cannons, which emphasized:

> These instruments which discharge balls of metal with most tremendous noise and flashes of fire … were a few years ago very rare and were viewed with the greatest astonishment and admiration, but now they have become as common and familiar as any other kind of arms (Cipolla 1996:22).

Not only did cannons possess the ability to physically obliterate entire fleets, but they could damage a crew’s mental toughness as well. The continuous echoing of explosions could provide just as much damage as dismasting the enemy’s ship. Maritime Historian Carlo Cipolla referred to a manuscript that was written during the great siege of Oudenarde (A.D. 1382) which stated that noise played an essential part in assisting the army of Philip van Artevelde that the cannons:

> Made a marveylous [marvelous] great bombard shotying [shooting] stone of marveylous [marvelous] weight and when this bombard shot it made suche [such] a noyse [noise] in the goynge as though all dyvels [devils] of hell had been in the way (Unreferenced source in Cipolla 1996:22,97).

European nations learned of the new style of tactical warfare and began to create independent versions of cannon, each comprised of features engineered with the specific intent to bring both fear and respect with each shot fired. The passion for gaining a naval advantage over enemies was a supporting force in the construction and use of cannons. Controlling a robust naval presence gave nations strength, though power meant nothing if rivals discovered weakness through a lack of proper organization and execution. Naval leaders used the knowledge they had previously gained through naval combat to their advantage when devising new strategies and tactics involving cannon. Naval historian Jan Glete explained the difference between tactics and strategy and how military powers perceived cannons. Glete wrote that "tactics were the physical actions performed, while strategy was the factors examined to devise a series of plans to be carried out. Strategies for naval warfare include variables such as distance, logistics, environment or geography, and endurance" (Glete 2000:17).

Combining naval strategies, tactics, and advanced technologies became a turning point for naval warfare. This combination was a force that established dominance on both land and sea. To ensure a prosperous future with consistently developing new warfare technologies such as cannons, admiralties were developed and viewed as a necessity if European nations intended to keep their military prowess.

The 1400s

Vessels constructed during most of the 15th century contained small quantities of cannons. Throughout this time, the sophistication of gun armament was still in its infancy, and attempts were made to understand how to harness this technology. Unfortunately, this would not be applied successfully to naval combat until much later. Since their discovery and development, cannons were used primarily for land battles or battles at sea that replicated land battle characteristics. For example, naval combat at sea in this period had not yet developed tactics that used cannons for long distance protection. Instead, the typical conflict at sea involved navigating close to an opponent's vessel, grappling and boarding, followed by fighting in close combat (Robertson 2015:6). Any cannons utilized on board a vessel during the later years of the 15th century was stationed on the top deck, small in size, and typically constructed of bronze.

The later years of the 15th century provided new developments in ship design and, as a result, propelled European powers into a competitive frenzy, especially after the discovery of the West Indies by Christopher Columbus in 1492. Until this time, European ships had only experienced the waters of the Pacific (via the East Indies), the Northern Atlantic, the Indian Ocean, and the Mediterranean. Thus, they lacked proper ship design necessary to compensate for the rough waters, wind patterns, and other geographic variables along the routes to the Caribbean and Americas (Robertson 2015:5). Ships built initially for trade or war required new designs, which became apparent while navigating the Western Atlantic during the Age of Exploration. Early ships of discovery returned to their countries severely damaged, if they returned at all.

The 1500s

In 1501, the French invented a valuable feature; the gunport, which changed all European ship design from that point forward (Robertson 2015:7). The gunport was a small square or rectangle cut directly into the ship's hull above the waterline. Because this feature allowed for the gunnery to be adjusted into an attacking position by penetrating the openings in the hull, most cannons were stationed on various decks. Gunports were designed with a wooden lid to seal the hull of the ship and cover the cannons when not engaged in combat. The lids were attached by hinges to the ship’s hull and were crucial for preventing the guns from being exposed to the harsh elements.

With the age of discovery, the 1500s brought two types of vessels: those designed for war and those for mercantilism. European nations understood that they needed to reconsider ship design. England was one of those countries that had the determination and an even more magnificent obsession to maintain a powerful navy over other nations. King Henry VIII wanted more effective ships than his rival countries: Spain, France, and Scotland. Thus, the King hired Italian shipwrights to assist in designing ships that would give England a stronger edge over other nations. He desired to possess a navy which harnessed the benefits of two ship types: the speed of sailing ships and the firepower of broadsides (Robertson 2015:6–7). These ships experienced severe problems with adequately incorporating the desired broadside armament. One famous example of this was King Henry VIII's *Mary Rose*, which sank rapidly due to the gunports being placed too close to the waterline.

The 1600s

In the 17th century, a new characteristic was added to cannons in the form of an additional ring to the cascabel with the intent of providing extra security to the cannons during both travel and combat (Howard 1979:209). The ring prevented the rope, which was firmly secured around the cascabel, from sliding off and inevitably losing control of the cannons during movement or hoisting after being fired.

Between European wars from 1649 to 1660, England modified its naval tactics. Due to the number of guns established on each deck per ship, firing at targets at the same time significantly increased the chance of damaging an enemy vessel compared to typical one on one vessel combat. When entering combat, fleets lined up one after another across the enemy and fired their broadsides. This tactical innovation created a wall of ordnance to cripple and demolish vessels from the topmast to the waterline of the hull and was later referred to as Ships of the Line. England introduced its fleet of the line tactic in 1653, which was proven successful in naval combat for following centuries (Lavery 2009:42).

Shortly after the introduction of the ships of the line tactic, navies made further modifications to their ship layouts and armament. In 1680, Navies shifted identification of cannons to the specific caliber of shot (Howard 1979:207). Until this change, cannons were referred to by a general name, such as Falcons and Minions. As a result, this shift in terminology greatly benefited naval tactics and future ship design by providing more specifics about the purpose of the cannons and where to place them to be productive and efficient.

At the end of the 17th century, shipwrights modified gun decks for naval tactics by utilizing various types of cannons based on their desired use and range of power. Larger caliber cannons were stationed on the lower decks just above the waterline in an attempt to cause as much damage as possible, while lighter caliber guns were stationed on the decks above (Howard 1979:207). Mid-sized cannons were applied in more strategic manners, they were positioned to hit opposing gun decks and damage the integrity of the enemy’s hull. The lightest cannons on the top deck were primarily used to fire at sails, masts, and other areas of the ship used for steering and navigating. If a ship was crippled, the crew was likely doomed. The lightest cannons on board the ships were swivel guns, which were smaller and produced the highest range of maneuverability and angling. These were primarily used to target men attempting to either board the ship or to fire at the opposing crew while on deck; swivel guns were referred to as man-killers (Howard 1979:207).

The most successful ship design modification that encompassed the aforementioned use of cannon was the tumblehome principle. This style of ship design applies the Tumblehome principle (Figure 2.2), which gradually tapers the shape of the ship’s hull inward just above the waterline (indicated by a blue dashed line). Using this design created a more efficient use of hull space and better weight distribution, making the vessel more stable (Lavery 2009:134).

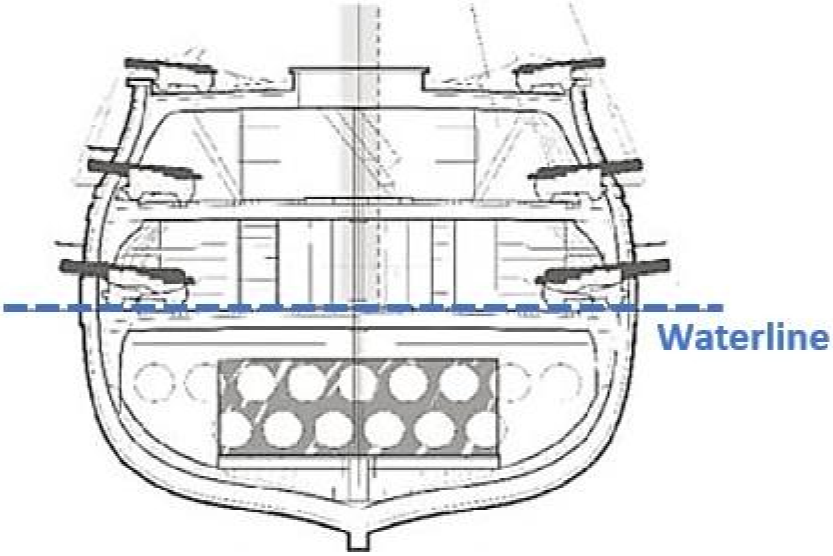


FIGURE 2.2. Tumblehome Principle (Lavery 2009:134). Alterations by the author.

Chase cannons, guns positioned to fire directly forward at the front of the ship, were viewed as the primary form of armament until the speed of cannon loading techniques advanced during the 16th century (Gardiner 1992:7). This provided more options for cannon placement and increased the number of cannons allowed on a vessel, eventually increasing the stability and security of the ship. As a result, this changed European ship designs to be a more effective for naval tactics during the Age of Sail.

The 1700s

In 1711, the science of naval architecture was explained in William Sutherland’s publication, *Ship-builders Assistant*. Prior to this discovery, shipwrights were trained to design ships by hand without complex calculations or an understanding of oceanographic factors. Most of the designs were based on trial and error over time. Scientific concepts involving shipbuilding were not positively recognized and appreciated until 1750 (Robertson 2015:35).

The English abandoned the favorite two decked design that carried 20 or 24 cannons in 1745. However, the Dutch kept this design and used it until 1780. This style of a ship was referred to in Holland as the “English Design” (Howard 1979:215). From 1753 to 1760, the Danish Navy experimented with shortening their 32-caliber cannon (Howard 1979:208). The results of this experiment were unsuccessful. The French also tested their armament by modifying the length of their cannons during this century; this venture was also unsuccessful (Howard 1979:209).

In 1780, England invented the flint-lock for cannons. This addition significantly increased firing accuracy, specifically with both aiming and timing (Lavery 2009:40). Before this innovation, cannons were either fired by lighting the touch hole or using a fuse. Either way, the spark ignited the gunpowder and created an explosive force which propelled the ordnance out of the cannon’s shaft. During this period, countries began to incorporate carronades into their naval armament and tactics.

Carronades were short and stout, but omnipotent guns. They were attached to metal stands that allowed for the broader range of mobility of a swivel gun with the power of a howitzer (Howard 1979:213) (Figure 2.3).

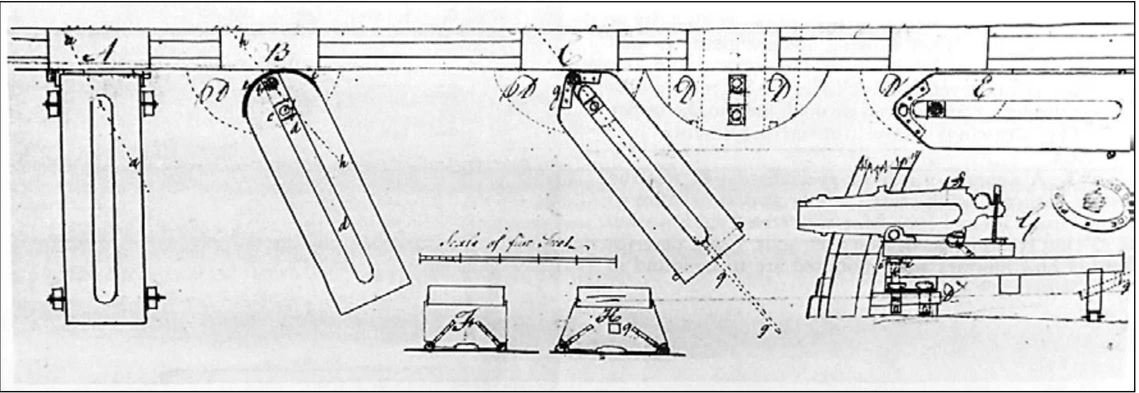


FIGURE 2.3. Carronade position plan (Howard 1979:214).

Carronades were used worldwide in short-range combat and typically arranged on the top deck for both anti-ship and anti-personnel activities. Merchant's vessels, for example, were often loaded with guns for protection during their ventures. During the 18th century, it was difficult to distinguish between a merchant ship and a mid-sized warship (Haws 1985:99). Besides the aspect of protection, a possible benefit of equipping merchant ships with large numbers of guns was to mask the vessel as a warship, which would likely repel pirates and privateers from attacking merchant vessels that were mainly targeted for their valuable cargos.

Eventually, improvements were made to cannon carriages to increase gun mobility. As a result, specific features of cannons became less useful and were discontinued. For example, naval historian Dr. Frank Howard wrote that "the general shape of carriage guns did not alter, but there were changes in detail. The loops for hoisting the gun (the dolphins) disappeared and so did the decoration" (Howard 1979:208). Dolphins were typically decorative, representative of creatures from the sea (Figure 2.4). This characteristic was strictly reserved for brass or bronze guns on essential ships.

FIGURE 2.4. Image of Dolphins on a bronze cannon (Lavery 1987:90).

England’s Board of Ordnance

England’s Board of Ordnance was one of the oldest contributing factors to the nation’s military success and can be traced back to medieval times. During the 17th century, England’s ordnance was world renowned as superior in comparison to any other European nation (Rodger 1996:301). The Board was assigned the duty of supplying guns and other necessary accessories to both the army and navy. Guns supplied to the army and navy were often manufactured in the same foundries. In the earliest stages of manufacturing military weapons, there were no real differences in cannon appearances. However, this changed later due to technological advances in engineering. Few members of the Board of Ordnance possessed firsthand experience working at sea, thus forcing the members to acquire advice from those who possessed the proper knowledge and experience concerning weaponry. In short, the Board required the assistance of the Admiralty and the Navy Board (Lavery 1987:80). As a result, this system established a symbiotic relationship between the three departments.

Cannons were often used both in terrestrial and seagoing battles and were interchangeable. As such, the weapon was highly marketable and valued universally by the military. Typically, when ships were retired or repaired for long periods of time, the cargo and armament were removed from the vessel. Nonetheless, there were frequent issues regarding which department was responsible for maintaining an inventory of the guns in supply (Lavery 1987:80–81). There was no system of checks and balances in place to hold the Navy Board, Board of Ordnance, and the Admiralty of the Royal Navy responsible. The Admiralty maintained some advantages over the Board of Ordnance and Navy Board. Nevertheless, the Admiralty consistently neglected to report finances and manifests to the lower boards. When questions about missing finances, supplies, and cannons arose, the three boards were usually the first to be accused among the governmental departments given their close and frequent encounters with the cannon supply. These arguments eventually led to the development of the Privy Council, which was given the authority to properly distribute power and duties among the three boards (Lavery 1987:81).

The Board of Ordnance did not make or manufacture many guns themselves. Local gunfounderies were hired via contract to produce many of the cannons for the Board of Ordnance. By the middle of the 17th century, most guns were ordered in higher quantities by naval powers. During this same period, gunfoundery manifests reveal a significant jump in production numbers from bronze to iron cannons. Bronze cannons were expensive to produce and maintain over time; iron was a cheaper material and could be produced in larger quantities at faster rates (Lavery 1987:80-85).

The Board of Ordnance was required to expand its source of production to submit special orders in more significant quantities. To meet the demands of the Board's superiors, who demanded substantial numbers of cannons per ship in naval fleets, the Board needed assistance to accomplish this task. Therefore, in addition to signing contracts with large gunfounderies, the Board hired private companies and individuals that met their level of standards regarding blacksmithing capabilities to assist in meeting immense production goals. Each company or employee was provided specific details and designs that were drafted by the members of the Board of Ordnance (Lavery 1987:81–82).

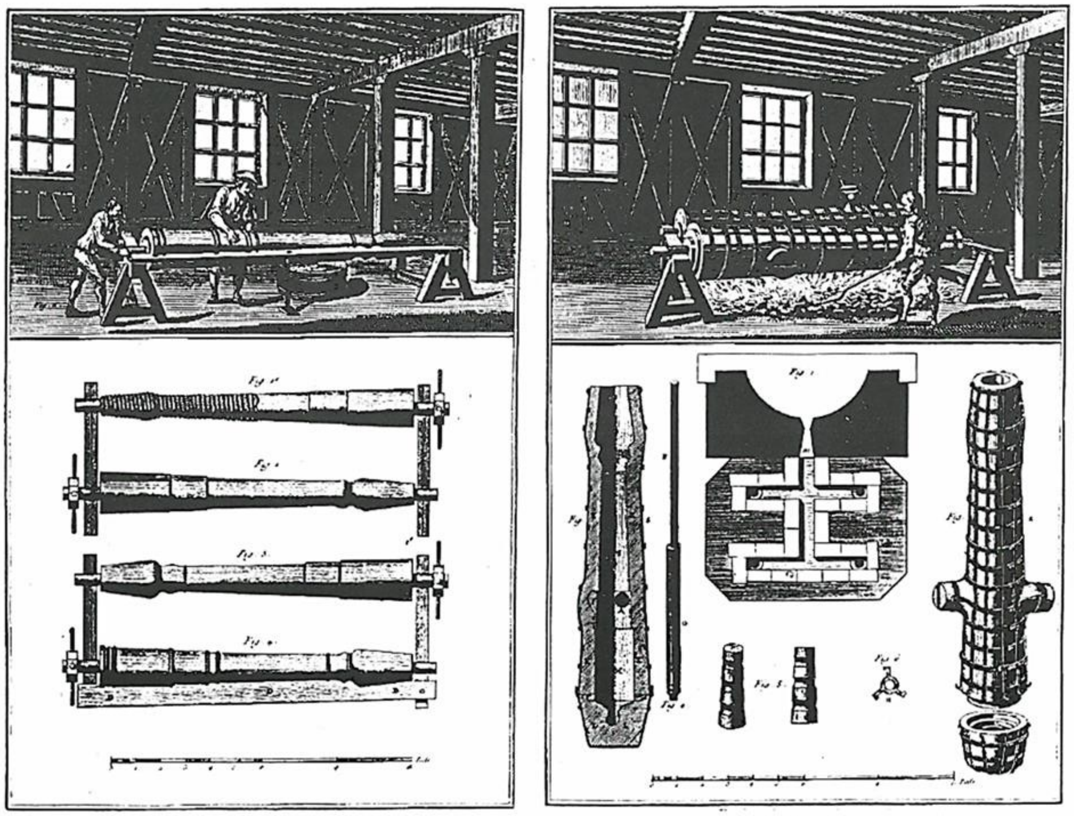
Gunfounders were companies hired to produce large quantities of cannon, ordnance, and other accessories that accompanied the weaponry to their destinations. The reputation of a gunfounder was his livelihood. Information traveled via word of mouth concerning to which projects founders were assigned. If a gunfounder's products failed examinations or were located on ships that were either captured or sunk, the failure of the weaponry served as the scapegoat in political debates to preserve the reputation of the naval military figurehead.

Tensions were high between European nations over maritime trade routes during the 17th century. Out of fear of the potential outbreak of war, the English attempted to prevent a situation in which they would lose marketability with their highly reputable ordnance or lose battles because of sub-par weaponry. To avoid this, England priced its exports uniquely and required potential enemy nations to pay a higher rate for English ordnance. Manifests from English gunfounderies provide supporting evidence to this claim and mention that the rate of ordnances sold to England were £12, Amsterdam £40, France £60, and £80 per ton for Spain (Lavery 1987:81). This strategy stabilized the English economy, while simultaneously continuing to provide the advantage of better preparation should any nation attack.

Other aspects of cannon production techniques used in gunfounderies also evolved during this time. Once cannons were cast from iron, a different method of forging was required. It was during this transition that cannon size or caliber was tested. Contracts that requested larger caliber cannons forced gunfounders to experiment with new manufacturing technologies.
The most successful manufacturing process was to forge the cannon into a mold similar to a wooden barrel. Strips of metal were placed together around a core that was then tightly bound by metal hoops. Larger cannons forged using this method were referred to as bombards. One example of a bombard was the Mons Meg, which was stationed in Edenborough Castle. Larger cannons were ordered with the intention of hitting the enemy from farther away, thus giving the castle of Edenborough a stronger force of defense (Lavery 1987:84).

After a series of trials found it sufficient for naval combat, this newly modified cannon style was referred to as a Breechloader. Breechloaders were smaller guns stationed on the upperworks of most Tudor Ships, such as *Mary Rose*. Ship designs that included smaller cannons were reported to contain insufficient weaponry that malfunctioned frequently. This inadequacy was the direct result of the lack of modifications to gunpowder that were needed to give cannons maximum performance. Since European navies did not possess the proper gunpowder during the 17th century, smaller caliber cannons were eventually expelled from the naval surplus system. During the Age of Sail (A.D. 1650 to 1815), naval vessels were equipped with muzzle loaded guns, which quickly became the preferred style. These cannons were produced by a mold that produced a single gun all in one step. Blacksmiths performed several complicated steps to craft the cannon. First, a full-sized model was created that consisted of several tightly wound strips of rope constricted around a wooden core. The rope was then wound in a tapering fashion to form the desired thickness of the cannon’s shape. After this step, the wooden core was completely covered in a mix of clay, hair, and loan, or horse dung. A critical step was to ensure that the model was turned against the stricken board while the mixture was still wet enough to sculpt the cannon (Lavery 1987:80–82). Figure 2.5 illustrates the steps associated with the casting process.

After the mold was complete, the extremities were then combined with the new base of the gun, including reinforcement rings, taper, and any extra thickness to the muzzle. The trunnions were cast into separate molds and nailed to the base. It was also during this time that decorations or maker’s marks were engraved into the surface. Once the design was finished, the entire model was covered again with a thick layer of clay. Separate molds shaped the breech and cascabel during the final step of the process (Lavery 1987:83).



Making the mould for a gun. In the top picture the mould is being turned against the strickle-board to give it its final shape. This illustration dates from the mid-eighteenth century.

Drying the mould (above) and its final shape (below).

FIGURE 2.5. Illustrations of the Process of Cannon Casting used during the mid-eighteenth century (Lavery 1987:81).

The cannon’s bore was formed by inserting a core stabilized by a tripod, which kept the core in place along the centerline of the mold. Hot metal was then poured into the mold and reinforced with several metal rings. The molds required a small opening into which the liquid metal was poured. Once the cannon cooled, the mold was broken away, often leaving behind a small spout fixture on the gun. The metal spout was broken off and melted down again. Another piece of metal was also formed at the muzzle of the gun, called the gun-head. After the cannons baked via fire or kiln, they were placed aside to cool. Since the exterior mold was baked onto the cannon with clay, the gunfounders had to break the mold off. As a result, every cannon constructed also required a new mold to be made; no two weapons were identical.

Making a new mold for each cannon was a tedious process and created issues once production numbers increased for each contract. This led to the creation of molds under shorter deadlines, which increased mistakes. Manuscripts from Gunfounderies contain status reports and inspection rejections of default cannons. The most consistent issues that lead to cannon defaults were differences in cannon weight and the lack of strength necessary to support the amount of gunpowder required to correctly fire the shot (Lavery 1987:85). The metal required a proper amount of time to strengthen in a fire or kiln; without appropriate time for the metal to bind at the molecular level, the cannon was at increased risk of developing fissure marks after firing a shot (Cipolla 1996:59–60). As a result, the cannon became weaker at an expedited rate, simultaneously increasing the risk of cannon explosions.

It was stated in a Naval ordnance report written in 1705 that seven 24-pound cannons produced by a single gunfoundery were rejected because they were all overweight and did not reach the explicit requirements of the contract. Another issue came from the movement of bore molds during the kiln process, contributing to inaccurate firings of the cannon. This led to requirements to have gunfoundery products inspected before a military or government contract was paid. In 1780, an Englishman by the name of Thomas Biomefield was assigned the official title of inspector of artillery (Lavery 1987:84-85).

Materials and Make

Bronze cannons date to the early A.D. 1300s. During the beginning of naval warfare, cannons were initially made of bronze. Naval historian John Guilmartin (1988) stated that:

> Bronze artillery was ideal for early warfare, and optimal during positional warfare. Before cannons were designed to be more versatile, cannons’ carriages were desirable for their mobility and fewer complications while carrying out

> tactics. Procedures with cannons became designed explicitly for positioning warfare, both by land and sea (Guilmartin 1988:176).

Another benefit of using bronze cannons was that they were less susceptible to damage or corrosion. Consequently, bronze was also an expensive material because of its high demand (Cipolla 2002:42). Any ship or fleet that used bronze cannons had to have a high capital invested in them.

Military powers viewed bronze cannons as distinct symbols of high status. One example of this is shown in 1569 by Queen Elizabeth I, who ensured that her naval fleet was equipped with bronze cannon. After her death in 1603, approximately 93% of the guns in her fleet were bronze. After the Queen’s death, her fleet was passed down to her successor, King James I who later passed it along to his son Charles I. With his reputation on the line as a new leader of global sea power, Charles I ordered the construction of HMS *Sovereign of the Seas*, a first-rate ship of the line holding 102 brass guns. The ship was contracted for £40,833, which included the construction, decoration, rigging, and storage of the cannons (Lavery 1987:84–85).

Another development in cannon construction was the forging of cannons using wrought iron. Wrought iron cannons, constructed from A.D. 1495 to 1525, were typically cheaper to make. Unfortunately, these cannons required more maintenance and upkeep (Guilmartin 1988:174). The necessity of having artillery able to hold a higher level of combustion from the shot made iron cannons a more appropriate choice for use on distant artillery at sea, a direct result of recent modifications made with gunpowder. The Venetian bombard was one of the earliest models of wrought iron cannon, which fired stones rather than human-made shot (Hogg and Batchelor 1978:7).

The iron founding industry significantly supported the increase of gunfounding production. In 1795, the iron founding industry used approximately 26,000 tons of iron annually, roughly a quarter of the total British production. Gunfounding expanded to an enormous extent since its debut roughly 200 years prior. Gunfounderies in 1795 possessed the technology to manufacture contracts to supply an entire fleet of 600 vessels (Lavery 1987:84).

Identification and Naval Status

There are many ways scholars can determine the origin of specific types of artillery. Cannons vary based on size, shape, bore diameter, inscriptions, maker's marks, dates, and symbols. How nations' branches of military preferred to mark their artillery varied (Guilmartin 1988:141). Since their initial construction, cannon production techniques were typically documented. Historical manifests reflect the total number of cannon inventory, including the total number and caliber. Evidence of these transactions vary based on times of war, invasion, expansion, and merchant export and import demands (Cipolla 2002:65–66).

Artillery Influence on Ship Designs

The concept of naval artillery is a complex one, which involved centuries of trial and error to allow techniques to be used in the most beneficial manner possible. When military leaders established the number of ships needed in battles at sea, the vessels' design was constructed based on the amount of the desired firepower before determining the ship's design (Lavery 1987:110; (Cipolla 2002:82–83). Once cannons became the highest importance aboard ships, other issues arose such as adjusting for proper storage space for supplies and ammunition, cabin sizes for the crew and officers, and thickness of the vessels' hull to shield against attacks.

Each factor of the ship's design had to be accounted for before construction, especially the tactical role the vessel would play in correlation to the other ships in the fleet. Naval Historian Nicholas A.M. Rodger stated that “Heavy gunfire from sailing warships was essentially from broadside-mounted guns … this is part of a general view of gunnery, tactics, and warship design in the 16th century” (Rodger 1996:301). Rodger also explained that with this naval revolution, the galley was no longer the superior design of ships and would be replaced with ships that could be armed heavily with broadside guns (Rodger 1996:301).

An additional circumstance that developed alongside the artillery influence of ship designs was storage of weaponry, which varied according to ship size, the number of cannons desired, total number of ship decks, desired spacing of cannon portholes, desired amount of ammunition needed for estimated assignments, and proper spacing for the crew to operate at their posts (Goodwin 1987:3–4). One early example of artillery’s influence in ship design and naval tactics is represented in a letter written in 1588 by King Phillip II of Spain to the Duke of Medina Sidonia, his appointed general, and the commander and chief of the Armada stationed in Lisbon. The letter emphasized, “That you might be forewarned, you will receive a detailed report of the way in which the enemy arranges his artillery to be able to aim his broadsides low in the hull and so sink his opponent's ships” (Rodger 1996:301).

Cannon placement and spacing was a critical aspect that affected ship design. There needed to be space that accounted for the numerous components of the ship’s journey, none of which could be excluded. Factors that needed to be accounted for during foreseeable circumstances included space for a proper number of crew members to man each station, storage for the ammunition, and space for the cannon to move into after the recoil of gunfire (Lavery 1987:140).

The gunport allowed for cannons to be stationed along the sides of the ship instead of being limited to the top deck and fired over the ship’s banister, or gunwales. Gunports also allowed heavier caliber cannon to be designated on ships, which provided more power and more range. However, this potential was not adopted for naval tactics and strategy until the latter half of the 17th century. Figure 2.6 illustrates a gunport outboard; the porthole was designed with minimal amount of space to successfully shield and retract the gunport.

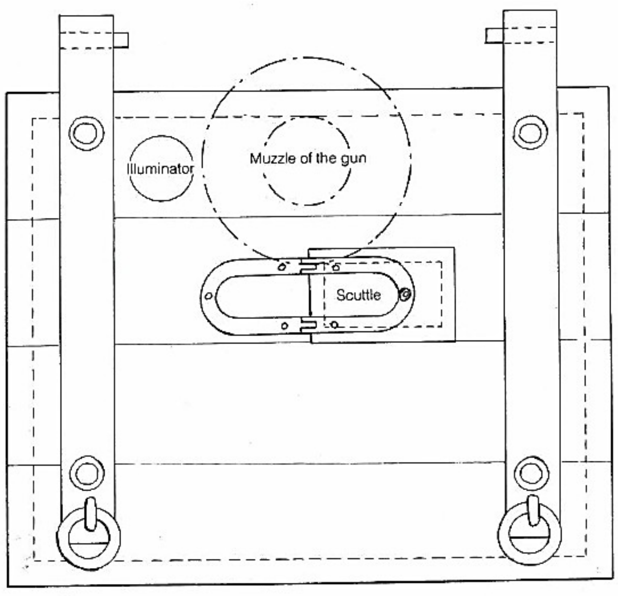


FIGURE 2.6. A view of the gunport (from outboard), 1814, showing the illuminator (*Top Left Side*) and the scuttle (*Middle*) From a drawing in the PRO (Lavery 1987:140).

The evolution of hull thickness also affected cannon placement. More massive cannons, abundant in both size and caliber, were stationed on the lower decks, while lighter guns were stationed on higher decks. Figures 2.7 and 2.8 illustrate how the thickness of the hull affected how the cannon size would be displayed during battle. The evolution of the gun carriage was an alternative factor introduced during this era; it was modified to fit the curvature of the ship's lines to allow the cannon to penetrate farther away from the gunport.

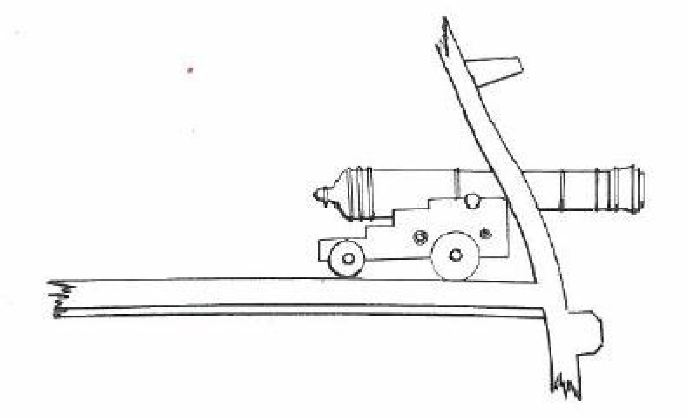


FIGURE 2.7. The gun placement on the carriage with a thinner ship hull in A.D. 1625 (Lavery 1987:127).

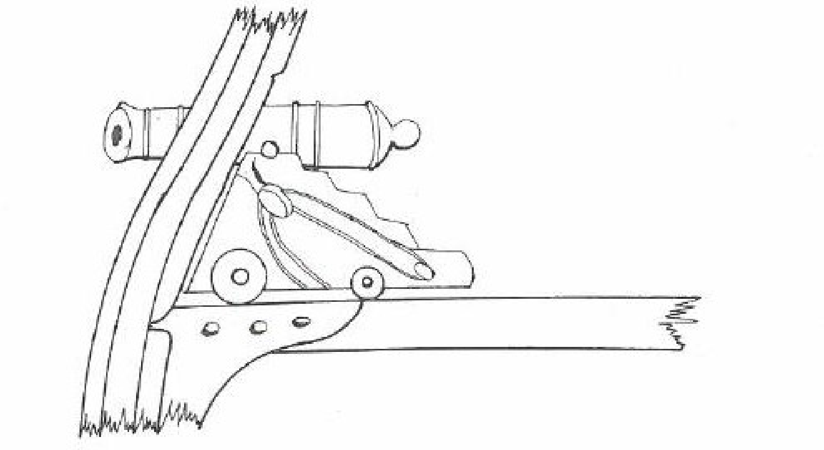


FIGURE 2.8. A gun and carriage stationed against a thick ship hull in A.D. 1693 (Lavery 1987:127).

A further aspect to examine is how the guns were stored during regular travel and not during enemy confrontations. Space was needed for the cannon to be completely retracted into the hull of the ship to prevent any risk of damage. Figure 2.9 illustrates how different ships used a variety of methods of securing their artillery.

Cannon rigging was an important factor in artillery storage. Cascabels were tied to the hull in many fashions; the examples (A through D) in Figure 2.9 illustrate a breech tackle used to stabilize the cannon firmly to the hull. Illustration A shows a secured position for firing the cannon, also referred to as the run-out position. Illustrations B and C present cannons secured inside of the ship's hull using a double breeching housing. Illustration B represents a side view of illustration C. Illustration D demonstrates cannons being stationed via alongside lashing technique, which provided extra support and security by lining the cannons within the ship's hull. These various techniques of storage increased both the safety of the ship, artillery, and crew.

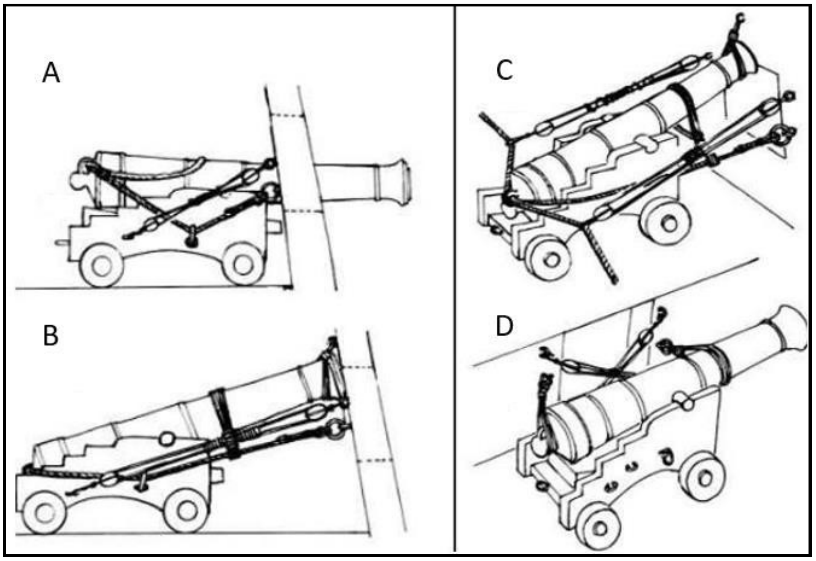


FIGURE 2.9. Methods of securing the guns: (*A*) Securing in the run out position; (*B*) housing; (*C*) double breeching; (*D*) lashing alongside (Harland 1984:210). Alterations made by the author.

The Age of Sail was arguably the most influential era for naval modifications in European history. Political tensions between the European nations created a high level of insecurity and paranoia, which forced each nation to strive for independent dominance. Nations that possessed a mighty naval presence acquired multiple forms of power, such as sea trade and the ability to aid foreign military conquests. Status was gained by the development of sophisticated artillery technology and various sized ships that were designed to provide specific tactical advantages. These developments worked together, as cannon technology advanced the ship designs that were adjusted to support new armament.

The larger ships were designated as symbols of national status, wealth, and power. These ships were the largest in both size and number of guns. However, having large ships also created points of weakness, creating easier targets. Grander ships could support more firepower but were consequently slower to maneuver (Robertson 1921:56–57).

With increased numbers of cannons, firing capabilities, and modified loading techniques, ships required a design that allowed for increased speed. Ships were modified to be longer in proportion to the breadth of the vessel (Howard 1979:95). With modifications of the ship proportions making ships faster, chase guns were no longer the primary artillery onboard; these were inevitably dominated by the effectiveness of broadside gunnery (Robertson 1921:4–10).

Jettison

William Johnson's *The Compleat Compting-House Companion: or, Young Merchant and Trademan's Sure Guide* defines the word jettison, getson, jetson as "(from the French words jetter, meaning to throw or cast away) a term signifying anything thrown out of a ship, being in danger of a wreck, and by the waves drove on shore" (Johnson 1763:19).

The second scenario for jettisoning heavy objects was when a vessel was under pursuit and attempting to escape a chase. In the Caribbean during the 18th century, many ships attempted to escape pirates, privateers, or other ships wishing to attack or raid. In jettisoning equipment, the ship gained speed by lessening the overall weight of the vessel. However, pirates and privateers would use a strategy to chase ships unfamiliar to the area into shallow waters with treacherous reefs submerged beneath the surface. Once the vessel wrecked, the pursuing ship salvaged goods from the stranded crew and wreckage (Harland 1984:305).

A fascinating aspect of jettison was the processes established for emergency situations. The historical record depicts jettison as a concept that required little reflection or analysis during times of crisis. However, there were steps to analyze which objects were to be sacrificed and why. Insurance companies created manuals with law-abiding policies for the merchant mariners they insured. This was established to uphold the protection of all parties involved, specifically the personnel and financial investors. The policies enforced every circumstance in extreme detail, which would involve the parties who signed and were required to be both stamped and signed prior to departure (Johnson 1763:18).

The priority of Merchant Mariners during the 18th century was to ensure safe delivery of crew, ship, and cargo to its destination. However, once an emergency situation took place, the captain or master of the ship would immediately consult the crew members with the most seafaring experience of whether or not their predicament indeed required objects to be jettisoned. If the crew agreed that jettison was mandatory for survival, the captain would relay the order to all personnel aboard the ship (Magens 1755:284–285).

The first protocol insurance companies enforced under these circumstances was to discard heaviest objects with the least value (Molloy 1769:4). However, the cargo being transported was prohibited from being jettisoned until absolutely required, forcing the captain and crew to sacrifice other objects from the ship to be cast overboard. Equipment which was often sacrificed during acts of jettison included anchors and cannon. While each object was used for different naval tactics and tasks, both were large and heavy, and ships typically carried multiples of each. Cannons and anchors were commonly salvaged from shipwrecks and raids and then sold again at local ports. Since acquiring this equipment was reasonably straightforward, their value depleted significantly when trying to escape chaotic situations (Magens 1755:284-286).

If the crew survived the wreck, they were required to log all salvageable cargo and items of the voyage that were intentionally jettisoned and lost as a result of the wreck. The captain and crew would then report the log and their accounts to the insurance company, which was followed by a court hearing (Magens 1755:285). Appendix A shows ship logs retelling their processes during the hurricane of 1780 in the West Indies.

While most maritime merchant insurances policies were similar internationally, there were some differences. Insurers would agree to cover a percentage estimated on the value of the cargo, precisely what it was estimated to be sold for after arrival to its destination. Another variable for coverage by insurers was the location of the ship when cargo was jettisoned. If the cargo was cast away prior to halfway of the voyage, then they [the owners of the cargo] were esteemed at the price of cost. However, if the ship was over the halfway point of the journey then the owners were reimbursed for the price that the cargo would have been sold for once arriving to its destination (Molloy 1769:4).

As a result of the enforced insurance protocols, cannons fit the criteria of what could be discarded without repercussion and were often jettisoned. Two methods were practiced to jettison cannons overboard. The first was hoisting guns over the gunwale; the second method was discarding below deck cannons through the portholes. Naval Sailing Master William Brady stated in his 1852 publication, *Kedge Anchor; Young Sailors' Assistant*, that to throw a lower deck gun overboard one must:

> Fit a chock in the port-sill, and over the pomelion of the gun, to which, from the housing- bolt, hook a stout tackle; unlash the muzzle, heave the breech, and put in the bed and coin; unreeve the breeching, throw back the cap squares, and place capstan bars under the breech to ease it, and prevent the gun from slipping back into the carriage again; man the side and port tackles, watch the roll, trice up the port briskly, run out, and throw the gun clear of the carriage, by the breech-tackles

> and capstan bars; shut in the port immediately (Brady 1852:184).

Figure 2.10 contains an image portraying a cannon being prepared to be jettisoned through a porthole based on Brady's description in his publication.

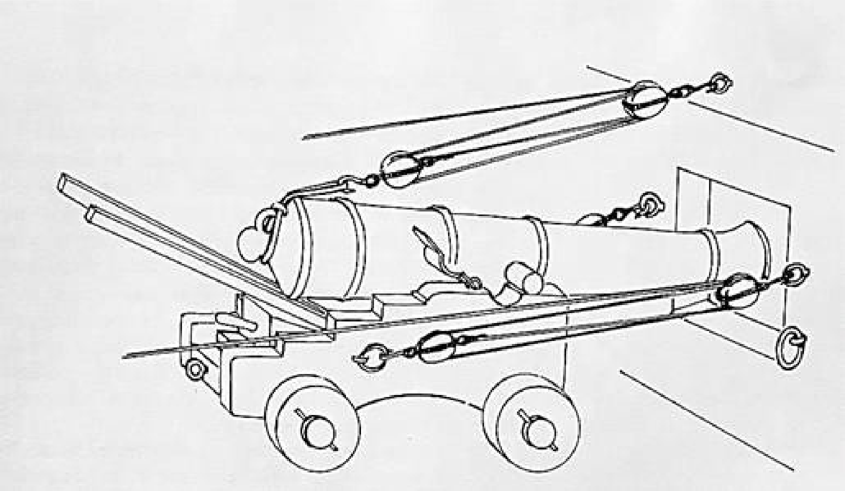


FIGURE 2.10. Cannon ready to be jettisoned through porthole (Harland 1984:305).

The tension between European nations established prior to and during the Age of Sail significantly contributed to the evolution of naval presence. These nations became obsessed with controlling maritime trade routes and resources across the Atlantic, heavily in the Caribbean; control over these trade routes and resources gave economic to expand national influence and overall power. As a result, nations that wished to have a strong naval presence required possession of the greatest naval assets, including ship designs that benefitted naval tactics and strategies, powerful armament, and overall methods of applications (Robertson 1921:20–22).

The maritime conflicts which emerged left behind remains via the abandonment of ships, pre- or post- wrecking actions such as jettison, or attempts of salvaging ship materials for survival. This study used submerged archaeological sites containing cannons and, in some case studies, hull remains to attempt to link pre and post wrecking events with the orientation of cannons on the sites.

To adequately understand the behavioral aspects of the crew and captain, the author researched how the act of jettison was applied and understood during the Age of Sail. The notion of jettison was to only be applied under emergency circumstances to best attempt to preserve the safety of both ship and crew, which allowed the author to find signatures in archaeological reports and maritime insurance manuscripts to understand how the crew performed of jettison, protocols associated with it, and techniques used for disposal of cannons (Magens 1755). The techniques which were applied are connected to the ship design and storage methods inside the ship's hull.

CHAPTER 3: CASE STUDY HISTORIES

Introduction

The author used 10 case studies to provide data for the cannon analysis discussed in this thesis. Each case study included similar variables, such as tropical water ecosystems and environment, similar depths, geographic features surrounding the sites, and types of cannon on the site. Figure 3.1 shows the locations selected for this study include Cannons Site, Costa Rica (Harris and Richards 2018); *Quedagh Merchant*, The Dominican Republic(Hoyt 1984) (Harris et all 2012); Pedro Bank, Jamaica (Hoyt 1984); Manilla Wreck, Bermuda (Karklins 1991); *El Buen Consejo*, Anguilla (Rodgers 2006); The French Cannon Site (GC-017)(Leshikar 1993), Cayman Islands; and Rockley Bay (TRB-5), Scarborough Harbour, Tobago (Batchvarov 2016).

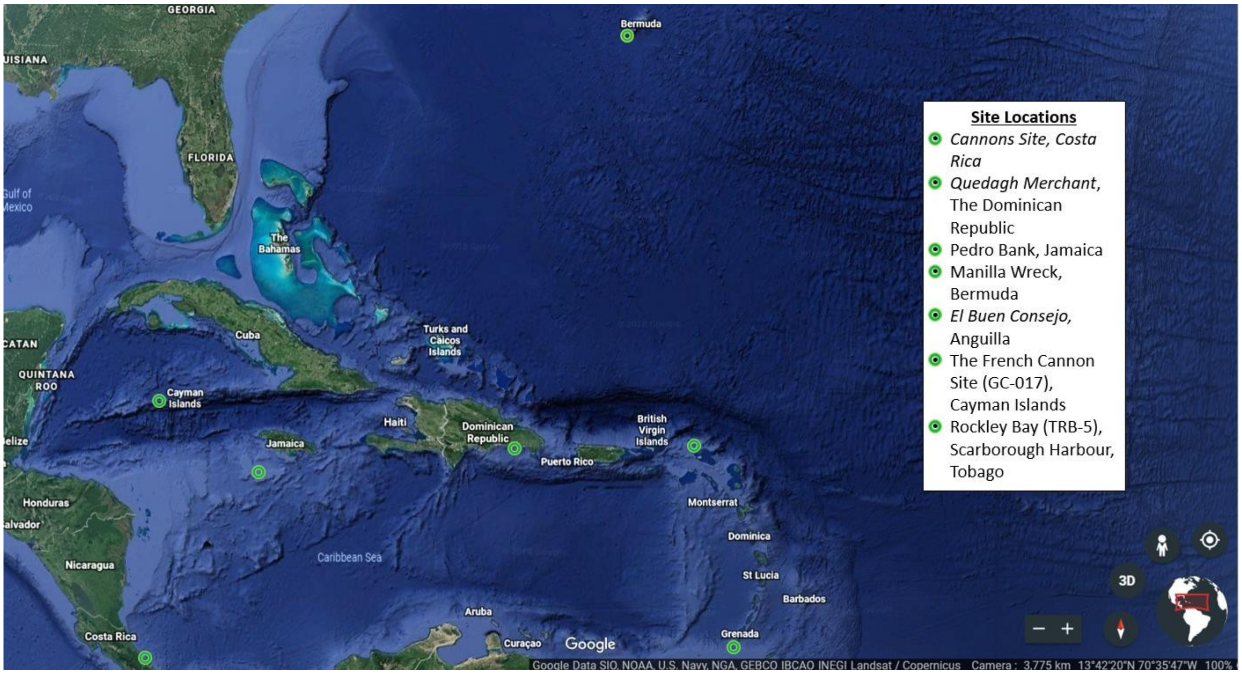


FIGURE 3.1. Map of the 11 Cannon Sites Case Studies (Courtesy of Google Earth. Accessed by the author October 30, 2018).

Cannon Site, Costa Rica

The Cannon Site (Figure 3.2) is located within the boundaries of Cahuita National Park in the Limón Province of Costa Rica. The site has an area of 9,491 m^2 with a perimeter of 529 m (Harris and Richards 2018:7). The area experiences a variety of natural factors influenced by the sea, from calm to rough currents, with large swells and strong surge (Harris et. all 2015:49). The farthest point of the Cannon Site is located approximately 257 m from shore and ends 32.4 m from shore. The site includes 11 cannons in three discrete areas with two small broken pieces of cannon. The suspected broken cannon pieces are identified in Figure 3.2 as numbers 9 and 15.

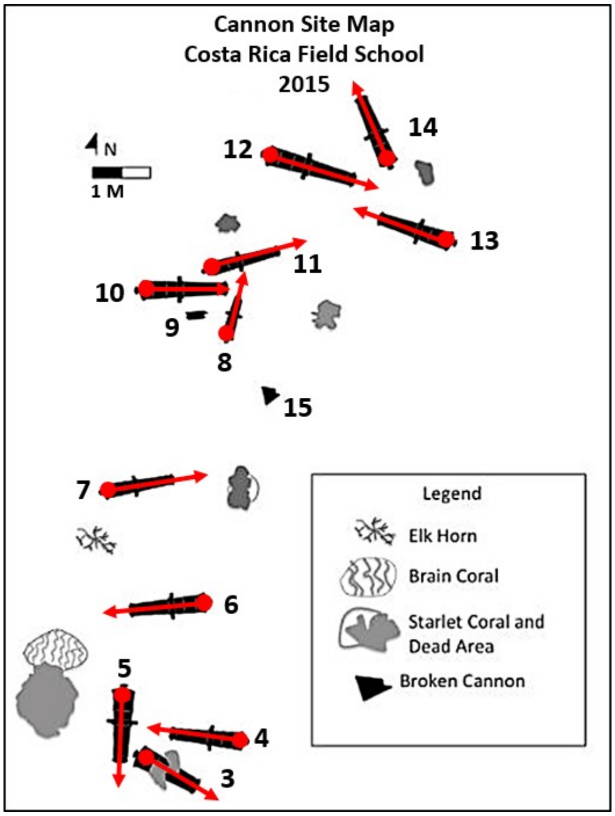


FIGURE 3.2. Map of “Cannon Site” in Cahuita, Costa Rica (Harris et al. 2015:72). Alterations by the author.

The site was mapped by East Carolina University’s (ECU) 2015 and 2016 field schools. The direction of the cannons on an individual basis supports the hypothesis of jettisoning, or intentional dumping of heavy materials by the crew to lighten the ship. Given the placement of the reef near the wreck site, a plausible conclusion could be that the crew attempted to avoid wrecking into the reef while coming into shore and dumped the cannons to allow for improved maneuverability.

In the Cahuita National Park report of 1982, Dr. Stephen Gluckman described 14 cannons were located on the site, including what appeared to be a broken one. The cannon lay in 4 to 5 m of water and were heavily encrusted in concretion and coral growth. As part of their recording methodology, the team made coconut buoys and tied them to the cannon and anchors to assess a discernable spread pattern (Gluckman 1982:461-462). Based upon the size of the cannon, Gluckman expected the ship would have needed ballast, so he assumed a site without this could not be complete (Harris et al. 2015:5).

Another site was discovered later during Gluckman's survey to the north of the Cannon Site containing yellow colored clay bricks. Although there was no standard wreckage pattern including artifact scatter previously produced in any site reports, Gluckman proposed a hypothesis for the layout of the cannon and the lack of structural remains and wreck debris. A possible hypothesis was that the brick stacks were not only cargo but were also used as ballast for the same ship that also produced the cannon site. This led him to conjecture that the ship could have smashed into the reef near the northern Brick site, allowing a portion of that vessel containing the cannon and anchor aboard to drift closer to the reef near the shore, potentially causing the cannon to slide off of that side of the vessel. Gluckman stated in his report that:

> Any cannon remaining would have then weighed down the other side of the float causing them to fall in the opposite direction and allowing the few remaining bricks to filter onto the site, too. The floating wood would have then broken up on

the reef or shore leaving no wreckage in the area (Gluckman 1982:463-464).

Concretions are vital for shipwreck preservation, the addition of marine growth adding calcified layers helps preserve the artifacts, as well as the entire site. The concretions act as a bonding agent, creating a shell around the artifacts distributed in their formations on the site. The active marine life in the tropical environment of Cahuita national park, which hosts both *brick* and *cannon* sites, provides an asset of producing concretions over the cannons. Since the cannons were protected by the concretions, Dr. Lynn Harris and the 2015 ECU team were able to determine the average length for the cannon was approximately 2.55 m, with a breech-to-trunnion measurement of 1 m and muzzle diameter of 0.80 m.

Quedagh Merchant, the Dominican Republic

The *Quedagh Merchant* site (Figure 3.3), located on the windward side of Catalina Island, the Dominican Republic, is in 3 m of water and subject to high-energy wave action (Beeker 2009:223). Archaeological teams with Indiana University (IU) and the Program in Maritime Studies at ECU produced reports of their findings during a field school in 2011 (Harris *et al*. 2012:15). The Dominican Republic has a tropical dry marine climate with weather patterns and oceanic currents that are heavily influenced by easterly trade winds.

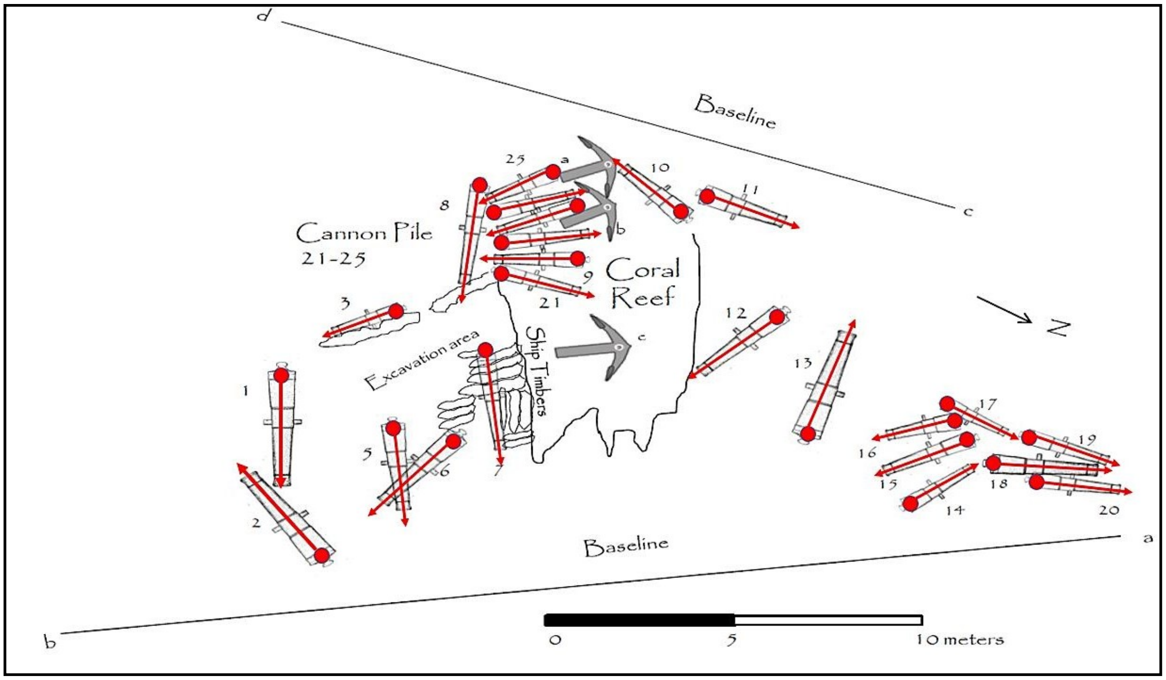


FIGURE 3.3. Sitemap of *Quedagh Merchant* (Harris et al. 2012:39). Alterations by the author.

Quedagh Merchant contained 25 heavily encrusted cannons that ranged in measurements between 1.8 and 2.6 m in length, a majority of which were located near or directly on the reef (Harris et al. 2012:41). The cannon size varied, containing 1, 4, and 6- pounders. Cannon disbursement suggested that the grander 6-pound cannons were moved by the crew to the aft of the ship to relieve weight from the bow to free the vessel from the bank (Harris et al. 2012:43–44). The cannon pattern supported the hypothesis that the crew had intentionally moved the cannons, illustrated by the fact that cannons were stacked muzzle to cascabel. Six of *Quedagh Merchant's* cannons were in a "*zipper*" pattern, cascabel to muzzle, muzzle to cascabel (as seen above). The *zipper* pattern will be elaborated later in this thesis. This evidence supports the hypothesis that these cannons were likely stored within the hull of the ship during the wrecking process. Once the ship settled on the sea floor, the timbers deteriorated, thus dispersing the cannons into their most recently viewed positions, which were noted in the sitemap (Harris et al. 2012:15).

Pedro Bank, Jamaica (PB-1 through PB-5)

Pedro Bank (Figure 3.4) is a massive submerged mesa formation that rises abruptly from depths of over 1,000 m to form a plateau covering some 7,247 square kilometers (km) as defined by the 20 fathom (36.5 m) contour. Located 80 mi south of Jamaica, Pedro Bank is still designated territorial waters of Jamaica. The depths over most of the plateau average 18 to 35 m, offering little hazard to navigation. However, reef and cay formation on the southern edge of the plateau has created hazardous obstacles for ships over the centuries (Hoyt 1984:99).

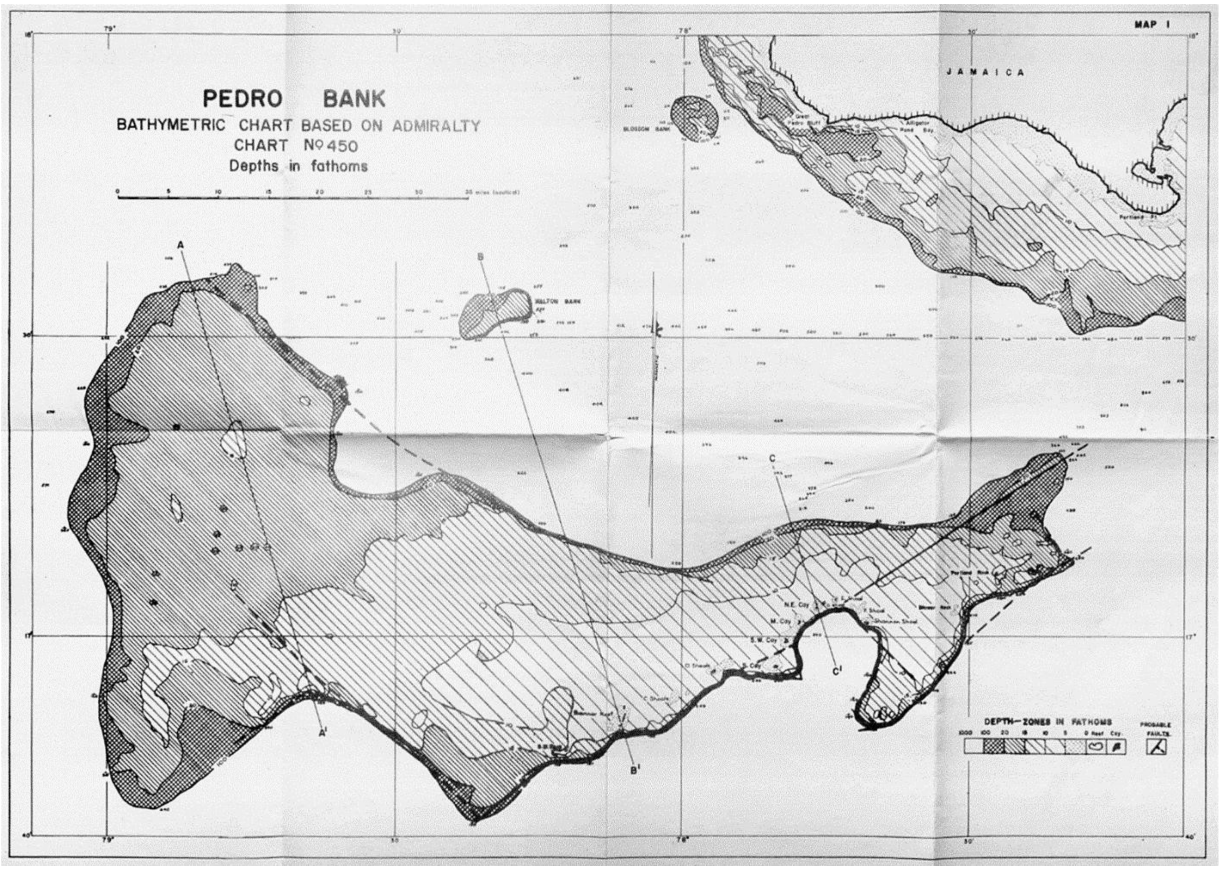
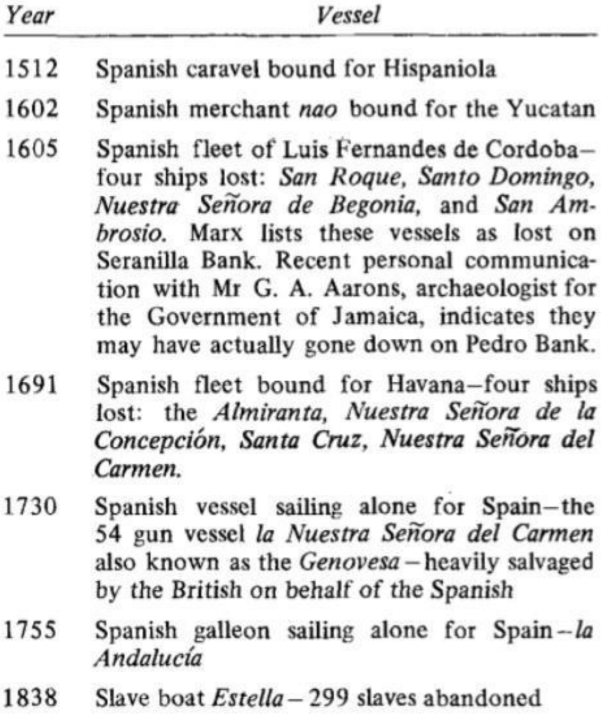


FIGURE 3.4. Bathymetric chart of Pedro Bank (Hoyt 1984:100; Zans 1958).

The first archaeological survey conducted on Pedro Bank took place from 1981-1983 by International Nautical Archaeology (INA) of Texas A&M. The primary objective was to investigate the bank for shipwrecks of historical significance as a defensive action for recent accounts of treasure hunting in the area. Figure 3.5 indicates the list of vessels which Hoyt researched as being lost on Pedro Bank and primary candidates for matching remains to shipwrecks. The team was interested in matching remains to *La Nuestra Senora del Carmen*, also known as *Genovesa*, a ship known to have wrecked in the area in 1730.



Year	*Vessel*
1512	Spanish caravel bound for Hispaniola
1602	Spanish merchant *nao* bound for the Yucatan
1605	Spanish fleet of Luis Fernandes de Cordoba–four ships lost: *San Roque, Santo Domingo, Nuestra Señora de Begonia,* and *San Ambrosio.* Marx lists these vessels as lost on Seranilla Bank. Recent personal communication with Mr G. A. Aarons, archaeologist for the Government of Jamaica, indicates they may have actually gone down on Pedro Bank.
1691	Spanish fleet bound for Havana–four ships lost: the *Almiranta, Nuestra Señora de la Concepción, Santa Cruz, Nuestra Señora del Carmen.*
1730	Spanish vessel sailing alone for Spain–the 54 gun vessel *la Nuestra Señora del Carmen* also known as the *Genovesa*–heavily salvaged by the British on behalf of the Spanish
1755	Spanish galleon sailing alone for Spain–*la Andalucía*
1838	Slave boat *Estella*–299 slaves abandoned

FIGURE 3.5. Ships lost on Pedro Bank (Hoyt 1984:102).

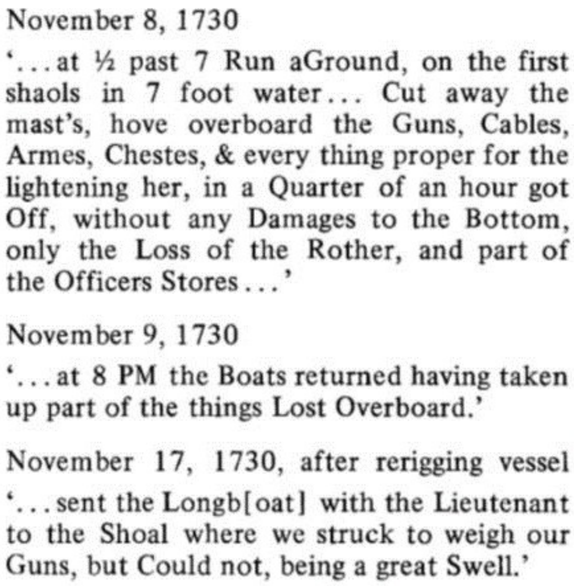
Dr. E.T. Hall, Professor in the art history program of Oxford University, performed a magnetometer survey supported by the Littlemore Scientific Engineering Company (ELSEC). The survey was the starting point of the team’s investigation over the five identified sites.

PB-1

Due to time constraints and environmental factors, recording PB-1 (Figure 3.6) only involved a preliminary survey. Dr. Hall’s magnetometer survey showed minor results, indicating that the site contained little archaeological evidence. Hoyt described another debilitation factor that forced the team to abandon the site as “a jungle of elk-horn coral,” measuring 2 m thick, which made examining site features difficult (Hoyt 1984:103). However, the team managed to remove a small piece of the concretion from what Hoyt believed to be covering the trunnion of a cannon.

FIGURE 3.6. Photo of Coral Coverage Over Site 1 in Pedro Bank, Jamaica (Hoyt 1984:102).

The historical record reveals that Royal Navy sloop, *Tryall*, was sent to retrieve whatever was salvageable from *Genovesa* after the wrecking. The log from *Tryall* (Figure 3.7) stated the ship had run aground on the shoals of Pedro Bank, showing that jettison was required to lighten the hull enough to refloat the ship.



November 8, 1730

'...at ½ past 7 Run aGround, on the first shaols in 7 foot water... Cut away the mast's, hove overboard the Guns, Cables, Armes, Chestes, & every thing proper for the lightening her, in a Quarter of an hour got Off, without any Damages to the Bottom, only the Loss of the Rother, and part of the Officers Stores...'

November 9, 1730

'...at 8 PM the Boats returned having taken up part of the things Lost Overboard.'

November 17, 1730, after rerigging vessel

'...sent the Longb[oat] with the Lieutenant to the Shoal where we struck to weigh our Guns, but Could not, being a great Swell.'

FIGURE 3.7. Log entries from *Tryall* during the salvage of *Genovesa* (Hoyt 1984:103).

One hypothesis provided by the researcher's archaeological survey is that PB-1 might be the area where *Tryall* ran aground, and the single cannon was initially jettisoned over and not later salvaged. While this site does not contain enough cannons to contribute to the data analysis portion of this thesis, PB-1 is a strong example of the wrecking process in Pedro Bank and how the captain and crew reacted to the situation.

PB-2

PB-2 (Figure 3.8) contained four iron cannons and two anchors on top of a pile of ballast stones. The site lies at a depth of 3 m. Hoyt (1984:104) noted that one of the cannons appeared to have evidence of recent movement, indicating looters attempted to harvest the artifact. The site is smaller compared to the other four sites in the Pedro Bank report, suggesting that PB-2 could be the remains of a smaller ship. A sand channel runs approximately northwest to southeast across the site. Hundreds of olive jars were found on site provide a date range between A.D. 1580 and 1780.

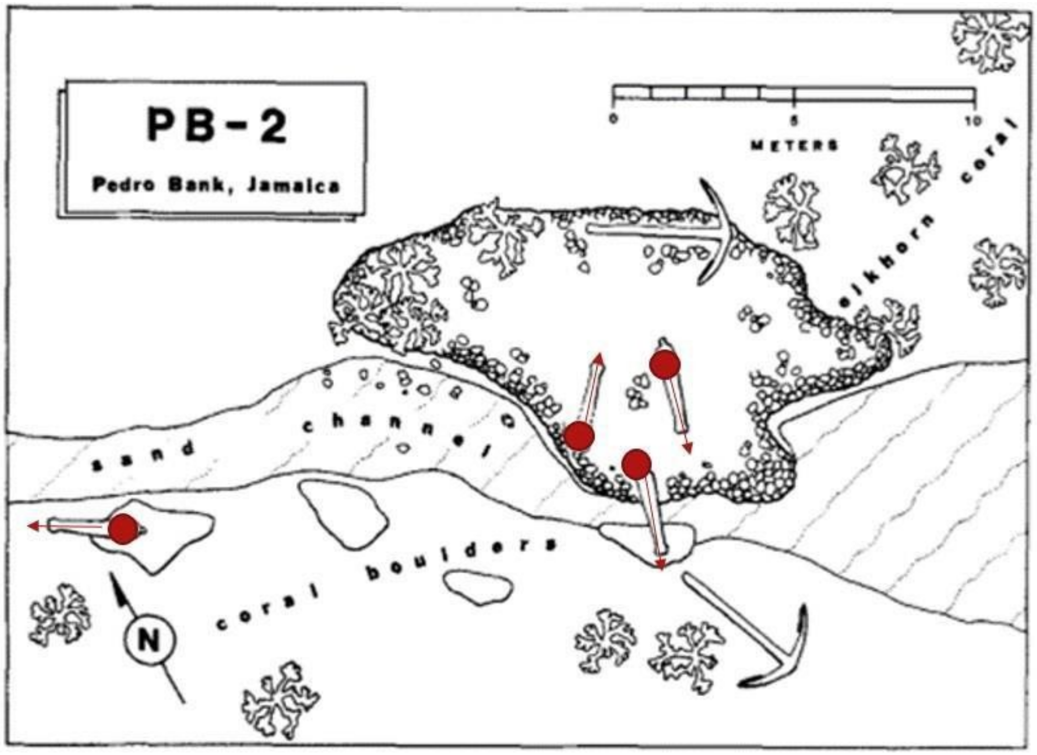


FIGURE 3.8. Map of Site 2 in Pedro Bank, Jamaica (Hoyt 1984:103). Alterations by the author.

PB-3

PB-3 (Figure 3.9) contained the most substantial amount of archaeological evidence of the Pedro Bank sites, which included 21 iron cannons, a ballast pile that extended 30 m long, and six large anchors. Other artifacts that were recovered included two silver coins and a compass, which dated the ship approximately from 1651 to 1700 (Hoyt 1984:104). The sitemap included areas of coral; however, the specific type was not indicated in the report. Site 3 included similar cannon cluster zipper patterns to *Quedagh Merchant*, suggesting a comparable hypothesis that the cannons were stored in the ship’s hull during wrecking.

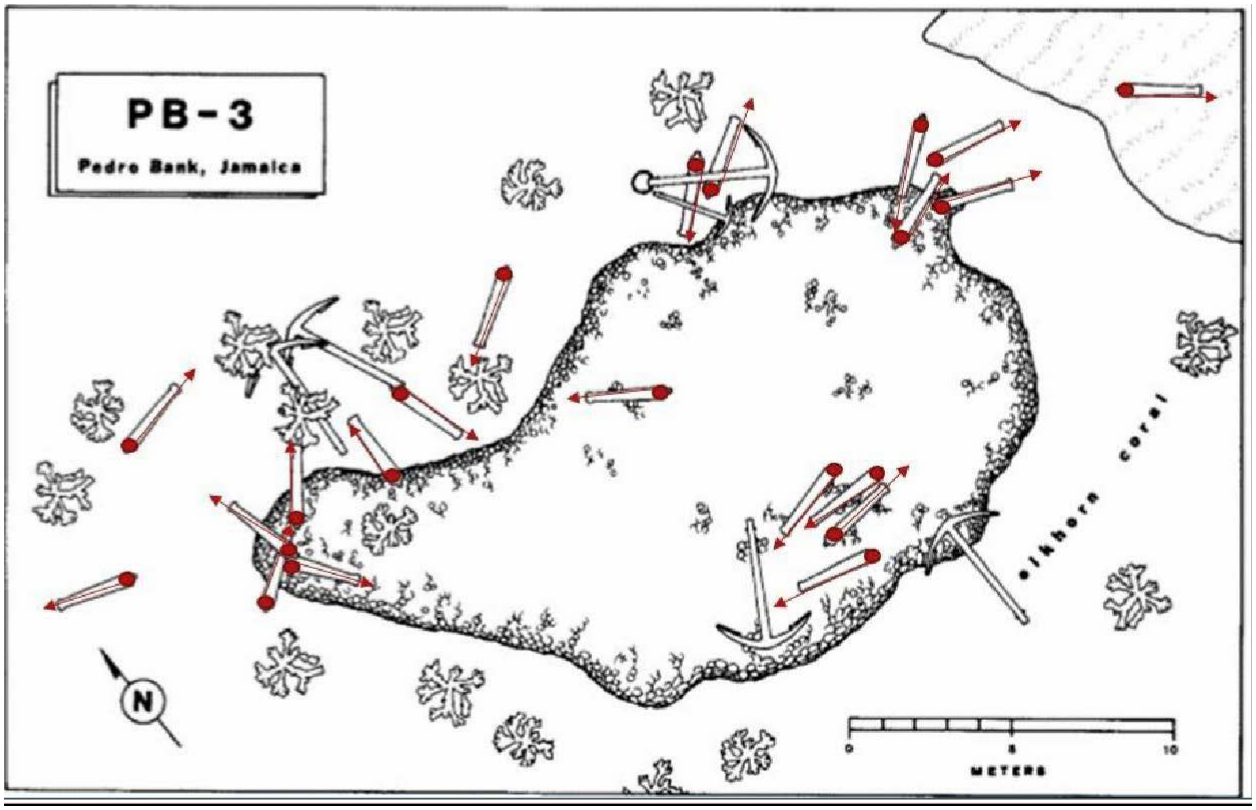


FIGURE 3.9. Map of Site 3 in Pedro Bank, Jamaica (Hoyt 1984:104). Alterations by the author.

PB-4

PB-4 (Figure 3.10) is located at a depth of 8 m and resting on a flat surface. Hoyt (1984:105) noted there was no significant coral growth on the ballast pile. PB-4 contained a ballast pile that was similar to PB-3 measuring 32 × 30 m; the ballast was not domed in shape. Even though no significant coral growth was found on the ballast pile, the stray cannons were located between two large elk-horn reefs north of the site. PB-4 included similar cannon cluster features, which reflected a zipper formation to both *Quedagh Merchant* and PB-3, suggesting the cannons were being stored in the lower areas of the hull at the time of the wrecking or abandonment of the vessel.

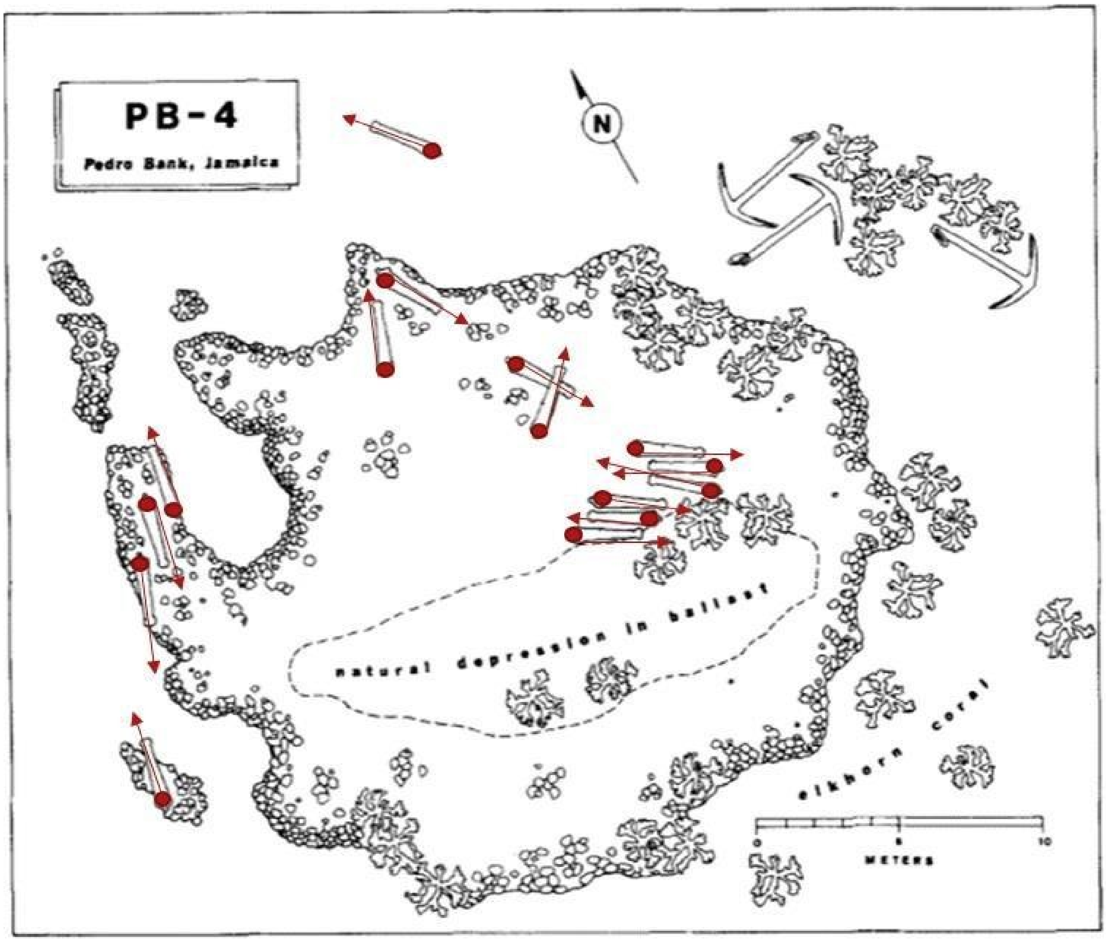


FIGURE 3.10. Map of Site 4 in Pedro Bank, Jamaica (Hoyt 1984:105). Alterations by the author.

PB-5

PB-5 (Figure 3.11) contained a 30 m ballast pile located between two elk-horn coral ridges. Near the southern end of the site, nine iron cannons were in a scattered formation (Hoyt 1984: 106). Six of the nine cannons lay near each other while two cannons were identified towards the northeast sector of the site. Approximately 75 m north of the site rests another cannon, largest of the ten believed to be associated with PB-5. The site also lacked anchors, a unique factor when compared to the other Pedro Bank sites identified so far. Figure 3.12 represents letters written by British officers commenting on the success of salvaging the wreckage of *Genovesa* in 1730 (Hoyt 1984:107-108).

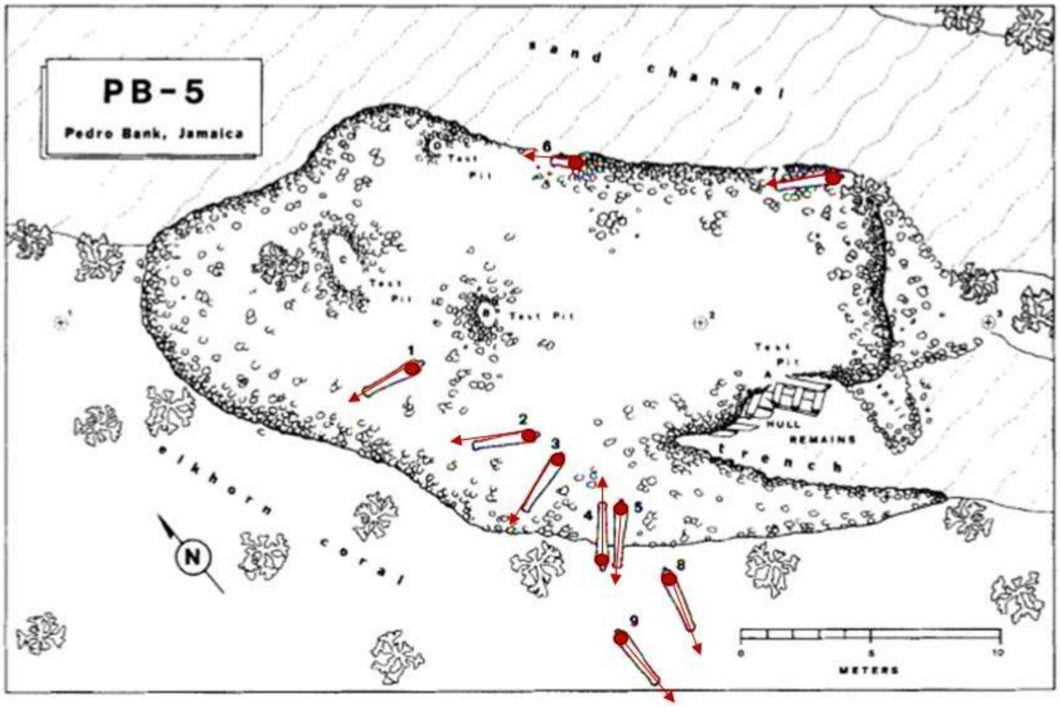
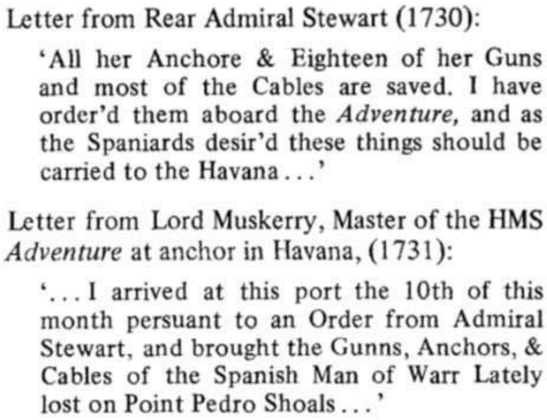


FIGURE 3.11. Map of Site 5 in Pedro Bank, Jamaica (Hoyt 1984:106). Alterations by the author.

Hoyt concluded that of the five sites examined in his 1984 report, PB-5 is the most likely candidate to match what the site of *Genovesa* would resemble today. The lack of anchors provides a thought-provoking concept which supports this claim by the letters represented in Figure 3.12.

The cannon arrangement, ballast pile, and remains of the hull on site five also have potential to suggest that the vessel wrecked into the reef along the port side of the ship. Once the wood from the upper decks of the hull deteriorated, the cannons settled into their current positions. The lower parts of the ship’s hull were preserved under the ballast pile.



Letter from Rear Admiral Stewart (1730):

> 'All her Anchore & Eighteen of her Guns and most of the Cables are saved. I have order'd them aboard the *Adventure,* and as the Spaniards desir'd these things should be carried to the Havana . . .'

Letter from Lord Muskerry, Master of the HMS *Adventure* at anchor in Havana, (1731):

> '. . . I arrived at this port the 10th of this month persuant to an Order from Admiral Stewart, and brought the Gunns, Anchors, & Cables of the Spanish Man of Warr Lately lost on Point Pedro Shoals . . .'

FIGURE 3.12 Letters from British officials on the salvaging of *Genovesa* (Hoyt 1984:108).

Manilla Wreck, Bermuda

Three sport divers discovered the Manilla shipwreck site (Figures 3.13 and 3.14) in January 1975. It is located approximately 11 km off the northern area of the East Pointers, a series of reefs that line the northeast portion of the Bermuda Platform and lay at a depth of roughly 6 m. The site contained a stone ballast pile that extended over an area of 28 × 5 m. Due to the site's location in a high energy coastline with frequently strong ocean currents, there was little hull remaining. The site was called the Manilla Wreck because of its distinctive cargo which included brass bracelets and a wide array of beads (Karklins 1991:33).

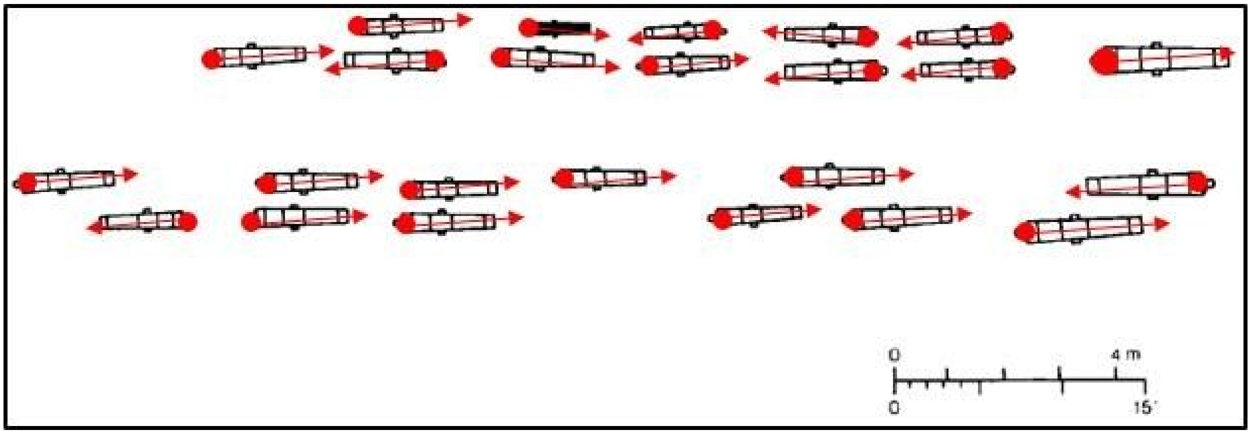


FIGURE 3.13. Sitemap of the Manilla Wreck; bronze cannon in black (Karkins 1991:38). Alterations by the author.

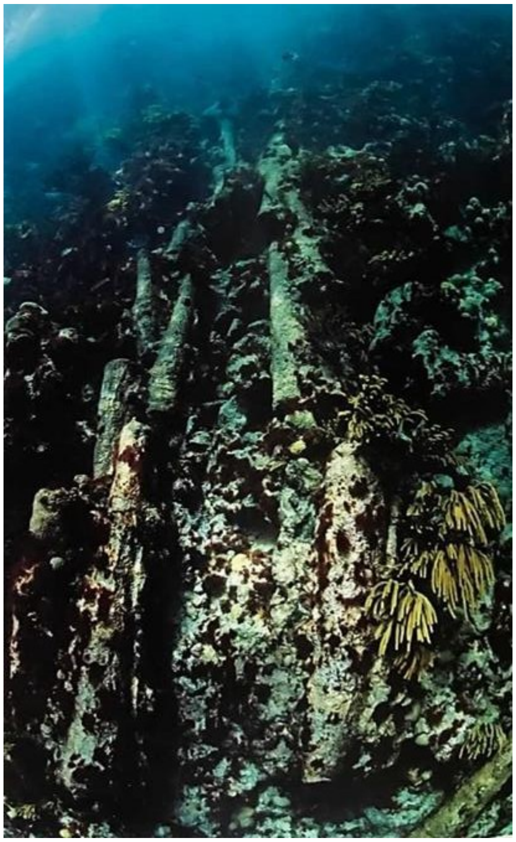


FIGURE 3.14. Photo of the Manilla Wreck (Watts and Steinhoff 2014:154).

The Manilla Wreck contains approximately 24 cannons: 23 iron and one bronze. The guns were located under the stone ballast pile, which likely prevented the site from being looted. The cannon lay in four lines in two parallel rows. The only cannon that was recorded in detail was the small bronze cannon, which measured 1.22 m long and weighed 136 kilograms (kg). The bronze cannon contained distinguishing features, such as dolphins and the gunfounder’s monogram, typically located on the first reinforcement of the cannon. These features assisted the team in dating the cannon between A.D 1630 and A.D 1660 and identified that it was cast by the Dutch West India Company (Karklins 1991:38).

Archaeological evidence suggested the Manilla Wreck was likely an escort ship instead of a slaver because there were no manacles, used to restrain slaves, present on the site (Karklins 1991:41). Other artifacts, most likely cargo, were traced to West Africa and the Caribbean, suggesting the ship was *en route* between the two continents as a merchant's vessel. A plausible explanation for the absence of more massive objects, such as anchors and other cannons, was that they were either jettisoned or salvaged at a later date. To ascertain whether the cannons were used in service or as ballast/storage, the orientation of the ship must be examined. For example, if the cannons from the higher decks (those used in service) were left on site, they would most likely lay on top of the stone ballast in perpendicular formations. Those used as storage would be underneath those used in service.

Author and diver William Gillies originally hypothesized that "…the ship struck the breaker side-on and turned over spilling out guns and contents and then immediately broke up, sending the ballast cascading down on top….[However] now I think that the guns were dismantled and stowed below deck on top of the ballast at the approach of a storm (Gillies 2007:60–61). Gillies' hypothesis about the unusual spacing and lines of guns is supported by Olliver's publication which notes about common methods for storing ballast in the 18th century (see source Ollivier and Roberts 1992).

El Buen Consejo, Anguilla-West Indies

The *El Buen Consejo* shipwreck site (Figure 3.15) is located off the northeastern tip of the Anguilla coastline in the West Indies. The site lies in water at a maximum depth of 25 ft. (7.6 m) and between 10 to 12 ft (3.3–4 m) at the area closest to shore. In addition to an extensive trail formation compiled of various cannon features, the site is marked by two large anchors located south and east of the shipwreck scatter. These cannons lie at a depth of 38 ft (11.58 m) and 30 ft (9.1 m). The most notable features to survive in the high energy zone are 18 iron cannons scattered over an area of 400 ft (122 m). Considerable coral growth formed around what would have once been cargo containers. The coral shell protected the integrity of the cargo's final orientation and preserved the artifacts within the containers, which included rolls of brass, pocket knives, thimbles, needles, brass pins, pewter utensils, glass beads, jewelry and religious medallions (Rodgers et al. 2006:13–16).

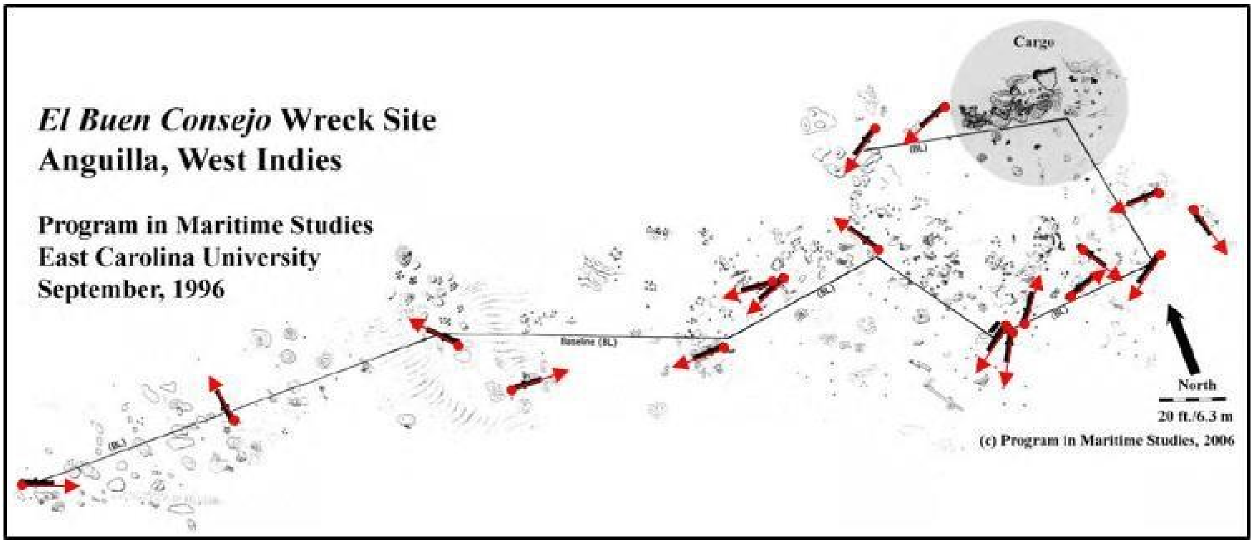


FIGURE 3.15. Sitemap of *El Buen Consejo* (Rodgers et al. 2006:15). Alterations by the author.

During its career, *El Buen Consejo* was a 990-ton Spanish Man of War that held approximately 70 cannons. Spanish merchant vessels typically traveled in fleets, or *flotas*, to prevent unwanted attacks from pirates and privateers on their routes to Veracruz via the Anegada Passage. However, *El Buen Consejo* failed to reach its intended destination and wrecked on the Anguilla reefs on 9 July 1772. The Anguilla coastline is a graveyard for ships due to its harsh rocky reef lines and consistently violent weather. The Anegada Passage was a popular trade route for Spain into the Caribbean, but it was incredibly dangerous if not adequately navigated (Rodgers et al. 2006:5–6).

Understanding the political climate between nations invested in the Caribbean during this time is critical for determining possible scenarios of the wrecking process of *El Buen Consejo*.

Signed in 1763, the Treaty of Paris established a temporary truce throughout the region by restoring power to Spain over Havana and the Bay of Honduras. Due to *El Buen Consejo*'s location in Spanish territory, every member from the wreck was rescued and transported to safety. This information suggested there was no disaster timeline, given the fact that there were no human casualties, and everyone was rescued (Rodgers et al. 2006:5–6).

Rodgers et al. hypothesized that the vessel had navigational issues while traveling at night and crashed into the reef surrounding the coastline. During the late 1700s, navigation technologies such as the chronometer were applied experimentally, and factors such as severe weather or night navigation were likely to cause malfunctions, primarily if the crew was unfamiliar with coastlines. Navigating during the day was safer because any obstacles or challenges could be noticed in advance, thus providing the crew time to make preparations. For *El Buen Consejo*, it was estimated that with the reasonable sailing speed of a 1700s vessel, between four to five knots, the crew had a maximum of five minutes to determine a problem and find a solution. The trail of jettisoned artifacts, specifically anchors and ordnance, illustrates the probable direction the vessel was traveling while attempting to navigate. The archaeological analysis determined the direction of the vessel by using the line the anchors formed as they moved from the deepest water towards the rest of the wreckage; the anchors were the first objects jettisoned (Rodgers et al. 2006:27).

The French Cannon Site (GC-017), Cayman Islands-British West Indies

The French cannon site (Figure 3.16), associated with the Wreck of the Ten Sail, is located in the North-Eastern area of Grand Cayman. Archaeologists have investigated the site over three different projects: 1980 by a crew from the Institute of Nautical Archaeology (INA), the mid-

1980s by Indiana University's Scuba Research and Development (SRD) group, and in 1991 by a Texas A&M field school. Each project compiled evidence which supported claims that the French cannon site was most likely associated with shipwreck HMS *Convert*. GC-017 has been noted as being mined for cannons for decorative land displays in years prior to the 1991 archaeological investigation (Leshikar 1993:303).

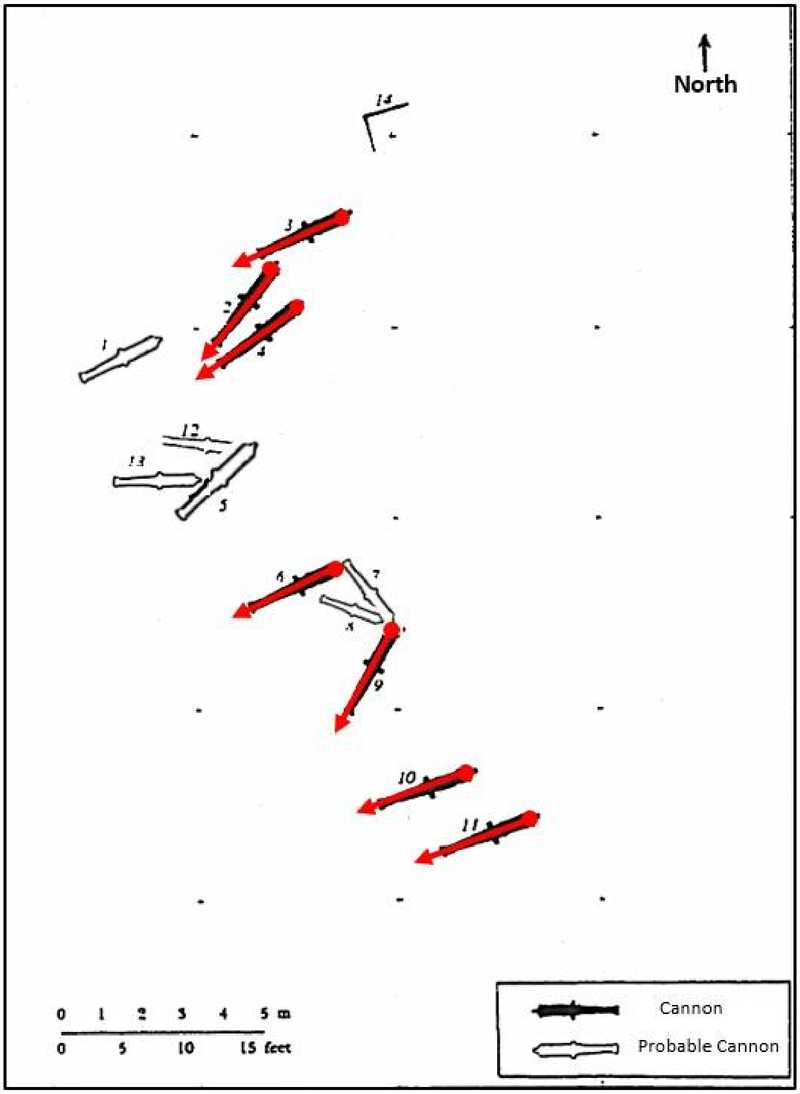


FIGURE 3.16. The French Cannon Sitemap (GC-017) (Leshikar 1993:315). Alterations by the author.

Convert was formerly a French frigate armed with 12-pounder cannons, originally named

L'Inconstante, which was captured by the Royal Navy off the coast of St. Domingue and later renamed HMS *Convert.* The ship was under construction amongst the break out of the French Revolutionary War in A.D.1789. Only seven other 12-pound frigates with the same ship design as *L'Inconstante* were constructed by France before 1798. *Convert*'s first mission was to escort merchant vessels back to Britain; however, due to unfortunate circumstances with harsh weather the convoy was reported as wrecking on the windward reefs of Grand Cayman on February 8th, 1794. Officers and crew of *Convert* salvaged goods from the site soon after the wrecking (Leshikar 1993:352-356).

The Royal Navy salvage records from *Convert* only reported recovering four swivel guns and 18 gun-carriages during the immediate salvage effort. After the captain and crew departed from Grand Cayman, local sources were appointed to assist with recovering the more challenging materials left behind, specifically tasked with collecting: primary and secondary ordnance, ordnance being stored, and any large anchors. *Convert* was fitted with 26 12-pounders and six 6-pounders, not reported as recovered by the Royal Navy during the year of the wreck (Leshikar 1993:304).

The first archaeological investigation was conducted by a crew from the Institute of Nautical Archaeology (INA) in 1980. The team recorded the GC-017 site at a depth of eight ft. on a flat area of sand. GC-017 was scanned with metal detectors, locating four other cannons buried in the area. The cannons were scattered in a direction from southeasterly to northwesterly and were reported as 18th-century French guns, potentially matching the gun types fitted on *Convert*. It should be noted that a lead cover over the touch hole of the cannon was discovered. Lead covers were used to protect the gunpowder from moisture during the loading processes, leading to the possibility that the gun was being prepared to be fired (Leshikar 1993:312).

During the mid-1980s a team of researchers from Indiana University's SRD group investigated GC-017. The crew plotted positions of six or more cannons, as well as recorded any other magnetic anomalies in the area with metal detectors. The team managed to predict previous positions of cannons previously salvaged from the site based on the archaeological evidence. During the 1991 field school, the team surveyed the area with metal detectors and created a 20 × 30 m grid over GC-017; it was recorded as being in an environment consisting of flat ground composed of sand and turtle grass, submerged at varying depths between 0.5 to 3 m of water. The environment is also known to have rough currents and has hosted hurricanes within the centuries after the wrecking. The 1991 survey noted, "poorly preserved bits of wood" discovered near the base of one of the cannons after hand fanning (Leshikar 1993:314). The metal detector survey identified eight large metal anomalies. Based on their magnetic signatures and positions, the crew predicted them to be cannons. A total of 13 cannons have been discovered and are believed to be submerged beneath sediment on GC- 017 (Leshikar 1993:312-316).

The investigations have led to multiple hypotheses about the wrecking and salvaging processes that could have potentially occurred over the years. Charles Beeker of Indiana University's SRD group from the mid-1980s believes that the cannons were placed on old wooden planks or boards after they were salvaged from *Convert* in the 1790s (Leshikar 1993:317).

One idea was that the cannons were salvaged from various areas on the sitemap and then positioned on a wooden surface or deck, which would explain the presence of wooden remains beneath the cannons as well as the orientation of cannons facing the same direction. Another premise for explaining the discovery of wood under the cannons insinuated both the gun deck and ordnance of *Convert* were potentially carried over the reef into the shallow sound, which explains why the largest cannons were not successfully recovered during the salvage attempts of the 1790s (Leshikar 1993:314-317). Appendix B provides a flow chart highlighting a potential scenario of how the ship might have wrecked.

Rockley Bay (TRB-5), Scarborough Harbour-Tobago

TRB-5 is located in Scarborough Harbour, Tobago. Scarborough Harbour hosts several submerged archaeological sites, many of which are speculated to have been sunk during naval conflicts between the Dutch and French in the 17th century. TRB-5 was noticed initially as a potential spot of archaeological significance by the late Westley Hall during his remote sensing survey in 1990. While archaeological surveys have investigated multiple areas of focus since the original investigation in the 1990s, TRB-5 (Figure 3.17) was not examined in depth until a later survey was conducted in March 2014.

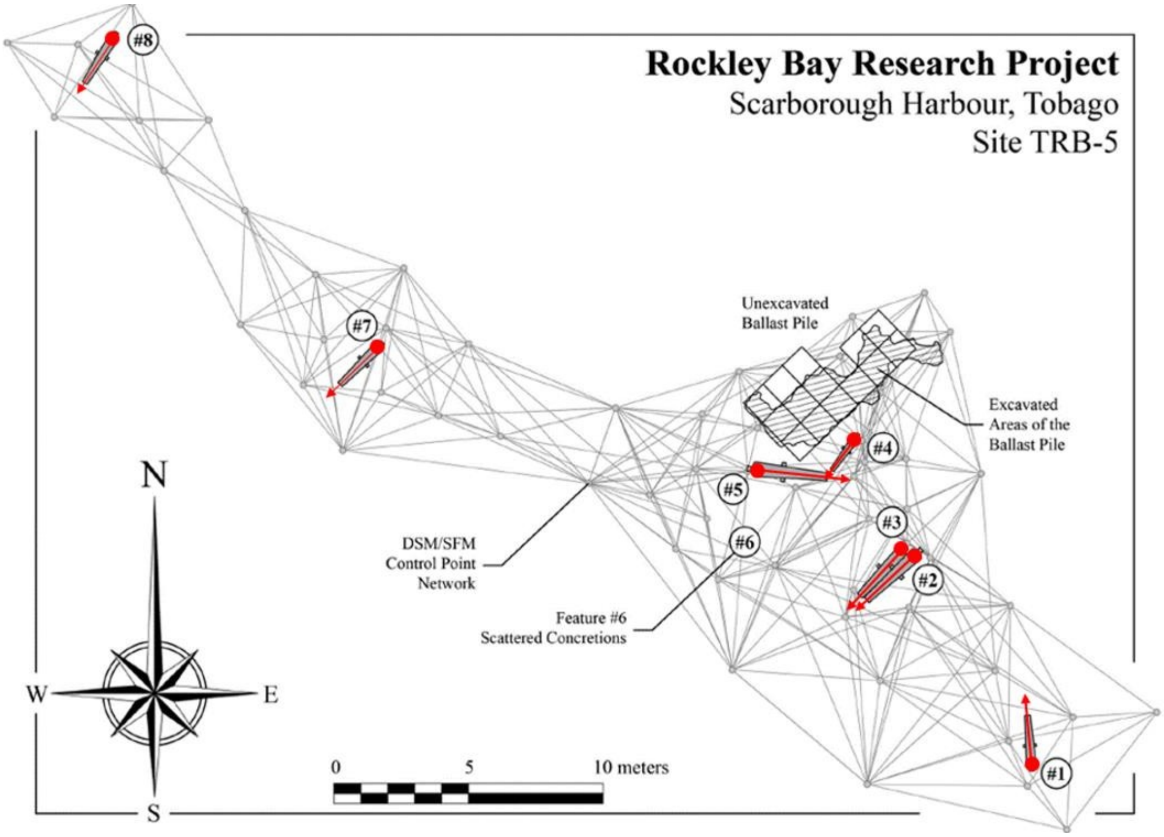


FIGURE 3.17. Sitemap of TRB-5 (Batchvarov 2016:111; Drawing: D. Inglis). Alterations by the

author.

Tobago was a deeply desired location for Caribbean trade during the 17th century. The location was spaced evenly between Europe and the Caribbean. The island provided a perfect location for militaries to send ships to be supplied and refitted without having to travel longer to reach South America.

The Franco-Dutch war (A.D. 1672-1678) caused Caribbean colonies to become targeted for invasions and attacks, including the colonies stationed on Tobago. Arguably one of the most significant conflicts associated with Tobago during the war occurred in March 1677, when a French squadron was sent to capture the island from the Dutch. The battle lasted for weeks and with their final attempt, outgunned and outmanned by the French squadron, the Dutch managed to sink four of the fifteen French warships, forcing the French to retreat from Tobago. However, the Dutch reported losing eight of ten warships in the conflict. It should be noted that an attempt was made to return and recapture the island in December 1677 but was found unsuccessful due to the entire squadron of 14 vessels wrecking into the Aves islands (Batchvarov 2016:106).

The first archaeological investigation occurred in 1990 after a construction project in the Harbour revealed excessive amounts of damage to submerged sites containing cultural heritage remains. Westley Hall was contacted to perform a remote sensing survey over the area, where the team had discovered multiple anomalies. However, two sites were explicitly recommended by Hall for further in-depth investigation. TRB-5 was described as a site with potential archaeological significance but was not given priority for archaeological investigation until Jean B. Pelletier of URS Inc. conducted a remote sensing survey later in 2014 (Batchvarov 2016:107).

TRB-5 consists of a large debris field compiled of bricks, cannon, and ballast stones distributed across a 40-meter area, where the debris field was remarked as a sizeable reef-like concretion. The site contains eight cannons which were recorded using a Direct Survey Method (DSM) with *SiteSurveyor TM 4* to calibrate distances of sitemap features accurately. While all cannons were found encrusted in concretions, the dimensions were successfully recorded (Batchvarov 2016:110). Table 3.1 represents the lengths of each cannon recorded on TRB-5 during the 2014 dive survey.

Table 3.1. TRB-5 Cannon Lengths created from 2014 dive survey (Batchvarov 2016:110-112) Alterations by Author.

Cannon 1	**Cannon 2**	**Cannon 3**	**Cannon 4**	**Cannon 5**	**Cannon 6**	**Cannon 7**	**Cannon 8**
2 M	2.85 M	1.8 M	1.65 M	3.1 M	1.7 M	2.3 M	1.7 M

Three different cannon sizes were located on TRB-5: 18-pounders, 6 or 8 pounders, and potentially a 3-pounder (Batchvarov 2016:112). It was noted that all cannons found on the site have flat breeches and trunnions below the centerline of the guns, which matches 17th-century gun specifications. Three different types of ordnance caliber were typical for medium-sized 17th-century men-of-war vessels. Merchant vessels of the time were known to be fitted with lighter caliber guns while frigates were equipped with a standard caliber for all ordnance (Batchvarov 2016:115). The evidence of the site provides the hypothesis that TRB-5 contains remains of a Dutch navy warship that was sunk during the French invasion of 1677.

Currently, the report did not provide any specific hypotheses concentrating on the final events of the wrecking processes of TRB-5. However, the team was able to create a supposition about the ship’s identity based on the archaeological evidence found on the site. During the conflicts, there were only three ships that were confirmed to be fitted with cannons of 18 pounders or greater size; for all ships outfitted with more massive cannons, identified to be present and lost in the battle of 1677 was *Huis te Kruiningen* (Batchvarov 2016:117).

The case studies used in this study vividly present various hypothesis for attempting to understand the history of the site. While each site contains an array of different variables, this study incorporated the hypothesis from archaeological reports to provide a foundation trying to link identify characteristics of cannons with the historical record.

CHAPTER 4: THEORY

Introduction

This thesis incorporates multiple perspectives of archaeological theory to understand the correlation between different variables on Caribbean cannon sites. This chapter intends to establish a concise foundation for this study by assessing previous aspects of the archaeological theory. Previous theories and analyses form the foundation which strengthens the accuracy of interpretation of this study. The two theoretical components focused upon in this chapter are site formation processes and behavioral archaeology. By examining various aspects of site formation processes Muckelroy (1978), Schiffer (1975), Ward (1999), and Gibbs (2006) and behavioral archaeology Tani (1995) this study connected factors of influence, which contributed to a clarified understanding the wrecking processes of ships.

Site Formation Processes

Site formation process is a critical aspect of maritime archaeology which focuses on the specific details of how, why, and what factors cause a ship to wreck. This study will require the use of site formation theory, which has been developed, modified, and expanded since first introduced to the maritime archaeological world in the 1970s.

Keith Muckelroy

The principal theory in this study focuses heavily on Muckelroy's original research evaluating site formation processes on shipwreck sites as a foundation to attempt to explain the processes of a cannon arrangement in shipwreck site formation. Figure 4.1 represents Muckelroy's original site formation flow-chart, which was expanded upon by Martin Gibbs (2006).

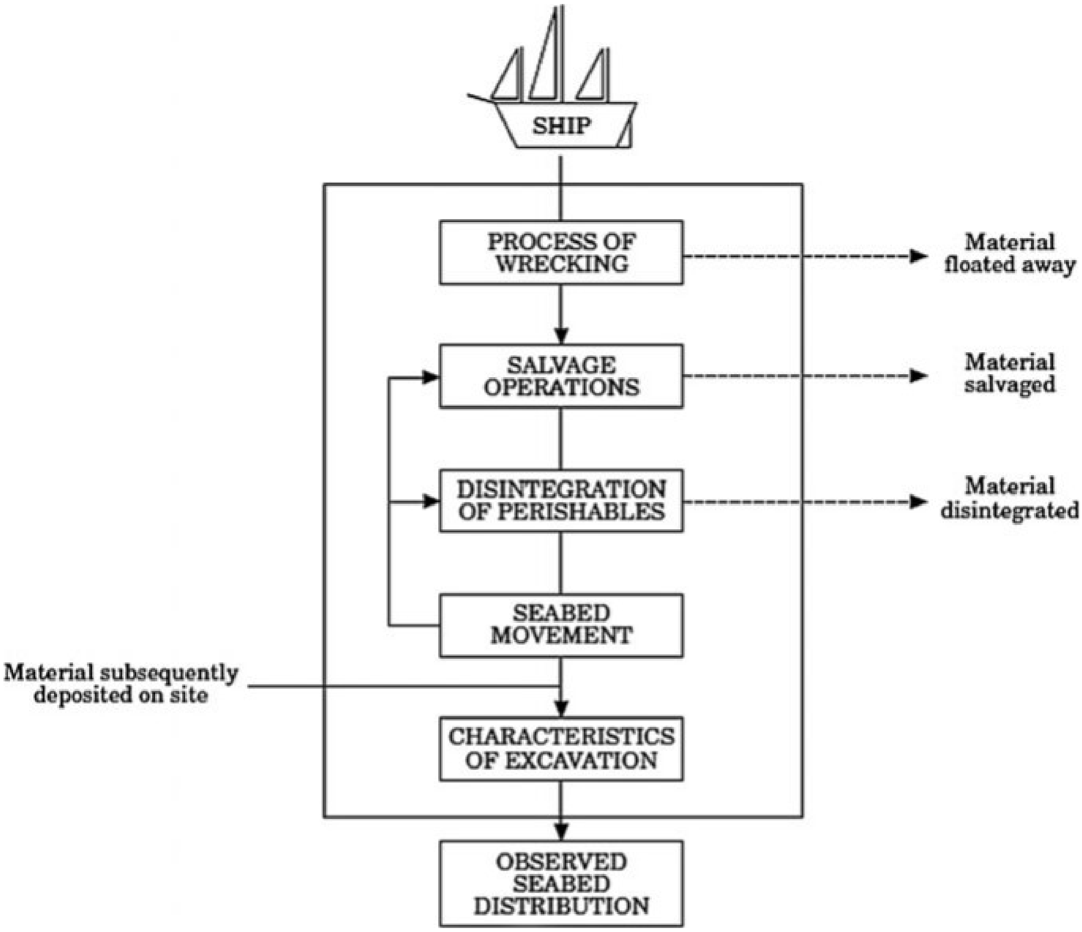


FIGURE 4.1. Muckelroy’s Site Formation Processes of a Shipwreck (Muckelroy 1976:282).

The flowchart (Figure 4.1) by Muckelroy (1978:165-169) included two different influences to explain the various stages of the shipwrecking processes: filters and scrambling. Filters are aspects which can explain how materials from the shipwreck are missing or detached from the site. Each of the three processes are identified on the right side of the flow chart: lighter materials which floated away during the wrecking process, attempts made to salvage resources from the shipwreck, and materials disintegrated or perished over time. The application of filters within the flowchart illustrates how the shipwreck arrived at its most recent state. To accurately understand the wrecking process, it is imperative to apply these filters as logical reasoning to account for missing features of an intact ship prior to wrecking.

Scrambling devices are used to explain the orientation of physical remains from the shipwreck. Muckelroy (1978) divided this application into two separate subcategories, types A and B. Type A scrambling occurs during the wrecking process, thus breaking down the intact vessel which is composed of many organized parts into a different arrangement on and within the seascape (Muckelroy 1978:169). Type B focuses on the movement of the seabed, which can engulf, push, and further manipulate features of the shipwreck site in various degrees from the original orientation of the shipwreck (Muckelroy 1978:175).

Michael Schiffer

As Muckelroy published his work on site formation processes, behavioral archaeologist Michael Schiffer was producing similar research. Schiffer categorized the differences between non-cultural factors (N-Transforms) and cultural factors (C-Transforms). In the context of maritime archaeology N-Transforms focus on the marine environmental effects on a shipwreck over time, while C-Transforms are a direct result of human influence (Schiffer 1975:848). Some examples of C-Transforms include intentional dumping of items over the side of the ship to prevent wrecking or salvaging a shipwreck for objects that could have been reused, traded, or sold. Examples of N-Transforms include, but are not limited to, hurricanes, strong currents, and biological growth. Schiffer’s research on behavioral archaeology concentrated on analyzing artifacts to understand the behaviors or interactions of people in the past and their systematic connection of artifacts in an archaeological context to their last actions before the wrecking event.

Ingrid Ward

During the mid-1990s, maritime archaeologist Dr. Ingrid Ward collected data on the N-Transforms affecting hull deterioration of shipwreck H.M.S. *Pandora*. Her study focused specifically on the oceanographic factors of site formation (tides, currents, sediment type, and grain size) and their influence on the degradation of *Pandora.* The research gathered by Ward created a foundation for scientifically understanding vital sediment movement, both covering and uncovering, on shipwreck sites. These data models of the wreck produced visuals of the probable stages of *Pandora*'s break down over time. Figure 4.2 shows a range of shipwreck deterioration via two diverse stages of high deterioration and low deterioration directly correlating with the intensity of sediment in each environment.

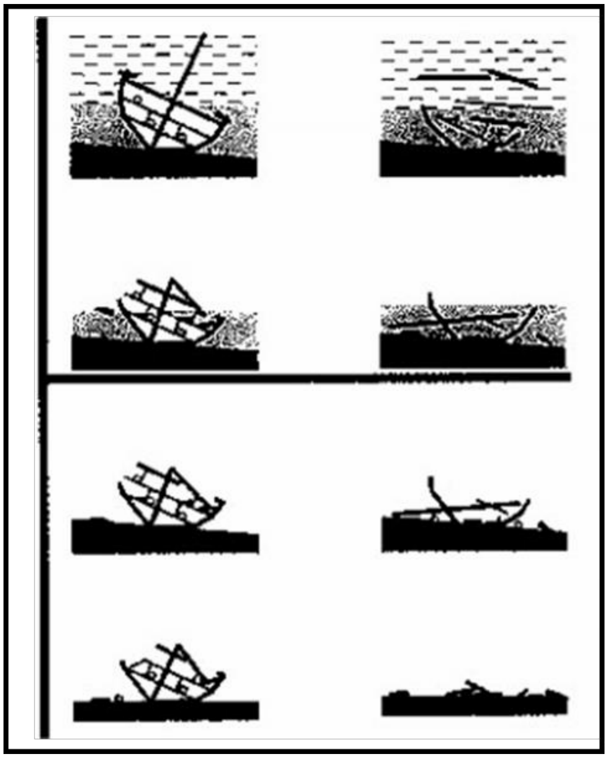


FIGURE 4.2. Ward's Prediction Model of Wreck Disintegration (Ward 1999:43).

Ward's prediction model of wreck disintegration is a valuable resource for this study for attempting to understand the cause of cannon orientation in their current arrangements and whether or not it was influenced deliberately by the crew during the pre-wrecking process or via N-Transforms (Ward et al. 1999).

Martin Gibbs

Thirty years after Muckelroy introduced site formation processes, scholars noticed that much of the research concerning shipwrecks focused heavily on the environmental aspects, or non-cultural transforms, that affect the sites. However, few studies received adequate focus geared explicitly towards the cultural transforms. Martin Gibb’s research involved gathering shipwreck studies that concentrated on the cultural transforms from the 1980s to 2006, thus expanding Muckelroy’s chart on site formation processes (Gibbs 2006:13). Figure 4.3 represents Martin Gibb's expanded chart.

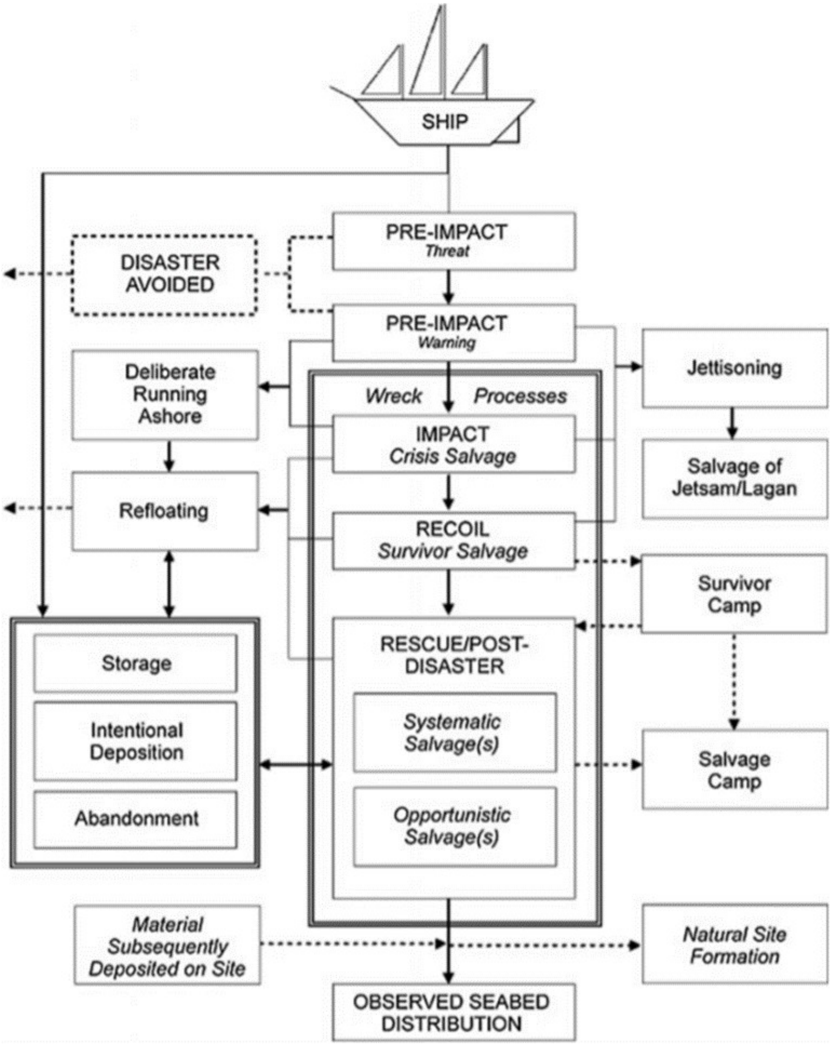


FIGURE 4.3. Cultural Transforms in Shipwreck Site Formation (Gibbs 2006:13).

Behavioral Archaeology

Behavioral archaeology focuses on making connections between the material culture and their intentional use to further comprehend aspects of behavior, which influence decision processes. Controversial perspectives concerning whether behavioral archaeology was an accurate process to apply on archaeological sites ensued. Some academics of the 1970s viewed the concept negatively, arguing that due to the complex nature of site formations without having a complete understanding of all the effective factors on sites, it would be impossible to make firm conclusions. Another argument implied the archaeological record contained a large number of site formation variables and that attempting to target human instinct or behavior with the material remains was not a viable method of inferring data (Tani 1995:232).

Masakazu Tani

In 1995, terrestrial archaeologist Masakazu Tani presented a case for the importance of creating a connection between the cultural formation processes and the archaeological record. Tani (1995:232) stated that:

> Cultural formation processes (CFPs) do not occur at random; rather, CFPs are related to and constrained by certain characteristics of activities. Therefore, once CFPs are identified by using observable variables in the archaeological record, the characteristics of the activities that affect CFPs can, in turn be inferred.

The author continued to argue that without bridging the gap between the two, valuable information concerning behavioral inference would be missed. Tani explained that more evidence of human behavior is available in the pockets of CFPs or refuse deposits/structures. The higher number of variables in these refuse deposits can conclude underlying aspects valuable for interpreting human activity through site formation processes. Tani (1995:232) stated, "while conventional analyses use information from the *contents* of refuse deposits, this approach [in this study] seeks other attributes of the deposits, such as location, size, shape, artifact density, number, and the like[likeness], for useful information." Her study separated site formation into two subcategories, primary depositional processes, and secondary formation processes. Primary depositional processes refer to the intentional act of quickly discarding refuse, which includes tossing and dropping. Secondary formation processes are those which alter or further "scramble" the deposit sites, such as dumping. Tani, being a terrestrial archaeologist, used terrestrial examples of secondary formation processes such as sweeping and raking to depict how a deposit site might be intentionally disturbed and changed from its primary deposit state. Tani mentions another category which can be applied to either process, called placing or provisional discard. Since these deposits are usually generated into one condensed area, they show intentional generation to that specific area. However, there is a level of difficulty in distinguishing whether the site was a primary deposit or one that was a result of a secondary formation process (Tani 1995:233-327).

The theoretical concepts introduced in this chapter provided a structured framework for the author throughout this study. The application of these concepts from behavioral archaeology and site formation processes produced valuable insight of the pre and post wrecking processes, providing support for potential scenarios linking C-Transforms to both recorded and unrecorded events associated with the cannons on their respective sites.

CHAPTER 5: METHODOLOGY

Introduction

Assessing the underlying connections associated with the pre- and post-wrecking processes of shipwrecks required a great deal of research from a wide array of sources. Each source provided valuable insights for directing correlating facets of data which otherwise might have gone unnoticed. To focus the scope of research, the sources used in this study were divided into three stages: historical research, archaeological investigations, and methods for analysis of data. The historical research segment recalls collecting primary and secondary sources which focused on variables of seamanship, such as storage methods of ordnance and steps to be executed during emergency situations, during the Age of Sail.

The second segment focuses on the archaeological investigations on the sites, or case studies, used in this research. The third and final segment of the study is the analysis, which included creating a Google Sheets spreadsheet containing data from the case studies to be interpreted further by the author. This chapter provides an in-depth chronological review of every process used for this study beginning with historical research. The protocols previously discussed via insurance manuals and guides for young merchant sailors, provided the author with perspective of underlined mentalities which were expected to be performed under stressful scenarios.

Historical Research

The author's first step of this study was creating limitations to the study to narrow the sites to be included. The study required all sites to include three variables: each case study was located in Caribbean waters, had recorded a minimum of three cannons via archaeological investigations, and the date of the wrecking event fell within A.D.1650 to A.D. 1800. Initial web searches for archaeological reports that included the three themed variables was then performed. Several case studies were successfully collected via this method. Each archaeological report included brief historical reviews describing the areas where the sites were recorded. In some instances, hypotheses of the wrecking process were included by the authors, which became a starting point for further research. Concentration on primary sources that retold seafaring methods and actions during the Age of Sail was also used.

Primary Sources

The Primary sources included in this study provided the researcher with how the act of jettison was perceived by merchants, insurers, masters, and other parties who were invested in the processes of maritime trade. Insurance manuscripts such as *An Essay on Insurances* by Nicolas Magens (1755), *The Compleat Compting-House Companion: or, Young Merchant and Trademan's Sure Guide* by William Johnson (1763), "*De Jure Maritimo et Navali" or a Treatise of Affairs Maritime, and of Commerce* by Charles Molloy (1769), and *An Analytical Digest of The Law of Marnie Insurance* by Henry Sherman (1841) each describe various scenarios illustrating hierarchy of power under various situations for which the emergency act of jettison is required. This information allowed the researcher to perceive various scenarios to attempt to better simulate the perspective of the captain and crew and how they made their decisions under extreme circumstances. This data provided insights into how the officer giving the commands perceived the overall value of the crew, cargo, ship, and law. Other primary sources included topics on seamanship such as *Treatise on the Theory and Practice of Seamanship* by Richard Hall Gower (1808) and *Kedge-Anchor or the Young Sailors' Assistant* by William Brady (1852). These sources gave the researcher valuable insight to the loading and unloading, distribution, and securing of cannons while at sea.

Secondary Sources

Secondary sources used in this study included: scholarly journals, especially *Historical Archaeology* and *International Journal of Nautical Archaeology*. John Guilmartin (1988), Brian Lavery (1987) and Mendel Peterson's (2014) research on cannon were vital sources for this project. Cannons have been recorded as being used as early as the late 1300s, producing many types over the centuries. These sources provide historical insight on cannon evolution throughout time and popular typologies used during the focus period of this study, the Age of Sail. John Harland (1984) provided valuable insight on the complexity of seamanship during the Age of Sail. His research and bibliography provided several primary sources used by the author in this thesis.

Archaeological Investigations

The methodology used for this research will require examining historical and archaeological reports from Cannons Site, Costa Rica (Harris and Richards 2018); *Quedagh Merchant*, The Dominican Republic(Hoyt 1984) (Harris et all 2012); Pedro Bank, Jamaica (Hoyt 1984); Manilla Wreck, Bermuda(Karklins 1991); *El Buen Consejo*, Anguilla (Rodgers 2006); The French Cannon Site (GC-017)(Leshikar 1993), Cayman Islands; and Rockley Bay (TRB-5), Scarborough Harbour, Tobago (Batchvarov 2016). Specifically, the methodology focused on analyzing the arrangement of cannons on each site to attempt to identify characteristics relating to non-cultural or cultural processes.

Analysis

All of the data extracted from the archaeological surveys were input into a Google Sheets document and processed into a variety of charts and graphs. By examining sitemaps for similar or identical characteristics, an effort was made to compare cannon patterns to historical information about traditions of cannon arrangement on board, seamanship, the wrecking event and post-wrecking local environmental processes. The sitemaps were edited in Adobe Illustrator and Photoshop to enhance image clarity, thus providing the researcher with maximum details to be interpreted.

Sitemaps allowed the researcher to highlight features and hypothesize meanings associated with common patterns shared during the wrecking process between the case study sites. Each sitemap was then placed on individual slides in Microsoft PowerPoint, so features could be highlighted by using shape tools. Before the highlighting process could begin, the researcher created a list of definitions and typologies to be used when analyzing the sitemaps to extract data more efficiently. The typologies were divided into two different categories presented below (Table 5.1).

TABLE 5.1. Typology and definitions of cannon patterns (Author 2018).

Formation-a structure or arrangement of something. Formations can have one or more features, but not required.

Feature-a distinctive attribute, characteristic, or aspect of something. Features make up formations

Crown-a crown formation is when multiple cannons are found facing the same direction, with consistent spacing between one another. In some cases, forming an arching line along the cascabels.

Trail-a trail formation is when multiple "stray" cannons are found spread out with limited correlation to one another, having the potential of leading to the site location of the shipwreck or strictly as evidence of a ship jettisoning. The cannon should be +5 meters apart.

Mound-a mound formation is when multiple cannons are found stacked on top of one another, most likely found concreated together creating height. Similar to a ***Zipper*** formation, where the cannons are organized cascabel to muzzle and vice versa but are not stacked.

Keel-Lane-a keel-lane formation shows the cannon positioned into lines with equal spacing, most likely parallel to the ship's keel or where the keel was once located.

Cluster-a cluster feature is when 3 or more cannons are found within a 3-meter circular proximity of one another, but not touching.

Stray-a stray cannon feature when one cannon is found disconnected and distant (+5 meters) from other features from the immediate perimeter of the site. With further examination, this could be connected to an undiscovered "trail" formation.

Fan-a fan, or fanning, the feature has two or more cannons touching, crossing or intersecting at either the cascabel or muzzle while spreading away from each other.

Pair- sets of two cannons which are discovered within 1 meter of each other, can be found touching but not required.

Riggs- a loose cannon, independent from other features on a site. Unlike a *stray* cannon, *Riggs* is found in the proximity to the site while *strays* are located outside of the immediate site parameters.

The parameters of the study required a specific classification of terminology and definitions independent from prior research to give the reader a clear reference. The typologies (Table 5.1) applied on each site and to provide structure throughout this study. Chapter 6 contains the author's data and results for each of the sites used in this study.

CHAPTER 6: RESULTS AND ANALYSIS

Introduction

> A ship is a cultural component that shares some conventions with the parent culture but is also a cultural entity in and of itself. Shipboard life is composed of behavioral patterns designed to affect a common, techno-intensive goal: the successful operation of a ship, completion of the mission, and survival at sea. The shipboard community is composed of groups with defined roles and duties, in a probable chain of command, which establishes hierarchy and certain patterns of interaction (Murphy 1983:67).

The case studies supporting this research within a temporal range approximately between A.D. 1650 and A.D. 1815, an era referred to as the Age of Sail. Each site was selected based on two requirements: they must contain three or more cannons (iron or bronze) and be located in either Bermuda or Caribbean waters. It was necessary to extract site maps from previous archaeological surveys for further analysis and data processing. Site reports containing hypotheses and analyses of the wrecking processes were also considered by the author, some of which were believed to be valuable for deciphering site identities. The author created a list of terms and typologies to provide clarification concerning data analysis.

Process

The data in this study required placing each sitemap into different classifications based on cannon positions. The term *features* (cannon distribution patterns at the time of archaeological investigation appearing in the report or article utilized) refer to, in this instance, cannon variables (*Stray, Cluster, Pair, Zipper, Fan*). Thereafter, the author assessed *feature* similarities and the potential meaning on each site to determine systematically the likely scenarios for how cannons were stowed on decks linking to information in the historic record or discarded at the time of the wrecking process. In addition, I noted ways in which the features and formation might lead to possible erroneous conclusions as a researcher. For example, C-Transforms might include missing cannons due to past or recent salvage, or easy public and diver collector access to the site. N-Transforms might include reef coverage protecting or hiding cannons, heavy seas and surge moving cannons from original discard locations, or protective bays and rock gullies keeping cannon in situ. Figure 6.1 below identifies some of the case study variables that should be considered.

Figure 6.1 included three sets of variables that were found frequently throughout the case study reports used in this thesis (site depth, site distance from shore, and age of the site). It should be noted that some of variables were originally provided in a range, for the purposes of this study the author used minimum site depth, minimum distance from shore, and minimum estimated age of shipwreck sites. This allowed the author to interpret overall likeliness of site disturbances due to ease of access and risk of salvaging or removal of artifacts from sites. Any sites that are left blank did not provide the desired data in the archaeological site reports used in this thesis.

The age of each site was interpreted with the idea that wreck sites (and their corresponding cannon patterns), that have been submerged for a greater time frame are at greater risk of experiencing site scrambling. Some examples include N-Transforms such as strong currents, tsunamis, and hurricanes. However, older sites are also at risk of being disturbed by C-Transforms, such as salvaging attempts, which includes both directly after the wrecking process and modern salvaging. The author also included site depth and distance from shore to attempt to identify and justify likeliness of C-Transforms which could potentially be associated with further scrambling the sites and their respective cannon patterns.

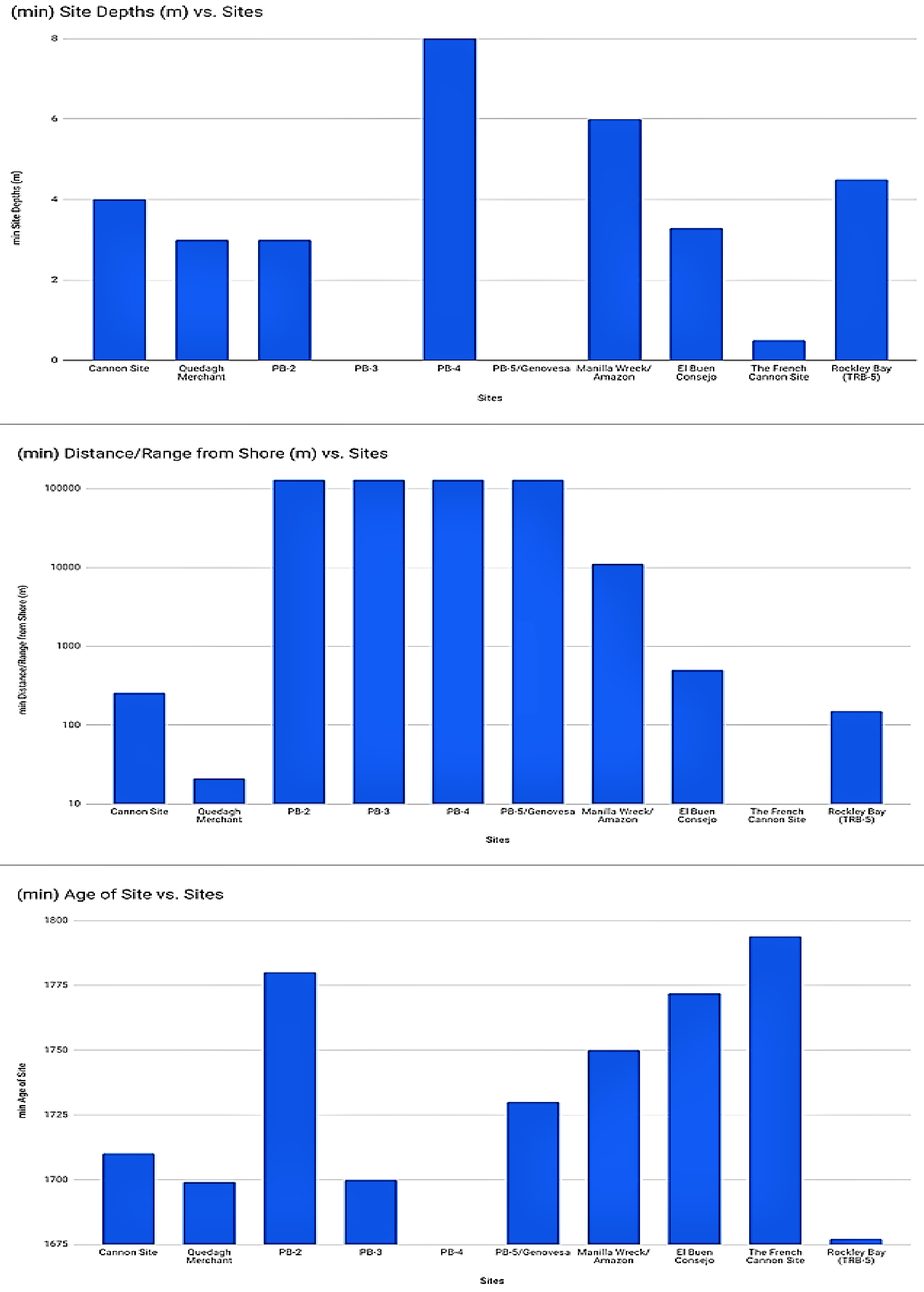


FIGURE 6.1. Diagrams representing minimal depth, distance from shore, and age of each site. Courtesy of Google Sheets (Author 2019).

The TRB-5 site is the oldest known wreck site to be confirmed in this study (A.D. 1677) and is located approximately 150 m from the closest shoreline at approximately 4.7 m (Batchvarov 2016). Due to its proximity to shore and being submerged beneath a commonly accessed harbor over a significant amount of time, the author inferred that TRB-5 should be considered at high risk of scrambling or removal of artifacts from the site. The Cannon Site, *Quedagh Merchant*, Manilla Wreck, *El Buen Consejo,* and The French Cannon Site showed similarities with the three variables which the author interpreted as being in a range between high and low accessibility.

The Pedro Bank sites (PB-2 to PB-5) include a range of hypotheses, which include some successful refloat and salvage attempts. The site depths (3 to 8 m) and distances from the Jamaican shoreline (80 miles or 128,748 m) suggest lower risk of salvaging attempts. While Pedro Bank was a known as an area for shipwrecks, the extreme distance from the nearest shoreline and dangerous environment (rocky shoals and rough currents) led the author to infer these sites were more likely to experience scrambling due to N-Transforms over time than C-Transforms.

From the three variables of data, the researcher interpreted that the oldest sites and most likely affected by N-Transforms and were at a higher risk of scrambling from their original cannon patterns. While factors such as quick burial of sites and artifacts and environmental barriers hold potential for protection from site scrambling, the data needed to make an accurate inference concerning these factors was not included in many of the site reports.

Assessing cannon *features* allow researchers to create hypotheses. For example, a site that contains three *Stray* cannon *features* and two *Cluster* features would equal a *Trail formation*. Due to the spacing between the *stray* cannons and the depth of which they were discovered the *formation* of the site led the author to hypothesize that the stray cannons were jettisoned during an emergency situation. Some examples might include avoiding wrecking on reefs or during bad weather. The *Cluster formations* lead to a hypothesis that cannons were stored in the lower areas of the ship when it wrecked or became abandoned. In some scenarios, after the crew recovered whatever cargo or ordnance was salvageable, they would leave the hull behind, including those objects located deep within unreachable areas. Cannons that were used as ballast or in stowage are examples of objects that were commonly abandoned with the ship, due to their excessive weight and high difficulty in being retrieved. The final part of this analytical process attempts to draw wider comparisons and conclusions between cannon formations and the behavioral perspectives of the crew during the wrecking processes.

Site Breakdowns

Each site was analyzed individually by the researcher and recategorized using the typologies provided (Table 5.1). Once the sites were identified by feature, the information was recorded into a document (Google Sheets) which allowed the author to interpret data about the *formations* on each site. The site's classification of *formation* attempted to provide potential scenarios supporting the validity of the previously hypothesized explanations of the cannon dispersal on the sites. Each site is explained below.

"Cannon Site"; Cahuita, Costa Rica

The sitemap of Cannon Site of Cahuita, Costa Rica was sectioned off and labeled (CF-1 to CF-4) by the author (Figure 6.2). The author did not include cannon No. 9 and 15 due to lack of confirmation whether the objects were in fact broken pieces of cannon. Understanding whether object No. 9 and 15 were parts of the same cannon or different cannons would have been beneficial to this study for better interpretation of how broken cannons were perceived by the crew and whether they were discarded immediately or intentionally stored in the hull. This is an important aspect and is highly recommended by the author to be analyzed in future research endeavors.

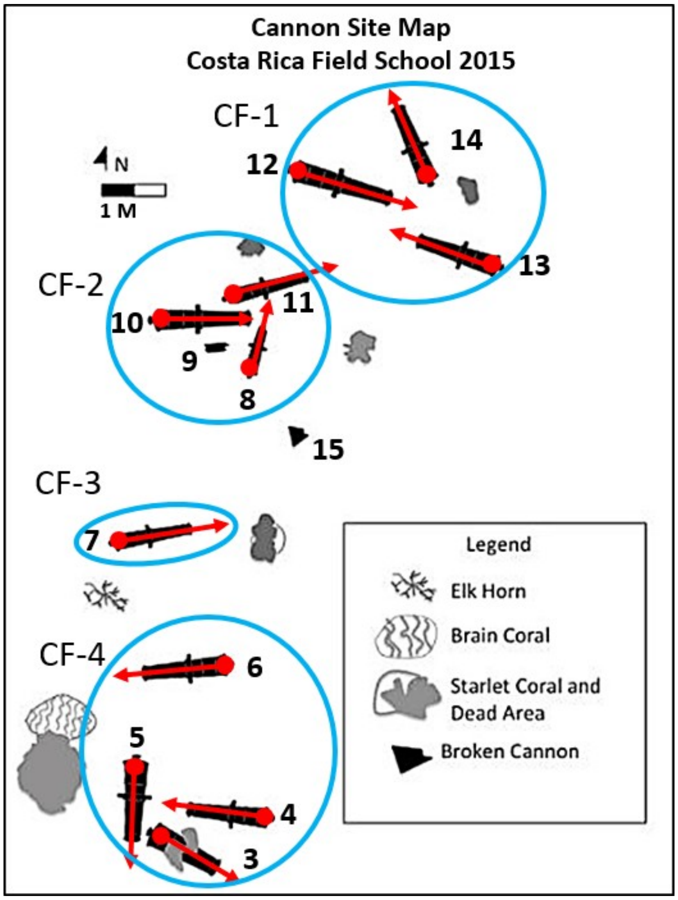


FIGURE 6.2. Map of "Cannon Site" classified by cannon *features* (Harris et al. 2015:72). Alterations by the author.

The extracted data from the sitemap was entered into a Google Sheets document (Table 6.1), logging each assigned cannon feature (CF) a number and typology classification: *Cluster*, *Fan*, *Pair*, *Riggs*, and *Stray*. The data confirmed that a total of four cannon features: three *Clusters* and one *Riggs*.

TABLE 6.1. of "Cannon Site" classified by cannon *features* from sitemap (Author 2018).

	Cluster	*Fan*	*Pair*	*Riggs*	*Stray*	**Feature Totals**
"Cannon Site"; Cahuita, Costa Rica	**3**			**1**		**4**
Cannon Feature 1	**X**					
Cannon Feature 2	**X**					
Cannon Feature 3				**X**		
Cannon Feature 4	**X**					

The data produced a percentage breakdown of site *features* identified, represented as a pie chart (Figure 6.3). The breakdown shows that four cannon *features* identified on the Cannon Site (Cahuita, Costa Rica), 25% were classified as *Riggs* while the remaining 75% classified as *Cluster*.

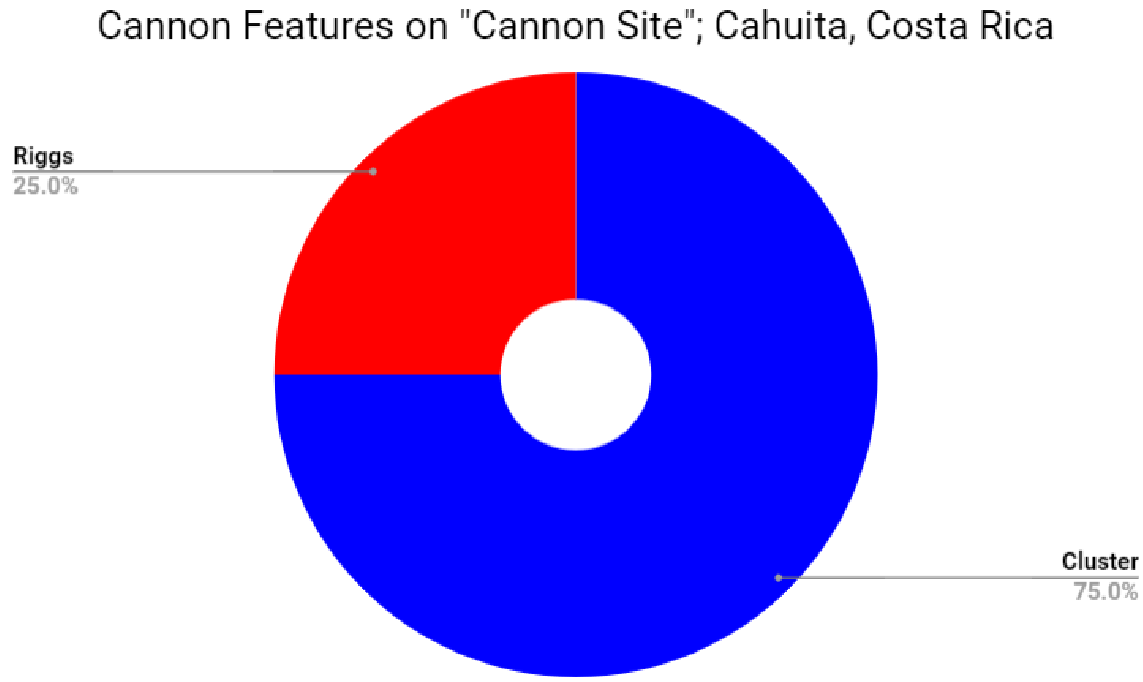


FIGURE 6.3. Pie chart of cannon *features* on "Cannon Site" (Author 2018).

El Buen Consejo: Anguilla

The site map of *El Buen Consejo* (Anguilla, West Indies) was sectioned off and labeled (CF-1 to CF-13) by the author (Figure 6.4).

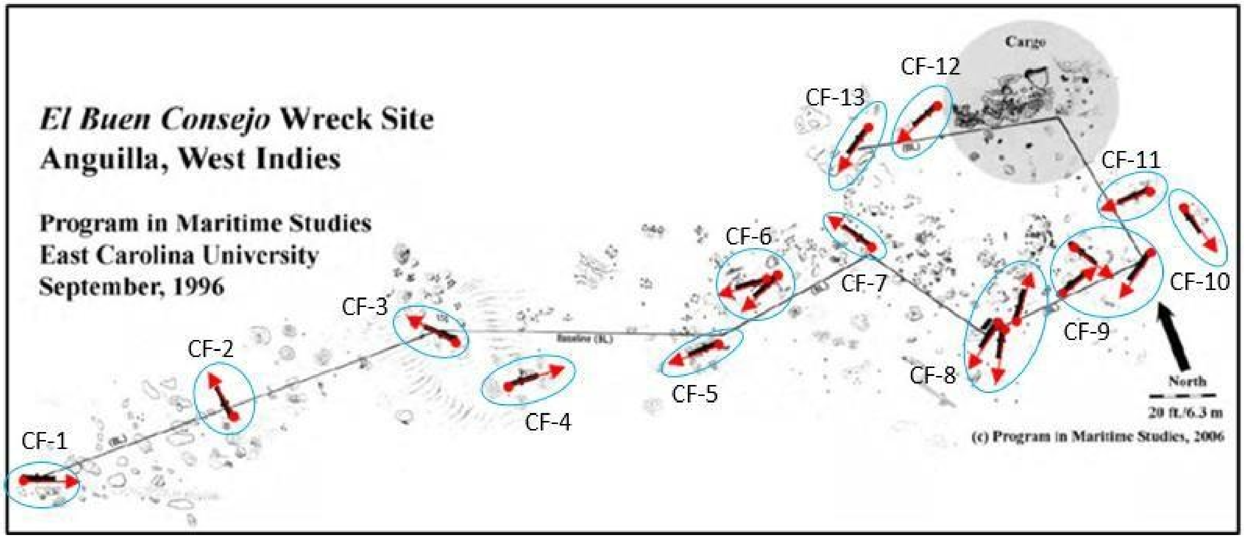


FIGURE 6.4. *El Buen Consejo* site map classified by cannon *features* (Rodgers 2006:15). Alterations by the author.

The extracted data from the sitemap was entered into a Google Sheets document (Table 6.2), logging each assigned cannon feature (CF) a number and typology classification: *Cluster*, *Fan*, *Pair*, *Riggs*, and *Stray*. The data presented a total of 13 cannon *features*: two *Clusters*, one *Fan*, five *Riggs* and five *Strays*.

TABLE 6.2. *El Buen Consejo* classified by cannon *features* from sitemap (Author 2018).

	Cluster	*Fan*	*Pair*	*Riggs*	*Stray*	Feature Totals
El Buen Consejo: Anguilla	2	1		5	5	13
Cannon Feature 1					X	
Cannon Feature 2					X	
Cannon Feature 3					X	
Cannon Feature 4					X	
Cannon Feature 5					X	
Cannon Feature 6		X				
Cannon Feature 7				X		
Cannon Feature 8	X					
Cannon Feature 9	X					
Cannon Feature 10				X		
Cannon Feature 11				X		
Cannon Feature 12				X		
Cannon Feature 13				X		

Figure 6.5 represents a percentage breakdown of the identified *features*. The breakdown shows that 13 cannon *features* were identified on the *El Buen Consejo* site, 15.4% *Clusters*, 7.7% *Fans*, 38.5% *Riggs*, and the remaining 38.5% were *Strays*.

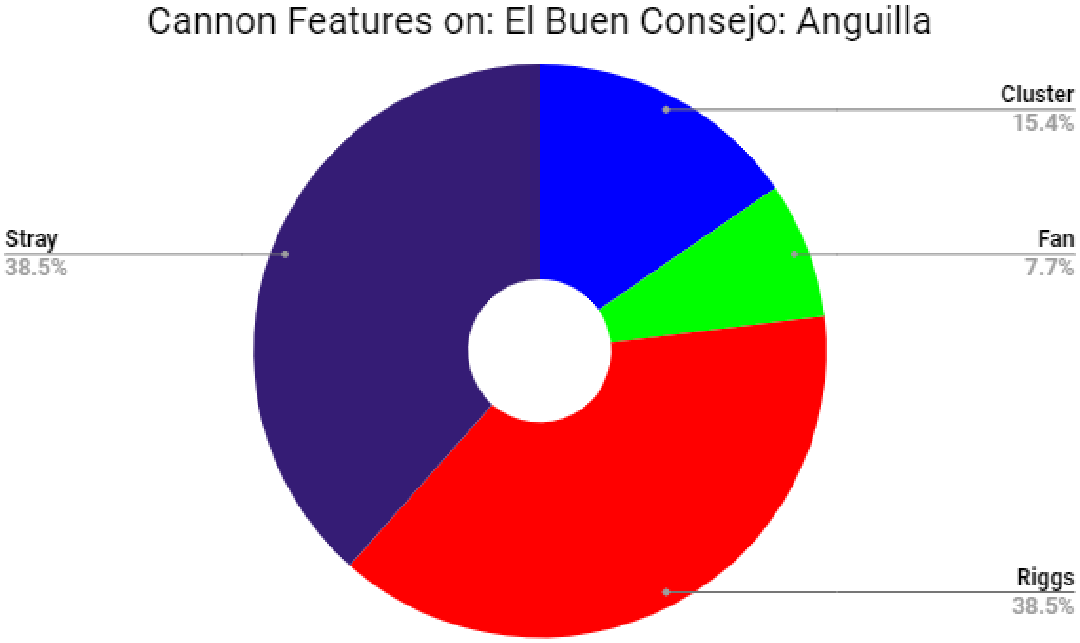


FIGURE 6.5. Pie chart of cannon *features* on *El Buen Consejo* site (Author 2018).

GC-017 "The French Cannon Site"; Grand Cayman

The sitemap of the French Cannon Site (Grand Cayman) was sectioned off and labeled (CF-1 to CF-5) by the author (Figure 6.6). The archaeological survey performed on this site included all cannons, both confirmed and probable. While the magnetic signatures found during the survey were believed to be cannons, the author only used data that was confirmed. The confirmed cannons are identified in sitemap key by solid black cannons, while white cannons mark the location of probable cannons.

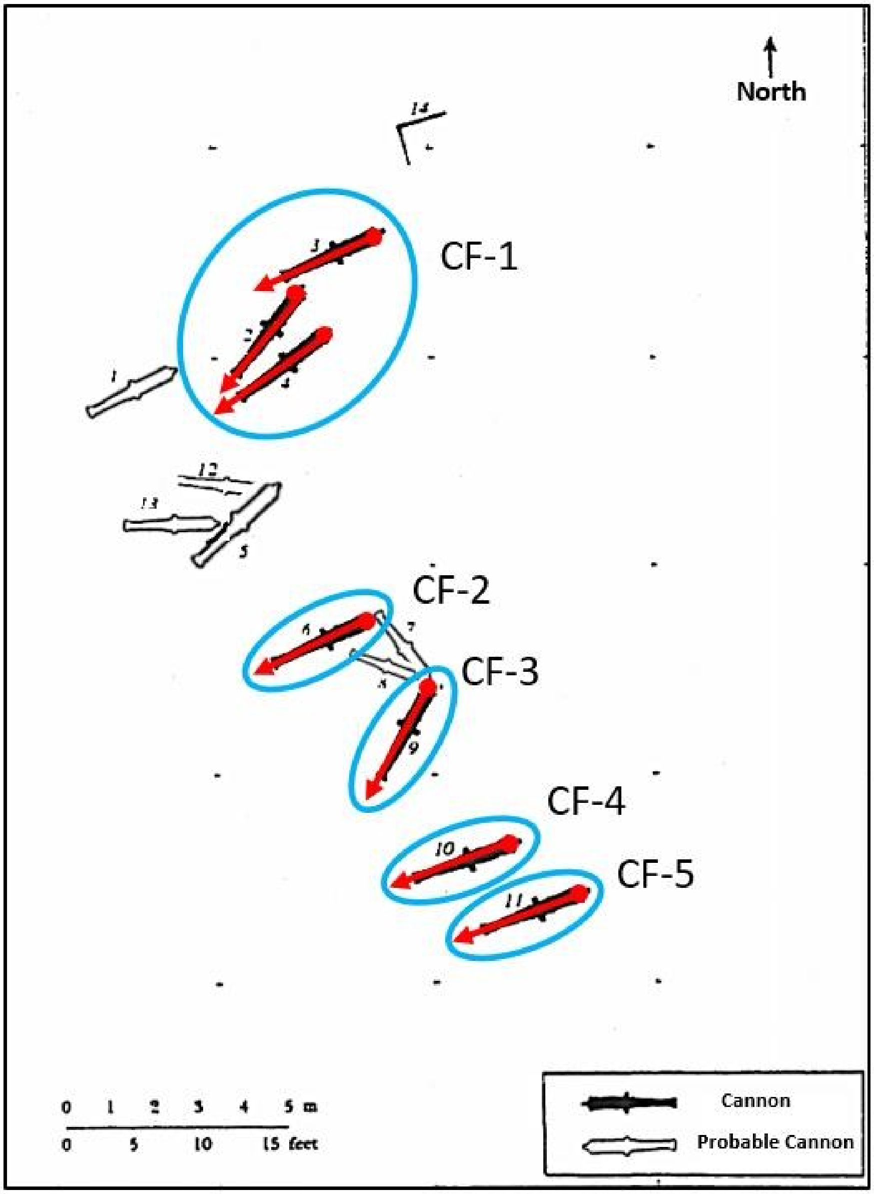


FIGURE 6.6. Map of "The French Cannon Site" classified by cannon *features* (Leshikar 1993:315). Alterations by the author.

The extracted data from the sitemap was entered into a Google Sheets document (Table 6.3), logging the each assigned cannon feature (CF) a number and typology classification: *Cluster*, *Fan*, *Pair*, *Riggs*, and *Stray*. The data that a total of five cannon *features*: one *Cluster* and four *Riggs*.

TABLE 6.3. "The French Cannon Site" classified by cannon *features* from sitemap (Author 2018).

	Cluster	Fan	Pair	Riggs	Stray	Feature Totals
GC-017 "The French Cannon Site"; Grand Cayman	**1**			**4**		**5**
Cannon Feature 1	X					
Cannon Feature 2				X		
Cannon Feature 3				X		
Cannon Feature 4				X		
Cannon Feature 5				X		

Figure 6.7 represents a percentage breakdown of the identified *features*. The breakdown shows that of the five cannon *features* were identified on the French Cannon site, 20.0 % were *Clusters* and the remaining 80.0% as *Riggs*.

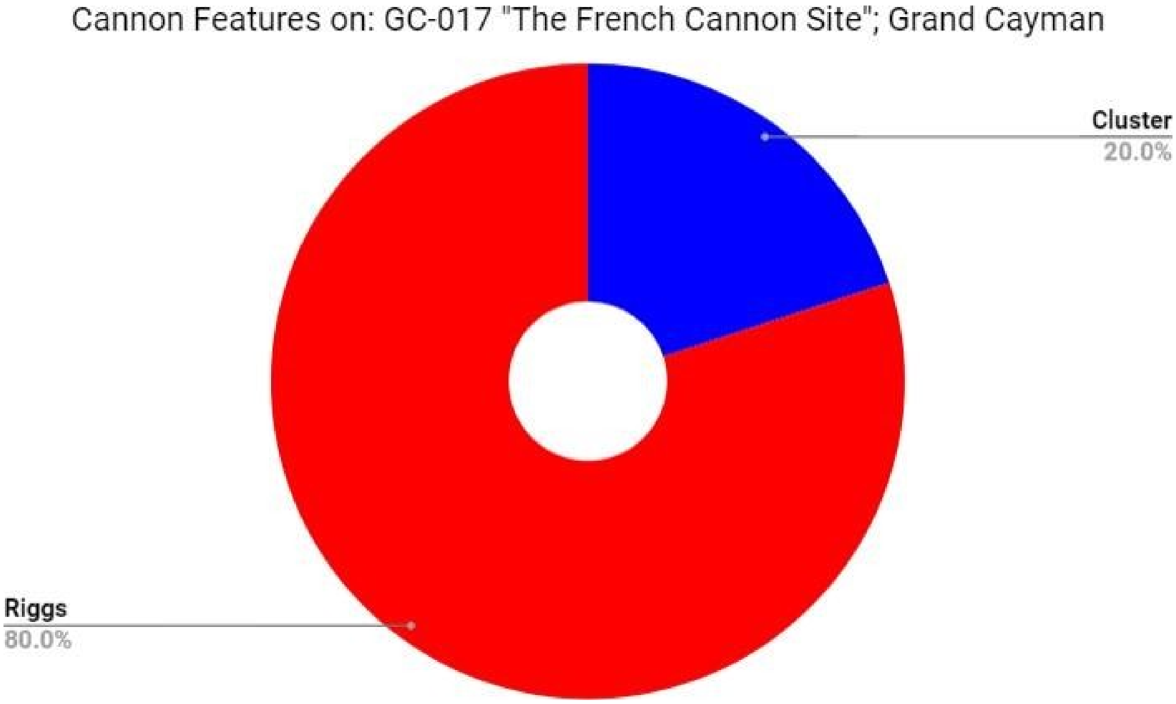


FIGURE 6.7. Pie chart of cannon *features* on "The French Cannon Site" (Author 2018).

"Manilla Wreck": Bermuda

The sitemap of the Manilla Wreck (Bermuda) was sectioned off and labeled (CF-1 to CF-13) by the author (Figure 6.8).

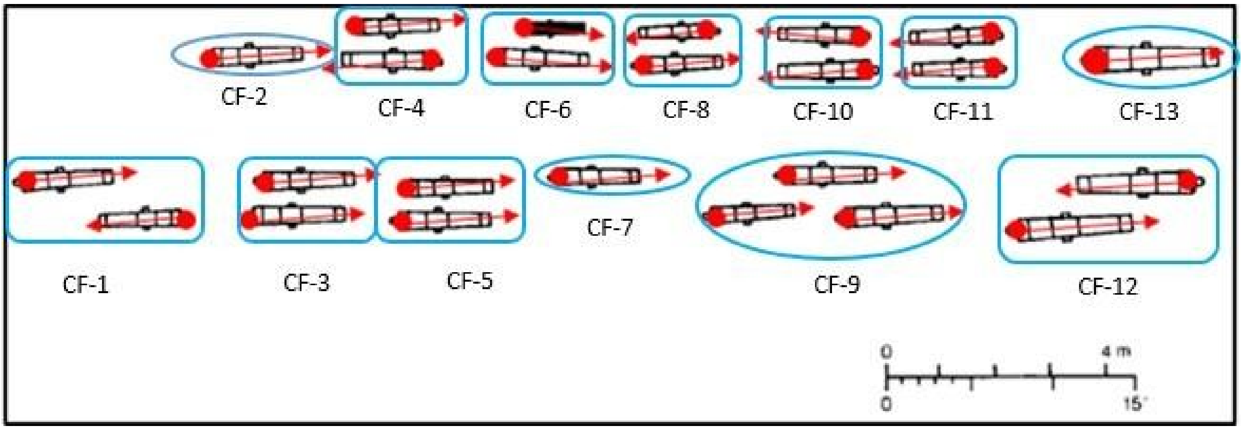


FIGURE 6.8. Sitemap of "Manilla Wreck" classified by cannon *features* (Karkins 1991:38). Alterations by the author.

The extracted data from the sitemap was entered into a Google Sheets document (Table 6.4), logging each assigned cannon feature (CF) a number and typology classification: *Cluster*, *Fan*, *Pair*, *Riggs*, and *Stray*. The data confirmed that a total of 13 cannon *features*: one *Cluster*, nine *Pairs*, and three *Riggs*.

TABLE 6.4. "Manilla Wreck" classified by cannon *features* from sitemap (Author 2018).

	Cluster	*Fan*	*Pair*	*Riggs*	*Stray*	Feature Totals
"Manilla Wreck": Bermuda	1		9	3		13
Cannon Feature 1			X			
Cannon Feature 2				X		
Cannon Feature 3			X			
Cannon Feature 4			X			
Cannon Feature 5			X			
Cannon Feature 6			X			
Cannon Feature 7				X		
Cannon Feature 8			X			
Cannon Feature 9	X					
Cannon Feature 10			X			
Cannon Feature 11			X			
Cannon Feature 12			X			
Cannon Feature 13				X		

Figure 6.9 represents a percentage breakdown of the identified *features*. The breakdown shows that 13 cannon *features* were identified on the Manilla Wreck site, 7.7 % *Clusters*, 69.2% *Pairs*, while the remaining 23.1% were *Riggs*.

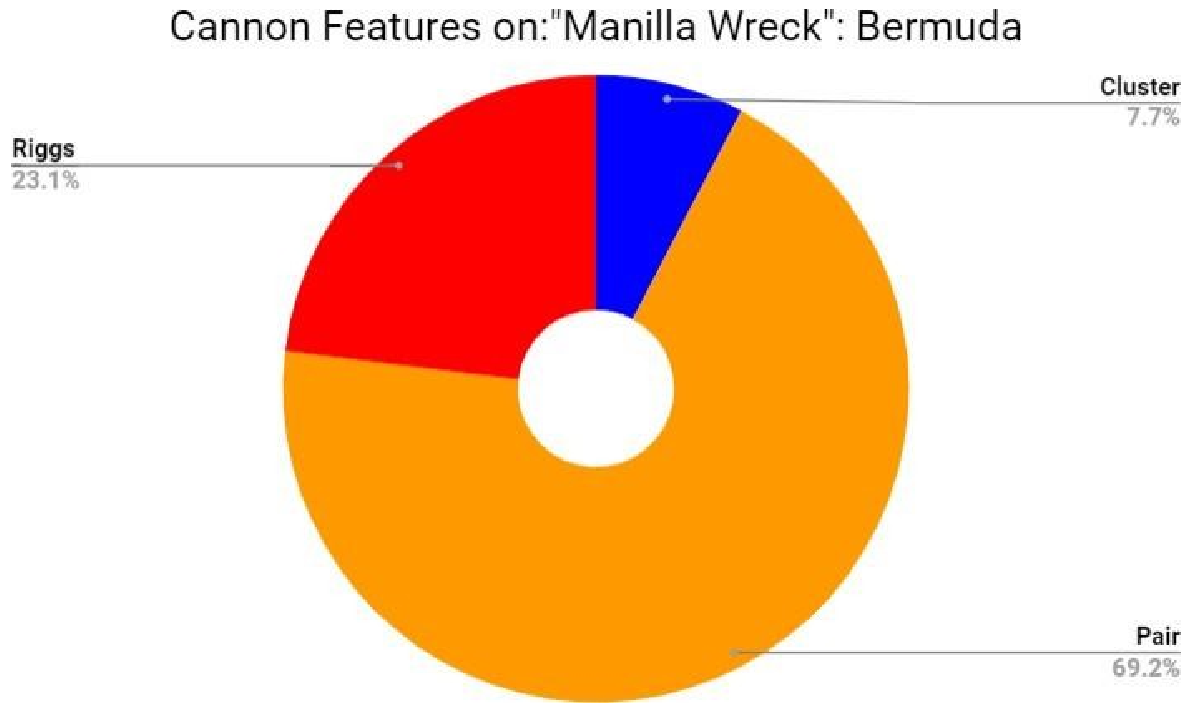


FIGURE 6.9. Pie chart of cannon *features* on "Manilla Wreck" (Author 2018).

Pedro Bank, Jamaica

PB-2

The sitemap of PB-2 (Pedro Bank, Jamaica) was sectioned off and labeled (CF-1 and CF-2) by the author (Figure 6.10).

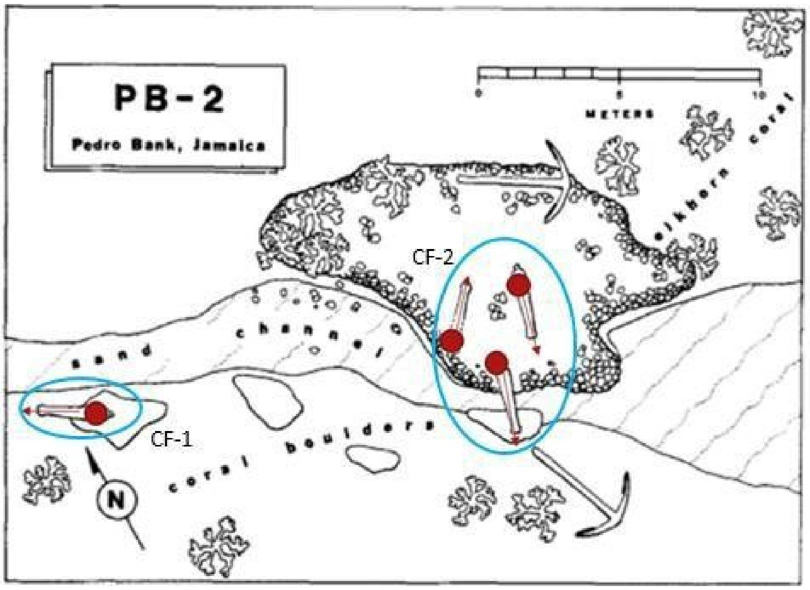


FIGURE 6.10. Map of PB-2 classified by cannon *features* (Hoyt 1984:103). Alterations by the author.

The extracted data from the sitemap was entered into a Google Sheets document (Table 6.5), logging each assigned cannon feature (CF) a number and typology classification: *Cluster*, *Fan*, *Pair*, *Riggs*, and *Stray*. The data confirmed that a total of two cannon *features*: one *Cluster* and one *Stray*.

TABLE 6.5. of PB-2 classified by cannon *features* from sitemap (Author 2018)

	Cluster	*Fan*	*Pair*	*Riggs*	*Stray*	Feature Totals
PB-2: Pedro Bank, Jamaica	**1**				**1**	**2**
Cannon Feature 1					**X**	
Cannon Feature 2	**X**					

Figure 6.11 represents a percentage breakdown of the identified *features*. The breakdown shows that two cannon *features* were identified on the PB-2 site, were 50.0% *Cluster* and 50.0% *Stray*.

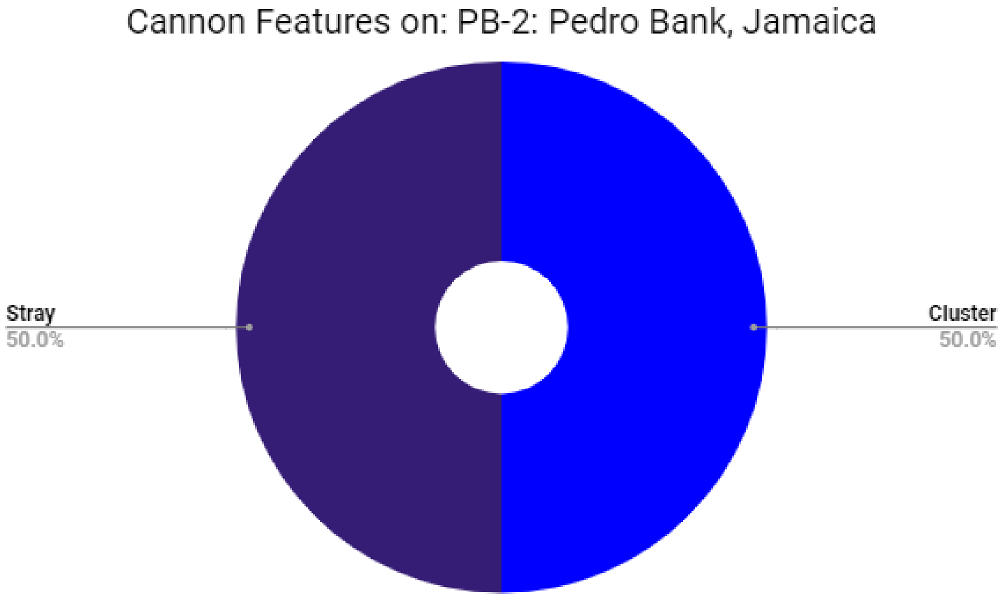


FIGURE 6.11. Pie chart of cannon *features* on PB-2 (Author 2018).

<u>PB-3</u>

The sitemap of PB-3 (Pedro Bank, Jamaica) was sectioned off and labeled (CF-1 and CF-10) by the author (Figure 6.12).

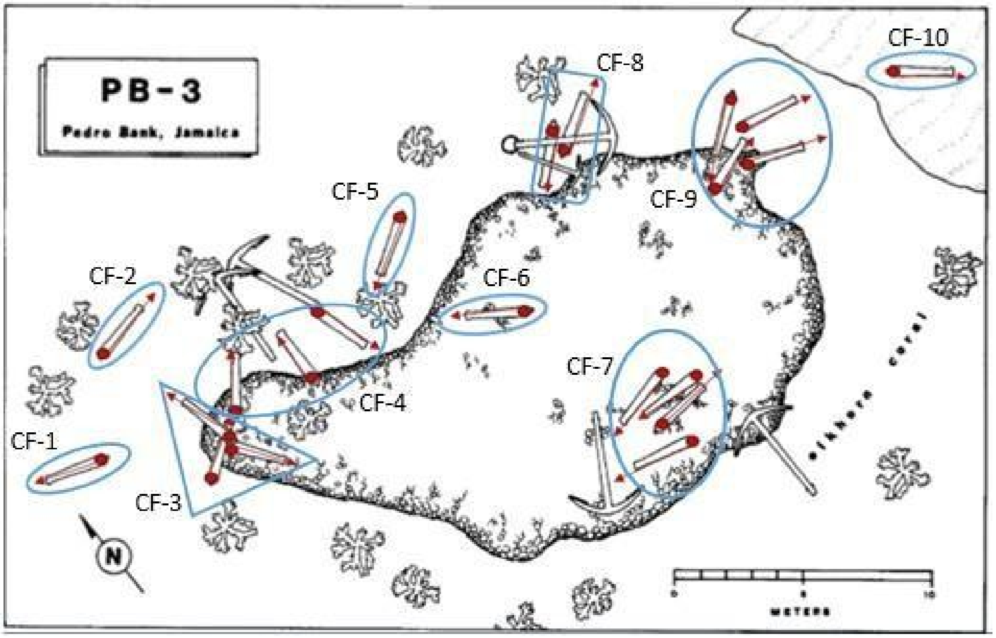


FIGURE 6.12. Map of PB-3 classified by cannon *features* (Hoyt 1984:104). Alterations by the author.

The extracted data from the sitemap was entered into a Google Sheets document (Table 6.6), logging each assigned cannon feature (CF) a number and typology classification: *Cluster*, *Fan*, *Pair*, *Riggs*, and *Stray*. The data confirmed a total of 10 cannon *features*: three *Clusters*, one *Fan*, one *Pair*, and five *Riggs*.

TABLE 6.6. of PB-3 classified by cannon *features* from sitemap (Author 2018).

	Cluster	*Fan*	*Pair*	*Riggs*	*Stray*	**Feature Totals**
PB-3: Pedro Bank, Jamaica	3	1	1	5		10
Cannon Feature 1				X		
Cannon Feature 2				X		
Cannon Feature 3		X				
Cannon Feature 4	X					
Cannon Feature 5				X		
Cannon Feature 6				X		
Cannon Feature 7	X					
Cannon Feature 8			X			
Cannon Feature 9	X					
Cannon Feature 10				X		

Figure 6.13 represents a percentage breakdown of the identified *features*. The results showed 10 cannon *features* were identified on the PB-3 site, were approximately 30.0% *Clusters*, 10.0% *Fan*, 10.0% *Pair*, and 50.0% *Riggs*.

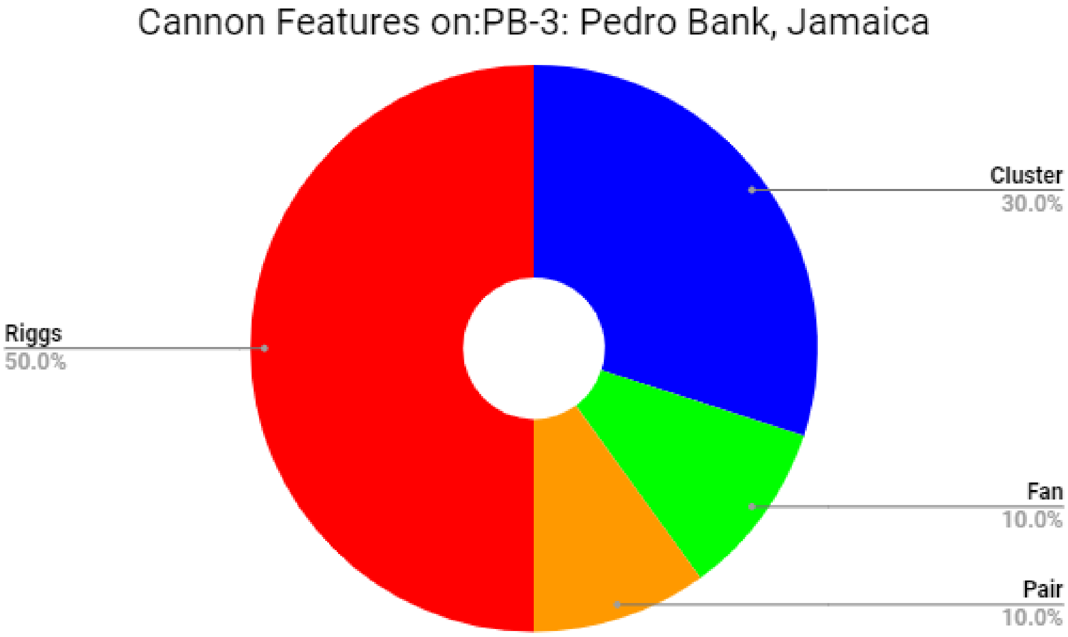


FIGURE 6.13. Pie chart of cannon *features* on PB-3 (Author 2018).

PB-4

The sitemap of PB-4 (Pedro Bank, Jamaica) was sectioned off and labeled (CF-1 and CF-6) by the author (Figure 6.14).

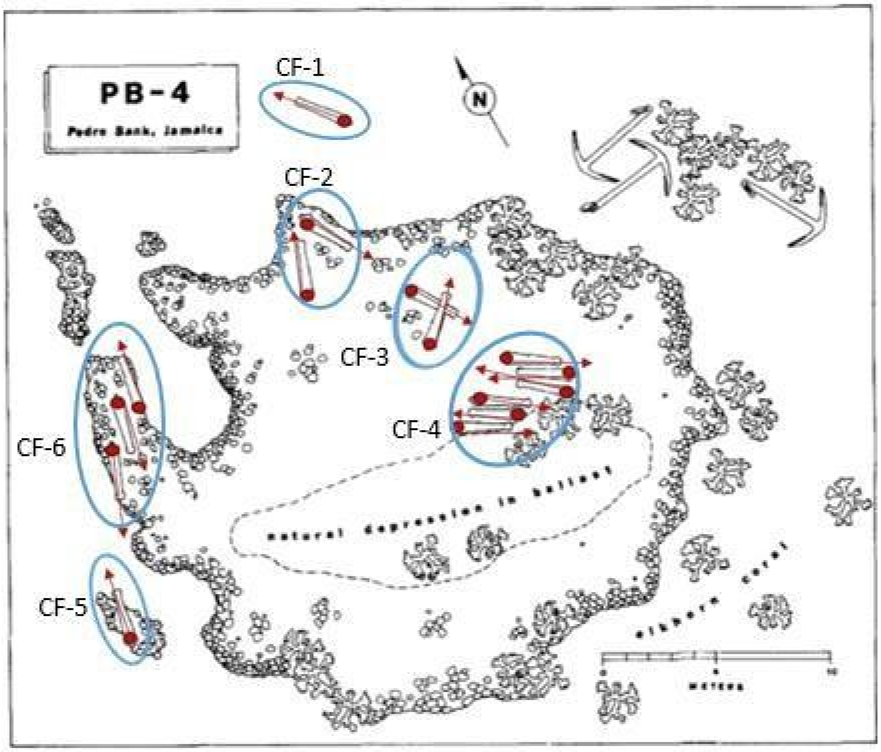


FIGURE 6.14. Map of PB-4 classified by cannon *features* (Hoyt 1984:105). Alterations by the author.

The data extracted from the sitemap was entered into a Google Sheets document (Table 6.7), logging each assigned cannon feature (CF) a number and typology classification: *Cluster*, *Fan*, *Pair*, *Riggs*, and *Stray*. The data confirmed six total cannon *features*: two *Clusters*, one *Fan*, one *Pair*, one *Riggs*, and one *Stray*.

TABLE 6.7. of PB-4 classified by cannon *features* from sitemap (Author 2018).

	Cluster	*Fan*	*Pair*	*Riggs*	*Stray*	**Feature Totals**
PB-4: Pedro Bank, Jamaica	**2**	**1**	**1**	**1**	**1**	**6**
Cannon Feature 1			X			
Cannon Feature 2				X		
Cannon Feature 3		X				
Cannon Feature 4	X					
Cannon Feature 5					X	
Cannon Feature 6	X					

Figure 6.15 represents a percentage breakdown of the identified *features*. The breakdown shows that six cannon *features* were identified on the PB-4 site, 33.3% *Clusters*, 16.7% *Fan*, 16.7% *Pair*, 16.7% *Riggs* and 16.7% *Stray*.

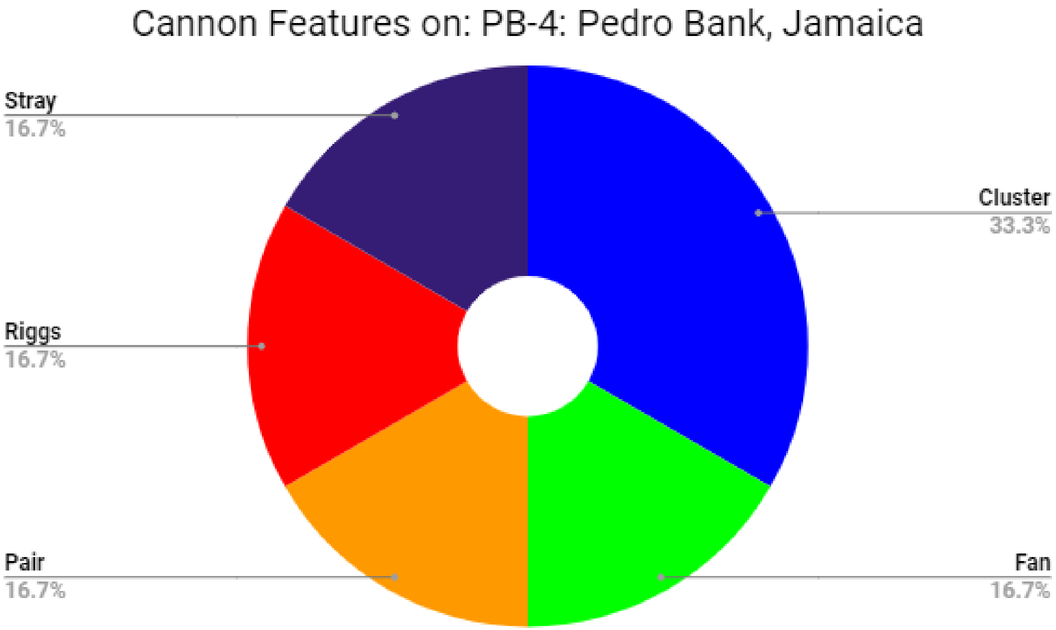


FIGURE 6.15. Pie chart of cannon *features* on PB-4 (Author 2018).

<u>PB-5</u>

The sitemap of PB-5 (Pedro Bank, Jamaica) was sectioned off and labeled (CF-1 and CF-8) by the author (Figure 6.16).

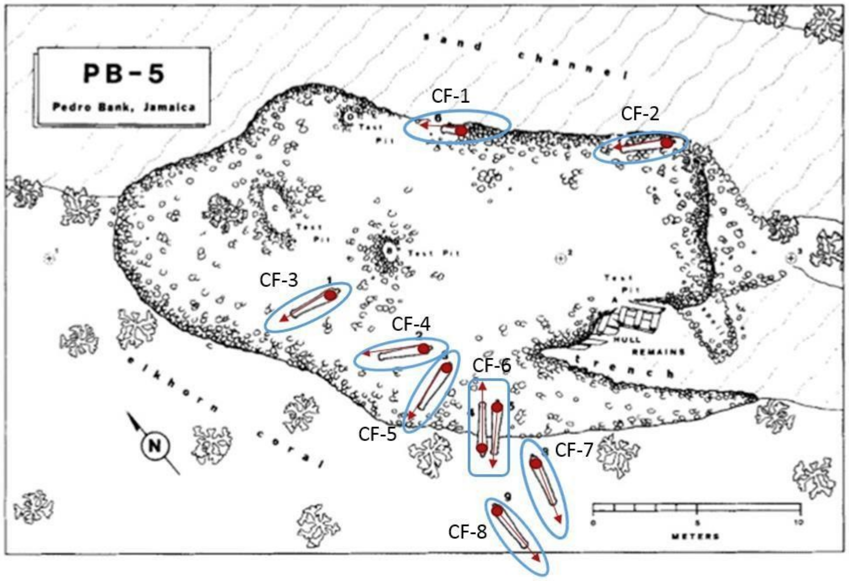


FIGURE 6.16. Map of PB-5 classified by cannon *features* (Hoyt 1984:106). Alterations by the author.

The data extracted from the sitemap was entered into a Google Sheets document (Table 6.8), logging each assigned cannon feature (CF) a number and typology classification: *Cluster*, *Fan*, *Pair*, *Riggs*, and *Stray*. The data confirmed eight total cannon *features*: one *Pair* and seven *Riggs*.

TABLE 6.8. PB-5 classified by cannon *features* from sitemap (Author 2018).

	Cluster	Fan	Pair	Riggs	Stray	Feature Totals
PB-5: Pedro Bank, Jamaica			1	7		8
Cannon Feature 1				X		
Cannon Feature 2				X		
Cannon Feature 3				X		
Cannon Feature 4				X		
Cannon Feature 5				X		
Cannon Feature 6			X			
Cannon Feature 7				X		
Cannon Feature 8				X		

Figure 6.17 represents a percentage breakdown of the identified *features*. The breakdown shows that eight cannon *features* were identified on the PB-5 site were 12.5% *Pair* and 87.5% *Riggs*.

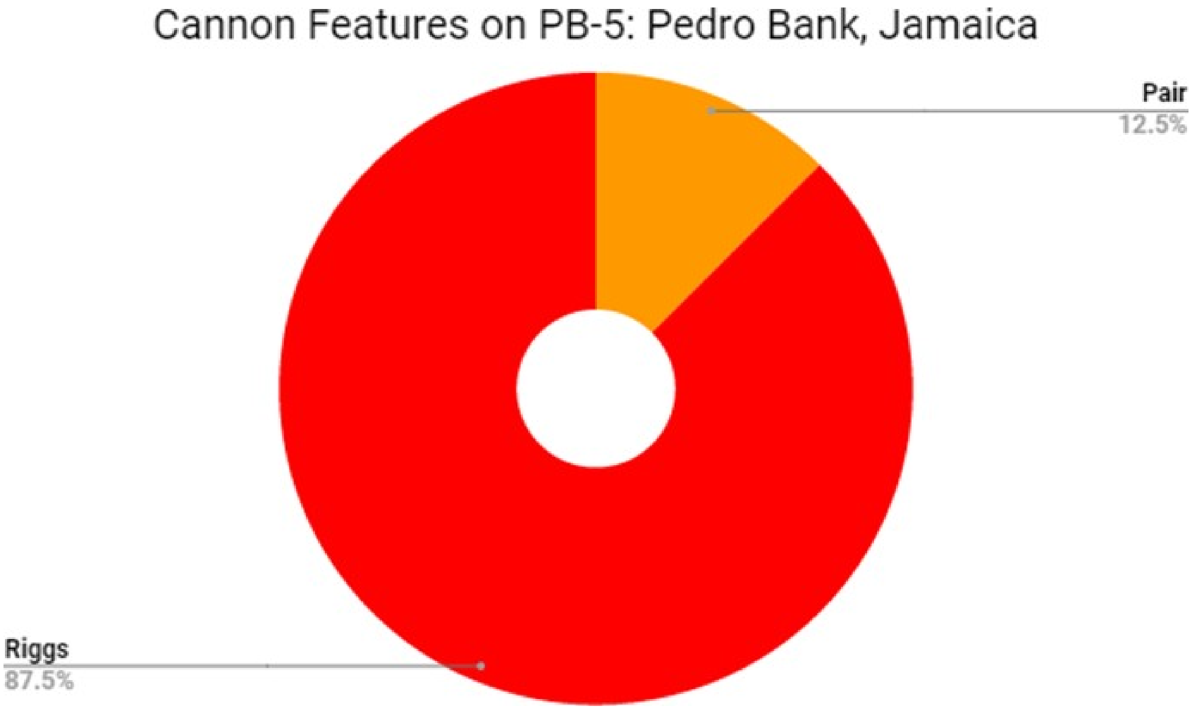


FIGURE 6.17. Pie chart of cannon *features* on PB-5 (Author 2018).

Quedagh Merchant: Dominican Republic

The sitemap of *Quedagh Merchant* (Dominican Republic) was sectioned off and labeled (CF-1 and CF-9) by the author (Figure 6.18).

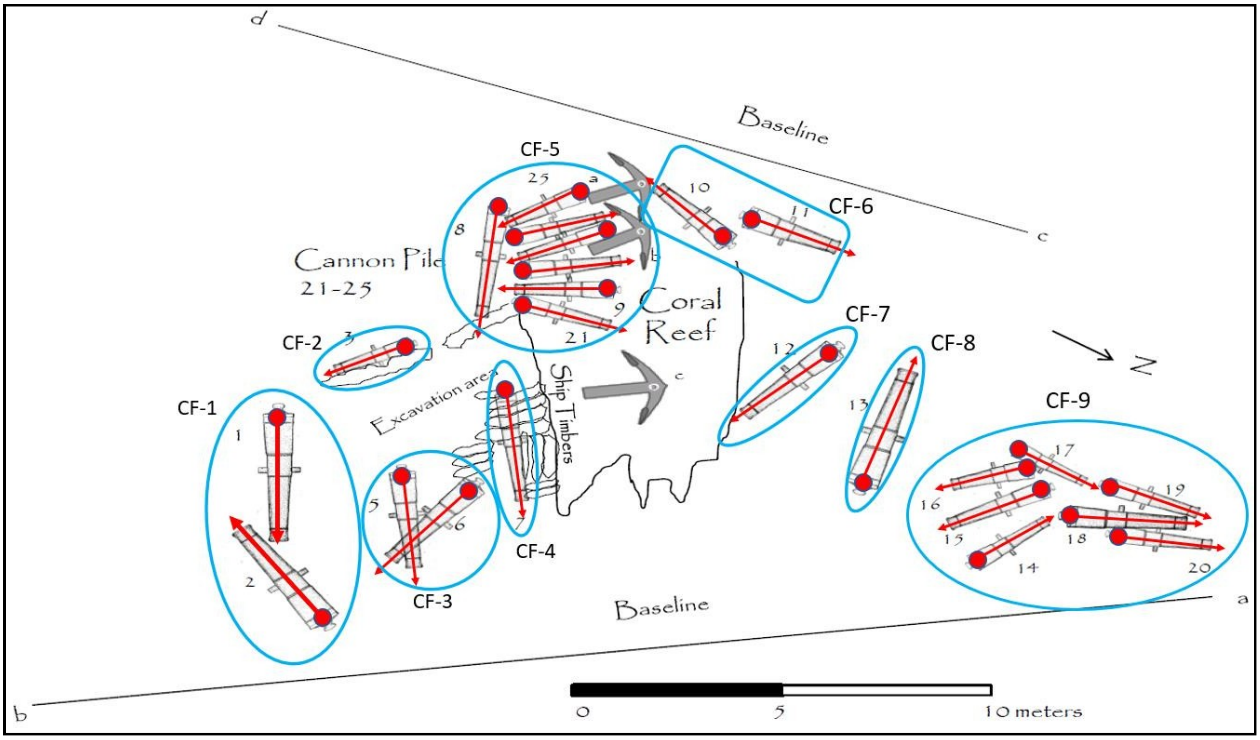


FIGURE 6.18. Map of *Quedagh Merchant* classified by cannon *features* (Harris et al. 2012:39). Alterations by the author.

The data extracted from the sitemap was entered into a Google Sheets document (Table 6.9), logging each assigned cannon feature (CF) a number and typology classification: *Cluster*, *Fan*, *Pair*, *Riggs*, and *Stray*. The data confirmed nine total cannon *features*: two *Clusters*, two *Fans*, one *Pair* and four *Riggs*.

TABLE 6.9. *Quedagh Merchant* classified by cannon *features* from sitemap (Author 2018).

	Cluster	*Fan*	*Pair*	*Riggs*	*Stray*	**Feature Totals**
Quedagh Merchant: Domincan Republic	**2**	**2**	**1**	**4**		**9**
Cannon Feature 1		X				
Cannon Feature 2				X		
Cannon Feature 3		X				
Cannon Feature 4				X		
Cannon Feature 5	X					
Cannon Feature 6			X			
Cannon Feature 7				X		
Cannon Feature 8				X		
Cannon Feature 9	X					

Figure 6.19 represents a percentage breakdown of the identified *features*. The breakdown shows that nine cannon *features* were identified on the *Quedagh Merchant* site: 22.2% *Cluster*, 22.2% *Fan*, 11.1% *Pair*, and 44.4% *Riggs*.

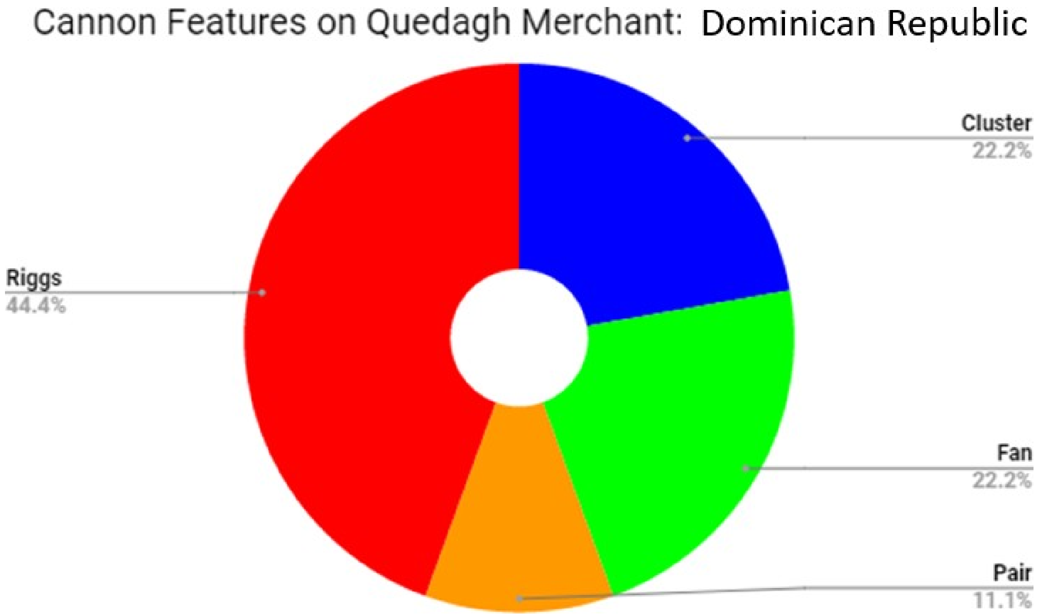


FIGURE 6.19. Pie chart of cannon *features* on *Quedagh Merchant* (Author 2018).

TRB-5: Tobago

The TRB-5 sitemap (Tobago) was sectioned off and labeled (CF-1 and CF-5) by the author (Figure 6.20).

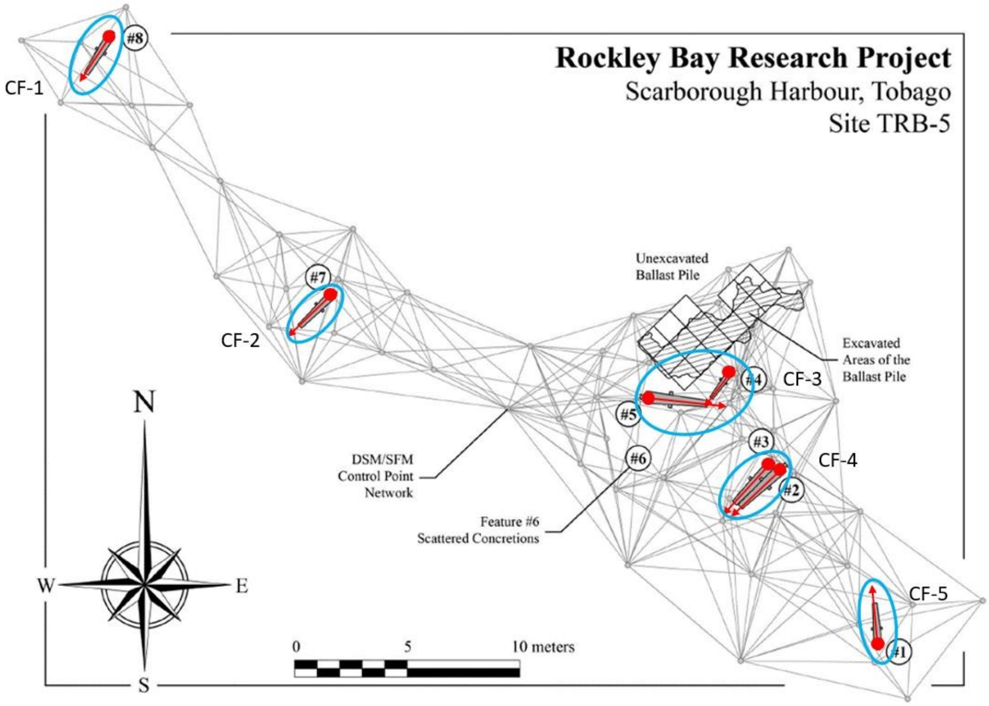


FIGURE 6.20. Map of TRB-5 classified by cannon *features* (Batchvarov 2016:111). Alterations by the author.

The data extracted from the sitemap was entered into a Google Sheets document (Table 6.10), logging each assigned cannon feature (CF) a number and typology classification: *Cluster*, *Fan*, *Pair*, *Riggs*, and *Stray*. There were five confirmed cannon features: one *Fan*, one *Pair* and three *Strays*.

TABLE 6.10. of TRB-5 classified by cannon *features* from sitemap (Author 2018).

	Cluster	*Fan*	*Pair*	*Riggs*	*Stray*	Feature Totals
TRB-5: Tobago		1	1		3	5
Cannon Feature 1					X	
Cannon Feature 2					X	
Cannon Feature 3		X				
Cannon Feature 4			X			
Cannon Feature 5					X	

Figure 6.21 represents a percentage breakdown of the identified *features*. The breakdown shows that nine cannon features were identified on the TRB-5 site: 20.0% *Fan*, 20.0% *Pair*, and 60.0% *Strays*.

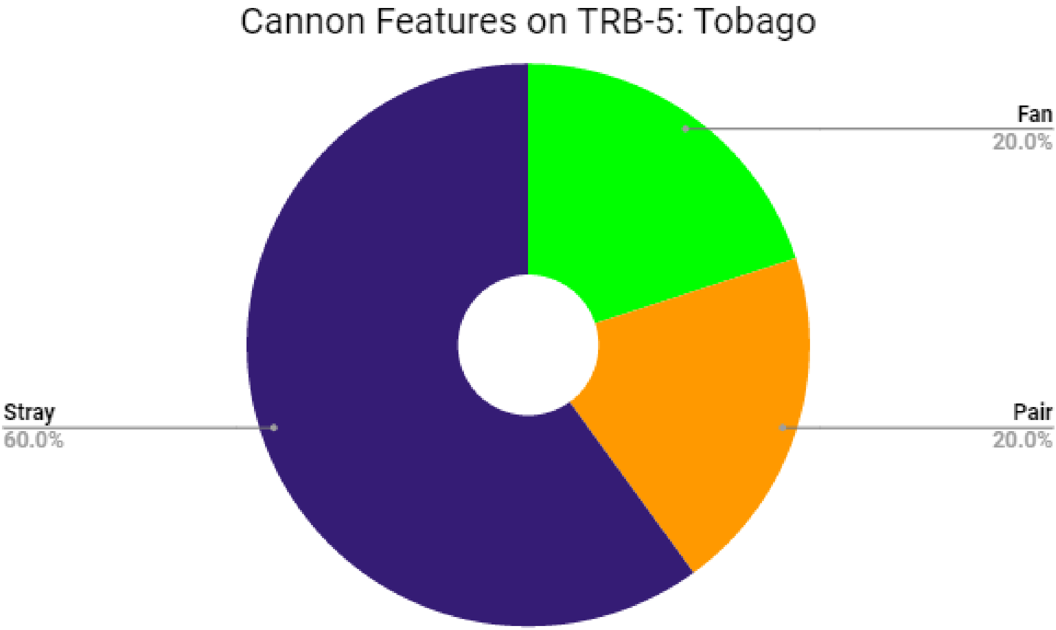
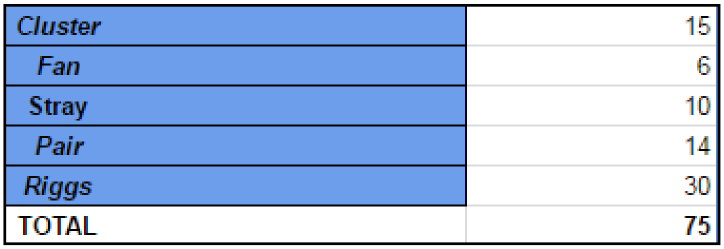


FIGURE 6.21. Pie chart of cannon *features* on TRB-5 (Author 2018).

Total Number of Cannon Features

After the sites were individually analyzed and entered into the database (courtesy of Google Sheets), the author generated data to compare total number of *features* to each site (Table 6.11 and Figure 6.22).

TABLE 6.11. Total cannon *features* classified in this study (Author 2018).



Cluster	15
Fan	6
Stray	10
Pair	14
Riggs	30
TOTAL	**75**

This study identified a total of 75 cannon *features*: 15 *Clusters*, six *Fans*, 10 *Strays*, 14

Pairs, and 30 *Riggs*. The percentage break down of Table 6.11 reflects that of the 75 cannon *features* consisted of: 20.0% *Clusters*, 8.0% *Fans*, 13.3% *Strays*, 18.7% *Pairs*, and 40.0% *Riggs*. Figure 6.22 represents a site by site comparison of the extracted data produced by this study.

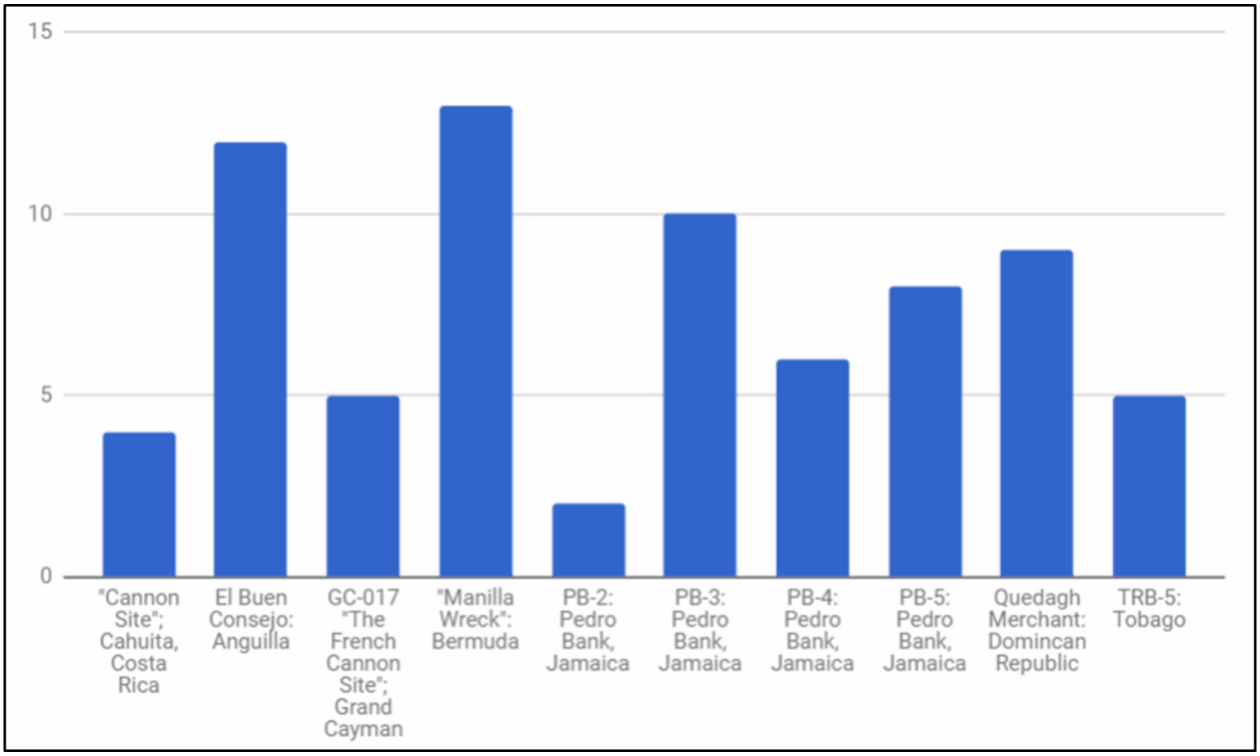


FIGURE 6.22. Bar graph comparing the total number of cannon *features* to each site (Author 2018).

One interpretation is that the archaeological sites which contained higher numbers of cannons, supports earlier archaeological investigations by Karklins (1991) and Leshikar (1993) where the researchers concluded that unsuccessful refloating or salvage attempts could have impacted the cannon signature. Thus, the sites which show lower numbers of cannon features (Figure 6.22) could be interpreted as representing a higher potential of successful refloating or salvage attempts. Further analysis was conducted through broadening the scope of the data to interpret how the cannon *features* and site factors found in Table 5.1 could give further information about the sites.

Analysis

The aim of this study was designed with the intent of discovering whether cannons found on submerged archaeological sites could assist in the interpretation of pre- and post-wrecking processes of vessels. After processing the data extracted from each of the selected case study sites, analyzing the hypotheses of possible multiple wrecking scenarios, and creating a framework connecting the site formation processes of C-Transforms, the researcher determined some evidence supporting and clues that may assist practitioners in interpreting wrecking processes of ships that carried cannons. This is not a universal system for interpreting the wrecking processes of all vessels, but rather establishes a foundation for future research to expand upon.

A challenging part of study of site formations was distinguishing between Cultural Transforms and Non-cultural Transforms before and after the wrecking event. N-Transforms take place the moment the vessel enters the marine environment. This includes materials unsubmerged and still stable on the vessel. For example, the intense salt water washing away paint and other exterior aspects of vessels during travel constitutes an n-transform altering the condition of the object(s). Cannons jettisoned, sold or acquired during the voyage beyond the usual ordnance compliment or compliance could also be misinterpreted in the cannon pattern observed on the seabed. Some assumptions that could be made are that the cannon patterns are not connected to the same wreck/wrecking incident or that jettison occurred over another unrelated shipwreck site.

Variables such as ocean currents, tides, intense hurricanes or other weather, alter the signature of a submerged archaeological site almost instantly. A claim could be made that the longer the material culture is submerged in such environments with lack of protection, the higher risk of scrambling reliable data connecting to the wrecking event. However, an N-Transform may also protect a site from disturbance. For example, rapid burial, coral growth, a protective rock barrier, further offshore. These factors are represented in Table 5.1 and were used in the site analyses to better attempt to understand aspects which preserve the integrity of the cannon positions. Figure 6.23 represents three types of cannon formations (*Trail*, *Crown*, and *Keel-Lane*).

In some instances, *Trail formations* contain *Stray* cannon *features* which lead to a density of artifacts, such as hull remains and artifact assemblages. In two of the case studies used in this research, the *Stray* cannons led to *features* which were sub-categorized as in situ in stowage rather actively utilized on deck. *Features* that could be associated to being in storage include: *Clusters*, *Fans*, *Riggs*, and *Pairs*.

Crown formations contain either or both *Riggs* or *Fan features* lined on a curvature that can be interpreted as lined up after a salvage attempt and abandoned. According to Leshikar, one potential explanation for this cannon arrangement was the result of salvors who removed the cannons and lined them up adjacent to the site (Leshikar 1993:316-317). Another interpretation is that the cannons were submerged beneath the hull of the vessel after it leaned to one side or deteriorated. This would create a separation of a *Riggs* or *Fan* features from the spacing per cannon station on the decks.

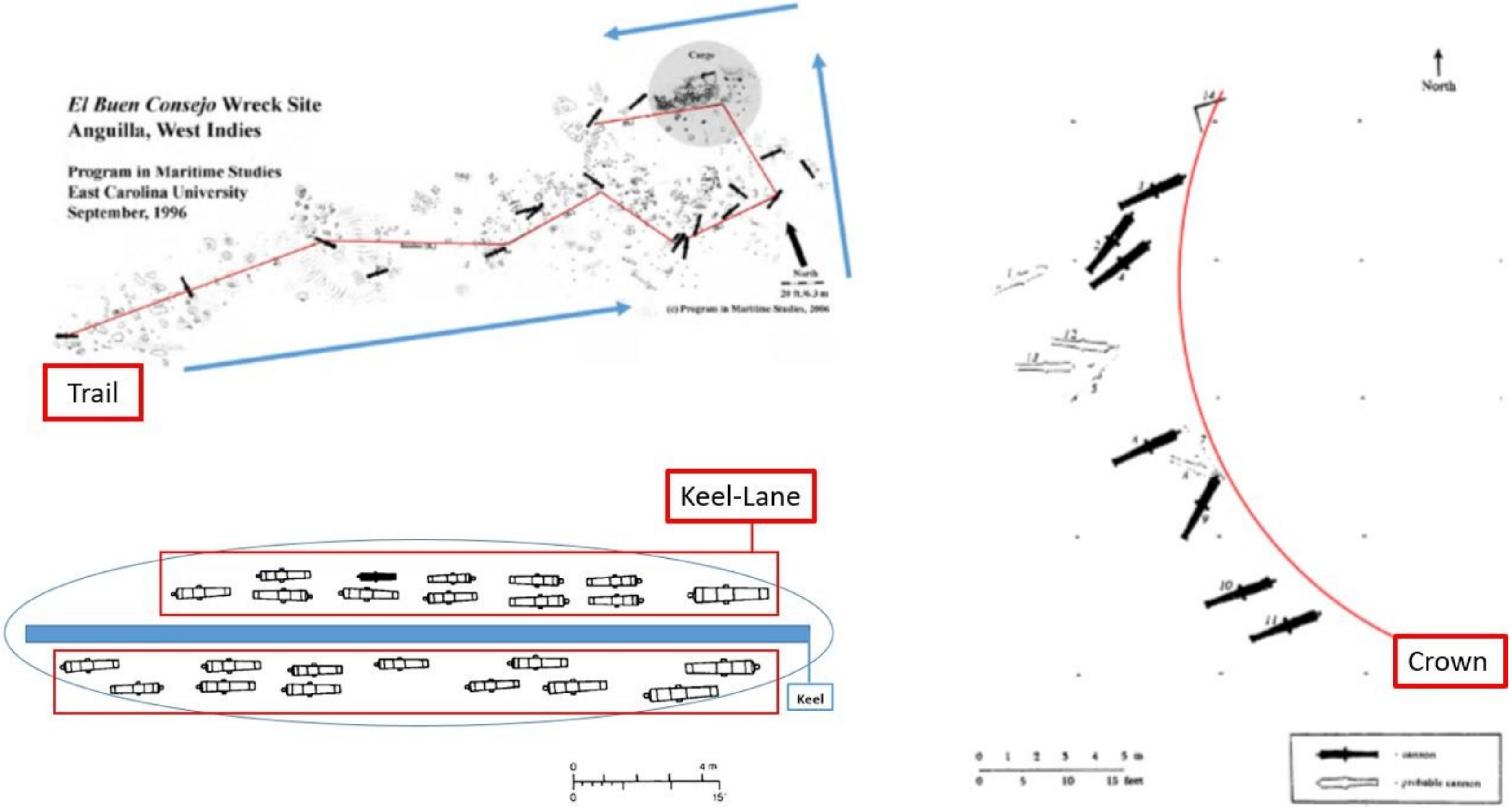


FIGURE 6.23. Sitemaps showing cannon *formations Trail* (*Top Left*), *Crown* (*Right*), and *Keel-Lane* (*Bottom Left*) (Karkins 1991:38; Leshikar 1993:315; Rodgers 2006:15). Alterations by the author.

The *Keel-Lane formation* is unique in comparison to the others in this study. The Manilla Wreck site includes over 10 pairs of cannons, each almost identically spaced. A potential explanation for this *formation* is that the hull of the ship was left, due to the wrecking or intended abandonment by the crew, to deteriorate over time. After the organic components of the hull, such as timbers and planking, were completely gone, the ballast and cannons that were left in the lower hull of the ship were then exposed. The cannon *Pairs* have equal spacing, which could imply that at the time of the wreck the cannons were stored in the lower portion of the hull with the stone ballast. Gibbs (2006:194) reiterates Brad Duncan's research by stating that "…the site of the stranding might be marked by considerable quantities of ballast and other material, which in some instances can look much like the signature of a shipwreck" (Duncan 2006a:218; 2006b:253, 393, 434, 520; Keith 2016:194).

Ballast are weighted objects, typically smooth stones or iron kentledge, were used to help stabilize and ease the ship's motions. The ballast was typically stored in the lower parts of the hull often on both sides of the keelson, which was found to be a successful method (Ollivier and Roberts 1992:167). Master Shipwright for the King of France, Blaise Olliver, published a manuscript titled *Remarks on the Navies of the English & the Dutch from Observations made at their Dockyards in 1737*. Olliver commented about methods of ballast stowage in this document, stating that,

> The English ballast their ships with earth which I believe to be as weighty as our [French] gravel ballast. They stow it in a straight line and parallel to the keel from the main forward bulkhead to the main after bulkhead, and also in a straight line athwartships. They do not use iron kentledge to ballast their ships save for long commissions, and in those ships which have insufficient space in the hold to accommodate earth ballast…The

> iron ballast stiffens all the movements of the ship, especially rolling. The English admit that if iron kentledge did not make the movement so harsh to ballast their ships with kentledge than with gravel or earth, since the weight of the iron is farther removed from the center of motion, and because the weight of the stores stowed atop the ballast is carried lower down (Ollivier and Roberts 1992:167,169).

The method of using iron kentledge to ballast a ship is important for analyzing the *Keel-Lane formation.* The evenly spaced cannon lines support the hypothesis of the Manilla Wreck site were used with stones to help ballast the ship. This concept also supports hypotheses about *Mound* and *Zipper formations* being associated with ballast stowage methods in the ship's hold, explaining how some sites with cannons are found in tidy organized piles and patterns (Blake and Green 1986:10).

The *Mound* and *Zipper* formations provide information linking to the processes of ship breakdown (Figure 6.24).

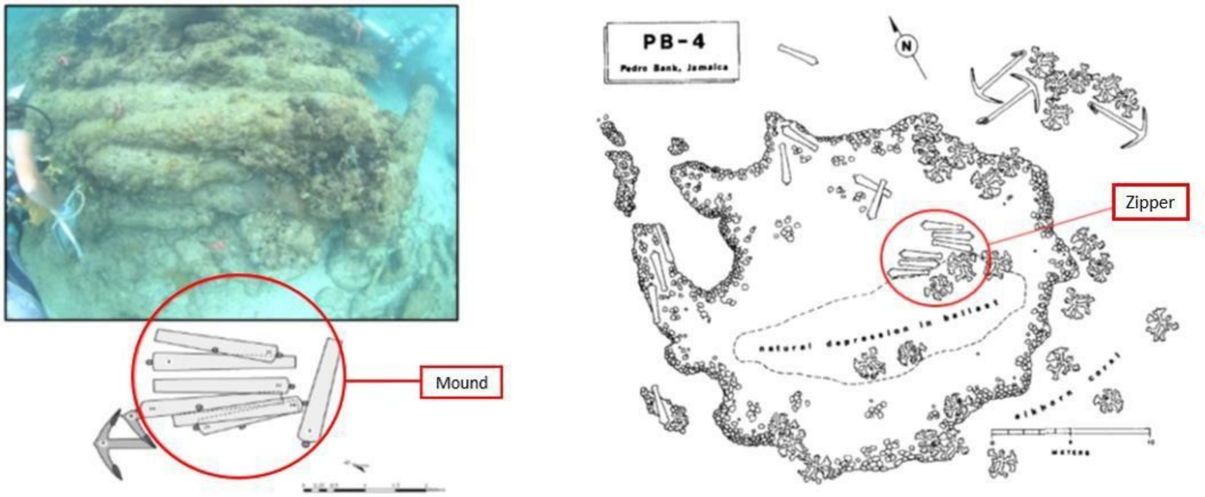
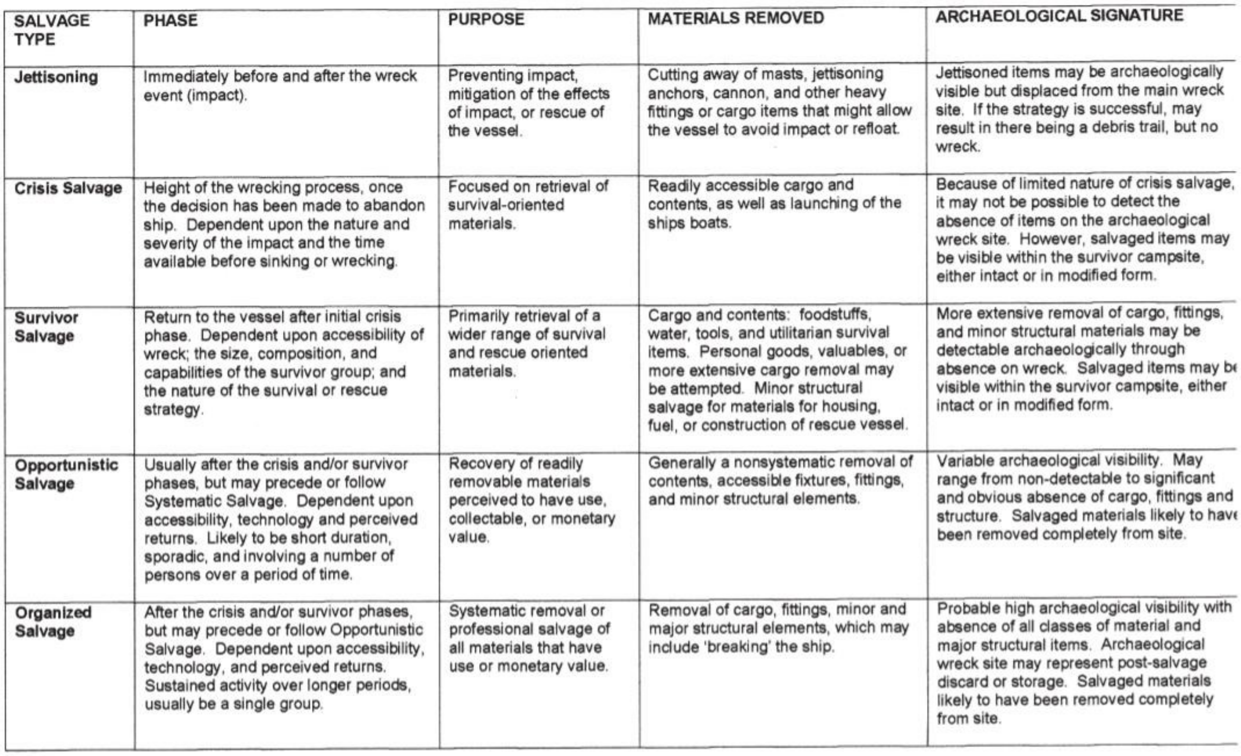


FIGURE 6.24. Site maps showing cannon formations *Mound* (*Left*) and *Zipper* (*Right*) (Harris et al. 2012:39; Hoyt 1984:105). Alterations by the author.

While each *formation* contained larger numbers of storage *features*, they each reflect different interpretations of the site. For example, a *Mound formation* is consistent of cannons located together in a pile, exhibiting a characteristic of height that cannons stacked together. A *Zipper* formation might have the same pattern (cascabel to muzzle, muzzle to cascabel) found on a *Mound*, but lacks the component of pile height, suggesting deliberate stacking (as in the case of the *Quedah Merchant* site; see Harris et al. 2012:39).

In this interpretation, it could be argued that increased height provides the archaeologist with different perspectives of the site formation processes. For example, after a ship is wrecked or abandoned, the ship is likely to lean or fall to either the port or starboard side. If the ship contained materials that were un-salvageable due to being submerged within the lower hull or left with little disturbance, a *Mound* could form once the cannon settled. A *Zipper* might represent similar events as a *Mound* but the cannons of this formation may have fallen over to one side during strong currents, salvage attempts, or decomposition of supporting timbers from the ship's hull. Gibbs classifies five types of salvage (Figure 6.25).

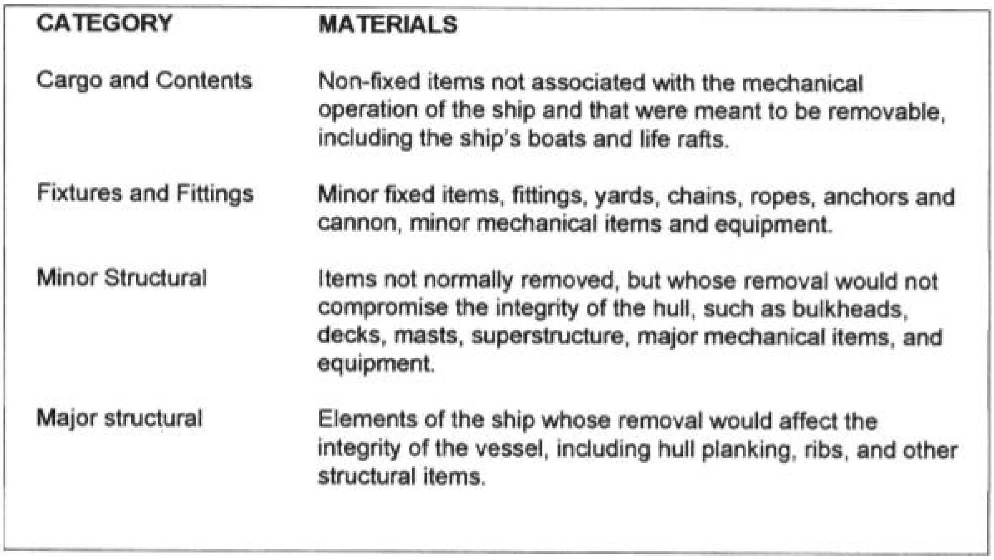


SALVAGE TYPE	PHASE	PURPOSE	MATERIALS REMOVED	ARCHAEOLOGICAL SIGNATURE
Jettisoning	Immediately before and after the wreck event (impact).	Preventing impact, mitigation of the effects of impact, or rescue of the vessel.	Cutting away of masts, jettisoning anchors, cannon, and other heavy fittings or cargo items that might allow the vessel to avoid impact or refloat.	Jettisoned items may be archaeologically visible but displaced from the main wreck site. If the strategy is successful, may result in there being a debris trail, but no wreck.
Crisis Salvage	Height of the wrecking process, once the decision has been made to abandon ship. Dependent upon the nature and severity of the impact and the time available before sinking or wrecking.	Focused on retrieval of survival-oriented materials.	Readily accessible cargo and contents, as well as launching of the ships boats.	Because of limited nature of crisis salvage, it may not be possible to detect the absence of items on the archaeological wreck site. However, salvaged items may be visible within the survivor campsite, either intact or in modified form.
Survivor Salvage	Return to the vessel after initial crisis phase. Dependent upon accessibility of wreck; the size, composition, and capabilities of the survivor group; and the nature of the survival or rescue strategy.	Primarily retrieval of a wider range of survival and rescue oriented materials.	Cargo and contents: foodstuffs, water, tools, and utilitarian survival items. Personal goods, valuables, or more extensive cargo removal may be attempted. Minor structural salvage for materials for housing, fuel, or construction of rescue vessel.	More extensive removal of cargo, fittings, and minor structural materials may be detectable archaeologically through absence on wreck. Salvaged items may be visible within the survivor campsite, either intact or in modified form.
Opportunistic Salvage	Usually after the crisis and/or survivor phases, but may precede or follow Systematic Salvage. Dependent upon accessibility, technology and perceived returns. Likely to be short duration, sporadic, and involving a number of persons over a period of time.	Recovery of readily removable materials perceived to have use, collectable, or monetary value.	Generally a nonsystematic removal of contents, accessible fixtures, fittings, and minor structural elements.	Variable archaeological visibility. May range from non-detectable to significant and obvious absence of cargo, fittings and structure. Salvaged materials likely to have been removed completely from site.
Organized Salvage	After the crisis and/or survivor phases, but may precede or follow Opportunistic Salvage. Dependent upon accessibility, technology, and perceived returns. Sustained activity over longer periods, usually be a single group.	Systematic removal or professional salvage of all materials that have use or monetary value.	Removal of cargo, fittings, minor and major structural elements, which may include 'breaking' the ship.	Probable high archaeological visibility with absence of all classes of material and major structural items. Archaeological wreck site may represent post-salvage discard or storage. Salvaged materials likely to have been removed completely from site.

FIGURE 6.25. Forms of wreck salvage and associated archaeological signatures (Gibbs

2003:140).

The framework presented in Figure 6.25 establishes a potential hierarchy for how cannons and anchors were perceived post shipwrecking. Gibbs also describes the various categories of materials comprising a ship (Figure 6.26).



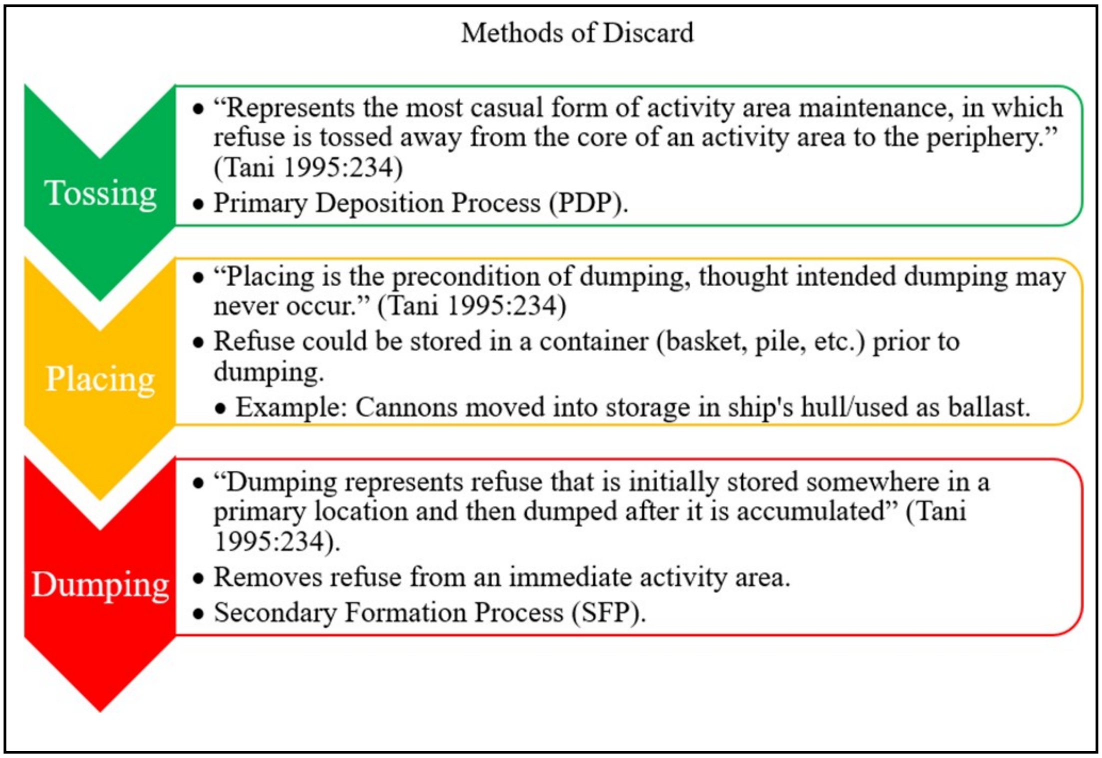
CATEGORY	MATERIALS
Cargo and Contents	Non-fixed items not associated with the mechanical operation of the ship and that were meant to be removable, including the ship's boats and life rafts.
Fixtures and Fittings	Minor fixed items, fittings, yards, chains, ropes, anchors and cannon, minor mechanical items and equipment.
Minor Structural	Items not normally removed, but whose removal would not compromise the integrity of the hull, such as bulkheads, decks, masts, superstructure, major mechanical items, and equipment.
Major structural	Elements of the ship whose removal would affect the integrity of the vessel, including hull planking, ribs, and other structural items.

FIGURE 6.26. Categories of materials comprising a ship (Gibbs 2003:139).

While these categories are not strict and should be noted to contain flexibility in hierarchy, depending on various factors that are likely to change priority by the salvage needs of each shipwrecking event; Gibbs lists the salvage of cannons and anchors under Fixtures and Fittings. He also listed the salvage of Fixtures and Fittings under the term opportunistic salvage, defined in Figure 6.25. Both Figures (6.25 and 6.26) demonstrate that during post wrecking events that cannons, and anchors were not viewed as essentials for survival. However, Figures 6.25 and 6.26 do represent that under more positive circumstances, cannons were salvaged post wrecking events (Gibbs 2003:139).

The research presented by Gibbs and Tani on behavioral archaeology complement one another, even though Tani concentrated on terrestrial sites and Gibbs focused on maritime sites. The definitions presented by Tani (1994) correlate with Gibbs' (2006) flowchart of Cultural

Transforms in Shipwreck Site Formation (Figure 6.28.). For example, Tani’s research supports her theory, which stated “formation processes are not exclusively destructive of behavioral information in the archaeological record but leave behaviorally significant information in the record that can be utilized for behavioral inference (Tani 1995:232).” Tani also added that while not all formation processes connect to aspects of behavior in the archaeological record that cultural formation processes (CFPs) should be analyzed as sets of specific behaviors that alter the state of materials in the systematic and archaeological context (Tani 1995:232). While Tani’s research incorporated terrestrial case studies, the author of this study found that her work complements Gibbs’ (2006) research on C-Transforms associated with shipwreck sites. The definitions for methods of discard (Figure 6.27) show strong similarities to stages from Gibbs’ flowchart of C-Transforms.


Methods of Discard

Tossing
- “Represents the most casual form of activity area maintenance, in which refuse is tossed away from the core of an activity area to the periphery.” (Tani 1995:234)
- Primary Deposition Process (PDP).

Placing
- “Placing is the precondition of dumping, thought intended dumping may never occur.” (Tani 1995:234)
- Refuse could be stored in a container (basket, pile, etc.) prior to dumping.
  - Example: Cannons moved into storage in ship's hull/used as ballast.

Dumping
- “Dumping represents refuse that is initially stored somewhere in a primary location and then dumped after it is accumulated” (Tani 1995:234).
- Removes refuse from an immediate activity area.
- Secondary Formation Process (SFP).

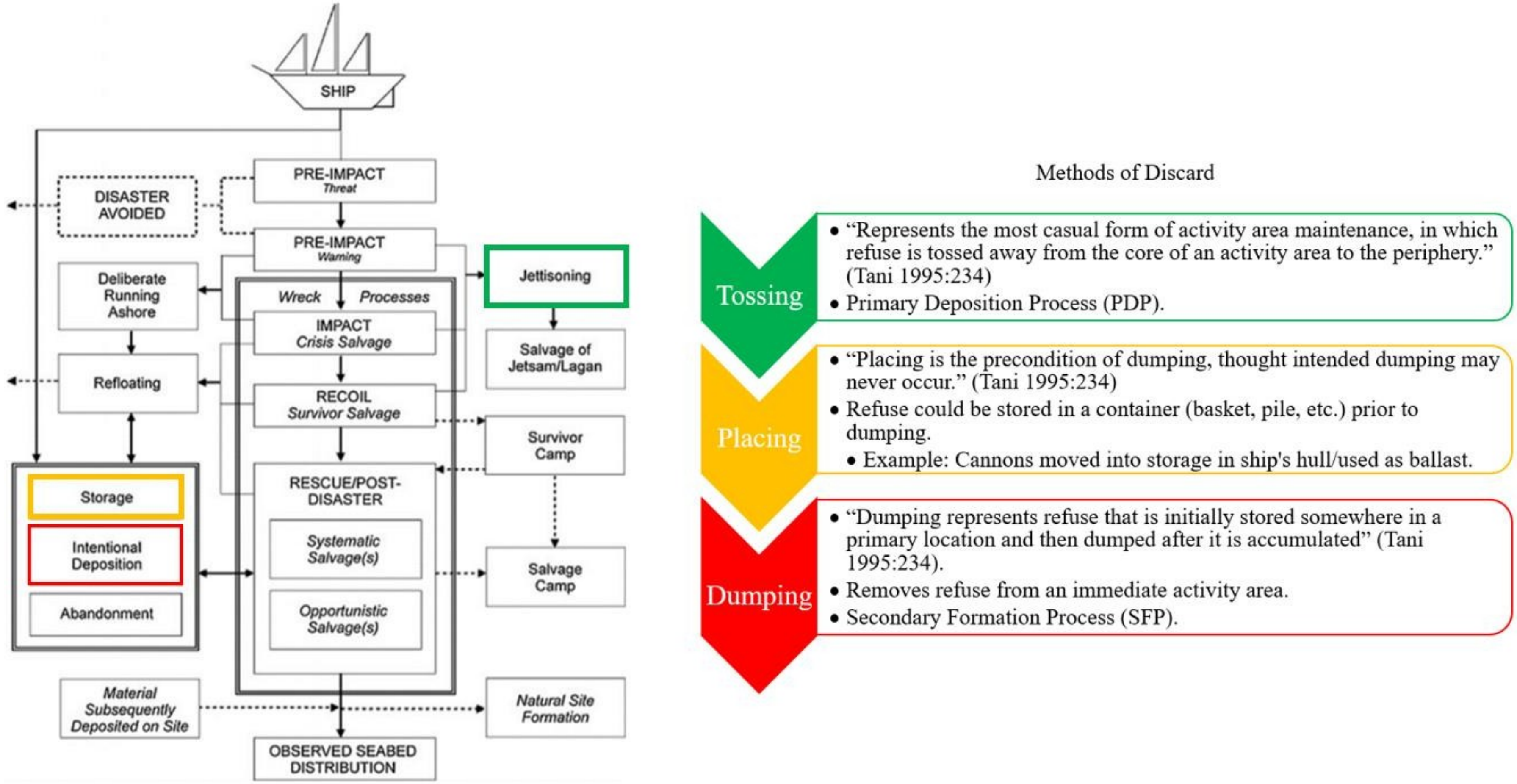
FIGURE 6.27. Methods of discard (Tani 1995:231-236). Alterations by the author.

The different stages of Tani's methods of discard (Primary Depositional Process and Secondary Formation Process) correlate similar to the flowchart, highlighting a timeline of deposition. The author of this study attempted to combine both Figures presented by Gibbs and Tani to link the similarities between the two theories to highlight how each of the sites of this study can identify behavioral characteristics associated with the various stages of shipwreck through the material found in the archaeological record.

For the purpose of this study the author has taken the combined structure of Gibbs' flowchart with Tani's sub-categories defining the various methods of discard to structure the analysis of this study. Figure 6.28 highlights the areas from both Gibbs and Tani where the author cross examined the various case study formation types.

The author incorporated the methods of discard with a color coding to create a timeline. The timeline provided the author with context to better understand where to apply Tani's terms within Gibb's flowchart. The color green indicates Tani's definitions associated with Primary Depositional Processes (PDP), while red represents Secondary Formation Processes (SFP). The color yellow represents steps that could be associated with either process. For this study the author applied these definitions to a separate "limbo" stage between both PDP and SFP.

The author cross analyzed the collected data from each site breakdown with the framework presented in Figure 6.28. This step was critical for evaluating linking characteristics between the behavioral aspects associated with wrecking processes and the cannon *features* and *formations* from the sites. Each site was sorted by the *formation* typologies provided by the author (Table 5.1) and then assigned to a color-coded stage (Figure 6.28).



Methods of Discard

Tossing

- "Represents the most casual form of activity area maintenance, in which refuse is tossed away from the core of an activity area to the periphery." (Tani 1995:234)
- Primary Deposition Process (PDP).

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- "Placing is the precondition of dumping, thought intended dumping may never occur." (Tani 1995:234)
- Refuse could be stored in a container (basket, pile, etc.) prior to dumping.
  - Example: Cannons moved into storage in ship's hull/used as ballast.

Dumping

- "Dumping represents refuse that is initially stored somewhere in a primary location and then dumped after it is accumulated" (Tani 1995:234).
- Removes refuse from an immediate activity area.
- Secondary Formation Process (SFP).

FIGURE 6.28. Cultural site formation factors in shipping mishaps (*Left*) combined with the definitions for methods of discard (*Right*) (Gibbs 2006:183; Tani 1995:231-236). Alterations by the author.

The sites that show characteristics associated with jettison include *El Buen Consejo* and TRB-5. Both sites include *Trail formations*, which have cannons spaced across the entirety of a site. In both cases, based from the position of the cannons, indicating that the cannons which have created a line pointing to the location of any ship remains. This claim would support behavioral methods of jettisoning cannons from the ship, which Tani defined as *Tossing*. Characteristics from these sites include distant spacing of cannons across the site and archaeological evidence or remains at one end of the cannon lines and imply an act of jettison.

While Gibbs and Tani's theories do show similarities, the concept of abandonment is not represented by Tani as a method of discard. The author applied abandonment as a potential process after Tani's dumping stage. The addition of abandonment allows flexibility for explanation of shipwreck remains in addition to the cannon formations found on/across a site. The author believes that sites containing *Mound*, *Zipper,* and *Keel-Lane formations* have the highest probability of linking to Gibb's storage stage (marked in yellow on Figure 6.28). Sites which contained a *Zipper formation* included PB-3 and PB-4. *Quedagh Merchant* contained both *Zipper* and *Mound* formations, while only the Manilla Wreck only contained a *Keel-Lane* formation.

The *Mound* and *Zipper formations* show characteristics of storage positions for cannons, while the *Keel-Lane formation* indicates a ship which had cannons stored low in the ship's hull, potentially as ballast. It should be mentioned that one aspect of this interpretation is that the cannons that are in one of the previously mentioned storage formations could also be associated with abandonment. The reason for this is because, as mentioned by Tani, placement is a prior stage to intentional deposition/dumping, which consequently could also make this a prior stage to ship abandonment in Gibbs' flow chart (Tani 1995:234; Gibbs 2006:183). Sites which contain hull timbers and ballast stones were most likely badly damaged upon the original wreck and were later abandoned if there were survivors.

The French Cannon site contained a *Crown formation*, which displayed cannons across the site along an arch pattern. Each of the cannons' cascabels aligned with the arch. Leshikar presented two hypotheses in her dissertation, one was that the cannons were salvaged and placed intentionally in their locations during an unsuccessful opportunistic salvage attempt, and the other was after the wrecking or abandonment of the ship the hull tilted to one side and the cannons stationed on deck dropped after the supportive hull features decomposed (Leshikar 1993). Until a dendrochronology analysis can be performed on the wood beneath the cannons, it will be challenging to confirm which hypothesis is more accurate. Understanding the type and age of the wood will allow archaeologists to better interpret if the structure under the cannons was from the ship's hull or felled later and used during an opportunistic salvage attempt.

The author notes that during the final analysis of the site formations used in this study, there was no evidence of a formation linked to the intentional deposition or dumping stage. This does not mean that no sites contain the missing characteristics, it simply means that a site with those specific characteristics were not discovered in this study. For example, the hypothetical signature for intentional deposition (see Figure 6.28) might be cannons chained or rope bound together for easy relocation or as a kedging off anchor on a reef or sand shoal in an emergency. It was challenging the researcher to support strong intentional deposition hypotheses for three sites Cannon Site, PB-2, and PB-5. A more convincing hypothesis was that the wrecks were abandoned leaving hull remains or stone ballast located under or in close proximity of the sites.

Conclusion

In summation, the analytical techniques presented in this study presents hypotheses of cannon patterns associated with pre- and post-wrecking processes. Cannons are an invaluable source for maritime archaeologists because these artifact distributions provide insight to the past. While investigations of the historical record were successful in answering questions associated with manufacturer and manufacturing techniques, materials used, there is potential for answering archaeological questions more fully. This study, through the application of new terminologies and hypotheses, might serve as an initial attempt to assist future practitioners in identifying and analyzing distribution patterns or formations of cannon (lines of iron) as signatures of human behavior.

CHAPTER 7: CONCLUSION

Introduction

This study incorporated an analysis of cannon patterns on shipwreck sites of the Caribbean and Bermuda waters with the intention of better understanding whether linking cannon patterns to pre- and post-wrecking processes was possible. The author used archaeological reports for this study which noted multiple cannons on site maps. By using previous work produced by Keith Muckelroy, Michael Schiffer and Martin Gibbs as a guide, the researcher analyzed the cannon patterns and attempted to identify characteristics which potentially link to behavior. This study has shed light on a new perspective for understanding the important role that cannon patterns play in identifying and understanding pre- and post-wrecking processes of shipwreck sites.

The chapters leading to the analysis of the case studies introduced important information that supported this study's conclusions. Chapter One identified the primary and secondary questions of this study, as well as providing an outline. Chapter Two identified the parts of a cannons, as well as a general history of their evolution. This was important to guide the reader in understanding how cannons played an invaluable role during the Age of Sail, thus influencing evolution of ship design, battle positions and stowage patterns. Chapter Three presented the selected case studies and their respective archaeological reports and site histories. Chapter Four established a foundation of previous theoretical research, while Chapter Five provided the methodology used to structure this study. Chapter Six presents the data gathered from the study as well as the author's interpretation of the results.

The application of site formation theory, as formulated by Muckelroy (1975), Schiffer (1976), and Gibbs (2006), to case studies assisted in interpreting a specific type of wreck site signature – a cannon scatter or pile. These cannon sites are prevalent in the archaeological record of the Caribbean and Bermuda, yet there is a paucity of systematic analysis to build a more substantive foundation of archaeological, historical and environmental knowledge. This study was the first step to further expand site formation framework to focus on linking cannon distribution patterns to C-Transforms.

Answering the Primary Research Question

- Is it possible to identify a shipwreck and explain the wrecking process of a ship by the arrangement of cannons on the site?

Maybe, the results from this study were not conclusive enough to establish a definitive answer to this question. The cannon patterns can be linked to some aspects of behavior during the pre- and post-wrecking processes, such as jettison during a dangerous scenario. However, while this information can help archaeologists narrow down potential candidates for shipwreck identities, the cannons would need to possess a unique marking or signature which would directly confirm being associated to a specific ship's identity.

Cannons provide researchers with several avenues of data to assist in narrowing down potential shipwreck identities. Maritime archaeologists and historians can research the make, design, any makers marks and materials to estimate a timeline for dating the artifact and ship. While case studies such as *Quedah Merchant* and *El Buen Consejo* have provided previous researchers with thorough documentation of the associated wrecking events, there are gaps of knowledge that have yet to be confirmed on remaining case studies used in this study (Rodgers 2006; Harris et al. 2012). However, the author's interpretation, based on previous hypotheses included in the site reports, has laid a foundation for more in-depth interpretations and hopeful expansion for future research.

Future researchers should include documentation of the wrecking event, provided through captain's logs or other primary sources, thus creating a timeline of the wrecking processes. From these pre- and post-wrecking processes, the author might then identify various stages from Gibbs' (2006) C-Transform flow chart.

Attempting to interpret cannon patterns with no historical or archaeological evidence or data weakens support for confirmation of such wrecking events. However, the sites which have a range of historical documentation has allowed the creation of useful hypotheses. The author used the identified case studies as general templates for such wrecking events (abandonment and jettison).

Sites without strong documentation still have site maps containing cannon patterns. From these general patterns the author created Table 5.1 to structure the various cannon patterns for interpretation. The patterns were broken into *features* and *formations,* which holds potential for linking to pre- and post- wrecking behaviors. It should be noted that N-Transforms can greatly alter such cannon patterns and have potential to mislead interpretation based solely on cannon patterns.

Cannons are sophisticated artifacts for dating sites and ships. The combination of researching the history of the ship with any records of wrecking, salvage, abandonment provide support for understanding the final processes and conditions of the ship. The archaeological reports of the sites in this study included such sources, which include travel routes, lists of missing ships, records of jettison, salvaging goods, and abandoning the ship. The method used in this study provides structure for linking aspects of behavior to associated stages a wrecking event through the list of cannon pattern typologies (Table 5.1.). The new typologies have created a framework for determining stages of the wrecking processes in cases where simple cannon identification and historic documentation research falls short.

Answering the Secondary Research Questions

- Can the case studies yield historical information on cannon type and original stowing pattern on the ship?

Yes, the case studies have provided historical information on the various types of cannons, which allowed researchers to narrow down potential ships that carried them. Documentation of ordnance stowage procedures, during the Age of Sail, has provided the author with the knowledge used to understand how cannons were stored during various situations. Some examples include attack positions, bad weather, and when being used as ballast and storage.

- Are some patterns representative of methods of cannon used as ballast or stowage?

Yes, some cannon patterns or *formations* can be interpreted to represent methods of cannons being used as ballast or stowage. *Formations* believed to have potential for linking to these methods include *Mound, Keel-Lane, and Zipper.* These *formations* contain a variety of *features*. However, the results of this study indicate that *Pair*, *Fan*, and *Cluster features* show the most potential of linking to methods of cannon ballast or stowage.

The results from this study also support that the case studies do yield historical information on cannon type and original stowing pattern on the ship, and that some patterns can be representative of methods of cannon used as ballast or stowage. The historical record provides a structure for attempting to understand the final condition and orientation of the vessel.

The *features* and *formations* used to structure the analysis of this study were created based from previous hypotheses from the archaeological site reports and historical record.

The author provided information from primary sources associated with cannon storage on ships and emergency procedures used during the Age of Sail. The stowage patterns and procedures recorded in primary sources correlate with the features and formations found on some of the sites in this study.

Future Research

The author, like other researchers, recommends expanding the scope of this research to include systematic environmental assessments, ideally by adding specialists like oceanographers, conservators, coastal biologists, and geologists to a team, who may have more expertise in scientifically interpreting how N-Transforms alter cannon distribution patterns. These assessments should expand beyond descriptive reports and include gathering measurable scientific data sets. This type of study could include a wide range of marine variables such as biological growth and ecosystems, water currents or corrosion of the cannons. Other archaeologists have brought attention to environmental assessments as a critical part of research design (MacLeod and Viduka 2011; Oxley 1998; Simon et al. 2013).

Limitations

The first limitation was that the author did not visit and collect the data first hand for this study, but rather relied on archaeological site reports which were produced over the past 50 years. The various techniques, technologies, and methods used in the earlier studies have evolved. As a result, the sophistication and accuracy of the data provided in the archaeological site maps and reports may vary under comparison. Some examples might include GPS coordinates of site features to create site maps in comparison to baseline surveys.

Another suggestion is to better incorporate a strong understanding of how the surrounding environment might have potentially changed since the time of the wrecking processes, and as a result whether any of these environmental alterations affected the cannons patterns. The final limitation that should be acknowledged is that cannon patterns can be altered by a wider range of C-Transforms and N-Transforms not mentioned or analyzed in this study. The author is hopeful this study will encourage future research to analyze more in-depth studies on how C-Transforms and N-Transforms alter cannon patterns.

Observations

The first observation was there were multiple methods for jettison cannons as opposed to only one. Another unexpected conclusion was the legal processes upheld by insurance companies, which outlined formal procedures under emergency situations for deciding what was to be jettisoned. Both aspects provided valuable insight for the author's interpretation and confirmation of cannon patterns associated with this behavior. One of the most significant findings were the primary sources which focused on jettison procedures (See sources Magens 1755; Anon 1767; Molloy 1769). Although the specific historic documentation for describing the wrecking processes of each case study were not located during the course of this study, the primary sources (such as marine insurances) were used to provide generic hypotheses about jettisoning practices reflected by cannon patterns.

This study incorporated a new method for examining cannon patterns on shipwreck sites by providing a new perspective for understanding stages of wrecking. The typologies introduced in this study as cannon *features* and *formations* (Table 5.1) can be applied for a base template on shipwreck sites with cannons. The typologies can also be used as a foundation for debate or to promote future research on this topic.

This study is valuable for providing a new method of analyzing an aspect of shipwreck sites that holds potential for providing new avenues of information about the behavioral aspects linked to the wreck. Interpreting the context of cannons helps archaeologists and historians uncover more information about the ship’s wrecking timeline, which can help narrow down ship identities when cross examined with historic records and documentation (captain’s logs, marine insurance claims, and journal entries of the passengers or crew). Cannons are the iron lines maritime archaeologist and historians must use to link shipwreck sites to the past.

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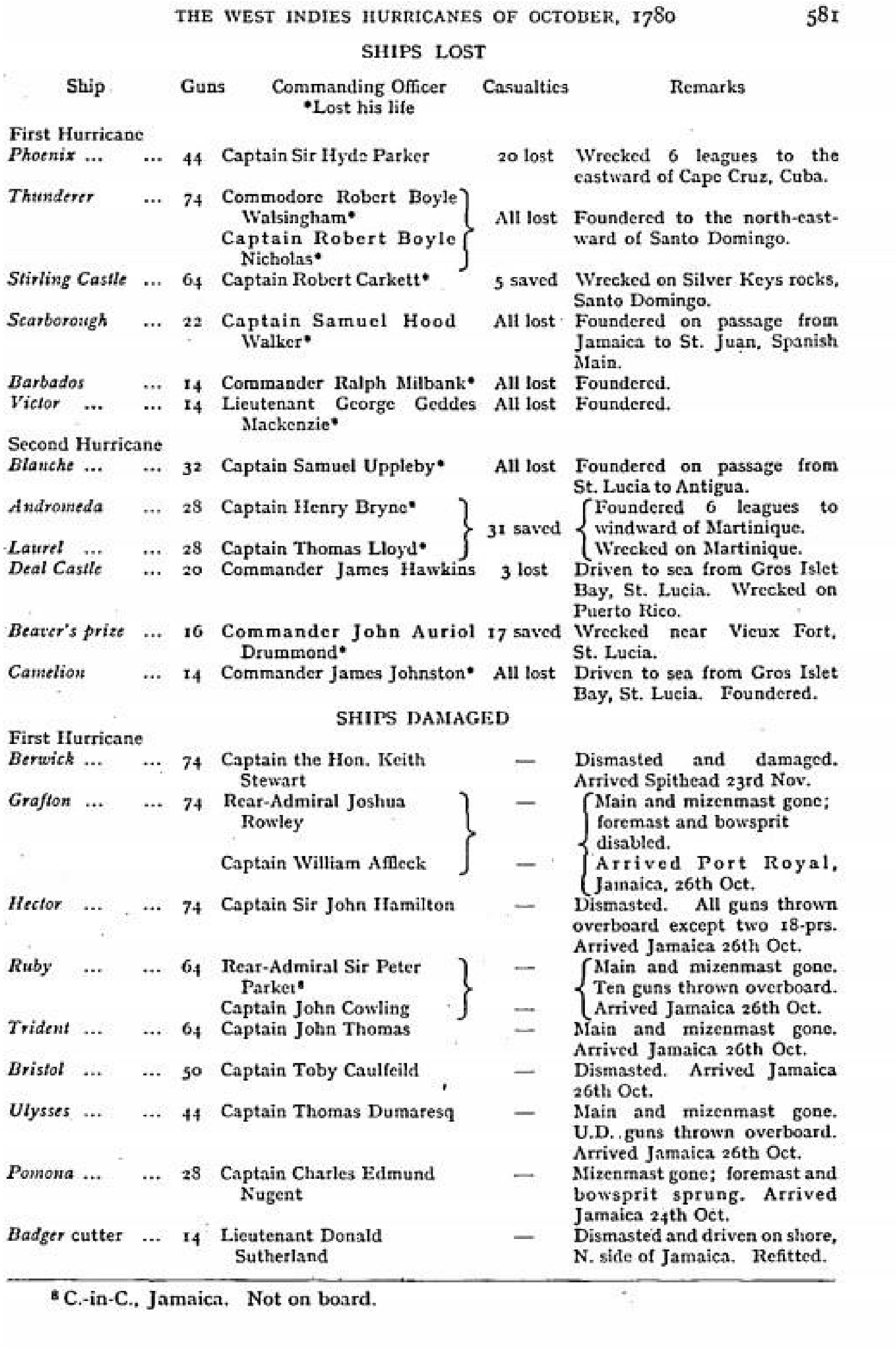
APPENDIX A (page 1 of 2)

Accounts of Jettison



THE WEST INDIES HURRICANES OF OCTOBER, 1780 581

SHIPS LOST

Ship	Guns	Commanding Officer *Lost his life	Casualties	Remarks
First Hurricane				
Phoenix	44	Captain Sir Hyde Parker	20 lost	Wrecked 6 leagues to the eastward of Cape Cruz, Cuba.
Thunderer ...	74	Commodore Robert Boyle Walsingham* Captain Robert Boyle Nicholas*	All lost	Foundered to the north-eastward of Santo Domingo.
Stirling Castle ...	64	Captain Robert Carkett*	5 saved	Wrecked on Silver Keys rocks, Santo Domingo.
Scarborough ...	22	Captain Samuel Hood Walker*	All lost	Foundered on passage from Jamaica to St. Juan, Spanish Main.
Barbados ...	14	Commander Ralph Milbank*	All lost	Foundered.
Victor	14	Lieutenant George Geddes Mackenzie*	All lost	Foundered.
Second Hurricane				
Blanche	32	Captain Samuel Uppleby*	All lost	Foundered on passage from St. Lucia to Antigua.
Andromeda ...	28	Captain Henry Bryne*	31 saved	Foundered 6 leagues to windward of Martinique.
Laurel	28	Captain Thomas Lloyd*		Wrecked on Martinique.
Deal Castle ...	20	Commander James Hawkins	3 lost	Driven to sea from Gros Islet Bay, St. Lucia. Wrecked on Puerto Rico.
Beaver's prize ...	16	Commander John Auriol Drummond*	17 saved	Wrecked near Vieux Fort, St. Lucia.
Camelion ...	14	Commander James Johnston*	All lost	Driven to sea from Gros Islet Bay, St. Lucia. Foundered.

SHIPS DAMAGED

Ship	Guns	Commanding Officer	Casualties	Remarks
First Hurricane				
Berwick	74	Captain the Hon. Keith Stewart	—	Dismasted and damaged. Arrived Spithead 23rd Nov.
Grafton	74	Rear-Admiral Joshua Rowley Captain William Affleck	— —	Main and mizenmast gone; foremast and bowsprit disabled. Arrived Port Royal, Jamaica, 26th Oct.
Hector	74	Captain Sir John Hamilton	—	Dismasted. All guns thrown overboard except two 18-prs. Arrived Jamaica 26th Oct.
Ruby	64	Rear-Admiral Sir Peter Parker[8] Captain John Cowling	— —	Main and mizenmast gone. Ten guns thrown overboard. Arrived Jamaica 26th Oct.
Trident	64	Captain John Thomas	—	Main and mizenmast gone. Arrived Jamaica 26th Oct.
Bristol	50	Captain Toby Caulfeild	—	Dismasted. Arrived Jamaica 26th Oct.
Ulysses	44	Captain Thomas Dumaresq	—	Main and mizenmast gone. U.D. guns thrown overboard. Arrived Jamaica 26th Oct.
Pomona	28	Captain Charles Edmund Nugent	—	Mizenmast gone; foremast and bowsprit sprung. Arrived Jamaica 24th Oct.
Badger cutter ...	14	Lieutenant Donald Sutherland	—	Dismasted and driven on shore, N. side of Jamaica. Refitted.

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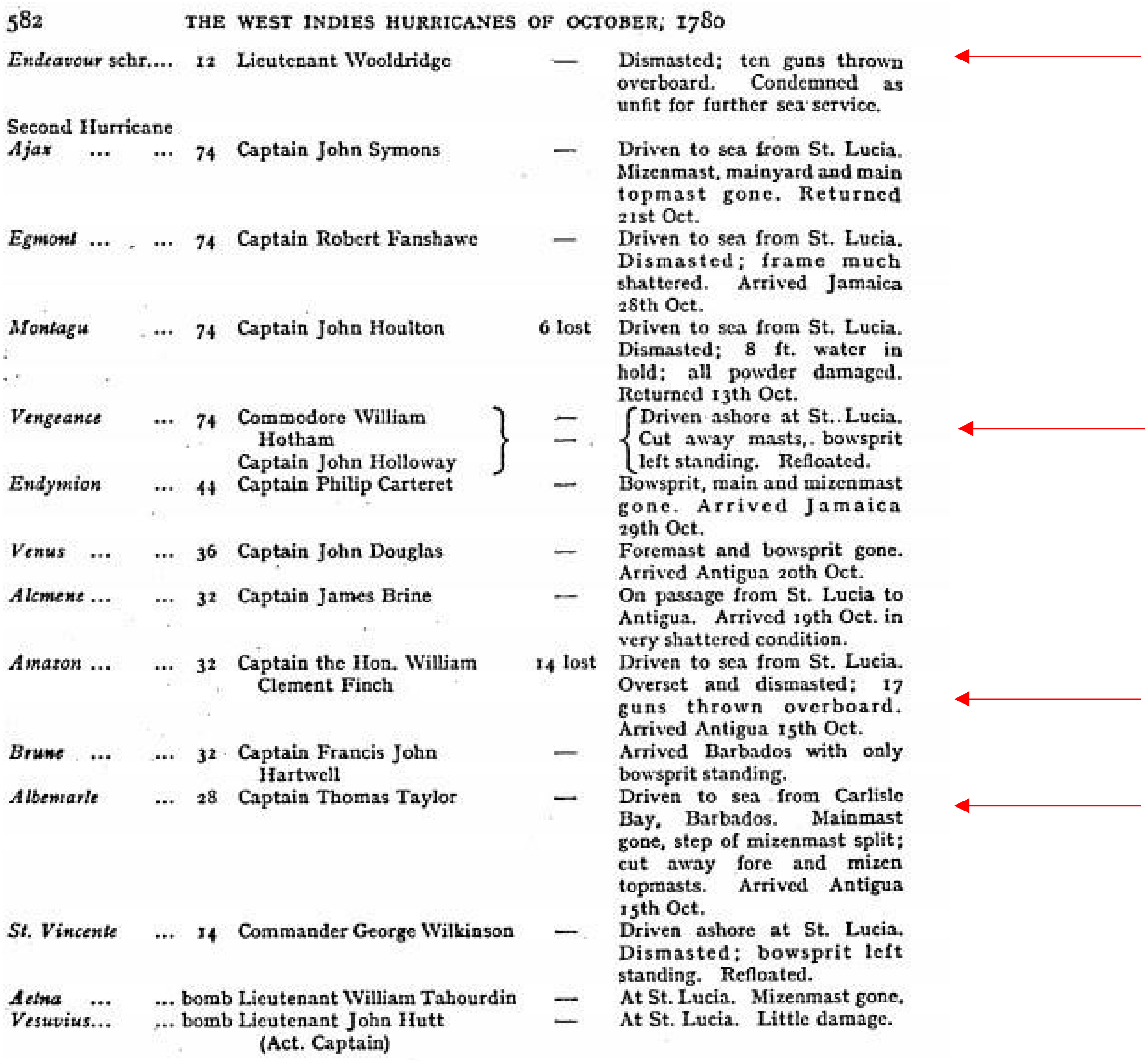
[8] C.-in-C., Jamaica. Not on board.

APPENDIX A (page 2 of 2)



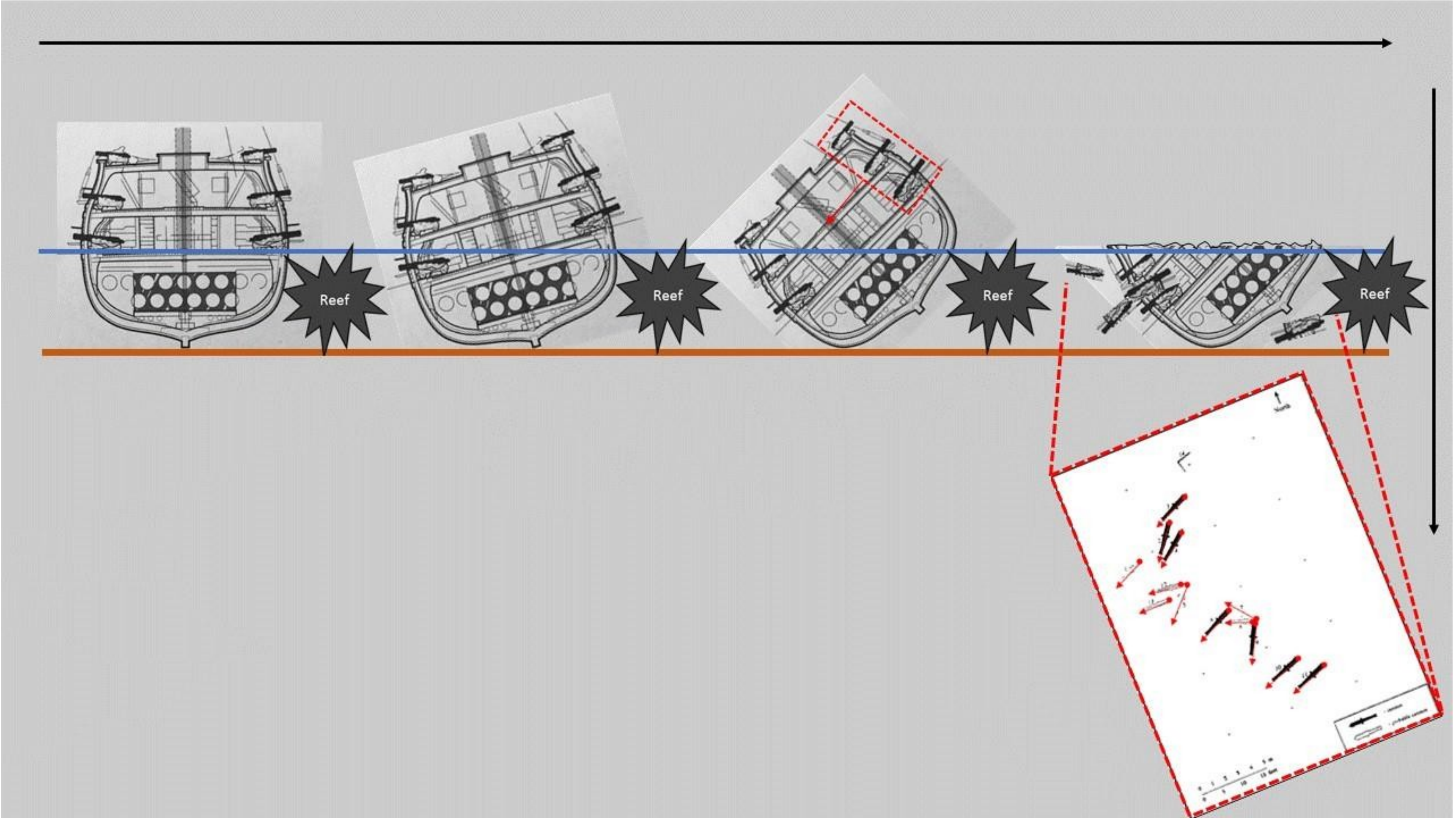
582 THE WEST INDIES HURRICANES OF OCTOBER, 1780

Endeavour schr....	12	Lieutenant Wooldridge	—	Dismasted; ten guns thrown overboard. Condemned as unfit for further sea service.
Second Hurricane				
Ajax	74	Captain John Symons	—	Driven to sea from St. Lucia. Mizenmast, mainyard and main topmast gone. Returned 21st Oct.
Egmont	74	Captain Robert Fanshawe	—	Driven to sea from St. Lucia. Dismasted; frame much shattered. Arrived Jamaica 28th Oct.
Montagu ...	74	Captain John Houlton	6 lost	Driven to sea from St. Lucia. Dismasted; 8 ft. water in hold; all powder damaged. Returned 13th Oct.
Vengeance ...	74	Commodore William Hotham Captain John Holloway	— —	Driven ashore at St. Lucia. Cut away masts, bowsprit left standing. Refloated.
Endymion ...	44	Captain Philip Carteret	—	Bowsprit, main and mizenmast gone. Arrived Jamaica 29th Oct.
Venus	36	Captain John Douglas	—	Foremast and bowsprit gone. Arrived Antigua 20th Oct.
Alcmene	32	Captain James Brine	—	On passage from St. Lucia to Antigua. Arrived 19th Oct. in very shattered condition.
Amazon	32	Captain the Hon. William Clement Finch	14 lost	Driven to sea from St. Lucia. Overset and dismasted; 17 guns thrown overboard. Arrived Antigua 15th Oct.
Brune	32	Captain Francis John Hartwell	—	Arrived Barbados with only bowsprit standing.
Albemarle ...	28	Captain Thomas Taylor	—	Driven to sea from Carlisle Bay, Barbados. Mainmast gone, step of mizenmast split; cut away fore and mizen topmasts. Arrived Antigua 15th Oct.
St. Vincente ...	14	Commander George Wilkinson	—	Driven ashore at St. Lucia. Dismasted; bowsprit left standing. Refloated.
Aetna	bomb	Lieutenant William Tahourdin	—	At St. Lucia. Mizenmast gone.
Vesuvius... ...	bomb	Lieutenant John Hutt (Act. Captain)	—	At St. Lucia. Little damage.

Source:

Rowbotham, W. B.
1961 The West Indies Hurricanes of October, 1780. *Royal United Services Institution. Journal* 106(624). November:573–584. DOI: 10.1080/03071846109420733

APPENDIX B



Flow chart of cannon pattern formations over time (Lavery 2009:134; Leshikar 1993:315). Alterations by the author.